William Hewson (1739-1774) and the Craven Street Anatomy School – Anatomical teaching in the 18th century

William Hewson (1739-1774), (Pastel in collection of the Hewson family, Philadelphia, courtesy of Melissa Hewson)

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Disclaimer

I, Tania Kausmally, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

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Abstract

In 1998 a small excavation, covering less than a cubic meter, was carried out in the basement of Benjamin Franklin house, 36 Craven Street, London. The finds revealed over 3500 dissected human and animal skeletal remains and a number of artefacts (incl. glass, microscopic slides and tubes, ceramics and metal). The finds were linked to the Craven Street anatomy school (1772-1778), founded by anatomist William Hewson. The tight time frame predating the anatomy act of 1832 and the association with a single well documented figure, allows for an unparalleled insight into the organisation of a private anatomy school through archaeological and historical records. It is a rare opportunity to place archaeological findings within a framework wherein it is possible to distinguish individual motivation and action and how these relate to broader tendencies in society. The recent surge in archaeological excavations of anatomy school has enabled Craven Street to be placed into a wider context comparing private anatomy schools to hospital anatomy schools. Patterns of procurement, use and disposal of human and animal remains shed light on the organisation of the school and its social and economic status in society, allowing reflections on the clandestine body trade and vivisections. The archaeological findings revealed at least 28 human individuals (over half were sub-adults) and a minimum of 43 species of animals; mainly cats, dogs and mallards, but also included exotic species such as green turtle. The human bones were testament to body sharing and surgical practice. Some cut marks suggested an experimental approach to making anatomical preparations and techniques applied to Hewson's own research. The animals exhibited limited cut marks, and therefore most likely used for vivisections. The burial environment reflected delayed burial procedures, with gnawing marks present on the bones, as well as casual disposal techniques reflecting the removal of the person and objectification of the body at the point of disposal.

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1 Introduction

Craven Street anatomy school was active from 1772 to 1778. The characters related to the school, including its founder William Hewson are well documented in the historical record and yet we know very little about the school itself due to a distinct absence of information relating to these private enterprises. In 1998 a very small excavation removing a mere cubic meter of deposits, was carried out in the basement of 36 Craven Street (Then number 27) (Figure 1), the premises in which the school is believed to have existed. Craven Street lies immediately north of the river Thames, adjacent to the Charing Cross station (Then Hungerford market), the Strand, London. The excavation was extremely dense and revealed well over 3500 fragments of human and animal bones as well as a series of artefacts, such as pottery, metal and glass, including a number of microscopic slides and tubes. By investigating the historical records, a number of artefacts and animal remains could be confidently linked to the founder of the school, William Hewson. The tight time frame of only six years and the association with a specific school and historical character makes this excavation unique. The archaeological investigations provide great opportunity to open up an enquiry into the anatomy school following a multidisciplinary approach, amalgamating the historical and archaeological evidence from the school and its founder.

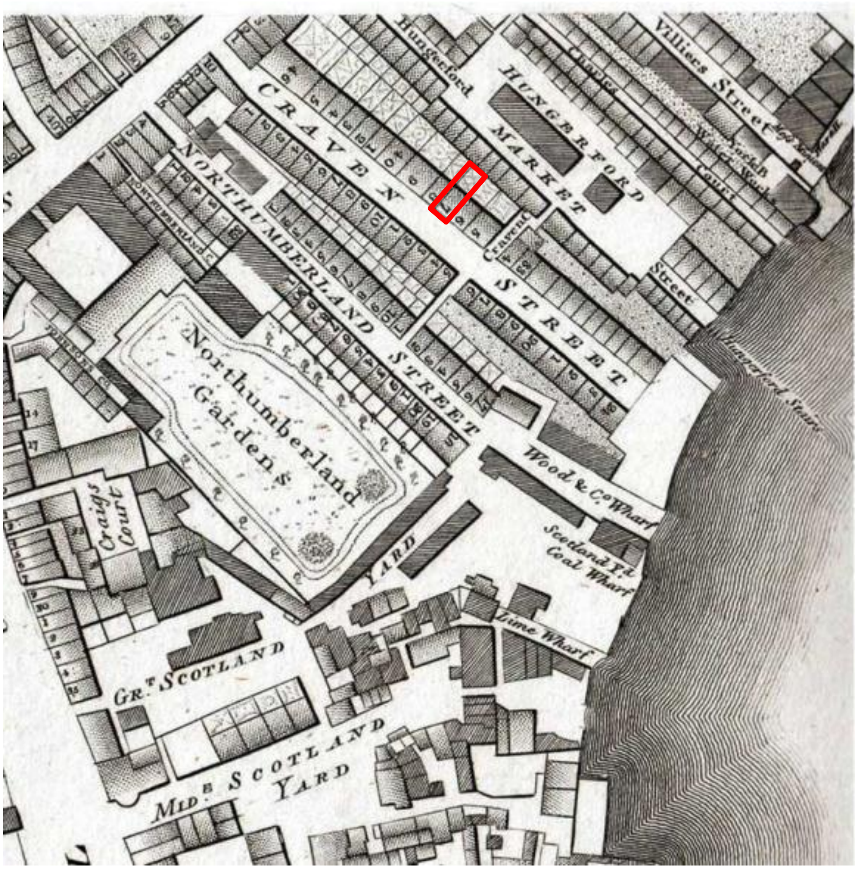


Figure 1 Location of 27 Craven Street in eighteenth century London (Map by Richard Horwood 1792-9)

This thesis is not about the people buried in the basement of Craven Street but the people who placed them there. The aim is not to highlight the social inequalities of dissection but about understanding the environment in which medical schools, like Craven Street anatomy school, operated and the methods applied to medical education in London in the latter half of the eighteenth century. It is the aim of this thesis to investigate the organisation of the school by scrutinising the evidence of procurement, use and disposal of human and animals at the school and how these relate to the historical evidence on William Hewson himself.

1.1 Frameworks in post medieval archaeology

The aim of this section is to explore the state of post medieval archaeology in Britain and the application of theoretical frameworks to this period, offering a discussion on the validity of theoretical methods to post medieval archaeology and how in particular "agency" may be relevant to this thesis. This leads onto a discussion of the application theoretical frameworks in osteology, and the role of osteology within archaeology itself. Finally the interplay between archaeology and history is explored and how these two disciplines may be united in their common goal of enlightening us on the past.

Post medieval archaeology is considered a well-established discipline in UK. With developer funded excavations there has been and exponential increase in excavations relating particularly to the eighteenth and nineteenth centuries (Courtney, 2009:169). In London in particular the number of excavations containing human remains from this period has exploded in the last couple of decades. Yet it is evident that this period still faces an identity crisis, with the definition of the period still open to questioning. Orser (1996) differentiates "historical archaeology" in America and "post medieval archaeology" in Europe, by stating that the former is related to the development of the new world and the latter to the continuation of the old world, yet they are fundamentally the same. The timeframe is equally unclear, whilst the majority agree the period commences in the late fifteenth century early sixteenth century in Europe, the end date is by seen some to be the onset of the industrial revolution in 1750, while others believe it persists to the present day. For the purpose of this thesis the term post medieval archaeology has been adopted following the Museum of London Archaeology (MOLA) period definition of 1500 to present day (Museum of London, 2002).

A theoretical framework in archaeology has been progressively developed since the Second World War, these have been predominantly applied to prehistoric societies but are none the less equally relevant in a post medieval context. One of the early introductions to the debate of social interpretation in archaeology was the construct of Hawkes' ladder of inference (c.1954). This implied a progression of increased level of difficulty in interpretation of material culture, subsistence economy, communal organisation and spiritual life (Martinón-Torres, 2008:17). But it was felt this this lacked any theoretical grounding (Evans, 1998). It was felt that the traditional archaeological focus on the chronological classification of objects, excluded the notion of material culture being an active and dynamic process (Hodder, 1986; West, 1999:5). Traditional archaeology was therefore rejected by the introduction of processual archaeology, which emphasised the anthropological approach of answering questions about humans and society as a larger unit through scientific research (Shanks & Tilley, 1987:61). This evolved to include thoughts on more abstract ideologies of past communities and religion, investigating the root of the changes in society (Renfrew, 1987). There have since been a great number of different theoretical frameworks in archaeology, each presenting as many different interpretations as there are people using them. These include but are not limited to; Marxism, phenomenological theory, feminism, cultural materialism and agency. Marxist archaeology became well established in the UK through works by Australian archaeologist V. Gordon Childe, who took inspiration from archaeologists in the Soviet Union of the early twentieth century. The framework essentially focuses on the way people lived and worked in the past believing that society principally evolved through economic means. Effectively, societies should be examined as having a materialistic basis where changes in society are instigated by class struggles (Harris, 1994). This concept that societies were largely formed through class struggles is interesting in the context of scientific advancement, where Lawrence (1996) and Chaplin (2009) suggested that upward mobility was one of the main instigators of the growth of anatomy schools in London. Cultural materialism is an interesting theory initiated in by Marvin Harris in 1968 and 1979, inspired by Marx and Engel he stated that human life is a response to the practical problems of earthly existence and infrastructure was almost in all circumstances the most significant force behind the evolution of culture. As in early Marxist thought, material changes such as technology or environment are seen as largely determining patterns of social organisation and ideology (Harris, 2001). This appears to be a broad concept well adaptable to archaeology as it through materiality we endeavour to understand society. Certainly the industrial revolution and the development of medical research was highly dependent on technological advancements and driven by population shifts. Phenomenological theory is largely concerned with how people interact with the landscape in a sensory fashion. This was inspired by Tilley (2010) who claimed archaeologist failed to acknowledge the impact of sight, smell and hearing in the use of the landscape. It is a thought-provoking concept that would be interesting to apply to the urban context of post medieval London, where all too often we fail to consider how sensory experiences impacted on the manner in which society was formed and how people lived. This is the case, despite the fact the historical literature often emphasises these experiences in the context of the formation of London (Fielding, 1776). Within medical teaching "sensory" impacts of dissection has been addressed (Clare, 1779:20; Lassek, 1958:139), and this would have had substantial influence in the manner in which the schools were formed both architecturally and geographically. Feminist theory is as relevant to the eighteenth century as to any other historical period, and offers a theoretical framework with important considerations. Though strongly gender orientated it also explores concepts of race and class, highlighting the more "invisible" members of society. Feminism also strongly critiques the uncritical manner in which we apply modern western norms and values to past societies (a notion supported by a number of theoretical frameworks) (Preucel and Chesson, 1994). Eighteenth century medical research in London has been presented in a very "white male" orientated fashion due to its key figures in a historical context, as well as the more far-reaching structural advantages men have over women. This theoretical framework reminds us to consider the "less visible", and not automatically allocate gender to material culture, such as domestic refuse is from women and building waste from men. In post medieval archaeology we may gain exceptional insight into how women were influential in a male dominated world. Though many were not the primary figures of pivotal points in history, it is important to consider their role as actors in a larger social network. It has been suggested by a number of scholars that archaeological theoretical frameworks tend to omit the appreciation of human action/motivation and interaction in the quest for greater understanding of social and cultural structures of the past (Dornan, 2002; Gardener, 2004; Fowler, 2004). It is interesting to address this idea in more detail in the context of this thesis, given the nature of the historical and archaeological material and its close association with specific persons and events in history. This concept is less concerned with the political and social agendas of society and more about the appreciation of how people influenced and shaped society through their actions. It is however important to appreciate that this cannot be viewed in total isolation from other theoretical concepts, as I have demonstrated above, they all have an important message to convey in relation to interpretation of medical teaching in the eighteenth century. In the last two decades the notion of "agency" has become an integral part of theoretical frameworks in archaeology, based on theories developed predominantly by Giddens (1976) and Bourdoir (1977). "Agency" has been defined as "the actions of individuals and the consequences of these actions on society" or Barrett (2012:152) recently defined human agency as "Discoverer of what the world can reveal". This term as used in archaeology is strongly linked to "structuration", meaning the attempt to unite the individual with a social structure (Gardener, 2004:2). The concept of "Society" has been widely debated amongst theoretical scholar questioning the position of "agency" within this structure (Giddens, 1979; Giddens, 1984; Hodder, 1982). It is the movement away from processual archaeology of the 1960s, which was largely interested in units larger than one individual (Shanks & Tilley, 1987:61) to a more holistic approach, looking to include the individual into the interpretative equation of social structure (Hodder, 1986:5). It has since been widely debated what this actually means and whether it is even possible to make these consideration in an archaeological context (Dobres & Robb, 2000:10; Dornan, 2002).

Barrett (2012:158) expressed concern about the widespread misinterpretations of "agency" being equal to "individual motivation", and that "agency" in fact is the recognition of the role of human action in creating society. In other words it is not about the individual as such, but recognising human cognitive and biological behaviour through material culture.

It has been questioned how this may be recognised in the archaeological record. In the end it boils down to an approach that is non-exclusive. Dornan (2002:325) argued that we must attempt to provide the broadest possible context based on multiple sources of data and incorporate as many "spheres" (Economic, legal, social, domestic, religious, funerary etc.) in life as possible in order to generate true experiences of self. It appears that in any theoretical framework the practical considerations of how material culture may actually support any of these ideas is more elusive and confined to case studies rather than overall practical considerations on the subject, and how indeed archaeologist are so dependent on material remains that we cannot imagine "culture" without the presence of material artefacts (Barrett 2012:163). Previously Barrett (2000:24) argued that material culture is the physical condition of social life and "agency" is automatically inherent in the material. Bell (1992) argued that it was not possible to ascertain motive in the actions of human agency from the past, through material culture alone and therefore more prudent to establish collective activities/generic traits rather than individual actions. Hodder felt "agency" in archaeology was void of subjectivity and self (Hodder 2000:25). His approach to "agency" was criticised by Dornan (2002), who stated that inclusion of specific individuals was extremely limiting archaeologically and negated the option of moving beyond the "top-down" model. Dornan (2002) did however agree with his notion of the necessity of tying "micro-processes" (individual) to "macro-processes (social structure) and conceded that this is entirely possible with the presence of archival or ethnographic data. Maybe Hodder (2000) felt "agency" in its broader sense was too dependent of predictable patterns in the action of the individual in society? This appears to be what Brück suggested (2001:655), if people are constituted through their bonds with others, then they would never be able to be considered "free agents" as their actions would always depend on the social construct of society. Barrett's argument (2012) that human agency was confused with individual actions, holds strong in these statements. It is inevitable that an abstract concept such as "human agency" is open to broader interpretation. It may be argued that the meaning of "agency" takes on a different dimension in post medieval archaeology where it may indeed be related to specific historical individuals and events. It may even to some extent help "archaeological agency" identify human actions and motives from the material culture. It appears that Dornan's (2002) breakdown of problems in identifying what "agency" is, may be helped by defining the meaning of "agency" for each archaeological investigation, depending on the nature of the material. It is surely impossible to apply a generic definition of "agency" to all sites as this would mean the exclusion of important observation at one site and include cases of pure conjecture on other sites. Fowler (2004) certainly adapted this approach of “shifting definitions”, though it may negate the purpose of enabling better communication between sites. It has been suggested that post medieval archaeology suffers from a lack of theoretical framework that is so well established in prehistorical archaeology (Deagan 1988). It may be argued that this move toward the incorporation of “agency” in archaeological construct may have a higher degree of success in post medieval archaeology where archaeological excavations have an increased chance of being associated with specific events or people through textual or physical remains. This in turn may allow us to distinguish actions and choices that reflect the “norm” from those that appear to be “cultural outliers”, perhaps allowing other sites to gain practical knowledge on how human agency may influence broader cultural developments and material culture.

1.1.1 Theoretical frameworks in osteology.

It appears to be generally acknowledged that science has become an appendix to “real” interpretative archaeology (Armelagos *et al*., 1982; Sofaer, 2006; Martinón-Torres, 2007; Tarlow 2007:195) and I would like to raise the question as to why scientific archaeology and mainstream archaeology are seen as two separate entities, when they should be an extension of each other? Are we in science not formulating questions that can be integrated into the social construct of the past? Are we ostracising ourselves by being too technical? This trajectory is certainly worrying as how can archaeology advance without uniting? Even within osteology we see a massive divide between osteological research on human and animal remains. If we want to merge with disciplines outside archaeology then we need to first understand the fissures appearing within archaeology itself. Certainly the inclusion of multiple “spheres” as stated by Dornan (2002), requires archaeology to unite rather than divide. Sofaer (2006) argued that the body is just as expressive about culture as material artefacts and should be included in a wider debate. She suggested that the science of human remains should be integrated into mainstream archaeology by effectively considering the body another material culture which has been formed by cultural influences and choices. This being more a suggestion as to how we may narrow the gap of perception between osteology and material culture. It is clear that osteology must aim to integrate the analysis of human and animal remains into the social construct of society and work much harder at understanding context and site formation processes. I would argue that this understanding is much stronger in zooarchaeology than human osteology as the interpretation of animal remains, to a larger extent depends on site construct and material culture. Human remains on the contrary, certainly in a post medieval context, tend to derive from large isolated cemeteries that appear almost in social isolation from other archaeological excavations. So how can we integrate human remains into a much wider framework of cultural construct?

As early as 1952, Pirie noted that scientific archaeology needed to be more considerate of the larger social implications of what we see. Sofaer (2006:6) argued that human osteology has been dominated by medical men in the past and therefore tended to focus on physiological questions rather than the sociality of people in the past. It is a trend that continues today where osteology seeks to embrace and concentrate on new medical technologies to interpret the body whilst placing them in a social context although of increasing importance, is still a secondary pursuit. All too often, when placed in a social context they tend to be anecdotal or poorly understood archaeological, historical or anthropological contexts. It is important to embrace the development of new technologies in the field but this must not be at the detriment of the ultimate goal of improving the understanding of people in the past. In order to do this we must understand the context in which they are placed. In the last two decades there has without doubt been much more emphasis on the social and cultural questions we may ask from the skeleton alone; such as kinship (Brown & Brown, 2011; Haak, 2008), migration (Powers, 2008; Tung *et al*., 2011; Beaumont *et al*., 2013), changes in subsistence (Hawkey, 1995; Isaksson, 2010), and the impact of rural and urban living (Garcin *et al*., 2010), but in the wider archaeological framework, science still appears relegated to a lower status with little integration into the more global questions that may be addressed through a united front (Martinón-Torres, 2008:25). It is perhaps important that we make a clear distinction between papers addressing technical and methodological developments and those addressing social construct of the past, and question which technological advancement will help address the social questions we want to ask. There is a clear tendency in osteology to ask *how* we can best identify variations in the human skeletons and to a much lesser degree *why* we want to interpret these variations. It is all too evident that osteology lacks a clear theoretical framework which can be tied to the overall archaeological and historical framework of social construct. The reality is that we all seek similar questions through different sources. A very recent discussion of human remains in the theoretical framework of "agency" has been brought together in *Cambridge Archaeology Journal*, affording a debate of the body as a material culture and the role of the body in "agency" (Crandell & Martin, 2014). In an interesting article by Tung (2014:438) a case is presented for the objectification of the dismembered bodies in the Andes. She argued that with death and dismemberment the physical attributes of the body changed and the individuals became viewed as objects rather than individuals in the eyes of the living. She argued for the case of "primary agency" and "secondary agency", the former constituting the "wilful" individual (living) and the latter an "object" (dead) that could induce change through the actions of the former. She stated that we must not separate objects and people as they are mutually dependent on each other and therefore both influence the trajectory of events that help form society. When considering the dead as objects and thereby allocated a status of "Secondary agency" the consideration of how they influence society will certainly be dictated by a "primary agent". Betsinger and Scott (2014) argued the important point, that objects may have different meanings or uses to different living parties and it is possible to interpret these differential uses and feelings towards the dead by analysing them as objects.

Sofaer (2006) and Tung (2014) suggested that the dead bodies become objects in the light of archaeological interpretation. Tung (2014:449) argued that, whilst objects tend to be the index of its user alone, "manipulated dead" (dismembered) allow for two trajectories to the past, namely that of the dead and that of the "user" of the dead. Crandell and Martin (2014:432) highlighted an interesting notion that the dead that "speak" to the living are the "exceptional" dead (i.e. those killed, famous people, unique people) so those are the ones most likely to affect agency. This takes us back to Dornan's (2002) argument that Hodder's stance on "agency" negates the omission of the "top-down" approach. To some extent the objectification and the search for "agency" of the dead has also lead the archaeologist to draw out the "exceptional" and leave the mundane behind. We tend to highlight the special individuals in published case studies on the bizarre rather than the average. As Lawrence (1996:340-341) argued, "case studies" can make anyone into an "expert" and may be considered a "safe" contribution to the advancement of knowledge. I argue there is a risk of this happening to a larger extent in post medieval archaeology with the greater possibility of linking the dead to specific events and names. Though we have a better chance of considering the individual through historical contextualisation, we also risk skewing historical events to focus on individuals that we can contextualise rather than those who are harder to distinguish. Take for instance the two places of burial of the Parish of St. Brides in London. The crypt that was populated by the more affluent in the parish, offers a wealth of information of the individuals with many named by associated coffin plates. The other cemetery Farringdon (Lower St. Brides) have a much larger number of individuals but none offer the person specific historical context of the crypt (Kausmally & Bekvalac, 2005). Invariably the Crypt population and thereby the rich receive much greater attention than the poorer Lower St. Brides population because we are able to generate a much more personalised account of the dead through historical records, whilst Farringdon offers more generic observations on society in the poorer populations. In this case we enter into the fallacies of historical research, which tends to be dominated by the histories of the more affluent and literate classes (see below).

In order obtain a more encompassing understanding of the dead it is evident we need to incorporate as many burial practices as possible. For instance if we only looked at crypt burials we may interpret these as being standard burials at the time. By including the spill cemeteries of London we appreciate the problems of over population and the social distinction in burial rites. If we take it a step further and include burials in un-consecrated grounds we come to accept that not all people in post medieval London remained or were necessarily buried according to religious protocol. By appreciating this variety, we also get to appreciate the complexity of social organisation of the time. Add historical accounts of attitudes towards the dead and it becomes inherently clear that this social differentiation we observe also came with a divide in the population with regards to the ethics of different burial practices and this is something we may not be able to pick up on in archaeology alone. When analysing places of burial it is equally important to note what is absent from the area as it is to note the spatial distribution of what is buried. This is particularly true of burial such as Craven Street where site formation offers important clues to the more elusive ethical question we may ask of such a unique archaeological assemblage. It is apparent that the formulation of theoretical frameworks in osteology still has a long way to go. We appear confused with regards to how theory and in particular "agency" can help us understand the past through bones. As Tung (2014) quite rightly highlighted, we are dealing with a dual perspective which may be the cause of some confusion; we may observe funerary rituals and speculate how these may reflect the ideologies of the living population or we may observe the dead in their own right and observe how they as individuals or a community impacted on society.

1.1.2 History and archaeology

With the problems of merging archaeological disciplines and how we may apply a solid theoretical framework to the discipline, it is natural to speculate on how we may marry archaeology and history in a united appreciation of the post medieval period. It has been questioned whether archaeology is simply "an expensive way of telling what we already know" (Deagan, 1988). Andrén (1998:3) argued that historical archaeology is marred by "theorylessness" because of this current state of being seen as secondary to history. Tarlow (2007:195-196) questioned what role archaeology has in the recent past and how we may think of it differently from prehistoric archaeology. She stated that it is not so much about fact finding but more about how the material we investigates relate to ideas, processes and values at the time, effectively allowing an expansion of "spheres" considered in an archaeological context. She saw this as a clear and important integration process between history and archaeology and highlighted the importance of a common goal in an age where specialisms are dividing the field rather than uniting them (Tarlow 2007:195). A clear dichotomy exists between textual and object based interpretation of the post medieval period and yet it is well known that both sources are equally fragmentary in nature (Galloway *et al.*, 2006:46). History itself is not without problems when it comes to interpreting sources. Like archaeology the sources are constructed from a myriad of choices made in the past right through to the present. The historian is as much the interpreter as the archaeologist. Historical sources are partial and tend to privilege the literate. In fact to some extent historical interpretation may be considered more selectively biased and exclusive than archaeology (Galloway *et al.*, 2006). Martinón-Torres

(2008:26) urged archaeologists to use historical text as critically as we would material culture, as text is equally charged with subjectivity.

It may be appropriate in this context to address the usefulness of objects in the presence of historical sources. Martinón-Torres (2008:19) summed up matrial culture well "*The media through which humans structure and express their position in the world*". This does place object interpretation in a position of being formed by conscious choices and it is perhaps worth highlighting that the unconscious treatment of objects are equally revealing. By considering the wider context of the objects; their position and location on site and what they were buried with allowes for further appreciation of the relationship between object and people. Andrén (1998) highlighted the constant juxtaposition of usefulness between text and object (ideology vs. technology, elite vs. people, conscious vs. unconscious) and suggested this was a problem for archaeologists as it was left in a position of "filling in the gap" or being subordinate to history. It is important to understand that textual and archaeological object sources are very different, but it does not mean they cannot answer a shared set of questions. Objects can certainly answer questions ideological in nature and text can answer questions that are technological. It is the manner in which the evidence is merged that is important and it may be necessary for the archaeologist to scrutinise the original sources to better relate the text to the object and vice versa.

Tarlow (2007:5) called for more integration of archaeological thought into history and at the same time promoted more engagement of historical issues into historical archaeology. She argued that the questions asked need to be global, taking in the development of capitalism, the nature of modernity and the development of consumerism. It is clear here that she is taking her inspiration from the "Four haunts" addressed by Orser (1996) (Colonialism, Eurocentrism, Capitalism and Modernity), urging historical archaeologist to think of the wider social context and not only the immediate function and production of an artefact. Orser (1996) stated that these "four haunts" were difficult to ignore when considering a theoretical framework of interpretation in historical archaeology. He (Orser, 1996:9) suggested that history is largely ideographic in nature, almost by default, as history is predominantly conveyed through singular characters or events. The nature of archaeology is on the other hand nomothetic in nature, due to the material we address we are most often forced to consider the larger social patterns at the detriment of the "individual". However, this approach has recently been widely contested (see above). Perhaps this is the strength rather than the weakness of historical archaeology. Gardener (2004:7) stated that we tend to interpret material culture through patterns in terms of routine, innovations and improvisations. Perhaps archaeologist are better equipped to identify patterns of the past as this is the very foundation of archaeological interpretation. The amalgamation of these two approaches allows us to create a multi-layered analytical approach that allows for the consideration of "agency" in the wider structure of society. The amalgamation of textual and material evidence further allows for a more inclusive and reflexive interpretation of the past with presence of both preserved and discarded evidence of social choices from all parts of society. It is interesting that most theoretical frameworks appear to believe in human motivation is driven by the desire to improve society in general or the concept of "the hard working make the changes" (see Hodder, 2012). Yet today we are well aware of concepts such as "path of least resistance", and this would be interesting to add to these theories as surely human agency is also strongly influenced by this thought. We desire to create a society, which we can inhabit through minimal effort. A more "egoistic" motivator is also important to recognise, in that "promotion of self" may by default cause significant changes in society whether intentional or unintentional. It is apparent from the above account of theoretical frameworks that this topic is incredibly complex, even to scholars of theoretical thought in archaeology. It is perhaps the adoption of theories from other social sciences into archaeology, where interpretation is dominated by material culture that has caused this confusion. It is important to appreciate the variety of approaches by which we may interpret the past, but not to get too immersed in the intricate and subtle meanings of each of these theoretical frameworks as surely they are open to interpretation depending on the nature of the investigation. Theoretical frameworks are not formulated to tell us *what* to think but *how* to think and remind us that our minds are invariably programmed to interpret archaeology in a manner related to the world, we ourselves frequent.

1.2 Archaeological research on anatomy scools

In recent years there has been an influx of work on archaeological sites with evidence of dissection and medical education from hospital cemeteries (Henderson, 1996; Boulter *et al.*, 1998; Western, 2011; Witkin, 2011; Fowler and Powers, 2012), anatomy schools sites (Blakely & Harrington, 1997; Kausmally, 1999; Hull, 2003; Murphy, 2010) and a few examples from lay cemeteries (Emery &Wooldridge, 2011; Ives *et al.*, in prep.). The majority of the sites are located in the UK but only one dedicated burial site is Located in London (Fowler and Powers, 2012). The relatively short timespan, in which these sites have been presented, has caused significant overlap in dissemination and a distinct lack of a shared framework upon which the sites may have shared a common focus of interpretation both methodologically and analytically.

The complex comingled nature of these sites are reflected in the manner in which they are presented with methodological problems as well as taphonomic considerations requiring more attention (Boulter *et al.*, 1998; Witkin, 2011; Fowler and Powers, 2012). The majority of sites have elected an integrated approach drawing on local and contemporaneous documentary evidence of dissection, with a discourse relating to a specific topic in history; Blakely and Harrington (1997) discussed the use of black americans in dissection whilst Witkin (2011) addressed medical treatment of the working classes and Fowler and Powers (2012) looked at the use of hospital patients for dissection. It is difficult through these snapshots to gain an overall feel of the true nature of eighteenth and nineteenth century dissection and medical education. Mitchell (2014) amalgamated evidence of hospitals and medical education in a series of conference papers including archaeological excavations, museum collections and historical research on the subject providing an overview of findings to date. Though these have been united in a single publication it is difficult to draw together overarching conclusions reached. It does however highlight the significant benefits of including multiple disciplines in the debate on medical education.

The distinction between dissection and autopsies and in-vivo surgery have been discussed from a methodological and historical viewpoint, with an overall consensus that it is possible to distinguish between the three procedures though not all cuts are exclusive to one process (Blakely & Harrington, 1998; Witkin, 2011; Fowler & Powers, 2012). Less attention has been paid to the distinction between dissection and the making of museum preparations and how these might be reflected in the osteological record, though Fowler and Powers (2012: 189) and Western (2011: 53) approached the subject relating to their finding of wired elements and staining of the bone.

A number of sites have included the analysis of the faunal remains from the excavation (Henderson *et al*., 1996; Terrell & McFarlin, 1997; Hull, 2003; Western, 2011; Fowler & Powers, 2012). The integration of the results in the actual overall analysis of the site has in most cases proved to be absent apart from at the Royal London Hospital (Fowler & Powers, 2012: 160) providing a more indepth discussion in additional publications by Morris *et al.* (2011) and Morris (2014) on the use of animals for medical education and as hospital food. A more integrated analysis between the human and faunal skeletal remains is called for to establish the exact relationship between the two groups.

Little distinction has been made of the difference in cadaver supply between hospital based (intra-mural) and extramural private anatomy schools, though an obvious distinction must be made in relation to availability and disposal of remains depending on the location of the schools. To date Medical College Georgia, USA (Blakely & Harrington, 1997), the Asmolean in Oxford (Hull, 2003) and Trinity College Dublin in Ireland (Murphy, 2010) are the only anatomy schools not directly linked to any hospital, but no discussion has been offered on the potentially differential procurement patterns of these two types of schools.

1.3 Historical research and the body in the eighteenth century

The aim of this section is to present present the secondary historical literature most influential to this thesis. It also aims to explore how the view of the body in the eighteenth century influenced medical education, in order to better appreciate what questions we might ask from the archaeological and historical records pertaining to Craven Street anatomy school and William Hewson. The final section is added to encourage us to question our understanding of morality to enable us to perhaps think more laterally when considering acts of the past.

There has been an interesting development in the portrayal of medical education and anatomical museum in history from account of the practicalities of these schools and museums (Cole, 1944; Edwards & Edwards, 1959; Warren, 1951) to more personal accounts of historical individuals (Peachey, 1924; Porter, 1983; Simmons *et al*., 1983; Porter, 1995; Bynum & Porter (eds), 2002; Brock, 2008; Moore, 2009) to a wider debate of the political, social and moral implication of the development of medical education (Richardson, 1988; Lawrence, 1995 and 1996; Hurren, 2004; MacDonald, 2006, Hurren, 2012). This reflects the developments seen in the theoretical frameworks of archaeology (see section 1.1). The debate on use of animals in medical education has been significantly more peripheral and rarely touched upon in conjunction with the use of humans for dissection (Cole, 1944; Daly, 1989; Bellanca, 2003; Guerrini, 2003; Ready, 2004; Guerrini, 2006; Atali-ç, 2012; Obenchain, 2013). The discussion of medical education has in recent years been presented from a variety of different angles. The use of non-consenting bodies for dissection have been addressed widely, highlighting the clandestine nature of the body trade and the social inequalities in the selection of bodies, following the anatomy act of 1832 (Richardson, 1988; Hurren, 2004; MacDonald, 2006, Hurren, 2012). The accounts are detailed in their approach, Hurren (2012) in particular provides an excellent very systematic approach on the topic that is very useful to any archaeologist dealing with dissection, in particular post 1832. In accounts of medical education in London, focus has been largely ideographic and hagiographic in nature, placing significant emphasis upon accounts by William and John Hunter, perhaps not surprising given the richness of sources available (Peachey, 1924; Porter, 1983; Simmons et al., 1983; Porter, 1995; Bynum & Porter (eds), 2002; Brock, 2008; Moore, 2009). This approach has caused medical education to gain a very distinct image of singular men in history changing the world "for the great good of humankind", though perhaps Moore's book (2009) on John Hunter, is more nuanced than most. Interestingly, quite contrary to the focus on the body trade, medical men have in this context been portrayed as the pillars of society and the heroes of medicine. Lawrence (1995; 1996; 1998) addressed medical education in a much more pragmatic manner, highlighting political and social motivation behind the evolution of the medical education scene in London during the eighteenth century. In her excellent book "*Charitable Knowledge – Hospital pupils and practitioners in eighteenth-century London*" she highlights the complexities in the formation and function of the schools, the manner in which courses were formulated to attract students and the motivation of the lecturers. The book demonstrates how the schools were predominantly entrepreneurial in nature and motivated by the inherent "authority" attached to medical practitioners at the time. This book is an extremely important contribution to the understanding of the motivations behind a complex system. Chaplin (2009) investigated John Hunter in his considerations on “museum oeconomy”, a term used to describe the relationship between dissection, preservation and display, he applies Hunter as a model and provides a fresh insight into the more complex social nature of museum display. He argues that museum displays were tools of public engagement, demonstrating the more “sober” side anatomical research and the skills of the anatomist. Chaplin’s thesis provides and insightful and throughtful contribution to the discussion on the social complexities of private anatomy schools in London (1750-1800). It also reminds us within archaeology that dissection for medical education was not necessarily the sole motivator behind the use of bodies. This position was also highlighted by McCormack (2010; 2013) who addressed the role of museum collecting in the world of medicine, providing an account of William Hunter’s collection from the eighteenth century. Use of animals in medical education, though a very current topic, has received much less or certainly more sporadic attention in the historical literature (Daly, 1989; Bellanca 2003; Guerrini 2003; Ready 2004; Atali-ç, 2012; Obenchain, 2013), perhaps because the accounts available in the primary literature places medical development in a highly precarious role when put up against our moral standards of today? The discussion of vivisection is often based on the moral conscience of the dissector and the changes in public attitudes towards experimenting on live animals. This is entirely understandable, but none the less it would be interesting to place these acts within a context of medical education and examine the views behind these actions and perhaps adapt a more pragmatic approach that will enable us to understand the reasoning behind these acts. It is of interest here to question how historical accounts may perhaps enable us to better distinguish between the public portrayal of events from that of personal intent and motivation, as the latter is perhaps less apparent in published literature. Textual accounts predominatly express the “desired” image of an individual rather than the actual personal motivation behind their actions. We may also ask how we can better understand the morality of using bodies for dissections and provide a more balanced view of the anatomists and the anatomised. Historical accounts have a tendency to portray the medical profession as villains or heroes depending on the approach and appear much less concerned about the intricacies of using non-consenting bodies and animals for dissection. Yet the historical literature, when scrutinised, can be very revealing of these finer complexties of social and moral conscience. It highlights the need to place individual accounts into a wider context of heightened appreciation of political and social intent. Both Lawrence (1995; 1996) and Chaplin (2009) emphasised the drive behind medical education as a desire for upward mobility in society and this is a very interesting concept that needs to be explored. It is entirely possible, even in an ideographic context, to question the driving forces in society and understanding how these actors may have conducted themselves within this political and social framework.

1.3.1 A moral dilemma

The social inequalities or ethical problems relating to the use of cadavers and living animals from medical dissection have been addressed extensively by very competent scholars on human dissection (Richardson 1988; MacDonald, 2006; Hurren, 2012) and vivisection (Daly, 1989; Bellanca 2003; Guerrini 2003; Ready 2004; Atali-ç, 2012). In the context of this thesis it is important to appreciate some of the dilemmas faced in the use of human cadavers and animals by the anatomy schools, and how this use of the body as a commodity was viewed by the public and the anatomist themselves.

During the eighteenth century we can observe the evolution of a dramatic reform in medical education. Previously medical knowledge was taught through ancient authorities such as Aristotle (384-322BC), Galen (AD129-216) and the bible (Harris *et al*. 2013:173; Tarlow 2011:88). The change was a gradual but clear direction towards understanding the body as a mechanical instrument that needed to be itemised to allow further appreciation of its functions (Tarlow, 2007:25; Tarlow 2011:72). In order to allow for this approach the medical world was in need of bodies to dissect and examine and this is where the schism between religion and science arose and the state utterly failed to accommodate both. With the protestant reformation of the sixteenth century, the body and the soul came to be viewed as two separate entities. It was believed that the soul removed itself from the earthly container, that is the body, at the time of death and, therefore, the body was no longer associated with the soul or living person (Harris *et al*., 2013:169-170). This belief, in itself, would suggest that dissection would then become acceptable as the body was consequently viewed as an empty container of the once living. This notion was however far from clear cut and caused a division of opinion within the religious community and thereby society itself. Some would argue that the body was but an empty shell at the point of death, whilst another argument was that the vacation of the soul from the body would not occur immediately and the person was still joined with the body following death (Ariés, 1981:353). Tarlow (2007:25) argued that to the majority of people in the eighteenth century, religion and reason were not mutually exclusive. Despite the widely recognised use of bodies for dissection on the continent, Britain still struggled to accommodate both the scientific and spiritual needs of the people. The Murder Act of 1752, stating that all murderers should be executed and then dissected, did very little to ensure a steady supply of bodies for dissection. Quite the contrary, dissection became a punishment to be abhorred and feared. As a consequence the supply of bodies for dissection was well below requirement throughout the eighteenth century and well into the nineteenth century (Tarlow, 2011). It is perhaps not even the notion that dissection was a form of punishment that drove the repulsion and fear towards going under the surgeon's knife. Tarlow (2011:62 and 101) argued that being dissected was the ultimate surrender of all privacy, meaning that the dissected had no say in their own fate.

Once dissection was inflicted upon the individual, it is interesting to consider the conversion of the body from being an individual to becoming an object and thereby a commodity to be manipulated and traded in the name of science. There is a clear indication in current literature that this was indeed the case when a body was acquired for medical research (Chaplin, 2009). This view is unmistakably in the eye of the beholder and it is interesting that dissection was so fervently rejected by society and yet numerous auctions and museums full of body parts were in the public domain without meeting any significant opposition (Chaplin, 2009). Chaplin (2009:239) argued that the process of dissection or making preparation turned the body from an individual into a specimen, and served to neutralise the more insalubrious process of dissection. The process of objectification was clearly also connected to the observer. To one person the "object" may represent a practical consideration or an object of art whilst to another person the same "object" may have evoked strong emotions of personal affiliation (Ingold, 2007; Casella and Croucher 2014:96). The eighteenth century was characterised by an obsession of dividing the body into small sections according to form and function, the lymphatic system being one of the great explorations of the eighteenth century (Cunningham, 2010:246). It could be argued that the more "non-human" the transformation the less likely the individual was to be subject to moral scrutiny. For instance a preparation of a complete foetus was more likely to be met with some objection than human tissue on a microscope slide. Though far from clear cut, the overarching concensus was that once the body was no longer complete it did not have any social attachment and the body therefore became an object (Chaplin 2009; Tung 2014). Yet objectification of the body was not only dependent of the personal objectives and division of the body. The idea of the body as an object may appear alien within our own immediate social or cultural sphere, but move beyond this in time and space and there will be an increased willingness to accept the body as an object or a commodity. This concept is amply emphasised in relation to our own objectification of the body in archaeology (Crossland, 2009:106). Richardson (1988) and Hurren (2012) richly illustrate the removal of association in their works on social inequality within dissection. Dissection was carried out by middle classes and the social elite, whilst it was predominantly the poor who became the dissected. In Archaeological investigations this social divide between the dissector and the dissected has also been demonstrated from sites such as Medical College Georgia, where slaves were selected for dissection (Blakely & Harrington, 1997). It is evident that the perception of the body was far from clear cut and the transition from individual to object was subject to individual perception.

When addressing objectification of the body we tend to concentrate on the human form but a transformation in the use and attitude towards use of animals was likewise significant in the eighteenth century. The objection did not touch upon the use of dead animals as they were by and large not considered to have a soul and therefore once dead they were effectively waste

(Guerrini, 2003:81). Towards the end of the eighteenth century, there was a maturing of social consciousness regarding animal rights and the ability of animals to feel pain, but it was not until much later in the nineteenth century that this was addressed legally (Guerrini, 2003:81). The role of animals has historically been debated when reflecting on the development of comparative anatomy and its role in medical research. Cunningham (2010:333-336) noted that though John Hunter dissected more than 500 animals in his lifetime, he never bothered to classify them. Haller (c.1774) argued that comparative anatomy predominantly came about as a result of the shortage of human bodies (Cole, 1944:464). According to John Hunter, humankind was the central object of any investigation with which other species could be compared thus assessing their abilities from a human perspective (Cunningham 2010:333-336). Animals were effectively substitutes for humans and not considered worth studying in their own right. In other words animals were only interesting if they could help enlighten on human physiology. Animals became subjects of experiments considered immoral to perform on humans, such as vivisections. With expansion of the empire, animals also became objects of desire in terms of being collector's items. The Hunter brothers, John Sheldon and William Hewson all had a wide array of animals; invertebrates, mammals, fish, birds, amphibians and reptiles were all represented (Paterson, 1778; Hutchins, 1787; Chaplin, 2009). From the museum catalogues it is evident that these animals were not only collected for their service to the advancement of medicine. They were also collectables in their own right as an expression of social status and economic ability of the collector, with exotic animals going for large sums of money (Paterson, 1778)

Let's explore the state of moral conscience in the eighteenth century in relation to dissection and vivisection and our sense of humanity of today. Tarlow (2007:195) emphasised how "obvious truisms" need to be put into context especially in historical archaeology as more often than not we tend to think we understand the world we are interpreting because it is so close to our own. It is very difficult to write and indeed read this thesis without being influence by today's ethical values on use of humans and animals for medical advancement, our reactions to actions of the past are heavily laden with morality as we understand it today. It is therefore worth putting our morality into perspective. We question eighteenth century attitudes towards use of living animals, because today we know that animals feel pain equal to humans and yet today we are less concerned with experimentation on small mammals and non-mammals than with that on monkeys, apes and, pets such as rabbits and dogs, thereby basing our own moral framework on feelings rather than rationale. In the light of perception, it is of interest to speculate on recent advances in botany and particularly the discovery that plants may feel "pain" or send out stress signals when they are cut (Smithsonian Channel, 2015). Most people today, consider this a ridiculous or incomprehensible assertion. Yet imagine if this was found to be the irrefutable truth in the future? How will future generations view our present sense of humanity? To the vast majority of the population, animal rights is a peripheral thought. We still use medicines and cosmetics that have been developed through experimentation on animals, and this moral lapse feeds through into the agricultural industries - the vast majority still eat meat of animals living in abysmal and inhumane conditions. In terms of humans, Richardson's (1988) and Hurren's (2012) excellent work on the use of bodies of people from marginalised communities in Victorian London questions the right of using the poor. Transpose this to today - we pay people, or "volunteers" as they are called, to test new drugs before they are put on the market. It is most probably the case that people put their health at risk, due to the need for the money rather than for the greater good of humankind. Cast your mind back to 2006 when the Northwick Park, North London, drug trial disaster of TGN1412 resulted in organ failure of six healthy young men (BBC News 16 March 2006 and 24 May 2013). Morality and reality are not an easy marriage and Scheper-Huges' (2001) article "*Bodies for Sale*" reminds us that the moral questions surrounding the use and objectification of the body are as rife today as they were 250 years ago. The point I am trying to make, is that our sense of humanity, and what we consider permissible, is constantly evolving and shifting to suit our world. Advancement of technology challenges that which we held to be true or we were unaware of in the past effecting our sense of morality. This notion is important to hold onto when considering actions of the past.

1.4 Methodological framework

The relationship between history, archaeology and archaeological science is complex. The nature of these disciplines separates the material despite an obvious shared goal of understanding the past. This thesis proposes to merge these disciplines through a systematic observation of patterns. The circumstances of the material allows for an unprecedented opportunity to try and understand both the specific and more general nature of the Craven Street anatomy school with the aim of generating a comprehensive picture of medical teaching in the eighteenth century. I stress at this point that this thesis is not about putting history and archaeology up against each other in an interdisciplinary contest of usefulness and accuracy. It is an attempt to amalgamate different strands of evidence and to address a series of shared questions on the organisation of a private anatomy school in eighteenth century London.

In this thesis I would like to loosely adopt the concept of "human agency", as encompassing the recognition of actions and motivations of people in the past as an influence on the formation of society. I support the concept that skeletal remains are "objects"and that cognitive behaviour is inherent in "objects". It is here recognised that this "encoded cognitive behaviour" does not only signify the conscious production of these "goods" but also the subconscious treatment of the same, and that through these actions we may understand both the physical and cognetive relationship with these "objects". It is recognised that different human agencies may attach different meanings to “objects”, and that “objects” may not have a single purpose. This notion is perhaps far more comprehensible in post medieval archaeology with the presence of textual evidence to enlighten us on the diversity of cognitive behaviour in society and the application of material goods to different actions. The remains of human and animals is perhaps exposed to this diversity of thought and use far more than any other object in the archaeological record. This thesis draws heavily on evidence of a single person in history, William Hewson. It is recognised the attributes of this individual must be placed within a wider context and serve as an example of “individuality”. It is important to be mindful of the variations in the archaeological records and appreciate that these are “cultural outliers” and not necessarily representative of the norm.

In this joint context of history and archaeology, the idea of absence of motive in an archaeological context has become significantly less problematic and we are able to interpret the remains in the light of this information. By merging historical idiographic information with an archaeologically more nomothetic approach, it is possible to reconstruct an event that includes both personal and generic information on the organisation of an anatomy school. By considering the human and animal remains as “objects” it is possible to consider how they affected the arrangement of the school and influenced the actions of individual agency in procurement, use and disposal.

Secondary historical texts have a tendency to generalise cultural experiences and ask different questions from the sources than perhaps relevant to an archaeological investigation. Thus an integration of historical sources will be addressed with specific relevance to the archaeological findings. It is the intention of this thesis to adopt a systematic approach of investigation of both the historical and archaeological literature and material, in order to truly understand the nature of the remains deposited at Craven Street. In this context it is the intention to identify which actions were specific to Craven Street and which were considered standard within the context of dissection and medical education.

The Craven Street deposit allows us to enter into the “silent past” of history and better understand how animals and humans were applied at this private school. While it is difficult to rationalise such a small archaeological context into a wider social framework, the nature of the assemblage and its historical context allows for considerations into a number of different spheres. The intention of the thesis is to ask a series of archaeological questions drawing upon historical accounts at different levels of inference from technological development, economic viability of the school, social and political context of scientific research to a consideration of the more spiritual, the cultural attitude towards the dead. By viewing the bones as part of a material culture of the school, it is entirely possible to make inferences on its organisation at all these different levels. The research questions below are dependent on the availability of both historical and archaeological evidence and would be difficult to address by using one of these disciplines alone.

1.5 Research questions

The presence of a museum catalogue (Paterson, 1778), the details of course outlines (Falconar, 1777a; 1777b) and the personal information on Hewson himself allows us to ask unique set of questions addressing both the individual and the broader social context. The opportunity of comparing Craven Street with other archaeological assemblages in a historical context also allows an understanding of the role of Craven Street in the wider community. The following research questions have been formulated from an archaeological standpoint to generate a rounded and comprehensive picture on its use of animals and humans with regards to procurement, use and disposal and what these actions might reveal about the organisation of the school itself and its role in the wider scientific community.

<u>1: Procurement</u>

a) Does the archaeological deposit reflect the buying power of the school?
b) Did Craven Street, as a private anatomy school, have the same access to bodies as those associated with hospitals?
c) Does the historical and archaeological evidence from the school reflect the nature of the trade in human cadavers and animals?

<u>2: Utilisation</u>

a) What were the specific uses of the individuals deposited?
b) Do the dissection techniques of the bones, reflect the apparent historical chronological progression of methods of dissection?
c) Does the deposit reflect Hewson's research methods?
d) Is there any evidence of differential treatment between adults and children?
e) Is there any evidence of differential treatment of human and animals?
f) Is there any evidence of differential treatment between different species and age groups of animals?

<u>3: Disposal</u>

a) What can disposal tell us about retention?
b) How does the burial environment reflect the social and moral conscience of the Hewson/ the school? Is there any evidence of objectification of the body?
c) How did the school dispose of the remains?

1.6 Overview of the thesis

This thesis has been divided into two main components; namely historical evidence, pertaining to documentary sources and museum objects and archaeological evidence from the Craven Street excavation combined with other comparative archaeological data.

Part 1 (**Historical evidence**)

Chapter 2 Presents considerations relating the approaches applied to historical research.

Chapter 3 addresses the historical documentation on anatomy teaching in the eighteenth century, placing the Craven Street Anatomy School into a wider context of London as the new capital of medical education in the latter part of the century. Emphasis has traditionally been placed on the cadaver trade and the effect of this on the anatomy schools both from a practical viewpoint of procurement and disposal but also from the moral perspective engaging in a review of public attitudes towards dissection.

Chapter 4 reviews the historical evidence on how the bodies were utilised at the anatomy school by addressing the eighteenth century literature of dissection techniques and comparing those to techniques of the nineteenth and twenty-first centuries. This is followed by a review of the surgical techniques at the time that would have impacted on the skeleton and methods of making museum preparations. The final section explores the role of animals in an anatomy school context addressing how they were used and how animal experimentation was viewed by the public during this period.

Chapter 5 looks at evidence directly related to William Hewson and provides a detailed image of the founder of the Craven Street School, by addressing different aspects of his life; his training, his partnership with William Hunter, his marriage to Mary Stevenson, his research and finally his death and successors to the school.

Chapter 6 looks specifically at the Craven Street School; from Hewson setting up the school and admitting students to lecturing and carrying out research; examining the different aspects of the school including the lecture theatre, the museum and the dissection room as well as the role of these in teaching.

Part 2 (Archaeological evidence)

Chapter 7: provides an overview of the archaeological excavation undertaken at Craven Street and the contextual information. This is followed by an overview of the finds; including a short summary of the stratigraphic distribution of the skeletal remains and a summary of the ceramics and glass also uncovered from the excavation.

Chapter 8: comprises the methodologies applied to the historical, human and faunal analysis

Chapter 9 presents the results of the analysis of the human skeletal remains, examining aspects including; taphonomic indicators, body part distribution, and demographic information. It then provides a detailed overview of the modifications caused by activities at the anatomy schools by reviewing the three age groups of remains separately. This is followed by a breakdown of the pathologies observed and considerations of the results of the analysis of the dentition. These results are then compared with results from other anatomy schools excavated archaeologically.

Chapter 10 provides the results of the analysis of the faunal remains which has been structured differently to the human remains chapter due to the different nature of the assemblage and the results. The chapter provides a discussion of the taphonomy, age, sex, pathology and modifications for each of the species identified comparing the results for each species with other anatomy schools containing faunal remains.

Part 3 (Discussion)

Chapter 11, the discussion, draws together the historical and archaeological findings to provide a detailed picture of the Craven Street anatomy school, addressing the three main research questions on procurement, utilisation and disposal at the Craven Street anatomy schools and placing them in a broader context. These three topics are also addressed in the wider context of the thesis including evidence not directly related to the skeletal assemblage.

2 Historical approaches

Historical sources on private anatomy schools are fragmented due to the lack of a central body governing the schools prior to the anatomy act of 1832. The illicit body trade has further caused many aspects of the schools to remain elusive in historical documents. This thesis investigates both primary and secondary sources. Secondary sources were used to generate a historical overview of the period whilst primary sources provided the majority of evidence on William Hewson and the Craven Street anatomy school.

2.1 Time frame

The aim of the historical chapter was to place this project into the context of the mid to late eighteenth century (1750-1800). Most literature on medical education in London pertains to the nineteenth century or encompasses a wider timeframe spanning both centuries. Some topics required exploration of documents outside the timeframe due to the paucity of material during this period, in such cases this has been clearly noted in the text.

2.2 Persons of investigation

The archaeological findings from the excavation trench at Craven Street were dated to 1772-1778 (the period during which the anatomy school was active). During this period both William Hewson and Magnus Falconar, were running the school and therefore the deposit in the pit may have been discarded by either or both of these persons. For the purpose of this thesis it was decided William Hewson would be the principle person of investigation; firstly he was the founder of the school, secondly he taught Magnus Falconar and Falconar's research were repeats of experiments carried out by Hewson and thirdly, the historical literature on Falconar is very limited and predominantly associated with Hewson and the anatomy school.

2.3 Letters of private communication

Epistolary evidence of Hewson's life and the Craven Street anatomy school pertains to both his private and professional life allows a reconstruction of Hewson's relationships with his contemporaries and reflections on his character and ideologies. Such letters provide a unique insight into the more personal thoughts and feelings of their authors. Private letters of communication feature strongly in the chapter relating to William Hewson, and have been acquired from two main sources; the first sources are the letters of communication between Mary Stevenson (Later Mrs. Hewson, William Hewson's wife) and Benjamin Franklin. These letters were transcribed and published on-line by Packard Humanities Institute (since 1988) under the project "Digital Ben Franklin" (Franklinpapers, 1988), which has been the main source of reference relating the Benjamin Franklin in this thesis. The second source relates to Hewson's relationship with William and John Hunter. Letters were transcribed by Brock (2008) in "*The Correspondence of Dr William Hunter*", with this publication being used as the main source. A few original letters in possession of the Hewson family in Philadelphia were kindly forwarded by Melissa Hewson to the author of this thesis and transcribed. Only a small number of letters available were written by Hewson himself and these were mainly related to matters of his profession.

The letters strongly feature reflections of feelings, some intended for the public domain and some entirely private. They also reflect the relationship between the author and the recipient and the manner in which they were written and the content represents a moment of this relationship. Some of the letters were evidently written during times of passion, whilst others were simple communications of arrangements and trivialities of life. In some instances the letters were entirely work related whilst on other occasions they reflected the social engagements with people of absence. The letters between Mary Stevenson and Benjamin Franklin were fewer during Mary's marriage to Hewson, and may be a reflection of the changes in her social circumstances or simply because Benjamin Franklin and Mary Stevenson both predominantly resided in London during this period.

2.4 Newspapers/public media

Burney's newspaper collection of the seventeenth and eighteenth centuries (British Library collections) was the main source for gathering evidence on anatomy schools in London at the time and in gauging public debate on topics such as the cadaver trade and events relating directly to William Hewson and the Craven Street anatomy school. In this instance no attempt was made to establish the nature and political orientation of the different media referenced. In topics of public debate the author has sought evidence of differing opinions to provide a balanced public view, though this in itself may not provide a true reflection of the ratio of opinions, it does generate an insight into the thoughts embodied in eighteenth century media.

In articles published in the local media during the eighteenth century the author rarely signed his or her true name but used a synonym relating to the content of the article (usually a Latin word). It further appears it was commonplace not to mention any person referred to in the article by name but by abbreviation (i.e. William Hewson was also called Mr H or Mr W.H. and William Hunter Dr H or Dr W.H.). In such cases every effort has been made to ensure the abbreviations did relate to the persons investigated by comparing other aspects of the article such as relevance of the topics, other abbreviated names and geographical place names. In most cases it was not possible to ascertain the true identity of the author.

In some instances, such as information on the cadaver trade, nineteenth century media was used as a source to support and expand knowledge on certain topics where eighteenth century sources were found to be limited. For this purpose on-line searches on databases such as "*19th Century*

British Library Newspapers" were carried out. No other sources on public media were sought for this purpose and the author is aware that though comprehensive, these are not exhaustive resources.

2.4.1 Unpublished literature

Unpublished archive material from the eighteenth century was sought at the *Wellcome Trust Library* on Euston Road, London and *Royal College of Surgeons' library*, Lincoln Inn's field in London, including lecture notes and auction catalogues. Other archival material was gained from the National Archive in Kew and the London Metropolitan Archives pertaining to personal wills and maps. An annotated copy of Paterson's auction catalogue (1778) was acquired from Dr. Simon Chaplin who had sourced a copy, archived at the Natural History Museum, Kensington, London.

2.4.2 Published literature

Published eighteenth century literature was employed as a primary source, in particular scientific publications by William Hewson himself, and his successor Magnus Falconar. Other published literature from the eighteenth century includes medical manuals and auction catalogues. These were gained from the Wellcome Trust Library archive and on-line sources including "Eighteenth Century Collections Online" and "Google books", who have digitised a great deal of literature from the eighteenth and nineteenth centuries.

In some instances more recent literature was included either to draw comparisons with the eighteenth century published material or to support sources of the period, at times when evidence was found to be scarce, in such cases this has been clearly noted in the text.

2.5 Object based historical research

The Royal College of Surgeons (RCS) and the Surgicat catalogue proved an invaluable resource for understanding techniques and methods of preservation. Being specifically associated with eighteenth century techniques of John Hunter, they were considered to be closely associated with techniques Hewson and Falconar would have applied. Hewson's microscopic slides are also currently curated at the RCS, a selection of these was viewed as a comparative to the archaeological findings.

3 Medical education in London in the eighteenth century

The aim of this chapter is to provide a framework to aid the understanding of the historical and archaeological analysis of the Craven Street anatomy school by establishing a broader context. The chapter has two main sections. The first is dedicated to looking at London during the latter half of the eighteenth century and how medical education evolved and was organised during this period. The second part reviews the procurement and disposal of cadavers for dissection, looking at how cadavers were obtained and disposed of in London at the time. Please see section 2 for methodological approach.

John Fielding (1776:ix-xxxiii) wrote a detailed description of London and its buildings in 1776. His account of the population of London at the time had the aim of providing "caution to all strangers" wishing to visit London. "*....London is a huge magazine of men, money, ships, horses and ammunition of all sorts of commodities necessary to expedient for the use of pleasure of mankind: The mighty rendezvous of nobility, gentry, courtiers, diviners, lawyers, physicians, merchants, seamen and all kind of excellent artifices…" (Fielding 1776:xii).* From his descriptions, London emerges as a city proud of its diversity and multi ethnicity but equally a place where the significant influx of people to the capital resulted in a place of both great beauty and abject poverty and filth. He remarked, the changes to the city since the Great Fire of London in 1666 were dramatic in terms of both architecture and population. London became a much divided city where the majority of the working classes lived to the east of the city walls, attracted by the ports and the prospect of a job. The area was over populated with poor housing and virtually non-existent sanitation systems. The West end of the City was to a larger extent inhabited by the elite away from the city's smoke and dirt. This was much more countrified with the main part of the city expansion running tightly along the river Thames down towards Charing Cross. Covent Garden was erected in the 1630s followed by Bloomsbury square and St James's square built in the 1670s. Properties shot up around this area, where typically the freeholds were owned by wealthy landowners (Schwarz, 2000:663). A map by J Ellis dating to 1767 shows how London clustered north of the river Thames (Figure 2). South of the river was largely rural with extensive areas of tenter grounds, tanning yards and timber yards. The city of London to the east was densely populated and criss-crossed with tightly packed streets whilst the area west of the city boasted large parkland areas and affluent houses.

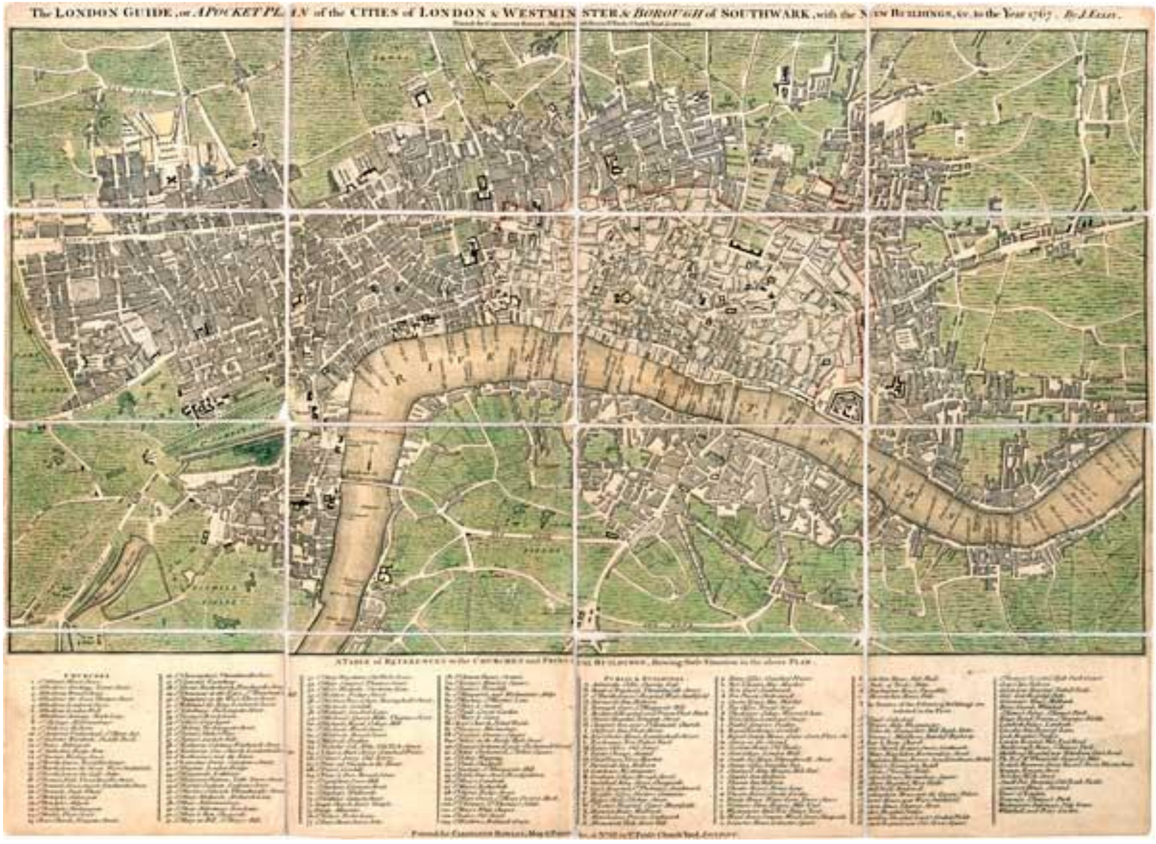


Figure 2 Map of London by J Ellis 1767 (for larger image please see attached CD)

London's population, according to George (1976: 37) grew from an estimated 676750 in 1750 to around 900000 in 1801, predominantly caused by immigration from the countryside and abroad. The age-at-death pattern was very different from today. Figure 3 shows the percentage distribution of age at death from the 1750-1780s, and demonstrates the consistency in the age-at-death patterns over this time period. Infant deaths remained high as a proportion of the total deaths with an average of 34.58%, in fact this is most likely an underestimate due to the movement of children to the countryside and unregistered death, particularly in the poorer populations (Woods, 2006; Newton, 2011). Ogle suggested that the Bills of Mortality figures for infants should be inflated by 1.39-1.44 (Woods, 2006: 12).

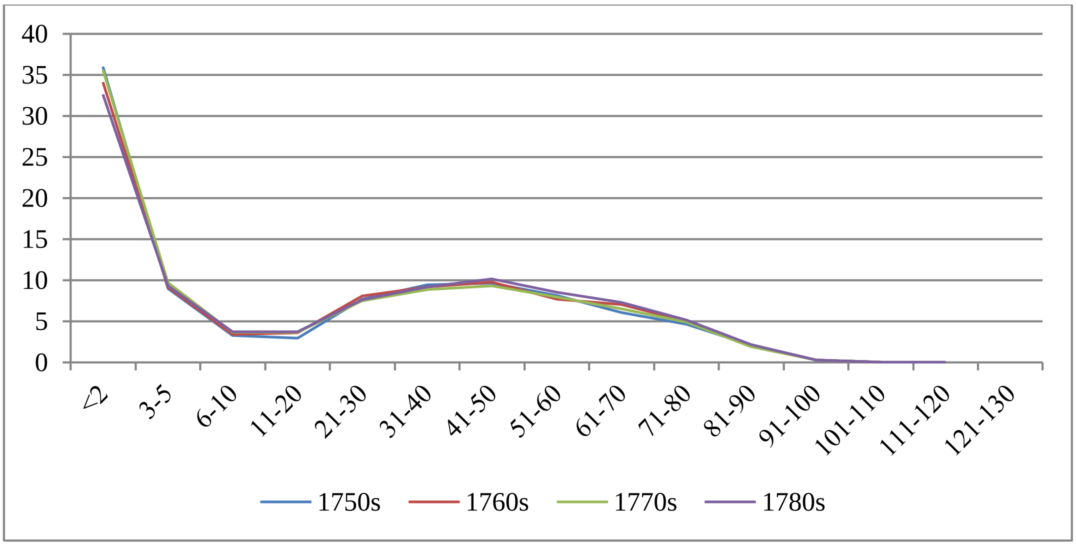


Figure 3 Percentage distribution of age at death from 1750s to 1780s illustrated based on the Bills of Mortality figures from (Roberts and Cox 2003, 304).

London was a thriving metropolis with a very large population. With the ever expanding population the capital had to accommodate a large number of church yards and burial grounds. Rocque's map of 1746 (Locatinglondon, 2011) revealed the presence of at least 69 church yards and 20 burial grounds in London and the Ellis map of 1767 recorded a total of 103 churches at the time (Figure 2). It is perhaps not surprising that London became the centre for practical anatomy; with the seemingly ready supply of cadavers medical students flocked to the capital to learn how to dissect (Lawrence, 1995: 208)

3.1 Science and medical education

The eighteenth century was known as the era of enlightenment and reasoning, governed by the promotion of science over faith and the advancement of knowledge through scientific experiment. It has been suggested that the period is not characterised by spectacular discoveries but laid the foundation for the bigger medical advancements of the nineteenth and twentieth centuries (Warren, 1951: 304). These ideas were rooted in the previous century but truly embraced during the eighteenth century. The teachings of the ancient Greeks had previously formed the main component of medical education but now served as a historical introduction to modern scientific thinking and reasoning. The Royal Society was founded in 1660 under the motto *Nullius in verba* (Take nobody's word for it) promoting the importance of scientific experiment. The society was formed by physicians and natural philosophers and acted as an advisory panel to the government in the latter half of the eighteenth century (Syfret, 1948: 75), when the Society accepted surgeons and anatomist as members, thereby recognising not only these professions but also elevating them to a Gentleman's profession (Lawrence, 1995: 200).

Medical education likewise saw significant changes, with a gradual but unmistakable evolution allowing a much wider section of society to enjoy such an education and as a consequence, move up the social ladder. Two major changes instigated this transformation in Britain. The freedom of the printing press in 1695 and the dissolution of the barber surgeons in 1745; the transformation of the printing trade was initiated through the lapse of the "Licensing Order of 16 June 1643", which restricted printing in Britain (Dobson, 1968: 279; Lawrence, 1996: 9). This allowed translations of scholarly texts from Latin to English and its free distribution permitted a wider section of society to acquire knowledge on topics which up until the 1750s were restricted to the learned members of society (Calman, 2007: 141). Both books and lectures were until then predominantly written and given in Latin, with William Cullen (1710-1790) being the first to deliver lectures in English during his time in Edinburgh (Warren, 1951: 310). The dissolution of the Barber-Surgeons Company in 1745 was followed by the establishment of the Company of Surgeons, as a consequence this removed the monopoly on dissection, opening up a free market for medical education (Appendix 1).

Prior to the dissolution, anatomy teaching in Britain was taught by demonstration only and students were unable to gain hands on experience of dissection (Peachey, 1924: 5). The passing of the Barber-Surgeons company put an end to this and opened up new opportunities for students, with the adoption of teaching methods from the continent; more specifically Paris and Leiden (Illingworth, 1967; Gelfand, 1971; Gelfand, 1983). Public lectures were continued by the Company of Surgeons, following the traditional pattern of demonstration. Though the lectures were outwardly meant to be of educational purpose, with the Murder Act of 1752, they predominantly served to demonstrate the consequences of murders (Appendix 1). The lectures which were open to the general public proved disruptive and unsatisfactory to students trying to improve their knowledge of anatomy. A young student described such a lecture in *The Gazetteer* on September 17, 1767 (Burney: Issue 12024) following the cancellation of a dissection of Mrs Brownrigg who was convicted for murdering her chambermaid; "*...a reader and demonstrator have been annually nominated, the first of whom automatically describes the parts to his audience, whilst the latter points out their extent and situation. Lectures of this species could not fail of proving useful to young students, and of consequence the amphitheatre was generally crowded; but (as) the presence of the mob was found to prove incommodious, From the noise and tumult occasioned by them…"* This method of teaching was unsatisfactory to both students and lecturers, who were ultimately working towards the advancement of medical knowledge and not for the purpose of public theatre. There was clearly a need not only for expansion but also changes in the method of education to keep up with the increasing number of students new developments on the continent; with hands on dissection gradually becoming the norm, students flocked to the capital to gain experience in anatomical dissection and attend the wards at one of the many teaching hospitals (Lawrence, 1995: 208). Hospitals and private anatomy schools became an integral part of medical education, gradually taking over the failing medical education provided by the Company of surgeons. By 1800 an estimated 40% of medical practitioners had completed at least part of their education in London (Porter, 1995: 96)

By the mid-eighteenth century London licences to practice were still under the control of three main bodies; The Royal Society of Physicians (1618- present), the Company of Surgeons (1745-1800) and the Worshipful Society of Apothecaries (1617- present) (Lawrence, 1996: 11). To gain a formal qualification, students had to sit an exam at one of the above; the Company of Surgeons controlled the examination of young surgeons, and to qualify as a surgeon they had to take an oral exam to gain a license from the Company (Lawrence, 1996: 79).

Despite these official bodies and the availability of diplomas, the surgical profession was not protected and an individual could still practice surgery without a diploma from the Company of Surgeons. This issue was highlighted by a letter published in *St. James' Chronicle* (September 16, 1788. Burney: Issue: 4268). The letter stated that the cost of a medical education was too high for some due to the extent of the requirements; first it was necessary to do an apprenticeship then attend courses of dissection and lectures in anatomy and surgery as well as gaining medical practice at the hospitals. To elevate the profession it was argued that more affordable access should be made to eliminate unregistered surgeons and that the conduct of surgeons should reflect that of a true gentleman; "*Exclusive to the Acquirements necessary to constitute the able surgeon, he should, to acquit himself with Reputation, possess a clear quick sight, a steady Hand, and a cool intrepid Courage. To exhibit those Talents with every possible Advantage, he should conduct himself with all admissible Tenderness to his Patients and their Friends, remembering, that suaviter in modo and Fortiter in re is in no character in Life so essential as in that of a surgeon*". "Gently in manner and strongly in deed" was the desired notion of a true surgeon and despite the acceptance of anatomists and surgeons as members of the Royal Society it was clearly still a profession viewed with some ambivalence, and by no means elevated to the status of university educated physicians.

With the absence of a university in London throughout the eighteenth century, anyone wishing to gain an education as a physician or attend a more formal structure of lectures had to attend universities outside the capital (Lawrence, 1996: 12). To qualify as a physician you would have to attend university either in Dublin, Oxford or Cambridge, with the two latter directly connected to the Royal Society of Physicians. The physicians considered themselves the elite of the medical world and positions were generally held by privileged gentlemen who had the education and means to attend university. Teaching was antiquated and lacked any practical aspect of medical training with focus instead on the teaching of Galen (AD 129 – 200/217) and Hippocrates (*ca*. 460 BC – *ca.* 370 BC) on which they were examined to gain the licentiate diploma allowing them to become member of the Royal Society of Physicians (Warren, 1951: 308). It was not until the late 18th century that teachers at these institutions encouraged visits to hospitals in London or abroad (Warren, 1951: 306; Copeman, 1965: 892).

With the emergence of "the clinical medical model" hospitals became an important part of medical training. This teaching method signified a removal from the traditional textual explanation to the use of observation and diagnosis, proving to be a great success (Geyer-Kordesch, 1995: 97). Edinburgh medical school was a later addition to university medical training; established by Alexander Monro *Primus* in 1726 it was modelled on teachings in Leiden. Edinburgh attracted many students from Britain and abroad and unlike Cambridge and Oxford, teaching was based on practical anatomy and boasted a teaching hospital (Geyer-Kordesch, 1994: 95). Teaching at the bed side started in 1746 and were initiated by physician John Rutherford (1695-1779) in the wards of the Royal Infirmary in Edinburgh, who adapted the methods of Thomas Sydenham (1624-1689) promoting "bed-side learning" (Fulton, 1953: 459). The shift to patient observation presented a significant change from traditional treatment methods and consequently medical training. The new approach relied on the process of investigation, diagnosis and treatment with a belief that diseases presented a rationality of appearance that could be easily classified and recognised (Schaffner 1985, 61). The number of students attending was testament to the popularity of the system with student numbers rising from 406 in 1700-1750 to 2500 between 1750 and 1800 (Geyer-Kordesch, 1995: 103). The Edinburgh model of clinical observation became a dominant feature of London's medical scene during the latter half of the eighteenth century (Porter, 1995: 93). There were seven hospitals in London (See below: Ellis, 2001: 55) where students could gain medical training by the mid eighteenth century (Fulton, 1953: 459).

1. St. Thomas' hospital (1173)
2. St. Bartholomew's hospital (1123)
3. Westminster hospital (1716)
4. Guy's hospital (1726)
5. St. George's hospital (1733)

6. London hospital (1740)
7. Middlesex hospital (1745)

London hospitals had physicians and surgeons on their staff and during the 18th century midwifery also became an integrated part of the medical system (Warren, 1951: 304). Appointments in these positions were generally honorary though some hospitals, such as Guy's and St Thomas, paid around £40 per year for both posts in 1794. The pecuniary disadvantage of hospital positions saw the emergence of the private anatomy schools, allowing physicians and surgeons to supplement their income through teaching (Porter, 1995: 98).

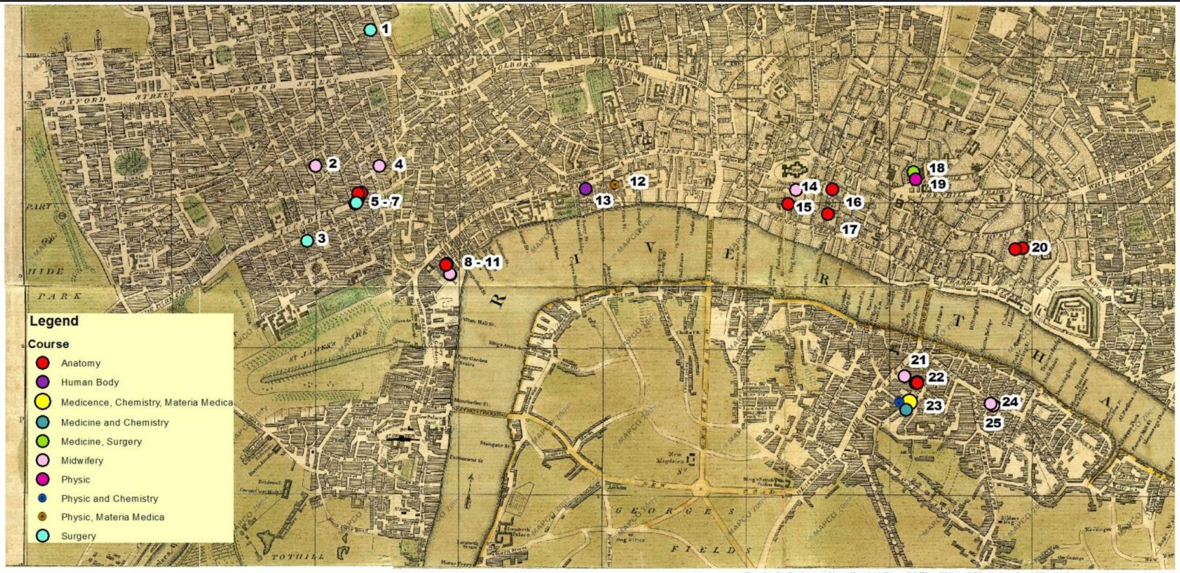
There were two main categories of private anatomy schools; the intramural and the extramural. The former was connected to a specific hospital and taught by appointed surgeons and physicians, with lecturing and dissection taking place at the hospital or within the private premises of the lecturer. Through these private practices and the associated teaching fees a physician could make upwards of £5000 a year (Warren, 1951: 305 and Calman, 2007: 141) and though Lawrence (1996: 169) suggested a figure closer to £1000 per year, even that was a not inconsiderable sum of money at the time. The extramural schools were independent from any hospital; entrepreneurial in nature they were run as businesses in a very competitive market (Lawrence, 1996). The emergence of private anatomy schools in London was not entirely a consequence of the loss of monopoly on dissection by the barber surgeons. The first schools started in the early 18th century and Peachey (1924: 8) counted at least 27 individuals providing private anatomy lectures prior to this event. George Rolfe appears to have been one of the first to offer such extra-mural courses in the Capital. In the daily newspaper "*Post Boy*" George Rolfe's lectures were remarked upon; "*We hear that Mr. Gorge Rolfe, professor of Anatomy of the University of Cambridge, at the request of several of his former pupils designs to give them a course of Anatomy, at his own house in Chancery Lane very speedily*" (Post Boy, February 19, 1713; Burney: Issue 2775). The notice illustrates the emerging need for further education outside the tuition given at the Barber-Surgeons Hall, at which George Rolfe taught at the time and outside the universities who seemingly provided inadequate courses. But the law of 1566 forbidding any dissections to take place outside the Barber-Surgeons Hall prevented any teaching of practical anatomy (Peachey, 1924: 2). It is not entirely clear how strictly this regulation was adhered to. In 1714 William Cheselden was reprimanded by the barber surgeons for procuring bodies from places of execution and dissecting them at his own house (Guerrini, 2004: 238). William Hewitt, a surgeon at St George's hospital advertised a course in 1740 at his premises in Leicester Fields allowing pupils to dissect and make their own preparations (Peachey, 1924: 38). Mr Hewitt advertised the course again in 1743 and

1747 having then moved to St Martin's Lane (General Evening Post, August 20, 1743; Burney: Issue 1548 and London Evening Post, January 3, 1747; Burney: Issue 2991). This suggests that despite openly advertising a practical course, he was not prevented from carrying out dissections outside the barber-surgeons hall, although the advertisement did not directly state that the pupils would dissect and prepare human cadavers. With the collapse of the barber-surgeons rule, the private enterprises were able to legally practice and in 1746 William Hunter finally realised his ambition to introduce "the Paris method" of teaching through hand on dissection, though the availability of bodies remained unresolved (Illingsworth, 1967: 29). He in effect pioneered the model of the private anatomy school, by opening his own school at the Piazza in Covent Garden in 1746, generating a model of teaching adapted by teachers for years to come (Cope, 1966: 90). This model of private anatomy school teaching was long lived and only ceased to exist with the closure of the Grosvenor Place School in 1863, though one anatomy school opened in 1871 and continued to exist until 1914 (Cope, 1966: 107).

Private anatomy schools were not governed by any official body and were truly a product of the free market (Porter, 1995: 95; Lawrence, 1996: 175). Lawrence (1995) argued that these enterprises served a dual purpose, not only as a business, but also to elevate anatomy to a science and promote the teacher's upward social mobility. Outwardly they offered students the opportunity to attend courses and expand their knowledge sufficiently to be able to present themselves for examination at the Corporation of Surgeons or the Society of Apothecaries (Fulton, 1953: 459). With a greater need to produce surgeons for the increasing population these establishments offered a fast track to medical learning and allowed students unable to afford a university degree or even the fees of the teaching hospitals to gain a qualification (Geyer-Kordesch, 1995: 104).

Several calculations on the number of anatomy schools which existed at this time are based on advertisements in the local media. Lawrence (1996: appendix III) expanded Peachey's (1924) list of private anatomy schools in London to include those established between 1750 and 1804. Chaplin (2009: Appendix 1) again expanded this list to include no less than 77 teachers of anatomy, surgery or midwifery between 1746 and 1800. This figure clearly demonstrates the demand and success of these establishments and provide an insight into the number of students flocking to the capital every year to gain medical knowledge. The map below (Figure 4) shows the location of anatomy schools who advertised in the local newspapers from 1772-1778, the period Craven Street anatomy school was active.

London Anatomy Schools 1772 - 1778



KEY

1 Percy Street Rathbone Place Mr Hunt 1776 Surgery
2 Queen Street, Golden Square Dr Osborne and Dr Denman 1773, 1775 - 1778 Midwifery
3 Jermyn Street, St James John Hunter 1775 Surgery
4 33 Gerrard Street, Soho ? 1774 Midwifery
5 Windmill Street Dr Hunter 1772 - 1773 Anatomy
6 Windmill Street John Hunter 1776 Surgery
7 Windmill Street Dr Hunter and Mr Cruickshank 1775 - 1777 Anatomy
8 26 Craven Street Dr Leake 1772 - 4 and 1776 - 1777 Midwifery
9 27 Craven Street Mr Hewson 1773 - 4 Anatomy
10 27 Craven Street Mr Falconar 1774 - 1778 Anatomy
11 27 Craven Street Mr Falconar 1774 - 1778 Anatomy
12 Essex Street, Strand Fordyce 1772 - 1774, 1776 - 1777 Physic, Materia Medica
13 403 Kings Arms, Strand Patence 1776 Human Body
14 9 South Side, St Pauls Church Yard Dr Orme and Dr Lowder 1774 Midwifery
15 17 Little Knight Rider Street, Doctor's Common Dr Maclaurin and Mr Andree 1773 - 1774 Anatomy
16 Trinity Lane, Bread Hill Dr Maclaurin1775 - 1776 Anatomy
17 Huggin Lane, Bread Street Hill Dr Maclaurin 1772 Anatomy
18 7 Chapel Sheet, Bartholomew Lane Dr Maddock 1773 Medicine, Surgery
19 6 Capel Court, Bartholomew Lane Dr Maddock 1774 - 1775 Medicine, Surgery 1777 Physic
20 12 Mark Lane, Fenchurch Street Dr Maclaurin and Mr Blizard1777 - 1778 Anatomy
21 St Thomas' Hospital Dr Orme and Dr Lowther 1777 Midwifery
22 St Thomas' Hospital Mr Else 1772 - 1778 Anatomy
23 Guy's Hospital Dr Saunders 1772 Medicince, Chemistry, Materia Medica 1773 - 1775 and 1777 Physic and Chemistry 1776 Medicine and Chemistry
24 St Saviour Church Yard Southwark Dr Mackenzie 1772 - 1774 Midwifery
25 24 St Saviour Church Yard Southwark Dr Orme and Dr Lowder 1776 Midwifery

Figure 4 London anatomy schools advertised in the local media 1772-1778 (Based on newpapers available in Burney's collection and plotted on Bowels' map 1775) (Map from MAPCO.net annotated by Richard Holden) (For larger image please see attached CD)

There were at least 20 different premises from which medical courses were advertised. The location of the anatomy schools show clusters in the west end and the city and premises near Guys and St Thomas hospitals. Some teachers were attached to the hospitals but an ever increasing number of anatomy lecturers were independent. Lawrence (1996: 88) indicated that about 50% of lecturers were independent, whilst Chaplin (2009: 38) based on his expanded list of lecturers suggested a figure closer to 83%. The ungoverned private anatomy schools in London could create courses as they saw fit, it was not until the apothecaries act in 1815 that formal requirements were laid down. Porter (1995: 93) suggested that they taught mainly practical anatomy and tended to teach subjects which were prerequisite for prestige reasons, such as midwifery which provided a good wage.

In 1792 George Edwards M.D (1752-1823) wrote to "*The Time*" (Burney: September 25, 1792) requesting a reform of the current system of medical education in London. He advocated a central school of medical education to enhance the quality of teaching, effectively calling for a more structured and centralised education system. He stressed that the current system of teaching resulted in serious shortcomings in qualifications. Edwards noted that lectures at hospitals were centered on anatomy and surgery which was only relevant to one quarter of any future practice. He suggested that the central school would conduct the courses and hospitals would remain involved as providers of case studies. He highlighted that such a school would make it much easier for students to attend different courses and be located centrally to most of the city's hospitals. His letter highlighted some of the problems in the entrepreneurial and ungoverned nature of medical education in London. Students could effectively pick courses they thought appropriate for their needs, resulting in gaps in their medical knowledge. Edwards noted the lack of knowledge of "physiks" as one of the shortcomings of hospital education. Even if such courses were offered privately students were under no obligation to attend them. Selecting courses was far from straight forward, students had to travel from one school to the other to attend lessons often finding that these overlapped. Despite being a sensible solution to the problems in medical education at the time, the idea of a central school gained opposition from medical men across the capital, because it would have caused the open competitive market to collapse meaning the loss of livelihood of many of the influential men.

3.2 The cadaver trade

Practical anatomy teaching required a steady supply of human subjects for dissection. The reputation of a school rested not only on the skill of the lecturer, but also on the availability of bodies. The students had to pay the lecturers for a body or body part (Lawrence, 1998: 118). it was therefore necessary for the teacher of the private anatomy schools to collaborate with grave robbers, as the supply of bodies from the gallows was scarce (Richardson, 1988; Porter, 1995; Lawrence,1998; Magee, 2001).

The laws governing dissection saw little change since the initial acknowledgement of the need for dissection in the 1540s, severely limiting the supply of legal cadavers. It was not possible to legally obtain bodies and several acts proposing an increase of supply failed to transpire (Richardson, 1988: 54) (Appendix 1), which gave rise to a lucrative illegal trade in cadavers with legal loopholes making it well worth the risk. Body snatching was widespread between 1675 and 1725, continuing right up to and beyond the Anatomy Act of 1832 (Hurren, 2004) (Appendix 1). Towards the end of the eighteenth century the public outrage against not only the illegal trade of cadavers but also the schools they were supplying, highlighted the need for changes in the law that would accommodate the need for education as well as satisfying the public abhorrence to this practice. Reports of the debates surrounding the Anatomy Act provide a wealth of information about the nature of the trade and public opinion. Public debates in newspapers and court cases at the old bailey as well as the famous "*Diary of a resurrectionist*" (Bailey, 1896) has likewise added substantially to the topic.

In the *Westminster Journal* of 1746, concerns were expressed regarding the supply of bodies; "*there are at least five or six lectures of Anatomy read every night during the winter season, and I am informed that it is absolutely necessary for every lecture to be furnished with, at least, one fresh body once a week and that it would be much more for the Advantage of the pupils who attend to have two or three bodies at the same time under dissection*" (Westminster Journal, December 20, 1746, Burney: Issue 264). In *The Penny London Post* (January 22 1750, Burney: Issue 1215) the number of bodies used in a private anatomy course was further discussed; "*I had the curiosity to read one of these Gentlemen's proposals, referred to by his Advertisement, and find thereby, that he uses no less than six bodies in every course..*". Monro *Primus* (1747) advocated the use of two bodies during lectures in order to demonstrate different parts of the anatomy, but also indicated that a body could last up to a month if well maintained. This suggests lectures may have required at least two bodies a week for demonstrations alone but these bodies may have been used for different lengths of time, depending on the point of anatomy being demonstrated.

In addition bodies were needed for student dissection, still further increasing the need for cadavers. The number of students attached to hospitals between 1750 and 1815 was over 10000 not including the students attending private anatomy courses (Lawrence, 1996: Appendix 2b; Chaplin, 2009: 37). The Dissection Committee of 1828 reported that around 62% of students attending anatomy courses also dissected (Monthly Magazine 6:34,828.Oct p.337). They estimated that a student should have access to at least three bodies over two seasons (one season lasting September to May) in order to gain sufficient knowledge; two for dissection and one for operative surgery (Goodman, 1944: 808). However other anatomists suggested that one body may be sufficient by allowing the student to dissect different parts over time. The 1828 Dissection Committee provided a figure of 592 bodies dissected by 701 students (0.8 bodies per student) that year (Richardson, 1988: 54). Whether this figure is applicable to the private anatomy schools of the late eighteenth century is unknown, in France during the early 19th century the number was considerably higher with 10-12 cadavers per student and it is not unlikely that William Hunter who trained in France would have considered this figure more appropriate (Monthly Magazine1828: 6:34,828.Oct p.337). The large number of students flocking to London meant the cadaver trade was flourishing at this time and despite the illicit nature of the trade the Dissection Committee remarked; "*a medical education, even of the lowest description, soon came to be considered defective without it [dissection]*" (Monthly Magazine 6:34,1828.Oct p.337).

3.2.1 The resurrection men

Body snatching was originally done by the medical students and lecturers. William Hunter himself was known to have participated in such ventures (Richardson, 1988: 57), as shown in a caricature where he has been caught by the night watchman and tries to flee the scene (Figure 5). Gradually, however, the illegal exhumations were undertaken by resurrection men (Frank, 1976: 401)

Figure 5 caricature of William Hunter body snatching; being caught by the night watchman he tries to escape. Etching, with engraving dated about 1775-1780. M. D. George, British Museum catalogue of political and personal satires, v, 1935, p. 120.

Stealing a corpse was only a misdemeanour under common law, not a felony, and was therefore only punishable with fine and imprisonment. This made grave robbing a worthwhile and a lucrative business for those willing to exhume the dead for profit (Richardson, 1988: 55). A ressurectionist with two assistants could raise 5-6 bodies in a night with one ressurectionist stating that between 1809-10 he had supplied schools with 305 adults, 44 children (under 3 feet) showing a gradual increase to 360 in the year 1811-12 (Anonymous, 1947: 380).

The resurrection men would frequent cemeteries across London. The Lambeth gang attended close to 30 cemeteries between November 28, 1811 and December 5, 1812 obtaining at least 161 bodies over this period, of these 123 were aged more specifically; 74 (60%) adults, 37 children (30.08%) and 12 foetuses (9.75%). One group known as the London Borough gang (1802-1825), would wait in the night at the church-yards looking for bodies at night and would uncover the head portion of the grave and pull out the dead body by the neck remove the shroud and carefully cover up the grave. It appears from the D*iary of a Ressurectionist* that they traded, as well as complete cadavers. On August 11 and 12 1812 Naples noted that one of his colleagues had cut the extremities of a body and sold them to Bart's hospital and on August 19, 1812 sold a head to Millard (Bailey, 1896). It is not known whether or not it was commonplace for the ressurectionists to dismember the bodies to sell the parts separately, perhaps they would fetch a higher sum than sale of complete cadavers. It is possible that it was the result of necessity during the summer months, mentioned in these accoutns, because the bodies would have decomposed faster, with the extremities being less vulnerable than the torso. In 1883 Alexander Macalister from Downing College Cambridge was offered a box of amputated parts for dissection, indicating that purchase of body parts took place as well as complete bodies (Hurren, 2004: 83). It was not uncommon for the body snatchers to encounter rotten bodies, in which case they would remove the teeth to sell, but leave the body in the ground (Bailey, 1896).

It has also been documented that anatomists were able to make specific requests for bodies, as illustrated in one case of a surgeon in 1738 being tried for receiving specific bodies he had ordered (Denison, 1799: 170). Naple's diary also supports this idea as on January 12, 1812 when he "*went to take orders from Capue and Wilson*", two surgeons (Bailey, 1896). It appears that the correct supply was dictated by commerce, and any "goods" could be obtained as long as the price was right. In 1828 the prominent surgeon Astley Cooper (1768-1841) stated in evidence to the select committee that; "*there is no person, let his situation in life be what it may, whom, if I were disposed to dissect, I could not obtain...the law only enhances the price and does not prevent exhumation*" (Russell, 1970: 40). The cost of a body appeared to fluctuate over time in a way most likely governed by supply and demand. In the 1790s the Lambeth gang charged two guineas and a crown for an adult corpse whilst children were sold for six shilling for the first foot and nine pence for every inch above this height (Richardson, 1988: 57). Goodman (1944: 808) concurred with this suggesting a price of 1-2 guineas in the 1790s rising to 8-10 guineas in 1823. In 1812 The Lambeth gang charged around 4 guineas and 4 shillings for an adult, 1-3 guineas for a child and 10 shilling and 6 pence for a foetus. The gang also sold teeth (priced from 11 shilling up to five guineas) and extremities and heads at a price of one guinea each (Bailey, 1896). The prices depended on the state of the body and the time of the year, with bodies in the summer more likely to fetch only one guinea. Ashley Cooper complained that it was virtually impossible to get bodies from London church yards at the end of the resurrection era due to public awareness and opinion. Scarcity of bodies often caused lectures to be suspended for weeks and the committee commented that "*the pupils are exposed to the danger of acquiring habits of dissipation and indolence*" (Anonymous, 1947: 381). Prices rose dramatically at the beginning of the nineteenth century where bodies were sold for as much as twenty guineas (Magee, 2001: 378), it was therefore perfectly appropriate to provide students with body parts over the duration of the course, eventually adding up to a single body (Richardson, 1988: 54).

3.2.2 Law and punishment

The law on body snatching is a classic example of a legal loophole. As a dead body could not legally be "owned", it could not be stolen either, so the taking of a body did not amount to theft. It was only in cases where the deceased's belongings, such as the shroud, were taken from the grave that the crime could be punishable by death (Frank, 1976: 400). In addition surgeons who bought the bodies should be punished if caught in the act was debatable. In 1738 the case of surgeon William Alexander was brought to light, as he had requested three specific bodies from the sexton for dissection. The sexton was prosecuted and it was debated whether the surgeon should also be prosecuted as "*..his having given the Sexton a particular order for three particular bodies, and not a general order only*". It was stated that whether it was a particular of general "order", it should still be considered a very "high misdemeanour" and that a pecuniary punishment would be more fitting, but if the individual prosecuted could not pay corporal punishment in the form of a whipping could be carried out (Denison, 1799: 170). In 1788 a John Lynn was brought into the court of King's Bench for "*taking a dead body for the purpose of dissection*", was defended by Mr Serjant Bond, who argued that the case did not belong in Court of Common law but instead should be under the jurisdiction of the Ecclesiastical Court of Common law. A Mr Garrow supported Serjant by remarking that "*the useful science of anatomy could not be promoted, nor the public receive any benefit from professional men, without subjects of dissection* *provided*" The arguments were overruled and the prosecuted fined five marks (General Evening Post, November 25, 1788. Burney: Issue 8587). These cases illustrate that it was possible to convict a surgeon, usually resulting in fines rather than imprisonment or corporal punishment. Grave robbers were much more likely to receive more severe punishments for their actions. In 1766 John Hope, a grave robber, was "*convicted of stealing a dead body, and sentenced to one year's imprisonment, and be publickly whipped from Charter-house wall to Dog-house, Old Street*". If the grave robber was caught it was often down to the lecturer to secure their release, which could cost as much as £50 (Report from the Dissection Committee, Monthly magazine 6:34, 1828, Oct. p. 345) and in the early 19th century a medical student was fined £20 for being in possession of a body, though he had not been part of the disinterment, indicating that the laws were tightening as body snatching was becoming more widespread (Anonymous, 1947: 380). In 1823 there were 14 convictions for body snatching in England, with imprisonment and fines being the punishment (one man was sentenced to 2 years and a £20 fine). It was suggested that the punishments did not eradicate the crime, but simply made bodies more expensive (Mackenzie, 1824: 89).

3.2.3 Public attitude

Public opinion about the removal of bodies from grave yards created a heated debate between religion and science. Perhaps not surprisingly dissection was generally perceived as an abhorrent activity and anatomists were often viewed as butchers rather than medical men. Men of science it was argued, using dissection as a form of punishment for murder, did not help to alter public opinion; "*the bodies of all those who, by laws of Great Britain, suffered death for murder, should be conveyed to their amphitheatre, and there exposed to the view of the populace. This was apparently intended as a means to deter the mob from such horrid practices, as in the minds of the vulgar the word dissection carries with it the most terrifying and alarming sentiments*" (Gazetteer and New Daily Advertiser, September 17, 1767. Burney: Issue 12024). Transforming public opinion was difficult given the manner in which dissection was displayed in the public media as a form of corporal punishment for sins committed during life. Hogarth's "*The Fourth Stage of Cruelty*" shows a public dissection as the final scene "the reward of cruelty" where it is the ultimate punishment of crimes committed during life (Figure 6).

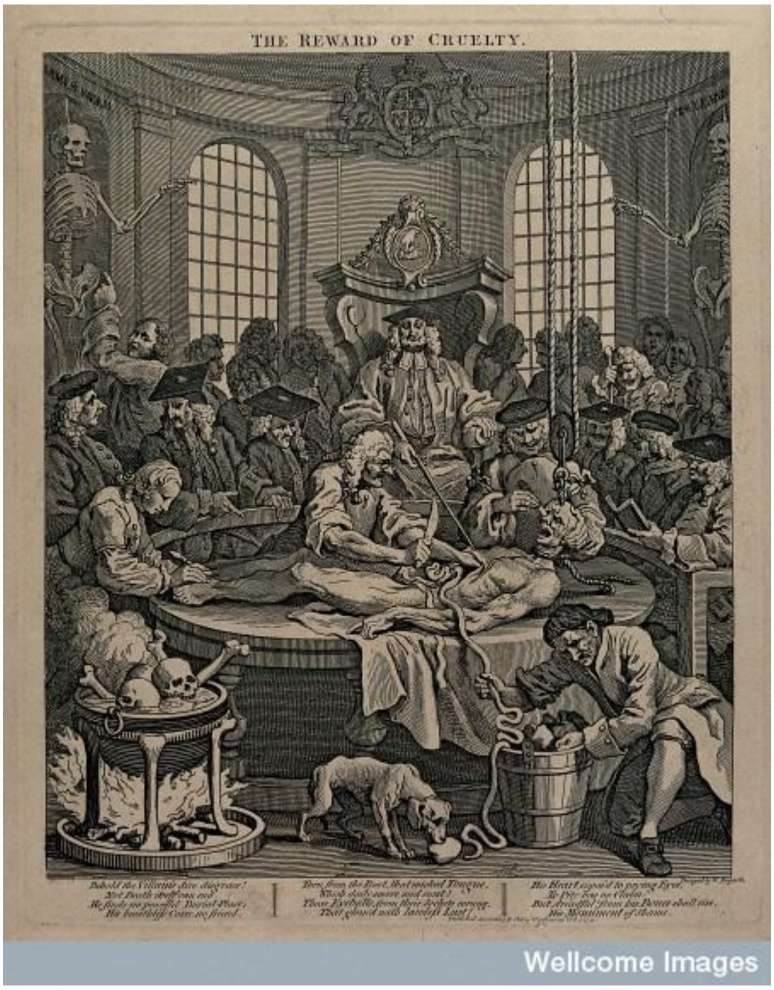


Figure 6 William Hogarth's fourth stage of cruelty (Wellcome image library)

As a response to public outcry over the illegal cadaver trade, the prevention of body snatching became a business venture in itself. In 1770 Jarvis & Son advertised a patented coffin to prevent grave robbers from getting to the body before it had decayed, a privilege that could be purchased at the price of three and a half guineas (Whitehall Evening Post, March 11, 1797; Burney: Issue 7155). Edgar (1826: 125) wrote an appeal to the general public, arguing the importance of science summarising the, to him, unfounded resentment displayed by the public "*there is, generally, Sir, in cases of disinterment, for the purposes of dissection, a great cry about it being revolting to humanity, - against the laws of god,- dreadful to contemplate, &c. This, Sir, is the merest gabble. Answer me this, all ye who shudder at the idea of dissection:- which is the most appaling to contemplate- the worm and corruption feeding on a dead body, or the dissecting knife of an anatomist piercing it? It boots not to the dead whether their remains become mass of loathsome corruption, or whether, by means of science, they become subservient to the interest of the living; but to the living it is an object of the greatest importance that every discovery should be made by which their lives could be prolonged. If this argument can be overcome, I shall then join the universal clamour against the resurrectionist, "but not till then".* Donations of bodies were very rare but not unheard of in the eighteenth century. In *the gazetteer* on July 26 1766 (Burney: Issue 11661) an anonymous contributor conceded the point made by the men of science by proclaiming anatomical dissection a necessity, but insisted that people had the right to dispose of their bodies as they saw fit", to which he added "*As I am indifferent about my carcass, and possess a defect in nature for which no present account can be given, and which anatomy might discover, I would much rather consign my body to the surgeons after death, than it should be buried, as it might be of some service to others in the like circumstance"*. A further donation was announced in *The Morning Chronicle* (May 11, 1772. Burney: Issue 925) where a gentleman suffering from angina (narrowing of the coronary arteries) requested to be autopsied to discover more about his condition, in order "*to be of as much service to Mankind as possible*". The dissection was carried by William Hunter, who was in turn expected to use his findings to benefit society. It appears that donations were predominantly made by those who realised the importance of dissection in the discovery of new cures and had suffered as a consequence of the lack of medical advancement.

3.2.4 Disposing of dissected bodies

The acquisition of cadavers and body parts was at the very least competitive, expensive and hazardous. Disposal of body parts after dissection was likewise a problematic endeavour, though this issue has received far less attention in the current literature than that of grave robbing. Chaplin (2009: 63) mentioned the discovery of body parts at John Hunter's residence in Earl's Court in 1886, where workmen found burial pits containing human remains. Human body parts were further discovered in 1773 in a stable in Tottenham Court Road and in 1747 on a dunghill in St George's Fields, the latter including the remains of one woman and eight children (Chaplin, 2009: 64). Transporting body parts from one site to another would have risked exposure. Therefore the shorter the distance bodies or parts of them were transported the less chance of getting caught in the act. Both locations mentioned by Chaplin (2009) were in the countrified outskirts of eighteenth century London, suggesting that bodies were taken to nearby rural locations to be disposed off after they had served their purpose at the anatomy schools. The illicit nature of procuring cadavers for dissection meant it would have been difficult to arrange any reburial in consecrated ground, though grave robbers may well have offered a service of body disposal at an additional expense. Archaeological excavations of church yards and burial grounds across London reveal very few bones which suggest that they were from dissected body parts, though evidence of autopsies are present, suggesting that re-internment in consecrated ground was not the preferred method of disposal (Crossland, 2009:107). Richardson (1988: 97) argued that dogs may have been used as a means of disposal, to "*save the surgeons the* *disagreeable labour of reinterring the many dead bodies after they have done with them*", though this is unlikely to have been an ideal or common solution. Richardson (1988:248) also noted that percious little would have remained to bury once the dissection was complete, but none the less the bones on the dead would have to have been buried somewhere. So where were all the bodies dissected for the period of 86 years between 1745 up until the Anatomy Act of 1832 disposed of? The history of London, the cadavers remain mainly unaccounted for both in the archaeological and the historical records (Crossland, 2009:107). It is puzzling that so few dissected remains have been discovered archaeologically both in consecrated ground and outside, particularly if the favoured disposal areas were in the outskirts of London, which today form part of urban central London. The river Thames would have been another potential location of disposal but it might be expected that more body parts would have washed up on its shores over time. The lack of dissected body parts suggests they were destroyed rather than buried, perhaps by incineration, but there is no archaeological evidence of this accumulation of cremated human remains from this period. It is not impossible that sawn and cut bones might not be distinguished from animal bones if discovered by a lay-person, but this level of cutting would have been laborious and time consuming. The most tangible evidence for the disposal of dissected remains came from the archaeological records associated with hospitals in and outside of London, revealing large pits and grave sites where their dissected human remains were buried (section 8.2), but it is questionable whether these included remains from the private anatomy schools, unless there was an agreement between the two parties. It is most likely that a combination of disposal methods was used, depending on the location of the school and convenience as well as the financial means of the schools, but it remains unclear why so few anatomized remains have been discovered in the archaeological record.

3.2.5 The Anatomy Act of 1832

The Anatomy Act 1832 was a twofold response to the debate on body snatching, which by the nineteenth century had become endemic. There was a clear need to accommodate public opinion and put a halt to the cadaver trade whilst it was equally important to ensure a steady supply of bodies to the schools. Due to the shortage of supply of bodies, students were abandoning Britain in favour of Dublin and Paris, where the supply was significantly better (Mackenzie, 1824: 85).

As early as 1767 the issue of body snatching was highlighted in the *London Evening Post* (June 20, 1767) where an article discussed the extent to which body snatching should be conceived acceptable or at the very least outside the law. The proposal was to impose only a small fine as a punishment for taking the bodies of poor persons, whilst the law should remain in full force where bodies of the gentry and the rich had been taken. The proposal resonates with the problems apparent in the Anatomy Act, proposed years later, and which made its acceptance difficult. A Committee on Anatomy was set up on the 22nd of April, 1828 in response to a 40 page letter written by Dr Southwood Smith in *the Westminster review* 1824 "*The use of the dead to the living*", promoting the use of unclaimed bodies for dissection in order to eradicate body snatching but at the same time ensuring that medical education did not become compromised (Southwood-Smith, 1824). A Bill was proposed in 1829 allowing unclaimed bodies from prisons, workhouses and hospitals to be dissected but it was felt that this allowed an unfair persecution of the poor and was rejected (Anonymous 1947, 381). *The Lancet* objected to the Bill, seeing it as a legalised trade in bodies (Goodman, 1944: 808). Another critic of the bill, Lord Teynham, opposed it in Parliament, on the grounds that the legislation failed to ban the sale of corpses and it would "*convert every workhouse keeper into a systematic trafficker in dead bodies*" (MacDonald, 2009: 381). It was not until the murder by two body snatchers Bishop and Williams, of a 14 year old Italian boy, Carlo Ferrari, for the purpose of dissection that a final bill was put forward in August 1832. This Bill "*An act for regulation of anatomy schools*" was passed straight away even though it proposed substantial changes to the law. The main points were;

a. It was in the power of the Secretary of state for the Home Department and the Chief Secretary of Ireland to grant licences to practice anatomy.
b. Parliament had the power to appoint three Inspectors of Places where Anatomy is carried out
c. Licenced anatomy places could lawfully be in custody of a body for dissection in certain circumstances;
    i. unclaimed bodies – unless the person in life specifically requested not to be dissected
    ii. unless relatives objected to dissection
    iii. Relatives donating bodies for dissection as the price of a funeral
d. If a person wished to be dissected this should be done, unless relatives objected

e. The deceased should not be dissected until 48 hours after death and 24 hours after notice has been given to the inspector with a certificate of death.
f. Persons licenced to receive bodies for dissection should provide all details and certificate of death to the Secretary of State.
g. Bodies must be buried in a coffin and within religious ceremony with six weeks of death.
h. The 1752 Act allowing dissection of murderers was repealed;
i. Any unlawful actions in terms of the Act were punishable with a maximum of three months' imprisonment or a maximum fine of £50.

A total of eight hospital schools and eight private anatomy schools were licensed in London alone following the passing of the Act. The first appointed Inspector of Anatomy Dr James Somerville declared the Act a success and in 1834 he stated that exhumations had ceased, prices of bodies had decreased dramatically and they were much fresher. He also stated the supply of bodies to anatomy places had increased from 300 the year before the Act to 600 in London itself (Somerville, 1835: 765; Goodman, 1944: 809). The Act of 1832 failed to alter main sources of bodies by still targeting prisons and workhouses as well as those who gave up bodies of relatives for dissection at the price of the funeral. The Act also did not actually prevent the selling and purchase of bodies, openly done by reputable establishments such as Bart's who sent requests to workhouses and prisons for bodies offering a price of £5 for each one (MacDonald 2009, 384). Another major shortcoming of the act involved the dissection of body parts, as the Act only demanded regulation of complete corpses (Macdonald, 2009: 388). In the *British Medical Journal,* 21 of January, 1882 (p.102), a letter was posted in response to claims of body-snatching in a previous issue highlighting that the fear of illicit trade in bodies was still rife 50 years after the act was passed.

The Anatomy Act of 1832 thus arose from the lack of legal supplies of bodies for medical education and research which, following the dissolution of the Barber-Surgeons grew hugely until the body trade got out of hand. Ethical issues still rife today were highlighted but not effectively dealt with in the Act. The arguments between ethics and science were blurred. Private anatomy schools were first and foremost businesses and illicit procurement of bodies was contributing to what was essentially a corporate enterprise, set up not only for the enhancement of mankind but also for capital gain. It is difficult to accommodate one without challenging the other. The private anatomy schools were frequently situated in residential areas where it would have been impossible to protect the public from seeing the moving of corpses to and from the schools, even when undertaken in the dark of night. Today it is difficult to comprehend fully the scale of resentment the schools must have generated amongst the general public, though the number of schools erected in London also indicates some acceptance of their existence. The scientific community took a more lenient stance realising the importance of dissecting bodies for the enhancement of science. Though the Anatomy Act of 1832 was effective in diminishing grave robbing, there were loop holes allowing anatomists to continue the trade in bodies to ensure a sufficient and steady supply. The Act stated that bodies should be lawfully buried no later than six weeks after they were acquired, but there is very limited archaeological evidence that this actually took place.

4 The use of cadavers and animals in eighteenth century medical education

The day to day teaching at anatomy schools was wholly reliant on the supply of cadavers and animals, which were used to fulfil many different requirements of medical education during the eighteenth century. This chapter has been divided into four sections; dissection for the purpose of education and research; surgery in the eighteenth century, the making of preparations and the application of animals in anatomical studies. These sections presents a discussion on the variety of function applied to cadavers, placing emphasis on how these functions may be detected in the archaeological record.

4.1 Dissection

It was viewed as paramount to the education of medical students to gain hands on experience in the dissection room. In France it was frowned upon not to have such experience; *".... Physicians or surgeons who are not acquainted with anatomy, is universally regarded as the most ignorant of men*" (Mackenzie, 1824: 335). This attitude was adopted in Britain with the introduction of practical anatomy and it was seen as "*necessary for young men to walk the wards after completion of their apprenticeship*" and to attend lectures on anatomy (Morning chronicle, November 13, 1772, Burney: Issue 1085). It eventually became just as essential to have "*gone through at least two courses of dissection*" in order to acquire a surgical diploma from the Company of Surgeons. Discontent was uttered over the fact that this was not the case at the Apothecaries' Hall, which resulted in many young men opting for this qualification instead to avoid "*the fatigue and disgust of the dissection room*" (Mackenzie, 1824). John Hunter once proclaimed "*Too much attention cannot be paid to the structure & situation of the human body. This knowledge will show the parts which can be cut*...." (Payne, 2007: 142), highlighting the importance of dissection in undertaking surgical procedures. The dissection room would have been an unpleasant necessity, but unquestionably an enlightening experience where first hand observations could be shared with fellow students and lecturers.

Only a handful of publications exist on dissection techniques pre-dating the nineteenth century. But after this period we see an abundance of detailed and richly illustrated books on the topic including "*The London Dissector*" (Hooper & Ruysch, 1809), and "*Holden's manual of the dissection of the human body*" (Holden, 1894). It could be argued that dissection techniques have seen minimal changes across the centuries and instructions dating to the nineteenth and twentieth centuries would have been equally relevant in the eighteenth century. It is however important to recognise that there might have been more substantial difference in technique between the eighteenth and nineteenth centuries than between the nineteenth and twentieth, though such variations may not be chronological in nature. For these reasons, this thesis focuses on techniques that were unquestionably used in the eighteenth century and compares them to those of the nineteenth century. Whilst there are numerous accounts providing descriptions of anatomical observations (Monro, 1744; Keill, 1759; Northcote, 1772; Cheselden *et al.*, 1784; Monro *et al*., 1784) there are only two major eighteenth century works in English providing details on how to dissect a human body. The most comprehensive manual is that of Lyser and Thomson, published in 1740, "*The art of dissecting the human body"* translated from Latin into English in 1740, followed by the treatise of Alexander Monro *Primus* (1747), "*A treatise on Anatomical Encheireses – Manual part of Anatomy*" which he wrote for his son Donald Monro, intending to instruct him how to dissect two cadavers during a demonstration (Lawrence C, 1988:197)**.** Monro's instructions were consequently not aimed at the students, but at the lecturer providing instructions to the students. With the teaching reform in the middle of the century allowing students to dissect rather than simply observe, there must have been a need for not only cadavers but also student manuals on dissection, it is surprising that no further works were produced in English on the topic of dissection until the nineteenth century. From lecture notes it does appear that students were openly discouraged from reading any book prior to or during the course, for example, William Hunter advised his students against reading books on anatomy until his courses had finished, as this would confuse them more than assist their understanding (Hunter, 1784: 108). John Hunter similarly discouraged his students from taking notes at any time as they would only serve to confuse as the course went along (Moore, 2009: 395), highlighting the dynamic nature of anatomy with new observations replacing the old on a regular basis.

It is not within the scope of this thesis to go through the whole process of dissection. Instead techniques that leave visible marks on the bone will be highlighted, to aid the interpretation of osteological material from Craven Street.

4.1.1 The dissection room

A dissection room in the eighteenth century would have had a very different appearance from those of today. Guttmacher (1955) provided a description of the dissection room at St Thomas's Hospital dated to the mid eighteenth century. The room was relatively small with lighting in the day time provided by two eastward facing windows and in the night time by a square lantern. The west of the room was furnished with stacked glass cases and to the south a large fireplace and copper kettle to prepare the cadavers. There was a large leaden sink beneath the windows and the central room was furnished with a dozen tables. Clare (1779: 119) remarked that the dissection room at St. Thomas had wooden floors, which were less cold than the more practical brick floors generally seen in dissection rooms. Each table would have accommodated 6-8 pupils allowing upwards of 70 students in the dissection room at any one time (Lassek, 1958: 139). James Williams, who attended John Hunter's anatomy school wrote to his sister In October 1793; "*The dissection room with half a dozen dead bodies is immediately above, and that in which John Hunter make his preparations is next adjoining to it…*" (Dobson, 1969. Cited/Payne 2007, 103). Chaplin (2009, 7) depicted a reconstruction of John Hunter's anatomy school as it would have appeared at the back of his house in Jeremyn Street in the early 1770s, with the theatre on the ground floor, the museum on the first floor and the dissection room on the top floor (Figure 7).

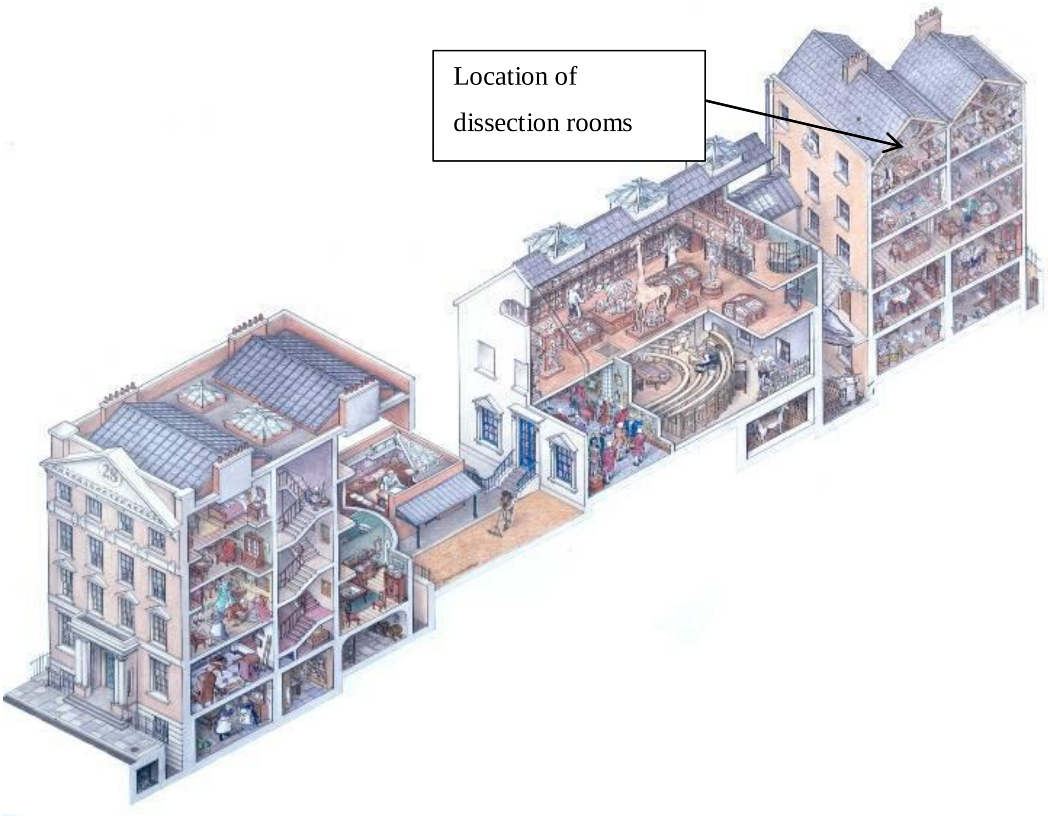


Figure 7 reconstruction of Hunter's home and anatomy school at Leicester Square, by John Ronayne (2004). Courtesy of John Ronayne/the Royal College of Surgeons of England (RCSSC/P 567) (Chaplin, 2009:404)

The dissection room at St Thomas appeared to be very crowded and the lack of lighting must have been an obstacle during the winter months. John Hunter's dissection rooms were apparently on the top floor which may well have been to provide sufficient natural light during the winter months. Lyser and Thomson (1740: 12) observed that lighting was crucial, and though it was not uncommon to dissect by candle light, they recommended natural sunlight and a table that could be easily moved to accommodate the light in the room. The illustration by Rowlandson of the dissection room at Great Windmill Street (Figure 8) depicted windows placed high up at an angle but was dismissed by Brock (welcome library comment below image) as being inaccurate, because it suggested an attic room. This was not necessarily the case; if this room was purpose built this arrangement of the windows would have been the best option for optimal lighting and protection against prying eyes, the lighting would have spread further and stayed longer in the room. Hunter (1784: 111) remarked that the sky-lights in his lecture theatre allowed superior viewing of the bodies, being made of ground glass they also refracted the light to avoid direct heat and glare on the body. Placing the windows in the roof would have allowed for better use of wall space and the limited dimensions of the room. It seems questionable, given the need for cool temperatures, whether the fireplace at St. Thomas (Guttmacher, 1955) would have been used to warm the room and would probably only have been lit if required for making preparations. Heat would have accelerated the decomposition of the cadavers and the dissection room had to be kept as cool as possible at all times. Clare (1779: 119) did however comment that the dissection room at St. Thomas was less cold due to the fire and the wooden floors, which seems to indicate that the fire was active during dissection. Lyser and Thomson (1740: 11-12) supported the need for a cool space when performing dissections, "*these operations should be performed in a cold place, therefore the Anatomist ought to have a Fire-pan for warming his Hands now and then, but allow for no Fire to be made in the Room where the Body is, because a warm Hand will soon reduce the ridged Members to their proper Tone*".

Figure 8 the dissection room (Thomas Rowlandson ca. 1770) (Wellcome Library Images)

Illustrations at the time portray a messy and chaotic environment with body parts scattered over the floor and tables with living animals running around helping themselves to the rich pickings (Figure 6 and Figure 8). The first image, by Hogarth "*The Fourth Stage of Cruelty*", depicts a public dissection whilst the second image is an illustration of the private dissection room in Great Windmill Street, but both convey the same sense of chaos. Contrary to these caricatures of dissection, cleanliness and aesthetics was promoted throughout a dissection by both Monro (1747) and Lyser and Thomson (1740). Lyser & Thomson (1740: 10) advised, "*Neatness must be minded as much as possible, without which Dissection will be both tedious and nauseous to the spectator*". "Neatness" involved clean hands, washing the body before dissection and shaving off any hair. It is interesting to observe that in both images (Figure 6 and Figure 8) the body is completely hairless. Lyser and Thomson (1740) advised that sponges should be kept nearby throughout any dissection to mop up any fluids and keep all parts of the body clean and features visible to the observer. Alexander Monro *Primus* (1747) noted that certain dissection cuts would allow the subject to maintain their decency, such as opening the abdominal wall in a cut from the navel to either side of the sacrum to fold the flap over the genital area (Lawrence C, 1988: 202). There is little in the manuals to suggest that dissection was as haphazard and casual as portrayed by public media. On the contrary, bodies were a scarce and expensive commodity that should be treated with care for maximum benefit and to prolong their preservation (Lawrence C, 1988: 202). With the lack of embalming prior to dissection it was undoubtedly messier than the dissection room we experience today. It must be appreciated that the images were caricatures of the truth to entice and provoke their audience. It is much more likely that these often cramped cold rooms had to be kept as neat as possible at all times to allow the students to perform proper dissection and allow observations to be carried out at all stages.

4.1.2 Selecting bodies for dissection

When selecting bodies for dissection, Lyser and Thomson (1740: 2-4) were very specific about their recommendations to select young and healthy individuals. Lyser and Thomson (1740, 2) also argued that the best subjects were those who had met a violent death, especially those hanged or strangled; presumably because they died of "natural causes", disease could not have changed the true morphology of the human body. Hunter (1784: 88) stressed that one body was not sufficient in demonstrating anatomy as diseases would have altered the state of the body. Lyser and Thomson (1740) further remarked that bodies should not be too fat or thin and were best in their adult prime as they were "*less full of juices*" than children and "*less emaciated*" than older individuals. They further argued that taller individuals were better as it was easier to observe "*smaller parts*" and stressed that dissection of all age and sex should be carried out and promoted the dissections of "*big-bellied*" women (presumably pregnant) if possible. The reality of body selection for dissection would probably have been a far cry from Lyser and Thomson's recommendation, because in the latter half of the eighteenth century, bodies became progressively scarcer and this was reflected in the prices (section 3.2). Lyser and Thomson (1740) would have been well aware of this and it is likely they provided these descriptions as the concept of "ideal circumstances". The dissection of body parts rather than complete individuals was not uncommon in the dissection room (Hurren, 2004: 75). Such division provided a more economical use of an expensive cadaver which would have been decomposing. In 1883 Alexander Macalister at Downing College Cambridge requested that all bodies should be dismembered to create a wider range of teaching material, the records showed that 188 students needed 56 hands, 40 arms, 32 legs, 32 abdomens and 8 thoraxes to dissect (Hurren 2004: 75). In 1884 students at Downing College dissected a total of 44 bodies and in 1885, 32 bodies, highlighting the continuing shortage of bodies even after the implementation of the Anatomy Act of 1832 (Hurren 2004: 81).

4.1.3 Preservation and decomposition

Embalming of bodies for dissection was not introduced until the nineteenth century (Goodman, 1944: 809). The rate and methods of dissection would have greatly depended on the state of the body when it arrived at the dissection table. Due to decomposition it was imperative the bodies were exhumed and delivered whilst still relatively fresh. Once embalming was introduced the sequence of dissection was altered and from starting the dissection in the area of the abdomen (Lyser & Thomson, 1740; Hooper & Ruysch, 1809), to the head (Holden, 1894).

Though putrefaction was part of everyday life for the anatomists and students, it was very poorly understood (Clare, 1779: 118). It was accepted and almost expected that students attending the dissection room would become ill at some point. Diarrhoea was a common complaint amongst the students, but it was not clearly understood why the students became unwell, though it was believed that the putrid odours or gasses (effluvia) of the cadavers as well as the cold might have provoked such condition; "*The indigestion, want of appetite, loathing of food and uneasy sensation of the stomach and intestines, preceding fever, may possibly arise from the putrid miasmata acting particularly on these parts*" (Clare, 1779: 120). William Hunter did not believe bodies could be infectious to the students and dismissed a direct relationship between the corpses and the ailment of the students; "*tho' effluvia from the living body are infectious, they lose that property on the body becoming dead*" (Clare, 1779: 120). In one of Cruikshank's introductory lectures (Saturday 20th January, 1798) (RCS/MS0268) he stated; "*Catarrh and Diarrhoea are frequently got in dissecting but this is unconnected with the dead body, as it is from the necessary cold of the place: would therefore recommend the use of fleecy hosiery*" again disassociating any illness from students being in contact with the cadavers. In 1828 the Kaleidoscope remarked; "*The study of anatomy is a severe and laborious study; the practice of dissection is, on many accounts, highly repulsive: it is even not without danger to life itself. A winter never passes without proving fatal to several students who die from their injuries received in dissection*" (Kaleidoscope 1828. 8:406; Apr. 8, p.335). By some it was argued that death was not common place as many famous anatomists had live into old age but Clare (1779: 119) was convinced that "*many intended anatomists….have died unheard of in early life*". Clare indicated that many students took to intoxication in order to cope with the environment of the dissection room, putting this down to one of the possible causes of the high death rates; "…… *it be urged, that because some men, having gradually accustomed themselves to drink brandy, can at last take a couple of bottles a-day without appearing intoxicated, or receiving any sensible detriment. That therefore a glass of brandy will not intoxicate some, and a couple of bottles infallibly kill other*". Kaufman's (2005) paper on the danger of dissection pointed out that a high proportion of bodies supplied for dissection had died from infectious diseases such as cholera, typhus and tuberculosis to which students and teacher would have been exposed, though he was unable to produce a figure of how many died from this type of exposure. It seems that a number of factors may have contributed to the mortality rate in the dissection rooms across London and the lack of clear appreciation of the reasons did little to alleviate the problem.

To appreciate the conditions under which most anatomists would have laboured, the average five stages of decomposition are listed (Table 1). They show that it starts immediately after death, though the rate of decomposition varies depending on temperature and to some extent moisture, with different parts of the body decomposing at different rates (Vass, 2001: 191).

Rigor mortis	3-6 hours	• Usually lasting around 36 hours where after decomposition is accelerated
Autolysis	4-10 days	• Skin blisters and falls off • Flies seek ovi-position sites (mouth, nose, eyes and ears and open wounds)
Bloating	2 weeks	• Anaerobic metabolism takes place with accumulation of gasses
Putrefaction	3 weeks	• Tissues liquefy (brain, organ and lungs first) • Flesh devoured by animals • Body parts turn black
Skeletonised	20-50 days 50-365 days	• Body starts to dry out • Body and hair consumed only skeleton left

Table 1 Stages of decomposition (Vass, 2001)

Mant (1987: 72) noted that decomposition was more advanced in autopsied remains compared to a complete cadaver, due to the putrefactive bacteria present during an autopsy. Vass (2001: 191) stated that putrefaction was not visible in the first few days but soon after this at the stage of autolysis (self-digestion) fluid filled blisters would appear on the skin and skin slippage might occur. *Algor Mortis* where the blood settles to the bottom of the cadaver and discolours the skin, would likewise occur relatively soon after death. The temperature during the winter months would have been relatively low, in particular the year 1776 where the Thames froze temperatures were recorded as a low as -14°C (White, 1829). Though the low winter temperatures would have slowed down these processes there is little to suggest that the bodies would not have at least entered the autolysis stage by the time they arrived at the anatomy school, in particular if the bodies, were already eight days dead or older, as suggested in Naple's diary (Bailey, 1896: 55). Certainly the dissection of the remains may have accelerated what the cold temperatures would initially slow.

With the introduction of the Anatomy Act in 1832 it was stated that bodies should be collected six weeks after they had been delivered to the anatomy schools for dissection. This presumably was the period estimated to be of use to the anatomist prior to embalming of cadavers for dissection (c.1867) (Ezugworie *et al*., 2008). It should also be noted that the bodies supplied after the Anatomy Act were not exhumed and were delivered to the anatomy schools 48 hours after death (Goodman, 1944: 809). It was naturally in the anatomist's interests to preserve the body for as long as possible and Monroe noted that a body treated with great care could last almost a month (Lawrence C, 1988: 202), whilst Hunter (1784: 89) stated that "*A subject is commonly of very little use for demonstration after 8-10 days*". Lyser and Thomson (1740: 11) suggested that the cadavers should be laid on a bed of scordium and periwinkle and when not dissecting, to cover the whole body in these herbs. They noted that the best way to preserve the body between dissections was to wash the internal parts with salt water or spirits, wrap it in cloth and place it in a cold environment, such as an underground vault. Preservation was evidently a meticulous business that warranted as much preparation as the actual dissection, again suggesting that bodies were kept clean throughout. William Hunter's attitude towards decomposition was much less positive than that of his teacher Monro *Primus* (Lawrence C, 1988: 202). Hunter (1784: 87) stressed the importance of having completely fresh bodies for dissection as they would start to decompose from the minute the person died and the components of the body would lose their original look. Hunter was certainly correct in his statement as we know today the onset of decomposition is rapid and causes significant changes to the morphology of the body (Vass, 2001).

4.1.4 Instruments

Lyser and Thomson (1740: 5-8) recommended a set of instruments for dissection as a basic tool set for the students (Table 2). These instruments illustrate the necessity for good equipment as well as the skill and precise application needed to achieve the desired results. Holden's (1894) instructions on dissection highlighted the use of different types of saws in dismemberment, generally using finer saws for slimmer and delicate bones, such as in the skull, and larger amputation saws for the more robust long bones.

Instrument category	Application
Needle (edged like shoemaker's awl)	Ligatures and sewing together body for better preservation over night
Thread (waxed)	Ligatures and tying up trunk of *Cava*
Dissecting knives; (1 Myrtle knife, 1 Crooked knife)	Soft tissue
Large knife (Broad razor) (8 inches long/1 inch wide)	Dissection of head
Small hooks (double or single with crooked point)	To hold aside any part of the body
Whet-stone	Sharpening knives
Sponges	Mop up fluids (excrement and blood)
Scissors (different sizes)	Cutting membranes including coats of eye
Probes (Bodkins) (silver, iron, steel, tin or boxwood)	Needle used for hole piercing
Small tubes	Opening of ducts either to inflate or inject and straight pipes for the orifices
Bellows	Inflation and extending of several parts of the body
Saw (steel), the smaller the better but must be strong enough to perform	Opening of the skull
Elevator	Raising the skull cap

Table 2 Equipment needed during dissection (Lyser & Thomson, 1740: 5-8)

4.1.5 Dissection techniques

Dissection techniques varied throughout the centuries not only in terms of sequence of dissection, dictated by the decomposition rate of the body, but also in terms of methods applied. In this thesis the interest in dissection techniques is on the impact on the skeleton, whether to gain access to the internal organs or for examining the bones themselves. The eighteenth century methods of dissection listed in Table 3 are based on Lyser and Thomson (1740), being the only comprehensive dissection manual translated into English from this period. Parallels will be drawn where possible with the descriptions from the nineteenth century texts, "*The London Dissector*" (Hooper & Ruysch, 1809) and Holden (1894) as well as the modern dissection manual "*Grant's Dissector*" (Tank & Grant, 2009). The level of explanation varied significantly between the manuals and the latter two offered rich illustration of cuts accompanying the text, with some cuts on the illustrations not being described in the text. The vast majority of dissection procedures would not have affected the skeleton but it is not within the scope of this thesis to offer an account of all procedures though these have been described to some detail in the above dissection manuals. Table 3 provides a summary of the dissection cuts impacting on the skeleton.

The following points were drawn from Table 3;

1. The largest proportion of the cuts described in all the manuals affected the skull whilst the extremities were the least affected.
2. The methods for removing the skull cap were very similar in all four manuals, with one noticeable difference between the two earlier manuals; these indicated that in removing the cap the skull should be sawn all the way through, whilst Hooper and Ruysch (1809) suggested sawing the outer table of the skull and removing the inner table with a chisel. Removal of the occipital wedge is commonly applied today in order to view the cerebellum *in situ* (Tank & Grant, 2009), but this method did not feature strongly in the eighteenth and nineteenth century manuals.
3. Lyser and Thomson (1740) described two methods of removing the upper portion of the skull and in the second method (Verolian method) it appears the occipital bone was removed. The description of the method was not entirely clear as "mamillary processes" are only used in labelling the vertebrae today. "Mamillary" is used to describe a protuberance shaped like a nipple and Lyser and Thomson seem to indicate there were two and in the path between the orbital margin to the occipital bone this could only mean parietal eminence, from here he instructs to cut down to either side of the foramen magnum. Lyser and Thomson (1740) did not recommend this method as it made the head unfit for demonstration. Holden (1894) advised cutting a v-shaped portion out of the temporal and occipital bone sawing towards the anterior condyloid foramina, which describes a slightly wider occipital wedge than that by Tank and Grant (2009).
4. Examining the eye required access through the orbital roof. All historical manuals instructed cutting through the frontal bone above either side of the eye, whilst Tank and Grant (2009) simply instructed cracking the orbital roof with the handle of a chisel.
5. To facilitate a view of the temporalis muscle removal of the zygomatic arch was necessary; this was done in a very similar manner in all manuals. Lyser and Thomson (1740) and Tank & Grant (2009) describe more or less the same location of the cuts; one near the eye and one near the mastoid process.

6. To trace the maxillary artery, Lyser and Thomson were the only ones not to mention the removal of the coronoid process. It appears they may have thought it sufficient to remove one half on the mandible. The other manuals all suggested cutting the coronoid process in slightly different manners. Removal of the entire mandibular ramus was only suggested in the later manuals. According to Tank and Grant (2009) this was necessary to view the infratemporal fossa and to permit the head to be bisected.
7. Bisecting the mandible was done in order to view the workings of the tongue and the lingual nerve with the manuals showing very little variation on this cut. To view the function of the inner ear required dissection of the petrous bone. Lyser & Thomson (1740) provided a complex instruction of cutting the bone in three directions whilst Tank and Grant (2009) suggested simply removing the tegment tympani. Holden provided detailed descriptions of the inner ear, but omitted to instruct how to gain access to the inner portions, whilst Hooper and Ruysch (1809) did not seem to provide any details on the ear at all.
8. Bisection of the skull was only instructed in the nineteenth and twenty first century manuals and it may be assumed that this cut in the earlier manuals would have been viewed using a preprepared museum preparation.
9. A number of different methods were described for the opening of the thorax. In the eighteenth and early nineteenth century manuals it was generally indicated that the sternum should remain whole, though options of cutting were also provided. In the late nineteenth and twenty first century manuals the sternum was cut transversely in its lower part. The clavicles in the earlier manuals were removed complete, whilst in the later manuals they were cut vertically through the middle. The ribs were cut at the cartilage in the eighteenth and nineteenth century manuals, which could not have impacted on the bone. Hooper and Ruysch (1809) did note ribs needed to be sawn off near the spine to view the intercostal nerve. Tank and Grant (2009) advised cutting the ribs in the axillary line on both sides, allowing the thorax to be opened up wide. Lyser and Thomson (1740) did note that ribs could be pulled aside (sometimes so violently they would break, as performed by Galen).
10. Very limited instructions were provided on the removal of the vertebral arch in the eighteenth and nineteenth century manuals other than simply instructing their removal. Tank and Grant’s (2009) instructions involved removing only the spinous processes of the sixth to twelfth thoracic vertebrae without affecting the transverse or mamillary processes.
11. Removing part of the pelvis was done by cutting the pubic symphysis, in the earlier manuals by cutting through the cartilage uniting the bones and in late nineteenth

and twenty first century manuals by cutting through the actual bone on either side. Lyser & Thomson (1740) then advised cutting the cartilage along the sacro-iliac joint whilst Hooper and Ruysch (1809) advised cutting through the ilium whilst Holden (1894) suggested cutting through the spine of the ischium and the sacro-iliac joint with Tank and Grant (2009) as the only ones suggesting bisecting the sacrum after cutting the pubic symphysis.

12. Very few cuts of the extermities were described in any of the manuals though Lyser and Thomson (1740) did on occasion recommend cuts depending on whether the limbs were attached or on a complete body but it appear there was no reason to cut any of the long bones. Tank & Grant (2009) instructed moving the humeral head in order to open up the joint capsule to view the muscles and Holden (1894) mentioned sawing though the neck of the scapula but separating the bones otherwise appeared possible without affecting the bones themselves.

Dissection	Bones affected	Lyser & Thomson (1740)	Hooper & Ruysch (1809)	Holden (1894)	Tank & Grant (2009)
Skull and mandible					
Skull cap	Frontal, Parietal, Occipital	[**common method**]Tie a string a little above orbit and around the head to the occiput. and there pass it over the lamboidal Suture, about two Inches Distance from the End of the sagittal Suture from thence bring it over the Temple Bone on the opposite Side, and to the fame Place of the Frontal Bone, above the Orbit of the other Eye, and then fallen it. Two people must do this operation, one to hold the skull and the other to do the sawing. Cut all the way around until you reach your starting point, with an amputation saw in a slow forward and backward motion. Use knife to check depth separate skull with spatula once sawn through leave head on trunk if intended for the public (112)	Saw directed anteriorly through the frontal bone above the orbitar process, and posteriorly as low as the transverse ridge of the occipital bone. It requires considerable force to tear of the skull cap (126)	Saw 1/2 inch above supra orbital ridge in front and on the level of the occipital protuberance behind. It is better to saw only through the outer table and to break through the inner table with a chisel (31)	Place rubber band 2cm superior to supraorbital margin to external occipital protuberance. Saw through outer lamina but not completely through. Whilst sawing alternate position of body from supine to prone. Break inner lamina with Chisel and mallet. Use handle of forceps to pry the skull from the inner dura mater working from anterior to posterior (215)

Occiptal wedge	Occipital, Temporal	[**Verolian method** (**also skull cap removal**) Separate head from vertebrae fix saw to the root of the nose so that you can cut above the orbits of the eye and continue over the mamillary processes (Parietal eminence?) to the occiput. Then just behind the mamillary processes make another incision continuing to either side of the great foramen on the occipital bone (115)	n/a	Saw out a V-shaped piece from the temporal and occipital bones, the prongs of the V pointing towards the anterior condyloid foramina (anterior condylar canal?) (225)	Remove muscles and fibres from the pericranium with a scalpel or chisel. Start cut where the lambdoid suture meet the calvarium saw cut. Saw from suture point either side of the foramen magnum, cutting only the outer lamina. Loosen the wedge off bone with a chisel or mallet, leaving the Dura mater intact (215)
Orbital roof	Frontal, Lamina	Saw off the remains of the os frontis two cuts the first by canthus major and the second by canthus minor. You may divide the lamina above the eye with a strong incision knife and remove it (134)	Remove the upper part of the orbit formed by Os frontis with a saw (223)	Saw through the roof of the orbit as far back as the optic foramen, making one section of the outer side of and the other of the inner side of the roof. The anterior fourth of the roof should be left *in situ*, the remainder removed with bone forceps (68)	Tap orbital part of frontal bone with handle of chisel until the bone cracks, remove fragments of bone (230)
Zygomatic arch	Zygomatic	Cut zygomatic arch twice, near the eye and by mastoid process (109)	n/a	Remove zygomatic arch to expose coronoid process (145)	Saw anterior of head of mandible and posterior of lateral orbital margin (211)

Coronoid process	Mandible	n/a	Remove coronoid process of the inferior maxilla [mandible] by saw (206)	saw through coronoid process in a direction downwards and forwards (as illustrated on image) (145) Cut through the ascending ramus with a Hey-saw	Cut coronoid process superior to inferior at an oblique angle towards last molar (M3). (212)
Mandibular neck	Mandible	n/a	n/a	Saw through the neck of the jaw and disarticulate the coronoid process (147)	Cut the neck of the mandible mesial to lateral in horizontal direction to remove head (212)
Mandibular symphysis	Mandible	The lower jaw must be sawn longitudinally through the Middle, between the incisors. If the head is separated from the trunk there is no need to dissect the jaw (109)	Saw across symphysis and remove one half (207)	Saw through, a little to dissector's side of the symphysis, and draw the bone upwards with a hook (117)	Use saw to cut through mandible in the median plane (249)
Ear - Petrous bone	Temporal, Petrous	Remove the temporal bone with the petrous bone. With forceps break the tympanum? Placed towards the frontal bone. Saw the pertous bone into three parts (144)	n/a	Provides a detailed account of the inner ear, but no instructions on how to gain access. (740pp)	Remove the tegmen tympani portion of the floor of the middle cranial fossa (257)

Bi-section of skull	Nasal, Frontal, Cribriform, Sphenoid, Maxilla,	n/a	n/a	Saw through one side of the middle line thereby exposing the cavity of the nose (257)	Cut skull just lateral of the median plane. Do not go through nasal septum. Bone that must be cut in the process are; nasal bone, frontal bone, cribriform plate, body of sphenoid, hard palate, basiliar part of occipital bone to foramen magnum. When sawing lean saw on crista galli and cut superior to inferior (239)
Opening of the thorax					
Sternum	Sternum	Separate cartilage of sternum from ribs, but leave sternum to adhere to the clavicle or cut it off by the superior part (88-89)	Cut [illegible]m by the first [illegible]cond divide along the inner surface of their junction or remove the sternum whole by separating its articulation with the clavicles (172)	Remove the upper 4/5 of the sternum (169)	Use a saw to make a transverse cut across the sternum and costal cartilage at intercostal space above xiphoid.

Clavicles	Clavicle	Remove clavicle by separating it with a knife from the sternum and lay it aside to get to the first rib (89)	n/a	Saw through middle of clavicle (125)	Cut both clavicles at their mid length using a saw (58)
Ribs	Ribs	Cut the cartilage along all the ribs except the first rib (89)	Opening the thorax by cutting through the cartilage of the ribs (172). To view the intercostal nerve; saw off the ribs near the spine (188)	Cut the cartilage of all the true ribs	Use a saw or bone cutters to cut ribs 1-5 in the mid axillary line on both sides of the thorax (58)
Vertebrae &pelvis					
Vertebral arches	Vertebrae	n/a	Dissection of arches cannot be performed until the muscles at the back have been removed, so that the posterior part of the spinal canal may be sawed off (146)	The arches of the vertebrae should be removed with a curved saw (708)	Use a chisel or power saw to cut the laminae of T6-T12 on both sides of the spinous processes. Make this cut at the lateral end of the laminae to gain wide exposure to the vertebral canal, angled at 45 degrees to spinous process (15)
Dismemberment of body at vertebrae		n/a	n/a	n/a	n/a
Pelvis	Illium,	You are also to divide the	One side of the	Saw through *Os Pubis*	The pelvis will be divided in

	Ischium, Pubis, Sacrum, Lumbar Vertebrae	*Ossa Pubis*, by cutting through the cartilage uniting the bones, either with a sword-like, or thick back dissecting knife….separate from *Os Sacrum* (67)	pelvis should be removed by dividing the pubic symphysis and by sawing through *Os ileum*, or separating it at its junction with the sacrum (51-52)	about 2 inches external to the symphysis and cut through the sacro iliac symphysis (*sacroilliac joint*); now draw the legs apart, and saw through the base of the spine of the ischium (*situated inferior of the acetabulum or anterior of greater schiatic notch*) (483)	the mid line. The pubic symphysis and the vertebral column (up to L3) will be cut midline with a saw. The right side will be transected at L3 …use saw to make two cuts midline: Cut Pubic symphysis anterior to posterior (138) Turn the cadaver to prone position. Cut through the sacrum from posterior to anterior. Spread the opening and extend the midline cut as far superiorly as the body of the third lumbar vertebra. (139) Use the saw to cut horizontally through the right half of the interveterbal disc between L3 and L4. Remove the right limb. (139)
Extremities					
Upper extremities	Humerus, Scapula	n/a	n/a	Remove the acromion by sawing through the neck of the scapula (364)	Use saw or chisel to remove the head of the humerus at the anatomical neck (51)
Lower extremities		n/a	n/a	n/a	n/a

Table 3 summary of the textual findings of dissection procedures impacting on the skeleton from Lyser and Thomson (1740), Hooper and Ruysch (1809), Holden (1894) and Tank and Grant (2009).

From comparing the four manuals from different time periods a number of variations could be observed. It is unlikely these manuals were strictly adhered to as this would have prevented the variations from occurring. It is more likely the cuts described were the classic cuts of traditional dissections with variations occurring depending on whom the instructor was and to what purpose the dissections were carried out.

4.2 Surgical operation and practicing surgery

Anatomy courses also taught students surgical operation techniques which were practiced in the dissection rooms prior to performing them on living individuals. A number of publications from the eighteenth century provide an overview of surgical operations commonly undertaken at the time (Sharp, 1740; Sydenham *et al*., 1742; Heister, 1750; Bell, 1784; Owen, 1785). The types of operations frequently discussed were the treatment of inflammations, paracentesis, stones, aneurisms, amputations and wounds of the head. Most of these procedures would have had no impact on the skeleton and therefore for the purpose of this thesis just two operations, which would have left characteristic marks on the bones, are focused on in this section. Comparisons are made between historical accounts and the osteological evidence of practicing these in the dissection room; limb amputation and trepanning. Both procedures formed an integral part of a surgeon's skill base and would have required much practice, speed and dexterity to perform. The author is aware that by selecting specific procedures, more subtle indicators of other operations may lack interpretation and that this would be a valuable exercise for any future research.

4.2.1 Limb amputation

Limb amputation was a dangerous and a highly controversial operation that was viewed with scepticism by many medical men at the time; "*The amputation of a limb is an operation terrible to bear, horrid to see, and must leave the person on whom it has been performed in a mutilated imperfect state….*" (Pott & Earle, 1819: 308). In the Morning Chronicle (November 13, 1772. Burney: Issue 1805) an anonymous contributor strongly opposed to the frequency of amputations performed in the hospitals in London and the manner in which students were taught the procedure, "*When an operation is performed, you flock in crowds to see it, as tho' the whole knowledge of surgery lay in taking off a limb with dexterity. I had almost said better it had never been known; but I will aver that more than half of limbs that are taken off, might be saved….whether it is that the bark is too expensive a medicine to be given in so large quantities as required; whether the time is thought too long for poor patients to fill the bed …or whether to show the dexterity of the operator [in front of students]*". Both statements reflected the misgivings concerning amputations; they were unsafe and at times unnecessary, causing much distress to the patient. Despite these misgivings amputations were one of the most frequently performed operations in the eighteenth century. The wars at the time and their victims required an increasing number of skilled surgeons and new techniques were used in an attempt to improve the success rate of these amputations and lessen the pain for the patients (Fillmore, 2009: 1). The amputation techniques applied in the eighteenth century had to be rapid as people undergoing operations received no pain relief until the discovery of general anaesthesia in 1846 (Kirkup, 2007: 68). There was no shortage of surgical manuals explaining the best procedures for amputation of various limbs, each surgeon appeared to have had their own preferred variations on the same theme. During the eighteenth century the most favoured methods of amputation were the "circular technique" and the "flap technique" discussed in detail below. It was generally acknowledged that amputations were risky and should only be performed when all other options were exhausted, although this nevertheless still seems to have been a point of debate (Morning Chronicle, November 13, 1772, Burney: Issue 1805). Sharp (1740: 212pp) recommended amputations in cases where gangrene was progressive (caused by old age or accidents) and in gunshot wounds, compound fractures and "sudden accidents", but acknowledged the low success rate of such operations.

The mortality rate of amputations was high at a rate of 45-65% (Fillmore, 2009: 3). Fillmore noted that the Monros of Edinburgh had a high success rate with only 8% fatalities, but unfortunately no official statistics were maintained in the eighteenth century, so these results must be viewed with caution. It is necessary to look towards the nineteenth century to gather more reliable figures on the success of amputations. Hayward (1850) used figures from Massachusetts General Hospital (1840-1850) to examine the death rates which appeared to be 1:4 in 2000 cases recorded in Great Britain, examining not only on how many died but also the possible causes. Sansom (1858) carried out a similar survey on amputations performed during the Crimean War (1853-1856) and found very similar results to Hayward. They both noted that the location of the amputation was a strong indicator of survival rate; amputations of the arm were far less perilous than those of the leg. Hayward (1850) reported a mortality rate of 10% for arm amputations whilst Sansom (1858) reported a rate of 28.8%. The survival rate of leg amputations in the Massachusetts General Hospital was 26.47% for the thigh and 21.74% below the knee (Hayward, 1850). Again higher rates were recorded by Sansom who divided the results further and noted a 100% mortality rate for hips, upper thigh 86.8%, middle thigh 55.3%, lower thigh 50%, below the knee 30.3%, and ankle joint 22.2%. The relative large discrepancy in the two results can perhaps be explained by the nature of the sources as one was taken from a general hospital showing a cross section of a population suffering from both acute (that is injuries) and chronic conditions (Hayward, 1850), whilst the other was taken from the results of amputations during a conflict (Sansom, 1858). It was certainly clear to Hayward (1850: 10) that survival rate was much higher in case of chronic disease than if amputations were performed on the victims of recent accidents. He reported a death rate of 11.11% in amputations relating to chronic conditions but a 45.45% death rate in amputations for acute conditions. Sansom (1858: 6) also compared the use of amputations for treatment of soldiers in the Crimean War with chronic and acute amputations from general London hospitals and concluded that during conflict one would expect a 50% death rate, whilst a 33% death rate was to be expected in general hospitals. Hayward (1850) speculated that the reason was most likely the shock associated with trauma. During the war, amputations also had to be carried out in less favourable conditions and rapid decisions had to be made in times of conflict, which may have affected both the surgeon's performing and the patient's recovery. Finally Hayward (1850: 16) concluded that it made no difference if limbs were amputated using the circular or the flap method (see below). The success of an amputation was not solely down to the skill of the surgeon, but it was still the ability of the surgeon to make the right decisions that influenced the outcome of an operation. Fillmore (2009) highlighted the problem of leaving wounds open to let them drain, which was common in the eighteenth century, though surgeons such as John Hunter favoured closing the wound and Le Dran (1768: 435) also agreed that the method where the flesh was stitched to leave the wound less exposed, allowed rapid healing and was key to a successful outcome.

4.2.1.1 Location of cut and position of the surgeon

Locations of cuts were of great importance to the success rate of survival and it was generally recommended that all amputation should be performed on the shaft avoiding the joints if possible. The bones were to be cut on a healthy part and always on the most distal point possible, though too low could sometimes hinder good fittings of prosthetics (Le Dran, 1768: 423). These observations were consistent with the death rate by location of cut reported by Hayward (1850) and Sansom (1858) (see above).

Locations of possible amputation of the extremities were described by Le Dran (1768) and Sansom (1858).

1. Shoulder joint
2. Arm (upper, middle, lower)
3. Fore arm (upper, middle, lower)
4. Hand (metacarpus middle)
5. Fingers (Phalanges mid bone or at the joint)
6. Hip joint

7. Thigh (upper third)
8. Thigh (Middle)
9. Thigh (Lower third)
10. Lower leg (below tibial tuberosity)
11. Lower leg (Ankle joint)
12. Foot (Medio tarsus)

Le Dran (1768: 436) described methods for an amputation of the arm by the shoulder joint. He recommended that this should only be done if pathological bone was present on the upper part of the arm. His description showed that no bone had to be cut in order to perform the operation. He reasoned that joint operations were prone to be unsuccessful due to the lack of flesh available to cover the wound following the amputation.

Detailed accounts of limb amputations were provided by both Sharp (1740: 220) and Le Dran (1768: 424), who generally agreed on the manner in which they should be performed. They recommended that for amputations of the upper arm and thigh the surgeons should be standing on the outside of the limbs, whilst amputation of the lower arm and leg the surgeon should position himself on the inside. Both lower extremities are made up of two long bones, the upper from the radius and ulna and the lower from the tibia and the fibula. In order to perform the operation at speed and avoid splintering it was paramount that both bones were sawn in one action. "*In amputation below the Knee, it is of advantage to stand on the inside of the Leg, because the Tibia and Fibula lie in a position to be saw'd at the same time, if the Instrument be apply'd externally: whereas if we lay it on the inside of the Leg, the Tibia will be divided first, and the Fibula afterwards, which not only lengthens the Operation, but is also apt to splinter*" (Sharp, 1740: 217). Le Dran's method would have avoided any splintering to the smaller bone as he ensured that this was held in place by the larger bone during sawing. *"If there are two bones, as in the fore-arm and leg, I apply the Saw to the largest, and make the first impression there; this done, I proceed, and Saw both the bones together, taking care to go quite though the small bone before the other is entirely divided"* (Le Dran, 1768: 427)

4.2.1.2 Circular technique

The *circular technique* was the traditional methods and was first recorded in the fifth century BC by Hippocrates, who devised this method for removal of limbs with gangrene. Since then the technique was improved upon from being a simple straight cut through the skin, muscle and bone to a more sophisticated two tier method of cutting the skin and muscle and then subsequently the bone (Sharp, 1740: 220). The double incision circular method started by cutting the skin circumferentially from two fingers breadth to 4-5 inches below the intended cut area of the bone. The skin and muscle were then pulled back and the bone was sawn as close to the muscle as possible. Once the amputation was performed the skin would be released and folded over the stump. This method did, however, lead to complications as the bone stump would often be left exposed and vulnerable after healing (Figure 9). Bell and Landseer (1821: 60) noted that one of the problems with this method was that the patient, when the bone was being cut, had his leg in a horizontal position and once the stump had been cut off the leg would automatically rise to the air and retract the skin and muscle further and expose the bone. They therefore suggested that the leg should be allowed to rise once the muscle had been cut and the saw be held in a horizontal position. Sharp (1740: 211) advised the opposite and stated that the leg should not be allowed to lift as this would cause the saw blade instrument to jam.

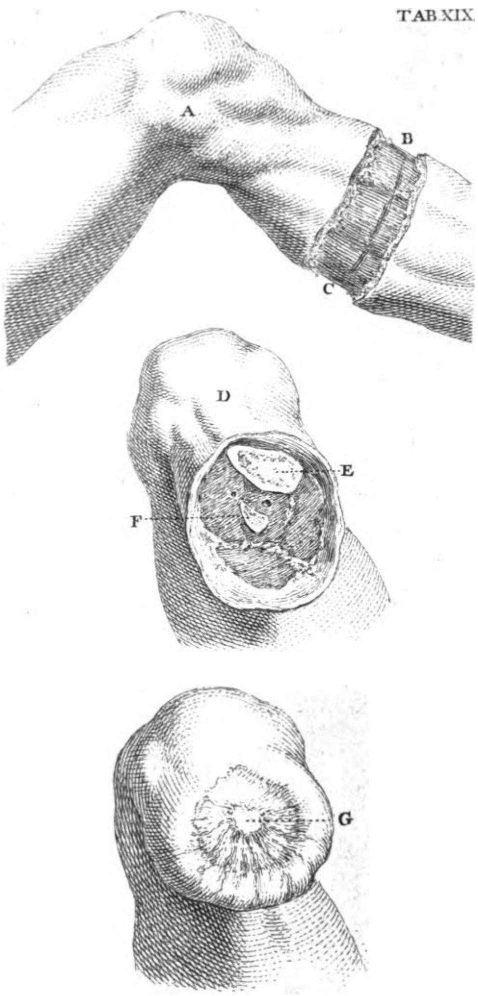


Figure 9 the circular technique (Le Dran, 1768: plate xix)

The manner in which the circular technique was performed in case of an above the knee amputation has been summarised below as advised by Sharp (1740), Le Dran (1776) and Bell and Landseer (1821). They varied slightly in detail but shared the main points:

1. Position patient in a supine position
2. Allow two assistants to hold onto the leg at either end (Le Dran appears to hold the leg straight, whilst Bell had the leg bent at the knee).
3. First cut the skin and the muscle circumferentially about 2-4 inches (or 4-5 inches) below the point of sawing the bone.
4. Some advised scraping the periosteum, argued that it took too long.
5. Draw back the skin and muscle and cut the bone as close to the edge of the muscle as possible.
6. Tie together extremities of the blood vessels.
7. Fold skin around stump.
8. Dress the wound.

4.2.1.3 The flap technique

The *flap method* (Figure 10) was devised in order to overcome the complication of exposure of the bone stump, as flaps cut on either side of the leg below the point of amputation would contain both skin and muscle tissue to cover the stump with once severed. According to Sansom (1858: 4) a Mr Lowdham of Exeter invented this method in 1679 and it would thus have been in use during the eighteenth century. Le Dran (1768: 432) described the two flap method as devised by a M. Ravaton, as he conceded this to be the most effective. He used an above the knee amputation as an example;

1. Position patient in supine position.
2. Allow two assistants to hold onto the leg at either end.
3. Cut the skin and the muscle circumferentially about 2-4 fingers below the point of sawing the bone. The larger the bone the lower down it needs cutting to allow the flaps to close over the bone.
4. Cut longitudinally from the point of the circumference. This has to be done twice, once to the front and once at the back.
5. The flaps should be folded up.
6. Make a circumferential incision around the bone in area where you intend to saw.

7. Saw the bone.

8. Tie together extremities of the vessels.

9. Close over the flap and stitch together.

Figure 10 amputation below the knee using the flap technique (R. HorsfieldLondon 1764) (Wellcome Library, London)

Le Dran noted that in general the circular method took 2-3 months to heal whilst by the flap method healing appeared to be complete after 3 weeks (Le Dran, 1768: 430pp). The techniques also provided better cushioning for the stump, resulting in a better fitting prosthesis (Le Dran, 1768: 436). The problem with this method was that it was performed at a slower speed, and due to the lack of anaesthetics this could prove fatal to the more fragile patients (Liston, 1836: 237).

4.2.1.4 Splintering of bone

Splintering of the amputated bone was a major problem often referred to by surgeons (Sharp, 1740; Le Dran, 1768: 431). Bone splinters occurred when too much pressure was applied to the bone during the sawing process causing the bone to snap when almost severed. The splinters could cause tears to the soft tissue when they were pulled over to cover the stump and resulted in infections and irritation to the leg (Le Dran, 1768: 431). Bell and Landseer (1821: 60) argued that the technique of holding the leg in an upright position would prevent splintering of the bone during the sawing process.“*Bones cut this way [leg in traditional horizontal position] will see friction of the saw and to ease this the assistant will lessen the pressure on the bone making the bone drop, then the saw will easily go through till the bone fractures, breaking off the lower part and making splinters. All this can be avoided by the horizontal technique*.” (Bell & Landseer, 1821: 60). Le Dran (1768: 426) advised to apply great pressure to the bones whilst sawing but then slow down at the end to avoid splintering. However, as Bell’s method was a relatively new technique introduced in 1821, most surgeons in the eighteenth century would have more often used the horizontal technique.

4.2.2 Trepanning

Trepanning is a procedure where a hole is cut into the skull to allow treatment of endo-cranial conditions. The procedure served the purpose of relieving any blood pressure on the brain and allowed the removal of protruding bone fragments in danger of penetrating the *dura mater*. Sperati (2007:155) spoke of a decline in trepanning during the eighteenth century due to the high mortality rate and Gonsalez-Crussi (2008: 23) noted a mortality rate nearing 100% during this period, though this did not seem to deter any promotion of the procedure in published works on surgical procedures. Publications by Le Dran (1768) and Sharp (1740) included instructions on how and when to carry out trepanning. They were aware the procedure was high risk and highlighted it should only be done if no other option was available. Percival Pott (1714-1788) was a great believer in the trepan and argued that the high death rate was not due to trepanning itself, but the nature of the conditions that were treated using the trepan (Pott & Earle, 1819). Trepanning was a skill any surgeon was expected to master, and it appears that the proposed decline in this aspect of surgery did not prevent its continued promotion in surgical manuals and lectures.

The methods and circumstances in which trepans should be applied were the subject of much debate during the eighteenth century, probably as a consequence of the high mortality rate associated. Valpeau’s thesis (1834) provided an excellent overview of the differing arguments on trepanning and outlined some of the misgivings in procedures of trepanning with a summary of his results published in *The Lancet* (Vol.22, issue 572 :725-728) in August 1834. Valpeau (1834) contested many of the “rules of trepanning” that had become established over the years. It was generally accepted that the following areas of the skull should *never* be trepanned; sutures, sinuses, temples, passage of the middle meningeal artery, occipital protuberance and the base of the skull. Valpeau (1834) argued that trepanning of all these areas could be successful though he agreed that trepanning was useless in cases of injuries to the base of the skull. The English translation of Le Dran's outline of surgical procedures (1768), which included observations by Cheselden (1688-1752), revealed conflicting opinions on the methods of trepanning. Le Dran (1768: 392) argued in support of the trepanning of sutures and temporal bones just like Valpeau, whilst Cheselden was adamant that one should never apply the trepan over the superior sagittal sinus, and recommended multiple trepans on either side to relieve any complications involving this area (Figure 11) (Le Dran, 1768: 445). Sharp (1740: 141) concurred with Le Dran that it was safe to apply the trepan over the sagittal suture, but still recommended avoiding it if possible as it caused substantial bleeding. He deemed any trepanning of the occipital bone impractical as the bone was very uneven and difficult to trepan as well as having large sinuses running across it. He argued that any fracture of the occipital bone was most likely to be deadly at any account. Sharp (1740: 144) added that trepanning near the orbits should be avoided and to apply the trepan to the side or above the orbits instead, to avoid the sinuses. Le Dran argued that the wounded portion of the bone should always be included in the trepan (Le Dran 1768: 374), whilst Cheselden argued that the actual injured part of the bone should not be trepanned if loose and trepanning should instead be carried out to the side of the wound (Le Dran 1768: 446). Sharp (1740: 144) agreed with Cheselden on this point and recommended the trepan be placed on the edge of the fracture so that the sawn piece included part of the depressed bone, as shown in Cheselden's illustration (Figure 11). He observed that it was perfectly safe to apply several trepans to an operation if it aided the removal of loose bone and noted that he had seen operations performed where a dozen trepans had been applied and the patient lived to tell the tale. Later in the nineteenth century Bell and Landseer (1821), partly supported Cheselden's observations but argued, trepanations should never be carried out on the actual injury to the skull as this could cause further damage, due to the instability of the bone. He also noted that the extent of trauma to the skull was often larger on the endocranial aspect than the external part of the skull and a similar observation was made by Le Dran (1768: 387), making it difficult to determine where to place the trepan in relation to the fractured bone.

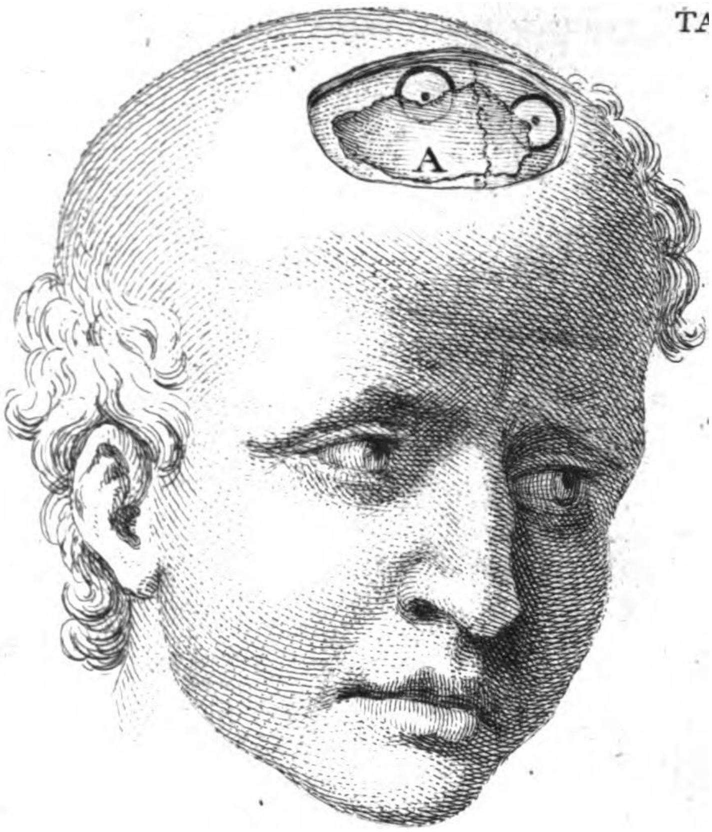


Figure 11 trepanning performed on either side of the sagittal suture to avoid the trepan being place over the longitudinal sinus (in Le Dran 1776, Plate I)

Surgeons differed in opinion on the location and methods of trepanning but they generally agreed on procedures for the actual cutting of the bone. Valpeau's thesis of 1834 recommended the following procedure;

1. Place patient in a reclining position.
2. Remove hair and make incision on scalp (shaped: O, V, T, or X).
3. Scrape the bone.
4. Fix perforator to protrude slightly below the teeth of the trepan.
5. Work instrument in a rotary manner backwards and forwards until deep enough to grip the bone.
6. Loosen the perforator and slide up (as it will otherwise wound the membrane)
7. Keep instrument perpendicular to the skull -take care not to penetrate the skull deeper on one side than the other.
8. Frequently check on depth and clean the teeth as once they enter into the diploe as they will clog up.

9. Raise the loose disc with an elevator.
10. Smooth the edges with a lenticular knife (this procedure was only recommended by Valpeau (1834) and is perhaps a later addition to procedures)
11. If a fracture, remove the projecting bone points.

Students would have attended the wards at one of London's teaching hospitals and assisted surgeons in performing trepanations and amputations (Lawrence, 1996). They would further have attended lectures and made practice amputations and trepananations on cadavers before being allowed to perform these procedures on living patients. These procedures were very high risk surgery that required much practice and dexterity. The survival rate of both was very low depending on the location of the intervention. There was clearly a lot of disagreement amongst surgeons as to where the operations should be performed but less so on how, with the perception that it was the trauma or medical conditions that was the cause of death rather than the operation itself (Heister, 1750: 357).

4.3 The anatomical museum – making preparations of human bodies

In a medical context bodies were predominantly preserved for the purpose of generating a reference collection and displaying the skill and dexterity of the maker. Preparations were made of both complete and partial bodies, where both internal and external structures could be appreciated, essentially objectifying the human body for display and acceptance by a wider audience (Chaplin, 2009; Korf & Wicht, 2004: 805). During the sixteenth to seventeenth centuries more than 44 anatomical museums were built in Europe alone, and this tradition was continued well into the eighteenth century and beyond (Turk, 1994: 40). Preparations were a hugely valuable commodity and a large and richly stocked museum was an outward display of social status and importance (Chaplin, 2009). John Hunter is perhaps one of the most famous collectors; he built up a collection from 1763 until his death in 1793 at a cost of over £70000 (Flower, 1881: 205). His collection today stands at c.4000 specimens but was originally at 14000 before the bombing of the Royal College of Surgeons in Lincoln Inns Fields in London during World War II, where the collection is now housed (Turk, 1994: 40). In the eighteenth century an anatomical museum display became an expected part of any anatomy school with the skill of making preparations forming an integral part of the curriculum (Chaplin, 2009). Preparation techniques were considered an art form and were closely guarded by the people who were able to make them (Lawrence S.C, 1988: 199). Though a large number of texts contained sporadic information on how to make preparations it was not until a publication by Pole in 1790 that a detailed manual was provided. Pole (1790: xi) claimed that only Dr Monro of Edinburgh and John Sheldon had provided any instruction on the subject, and then only in part. This section of the chapter will examine some of the aspects of Pole's work and by drawing parallels with works of Lyser and Thomson (1740) and Parsons (1831), focus on techniques and preparations which would have impacted on the skeleton.

4.3.1 Making preparations

Preparations formed an essential part of any anatomy school and would have been used during lectures to demonstrate specific points of anatomy that may not have been immediately visible during dissections. Most anatomy schools would have boasted a museum containing intricate and beautiful preparations exhibiting the skills of the executor and the quality of the school (Chaplin, 2009). This was after all an important way to attract students.

Pole (1790) provided instruction on seven different techniques for making preparations. It is not within the scope of this thesis to provide a detailed account of each one. However a brief summary of techniques have been provided in Table 4. There were essentially two different methods of preserving the body; by the "dry" or the "wet" method. The "dry" method consisted of varnishing the preparations to slow down decay, whilst "wet" preparations were kept in spirits in glass containers. The cost of the latter led to the former being most frequently applied (Pole, 1790: 163-183).

Preparation techniques	**Explanation of techniques**
Coloured injections	Injection of veins and arteries Coarse: complete individual extremities and large vessels. Fine: Smaller branches of principle vessels. Minute: smallest vessel injected in skin (cutis) to add "natural colour". Colours available; Red, Yellow, green, blue, black and white.
Mercurial injections	Used for minute injections such as the lymphatic system.
Corroded preparations	Once injections have been completed a dried corrosion using nitric acid, may be applied to remove tissue and expose the injections.
Maceration	Immersion in water. Recommended in de-fleshing skeletons.
Distention	Swelling or enlarging of organs using spirits, to make them appear more natural in shape.

Articulation	Reassembly of skeleton using tin plate and brass wire to emulate joint movement.
Modeling	Application of plaster of Paris for making casts and moulds of body parts (soft tissue and bones).

Table 4 Pole's methods of making preparations (Pole 1790)

A museum could be expected to have had in its display examples of all of these techniques. Pole (1790: xii) highlighted the problems of cost and availability in acquiring subjects for making preparations, as well as finding the right environment in which the preparations could be made; "*The want of proper accommodation to perform my processes, has, not infrequently, been a source of inconvenience, and the well-known expense of pursuing anatomy is no inconsiderable obstacle to its improvement*". It is inherent from Pole's descriptions of making preparations that they not only required great skill and accuracy but also sufficient space for preparations to be processed and dried. Some underwent several months of intermittent treatment before being completed, highlighting the great expense of making preparations as both glass and spirits were costly (Pole, 1790: 259). Alcohol was introduced as a preservation technique in 1662 and with the invention of flint glass it was possible to display wet preparations in glass vessels. John Hunter was recorded as having bought some 5000 museum jars for his collection (Turk, 1994: 40). Once preparations were completed the collection had to be maintained as alcohol tended to evaporate and needed constant topping up to avoid decay of the specimens which was both time consuming and expensive (Pole, 1790: 166)

4.3.2 Selecting a body for preparation

Acquiring the right bodies for making preparations was part of the process on which Pole placed great emphasis. He discouraged the use of adults for whole body preparations, as they would decompose before the preparation was complete and prove costly to preserve and varnish. He also noted the difficulties in transporting sizable subjects if required. He recommended bodies of individuals from early infancy to a maximum of fourteen years of age, preferably thin emaciated subjects as they were quicker to dry (Pole, 1790: 36). He further suggested anasarcous individuals (individuals with high levels of fluid in tissues and cavities) as their cellular membranes would dry with "greater transparency" (Pole, 1790: 37). Pole (1790: 64) was very particular in the use of individuals for injection of the lymphatic system. He stated that individuals who died anasarcous were particularly useful as their lymphatic vessels were enlarged and they should preferably also be emaciated. He noted that this type of preparation was one of the most difficult and required great skill; "*This is one of the most delicate preparations, requiring the greatest dexterity of any part of experimental anatomy*" (Pole 1790: 66). For preparations of heads he recommended individuals of young adults, and persons of about 20 years of age for demonstrations of the skull bones as the sutures were perfectly formed, the bones nice and white and the teeth in good condition (Pole, 1790: 154-156).

The use of foetal or newborn individuals was likewise highly recommended as they were relatively easy to prepare (Pole, 1790: 67-70). Foetal or newborn individuals were particularly good for making “natural human skeletons”, which required the tendons to remain *in situ*, by using the maceration technique. For injections of foetuses he recommended children who had died shortly after birth rather than still born as the lungs were better developed (Pole 1790, 47). Individuals with pathological bone were in great demand, but due to the usually fragile state of these, they had to be left for the flesh to decompose naturally and completely, which Pole suggested could take 5-10 months if the weather was cold (Pole, 1790: 157).

4.3.3 Dissecting/cutting the bone

It is of interest in this thesis to consider how preparations of cadavers impacted on the bones and how this may be reflected in the osteological record. Cadavers were generally processed partially or whole depending on the type of preparation (Pole, 1790: 35). Dissection of the skeleton may have been carried out to allow access to or display of internal organs or even to make preparations visible. Other cuts may have been made simply to limit the size of the preparation to make it fit into a container. A summary of cuts to the bone as described by Pole (1790) and Parsons (1831) can be viewed in Table 5. The types of cuts have been divided into age categories; adults, foetuses and young people (children) as specified by Pole, whilst Parsons (1831) did not make such a distinction. The table does not include alterations to the bone as a part of articulating a skeleton, this has been discussed below (section 4.3.4). Parsons (1831) frequently quoted Pole’s (1790) preparation techniques making the two manuals very similar, many cuts resembling those performed during dissection.

Parts of body (Adults)	**Techniques**	**Pole (1790)**	**Parsons (1831)**
Skull	Removal of skull cap	Horizontal section through the whole summit of the skull (34)	Saw from nasal prominence through upper part of squarmos and the external occipital protuberance (166)
Skull	Bisection of head	Cut perpendicularly through the whole head and cervical vertebrae beginning 1/4 inch to one side of the sagittal suture to avoid longitudinal sinus and nasal septum. Incline	Saw 1/4 inch from sagittal suture incline saw towards foramen magnum (167)

		saw towards foramen magnum and cut through the middle of the vertebrae (35)	
Skull	Section of parietal bone	Perpendicular section 1/2 inch to the right and/or left of the sagittal suture, carried down to an inch of the orbit anteriorly and as far as the lambdoid suture posteriorly. Saw horizontally through the upper edge of the temporal bone to meet extremities of cut, and remove elliptical portion of the cranium. (34)	Saw 1/2 inch to either side of sagittal suture to an inch above the orbit at the front and lambdoid suture at the back. Then saw horizontally through the upper edge of the temporal bone to take out an ellipitical portion of bone (166).
Skull	Removal of brain from complete skull	Trephine 1-2 perforations to posterior (31, 35, 101)	If there is no need to cut the skull remove brain by making two perforations with a trephine anywhere at the back of the skull (167)
Skull	Exposure of frontal sinuses	Remove portion of external table by frontal sinuses with small trephine (35)	n/a
Skull	Orbital wedge	n/a	Saw though orbit on one of the sides in two places, leading from foramen opticum and diverge towards each angle of the eye and raise carefully (168)
Skull	Mandible (view carotid artery)	Cut to posterior of last molar (33)	Use a fine saw and make a vertical cut posterior of last molar (127).
Skull	Mandible (view nerves of face)	n/a	Remove cheek bone (Zygomatic) and divide lower jaw at symphysis (127).
Sternum	Opening of thorax	Cut the whole length of the sternum divided longitudinally (27, 44)	Divide sternum with saw or detach from cartilage (175)
Ribs	Opening of thorax	Bend back each side of the rib cage and cut cartilage three inches from sternum, (At no point does Pole suggest cutting the actual ribs) (27, 44)	Saw ribs about mid way between spine and sternum from first to last (to display heart *in situ*) (40).
Vertebrae	Removing the head from the	Horizontal cut between C6-7 (56).	n/a

	body		
Vertebrae	Removing the lower torso	Cut through T12 horizontally (56).	n/a
Vertebrae	Exposure of vertebral canal	n/a	Saw away each side of the posterior plates from base of transverse and articulating process and remove with spinous process (173)
Vertebrae	Exposure of vertebral canal	n/a	Saw, with a hand saw, through the middle of the spinous process from behind forwards. And then by making an oblique section on either side of the spine, penetrating to the vertebral canal through the middle of the transverse articulating process (173)
Vertebrae	Exposure of vertebral canal	n/a	Make oblique section on either side of the spinous process and remove the intermediate section (173)
Vertebrae	Section through whole skeleton	n/a	Saw through sternum and pubic symphysis. Then saw through coccyx upwards through the spine. Finally saw head from top down (175)
Pelvis	n/a	Cut pubis bone longitudinally (56)	Saw two inches from the symphysis (only if pelvis is of no value to other preparations) (59)
Arms	Removal of arm once injection has been completed	Raise clavicle from sternum and dissect under scapula to remove arm, scapula and clavicle together (35).	n/a
Arms	Removal of lower arm	Amputate a little above the elbow (35)	n/a
Legs	Removal of legs	Make section through pubis symphysis (cartilage) and remove each side of the pelvis (35)	n/a
Extremities	To allow access of water during maceratio n of bone	Holes should be bored in large cylindrical bones the size of a swan quill (99).	n/a

Foetus			
Head	Removal of head after injection	Cut as close to the base of skull as possible (48)	n/a
Trunk	For display following injection	*Preserve* trunk, whole vertebrae and posterior portion of ribs and pelvis. (He does not mention cutting of the ribs) (48)	n/a
Legs	Removal of lower extremitie s for display	Detach articulation with acetabulum (48)	n/a
Young people			
Head	Following injection remove head from torso for display	Cut C5-6 perpendicular through the middle (knife/saw/scissors) (56)	n/a
Femur	To display Cancellie	Cut out middle portion of bone, only use where cancellie bone is most delicate. Cut in portions of 2 inches with a fine saw. Do not jar the saw! (56)	n/a

Table 5 descriptions of bone cuts as advised by Pole (1790) and Parsons (1831)

Generally, the tissue was injected first and the body then separated for display. Using foetuses and young children required less sawing and trepanning as bones were un-fused and easier to separate at the joints. Opening of the thorax and division of the pelvis appears to have been carried out by cutting cartilage rather than bone. It is evident from Pole's manual that dissection of the skeleton was kept to a minimum and preserving the body as complete as possible was essential. Parsons (1831: 59) noted that the bone of the pelvis should only be cut if it was of no value to other preparations. Divisions were predominantly made for ease of display and exhibiting internal structures in the skull and bones. Evidently there would have been many different methods of displaying parts of the body and Pole's manual (1790) has not exhausted these. Illustrations in Holden (1894) and Tank & Grant (2009) provided further insight into types of cuts made to view different anatomies of the body, showing complex cuts such as exposing the roots of dentition *in situ* (Holden 1894, 258) and a vertical section through the hip (Holden 1894, 640). The illustrations also revealed that cuts through the long bones were frequently performed to limit the bulk of the preparations, whilst such cuts were only described in limited detail in the manuals. It was conceived that these were images of preparations made to display aspects of the anatomy without the student having to perform the cuts, most likely because they were too complex and/or disrupted the natural progression of the dissection. Viewing Hunter's displays at the Royal College of Surgeons and exhibits at the pathology Museum at Guy's and St Thomas' hospital, the range of cuts includes many applied to the cranium and pelvis not addressed by Pole (1790) and Parsons (1831). Effectively once injections were made the body could be dissected to display any part of the anatomy desired. The cuts described by Pole (1790) and Parsons (1831) were most likely those necessary in making the classic preparations, but a museum would have encompassed many more types to display unique traits, pathologies and specific fields of interest. A number of the cuts would have been performed both as part of a normal dissection of the body (section 4.1.5) and for making of preservations; such as the classic removal of the skull cap and opening of the spinal cord, making a clear distinction between the two difficult to identify osteologically.

4.3.4 Preparing and articulating a skeleton

The skeletal system formed an important part of any anatomy lecture series in the eighteenth century and well-preserved articulated skeletons therefore formed an integral part of any good anatomical collection. Preparing bones for articulation required the skeleton to remain as complete as possible. Lyser and Thomson (1740: 226pp) provided a detailed account of how this was to be performed. They advised dividing the extremities into three parts (upper portion, lower portion and hand/foot) and the torso into three portions (head, spine/ribs and pelvis) and recommended a combination of maceration and boiling. This combination of methods for breaking down the soft tissue allowed for relatively rapid processing, with boiling time of 4-5 hours and maceration time of 4-5 days. Pole (1790: 150) strongly advised against boiling the bone unless this was done in pearl-ash (potassium carbonate) as the bones would otherwise lose their whiteness. Pole recommended macerating the bones, which involved an extended procedure of covering the bones in water and changing the water every day until it was clean (about a week) then leaving them in the tub for 3-6 month to ensure the removal of all soft tissue. Once removed from the tub they had to be scraped of flesh, ligaments and periosteum and then immersed in water for another few days and then in lime water (calcium hydroxide solution) for a week. He remarked that London faced an additional problem in ensuring the bones maintained a good colour; "*it is necessary, in order to preserve the skeleton as clean as possible, especially in London, and other large cities, where the atmosphere is abounds with particles of soot and other impurities, to keep the maceration vessels always closely covered; as from neglect of this, the water will acquire so much of it, as to blacken the bones*" (Pole, 1790: 99-100).

Preparing the body for articulation was an extended process that could take weeks and even months depending on the method applied. William Hunter favoured the maceration method without boiling, stating that this could take upwards of 10-12 months (Notes of W. Hunter's lectures c.1771, 179: RCS Lib MS0204/1/7-8).

1. Separate bones
2. Perforate cylindrical bones (Table 6)
3. Immerse in water (4-5 days- 1 week)
4. Boil the bone (>4-5 hours) or leave in water 3-6 months
5. Leave in water with lime a few days
6. Clean the bone
7. Articulate the bone

Table 6 shows the location of perforations for extracting the bone marrow as advised by Lyser and Thomson (1740). Some would have differed from perforation made for the purpose of articulating the skeletons whilst others would have been reused for that purpose.

Bone	**Proximal**	**Distal**
Humerus	Head of humerus	Olecraneon fossa
Ulna	Most superior portion	Groove by styloid process
Radius	Middle of head	Middle of epiphysis
Femur	Cavity by greater trochanter	Middle sinus between condyles
Tibia	Middle aspect of epiphysis	middle aspect of epiphysis
Fibula	Joint surface	Cavity belonging to malleolus externus

Table 6 location of perforations made for extraction of bone marrow (Lyser & Thomson, 1740: 233-235)

A number of different methods of articulation was proposed and Lyser & Thomson (1740: 248) and Pole (1790: 113) had different approaches. Both recommend brass wires over iron as these would not corrode. Lyser and Thomson (1740) recommended the use of twisted wires throughout the skeleton by perforation of the bone in two places, whilst Pole (1790: 181pp) used tin plates and pins to fix the joint. As an example; articulating the humerus with the scapula, Pole (1790: 124) advised cutting a longitudinal oblique slot through the head of the bone to a depth of about one inch and fixing a screw in a lateral direction and attaching it to a perforation in the glenoid cavity, which would then enable the screw to move up and down in the incision, emulating the movement of the joint by adding a tin plate to avoid the screw coming out. Lyser & Thomson (1740: 257) advised the more simple device of making a perforation of the joint through the neck of the scapula and the glenoid cavity to feed the wire and match this to the humeral head where a perforation would be made following through to the sinus of the second tendon, effectively creating a "brass ring" in which the joint could be moved. Parsons (1831: 156) described two methods for joining the humerus with the scapula; the first was similar to that of Lyser and Thomson (1740) with a simple perforation whilst the other involved making a cross section on the head of the humerus and a perforation on the posterior portion of the neck, allowing a pin with a double ring in the middle to be pulled through and joining a perforation in the glenoid cavity. Like Pole's method this would have allowed a more natural movement of the joint but in this case in two directions. Similar principles were applied to all joints in the body regardless of whether it was the torso or the extremities.

Preparations played an important role in anatomy teaching and were essential to any anatomy school. They could be used to explain details of the body that could not be readily viewed during a dissection and created a commodity that was of both aesthetic and pecuniary value. Students were taught how to make preparations as part of the curriculum, though it is not clear to what extent this was carried out on human bodies. Certainly, making preparations was time consuming and required ample space for storing and cleaning, not to mention the smell of decomposing bodies during the process. It is perhaps not surprising that preparations sold for large sums of money and good examples were highly sought after.

4.4 The use of animals at anatomy schools

Animals were frequently used in the study of anatomy and, unlike humans were used for both dissection and vivisection, that is, both dead and living (Atali-ç, 2012: 400). Anatomy schools across London would have acquired animals for many different purposes such as; scientific experiments, demonstrations, preparations, surgical practice and comparative anatomy. Animals were not hard to come by in London where domestic livestock was sold for consumption in the markets and pets were increasingly popular. Exotic animals were available from menageries and animal merchants across the capital (Plumb, 2010). Unlike humans, animal dissection and vivisection were not governed by any laws and the absence of regulations as well as their much lower cost in comparison with human cadavers would undoubtedly have played an important role in the use of animals at the anatomy schools across London.

Animal experimentation is an ancient undertaking and can be traced back to Croton (450BC) and Hippocrates (460-377BC). Galen (AD130-210) allegedly carried out more than 600 experiments on animals and drew direct parallels with human anatomy, causing many misconceptions in later centuries. Such practices were challenged in the sixteenth century by Vesalius (1514-1564) who proved Galen's descriptions of the human body were wrong as they were based on large mammals such as oxen, it became generally accepted that dissection of animals was no substitute for dissecting humans (Atali-ç, 2012: 401pp). In the eighteenth century it was acknowledged that life could be explained through biological processes, rejecting the idea of the human body as the pinnacle of God's work. Linnaeus (1707-1778) made a structured classification of animals in 1735 leading to a new discipline of "comparative anatomy" which was fostered throughout the eighteenth century and beyond, eventually leading to Darwin's evolution theories in the nineteenth century. Comparative anatomy therefore did not become an integrated part of most anatomy courses until the eighteenth centuries (Guerrini, 2003)

Animals were frequently vivisected in lectures to demonstrate the function of the body and students were encouraged to carry out such experiments for themselves. Monro *Primus'* treatise of 1747 highlighted just how common such animal demonstrations were. During his lectures he made several demonstrations on the nerves, lungs and blood, observing the reactions of animals when exposed to stress (Lawrence C, 1988: 198). A student described Dr. Monro's lectures at the University of Edinburgh, where on more than one occassion a dog was tied to the table to demonstrate its ability to breathe despite trauma to one lung and another where the wind pipe of a pig was removed in order to silence it whilst opening the abdomen. The student considered that such practices were completely unnecessary and that "*a verbal description would have covered the subject just as well*". Concerns were expressed that young impressionable students were taught to perform cruelty "in the name of science" by their heroes, when in fact such demonstrations rarely served the purpose of making new discoveries (Drummond, 1838: 156-158). It was generally accepted that animal experimentation was in some cases necessary for the advancement of science but the use of animals for demonstrations was unacceptable (Drummond, 1838: 158)

Lyser and Thomson (1740: vi) advocated the use of animals in anatomical and *chirurgical studies* as they could be experimented on alive; "*When human Bodies cannot be had, we ought to exercise ourselves with, Animals; for by them we may learn to know the Parts, how to dissect, trepan, or perform any other chirurgical Operation. We may likewise make different Experiments without opening the Cranium, by applying Medicines externally by mixing them with the Food, 'and by Injections into the Vessels, in order to discover what disturbs the animal Actions, and what is most proper to restore them when disordered*." Lyser and Thomson (1740) essentially advocated using living subjects to experience a realistic surgical operation and to inflict injuries upon the animals in order to observe the effect of these and learn how to cure them.

Animals featured strongly in research and new discoveries during the eighteenth century, with *The Philosophical Transactions* published by the Royal Society recording many such animal experiments. The Society strongly believed in the Baconian method in which research of "inductive reasoning" (section 3.1), was used to form a strong argument from the accumulation. This form of research required consistent and repeated experiments in order to build a valid argument, often involving dozens and sometimes hundreds of animals to prove a single point. Experimental research became an expected part of any new discoveries and work with animals was openly discussed at the Society's meetings (Syfret, 1948). Most commonly this involved living animals, such as the experiments carried out by William Hunter (1777: 42pp) 1758-1759 on dogs, sheep and an ass to prove his theory of absorption of the lacteals.

With the increasing interest in the similarities and differences between species, comparative anatomy became an integrated part of the study of anatomy. It was well recognised in the eighteenth century that ancient texts on anatomy were marred by errors caused by directly comparing anatomical features of different animals with those of the human body. Monro (1744: 1pp) explained the importance of realising the differences between species in order to interpret these older texts correctly and also highlighted comparative anatomy as an important tool in understanding the human body by looking at the function of the same organs in different animals. Dodsley (1765: 161) wrote "*the pride of man is alarmed, in this case, with too close a comparison, and the dignity of philosophy will not easily stoop to receive a lesson from the instincts of brutes. – But this conduct is weak and foolish*-". It seemed generally accepted that comparative anatomy within the realms of anatomy teaching was for the purpose of advancement of mankind and that understanding animals would lead to better understanding of the human anatomy.

John Hunter was an avid collector of different species spending many hours a day dissecting and making preparations to house in his museum (Hunter & Palmer, 1835: 72). Preparations of animals formed an important part of any museum collection, including animals from common domesticated species and exotic animals from across the world. Insects, mammals, fish, birds and amphibians were all used to demonstrate points of anatomy. They also undoubtedly demonstrated the ability, wealth and social connections in acquiring interesting and exotic specimens. They were treated and prepared very much like human cadavers (section 4.1.5 and 4.3.3) either complete or in parts.

4.4.1 The use of different species

A wide variety of species was available to the anatomist in the eighteenth century. The passion for world exploration and discovery saw ships from all over the world dock in

London. Animals were a great source of curiosity and a growing taste for the exotic and the unusual fuelled an increased trade and display of creatures foreign to the British Isles (Plumb, 2010). Animals in medical research were used as and when available. Domestic species such as dogs and sheep were generally used for experiments when any species would do, whereas more exotic animals, such as turtles and crocodiles were used when comparing the anatomy of different classes of animals. For comparative anatomy Pole (1790: 117) highly recommended fish and turtle for demonstrations of the lacteals as they were large in the turtle and fish had no valves to disrupt the flow of injections. Animal size at times played an important role in making observations; simply to see small structures better, or to find as close as possible a comparison for humans. William Hunter (1777: 42) in his experiments on the lacteals and their absorbance (1758-1759) experimented first on a dog but then chose sheep as they were larger and then finally moved onto an ass stating; "*If any animal could be supposed fitter subject for such experiment than a sheep, it would be an Ass. He is not so large, nor so strong, but that he may be managed*". Living animals were at times difficult to handle and it was necessary to consider whether sufficiently manageable to carry out the planned experiment. John Hunter used a wide variety of species in his experiments including chicken, hedgehog, ass, toad, snake, frog, viper and deer, and appeared to have very little aversion to experimenting on many animals in a variety of ways (Hunter & Palmer, 1835). Hales (1740), in his experiments on the flow of blood, used predominantly dogs and horses, though several experiments included ox, fallow deer, cats and sparrow as well. Dogs were particularly favoured, most likely because they were relatively easy to acquire and can be docile. They were frequently used in Galen's studies of anatomy and Vesalius -dissected a great number of dogs in order to make comparisons with the works of Galen (Wells, 1965: 7). Dogs therefore became the traditional and acceptable species to use. Hales (1733) experimented on dogs of different sizes; from small spaniels to large mastiff dogs, suggesting that there was no specific preference of breeds. There is evidence of only very limited use of species such as pig, rabbit and cat, which although they would have been as readily available as dog, sheep, ass and horse. It is somewhat unclear why some species were selected over others though William Hunter implied that some were easier to handle as they were a more convenient or suitable size and more amicable than others (Hunter, 1777: 43).

4.4.2 Public attitudes

Like the cadaver trade in the eighteenth century, the use of animals for vivisections evoked a wide range of feelings in the public domain particularly in the latter half of the century with disgruntlement ever present in the media (Bellanca, 2003). Perhaps the controversies surrounding the cadaver trade highlighted the worse fate of living animals used for the same purpose. Writer Samuel Johnson (1709-1784), who usually advocated scientific research, wrote in *the Idler in 1758* to express his disgust for "*the inferiour professors of medical knowledge" a "race of wretches,*" he declared, "*whose favourite amusement is to nail dogs to tables and open them alive; to try how long life may be continued in various degrees of mutilation, or with the excision or laceration of the vital parts . . . . if the knowledge of physiology has been somewhat encreased, he surely buys knowledge dear, who learns the use of the lacteals at the expence of his humanity*" (Bellanca, 2003: 56). Despite the ever increasing opposition, animal experiments were openly discussed at Royal Society meetings where there was little to suggest the practice was in decline. The only obstacle in using animals for experiments was the moral conscience of the experimenter (Atali-ç, 2012: 403). Swiss anatomist Albrecht Von Haller (1708-1777) expressed an unease in his pursuit for medical knowledge; …*and since the beginning of 1751 I have examined several different ways, a hundred and ninety animals, a species of cruelty for which I felt such a reluctance, as could only overcome by the desire of contributing to the benefit of Mankind, and excused by that motive which induces persons of the most human temper, to eat every day the flesh of harmless animals without scruple*" (Wells, 1965: 14). Haller's feelings seem not to so much involve a discomfort in performing vivisections as an attempt to find justification for his actions. He certainly did nothing to suggest how he may have been able to cause less distress to the animals. Philosopher Jeremy Bentham (1748-1832) highlighted that animals, regardless of their lack of speech and reason, still felt pain. This promoted the view that animals should be protected in their own right and did not solely exist to serve humans (Atali-ç, 2012: 404). Despite public opposition to animal experimentation, very little action was taken on their behalf and it was not until well into the nineteenth century that laws on use of animals in medical research were established. The first Parliamentary Act for animal protection was in 1822 and it was amended in 1876 specifically to regulate animal testing, though it only included vertebrates. The act specified that animals had to be anesthetised and used only once in experiments. It also stated that animals could only be used if absolutely necessary … "*to save or prolong human life*".

Animal experimentation today is steeped in ethical and moral issues which are far from resolved, but there is little to suggest that the anatomists of the eighteenth century were much troubled by the complex issues surrounding the far from unresolved topic today. Papers given at the Royal Society openly described complex and invasive experiments on animals and gave little attention to alternative methods of experimentation. We may view the eighteenth century as lacking a moral compass with regards to animal experimentation, but it is worth remembering that today in Britain alone over three million animals are killed every year in the name of science, 80% mice and rats, 10% rodents, birds and fish and 1%

cats, dogs and primates (Atali-ç, 2012: 413). It appears that our own morals only include animals that humans can truly relate to and we regard smaller animals less important than the larger ones. Jeremy Bentham's reminder that despite the animals inability to speak and reason they still feel pain, seems to still be an issue we are battling with in the 21st century. Philosopher Peter Singer (1975) reiterated Bentham's notion by pointing out that this sentiment towards living creatures would allow for inclusion of unborn babies, mentally retarded and senile elders, who are equally unable to defend themselves through speech and reasoning.

5 William Hewson

This chapter explores the historical evidence relating to William Hewson as the founder of the Craven Street anatomy school, which gives a nuanced picture of what is was like to be an anatomist and researcher in the latter half of the eighteenth century. Documentary sources provide a detailed account of Hewson as in both a private and professional capacity. His marriage to Mary Stevenson, who corresponded frequently with Benjamin Franklin and discussed family news, allows an rare insight into a man dedicated to both his family and to physiological research and provides a more comprehensive picture of his personality than may be afforded many of his peers. His associations with William and John Hunter likewise allow a unique insight through their private communications. This section of the thesis has therefore been dedicated to exploring Hewson as a person and how he was viewed by his family and his professional peers. Throughout the chapter references will be made to Hewson's professional associates. Please see Appendix 2 for further information on these individuals.

William Hewson (Figure 12) was born in Hexham in Northumberland on the 14th of November 1739, under the name Hewatson, which Hewson himself changed when he arrived in London (Wilford, 1993: 138). Hewson's father William Hewatson was an apothecary and Hewson's mother, Mary Heron, was local to the area and gave birth to eleven children but only Hewson and two girls survived by 1767 (Lettsom, 1810: 53). Hewson attended the local grammar school under a reverend Brown until 1753 when at the age of 14 he travelled to Newcastle to start his apprenticeship under Dr Richard Lambert (Wilford, 1993: 138).

Figure 12 William Hewson (1739-1774), oil painting (Wellcome Library, London)

5.1 Hewson's training

Hewson's educational background was very typical of the eighteenth century; his father encouraged his son to take the medical route, probably with the hope that he would one day return to take over his father's practice. Hewson completed his Apprenticeship with Dr Richard Lambert in Newcastle-upon-Tyne, where he trained between 1753 and 1759 (Gulliver, 1846: xv). It was most likely his father who provided funds for this. Evidence from similar arrangements such as in a note from John Fothergill (1712-1780) in which his father paid £50 for his son's apprenticeship with an apothecary in Bradford (Benjamin Bartlett) in 1728 with an agreement that he should "*his master well and faithfully serve; his secrets shall keep; taverns he shall not haunt; at dice, cards, tables, bowls or any other unlawful game he shall not play*" and in return his master decreed to teach "*the art, trade, mystery of occupation of an apothecary, and provide him with sufficient enough meat, drink washing and lodging*" (Warren, 1951: 305). Hewson would have entered into a similar agreement with Dr Lambert. In 1759 at the age of 20 years he travelled to London to attend the courses of William Hunter in Covent Garden and gain experience in practical anatomy. He resided with Dr Hunter's brother John, who was then in charge of the practical anatomy lessons at William Hunter's school. He attended two seasons at the school in 1759 and 1760, whilst he was also registered with Guy's and St Thomas's hospital attending the medical lectures of Dr Hugh Smith and midwifery lectures of Mr Mackenzie (Lettsom, 1810: 53). It was most likely at this point that Hewson decided his passion was within physiological research rather than medical practice. It is unclear how he funded his London venture, but he may well again have drawn upon his father's finances. His skill in the anatomy room did not go unnoticed and when John Hunter left London to serve as an army surgeon in France and Portugal during the Seven Years' War in 1761, William Hunter asked Hewson to step into his brother's position in the dissection room (Gulliver, 1846: xv). This finally allowed Hewson to generate his own income at an age when most students were still spending money to further their careers (Wilford 1993) . In the winter of 1761 he travelled to Edinburgh to attend courses at the university under the famous Alexander Monro *Secundus*. He returned to London in 1762 to join William Hunter in a partnership in which he remained for ten years (Gulliver, 1846: xv).

5.2 The partnership with William Hunter (1762-1772)

Hewson's partnership with William Hunter (Figure 13) proved to be of significant benefit. It allowed him to pursue his interest in anatomical research first at the Covent Garden anatomy school (1746-1763), then at the facilities in Litchfield Street (1763-1767) and later in 1767 at the purpose built Great Windmill Street anatomy school (Gulliver, 1846: xv). William Hunter's influence on Hewson's career path cannot be underestimated. He presented several papers on Hewson's behalf at the Royal Society prior to Hewson becoming a member himself. Hunter further introduced Hewson to some of the most prominent medical men at the time, including John Pringle (1707-1782), ensuring the young anatomist was heard and noticed. Unfortunately little is known about their relationship prior to the acrimonious correspondence following the termination of their partnership and it is easy to assume from these later communications that Hewson and Hunter had a very turbulent and often less than amicable relationship. It is worth keeping in mind that most of these letters were written in moments of passion and anger reflecting the end of a ten year partnership.

Figure 13 William Hunter (1718-1783), oil painting (Wellcome Library, London)

Hewson's partnership with William Hunter was not an even divide. Personal letters show Hewson's position to have been closer to a valued employee than an equal partner. It is unclear what William Hunter gained from offering Hewson a partnership as opposed to employment, other than a higher degree of commitment to the school and Hunter himself. Hewson's earnings amounted to £270 *per annum* at the end of their partnership (Notes by W. Hewson c1772. Cited/Brook 2008: 75), which was considerably less than the amount earned by lecturers at hospitals, who could generate an income of over £1000 *per annum* in tuition fees. On the other hand, if Hewson had been an assistant as opposed to a partner, his income would have been significantly less at £50 *per annum* (Lawrence, 1996: 169 and Notes by W. Hewson c1772. Cited/Brook 2008: 84). Hunter himself was a man of considerable means and his income amounted to some £10,000 a year, generated through course fees, medical fees and stock market investments (Porter, 1983: 51). How much each of these sources contributed is unknown but it seems unlikely that Hewson had a 50% stake in the anatomy school business. It is not known whether Hewson made any financial investment in the school, but given his relatively modest background it is unlikely that he would have been able to contribute any sum that might have made a difference to William

Hunter. Later letters of communication suggest Hewson's role was largely confined to teaching in the dissection room and maintaining the museum collection whilst Hunter's role was to undertake the lectures (Notes by W. Hewson c1772. Cited/Brook 2008: 76). Hunter seemingly only rarely ventured into the dissection room as he was not keen on this aspect of teaching, despite the fact that the whole ethos of his empire was based on the notion that practical dissection for all students was paramount (Notes by W. Hewson c1772. Cited/Brook 2008: 80). He most likely selected Hewson to replace John Hunter as he showed very little aversion to the sometimes unpleasant tasks required. The clear division of roles was apparently of some discontent to Hewson who requested to do some of the lectures but was turned down by Hunter on several occasions (Notes by W. Hewson c1772. Cited/Brook 2008: 74). Lecture notes dating from around 1770 (RCS: Lib.MS0204/2/3) provide evidence that Hewson did carry out some of the lectures on blood and lymphatics in the later years. It was this desire of Hewson to extend his duties to lecturing that saw their partnership crumble which, according to Hewson, occurred around 1766 when Hunter refused to allow him to give lectures on blood (Notes by W. Hewson c1772. Cited/Brook 2008: 76). Hewson felt stifled by Hunter's management and wanted to expand his skills and pursue his own experiments. Hunter was becoming an obstacle rather than an aid in Hewson's upward mobility.

Hewson was fast becoming an established anatomist in his own right and became a Fellow of the Royal Society on 8 March, 1770) (Royal Society, 2007: 168). He was awarded the prestigious Copley Medal the same year (November 30, 1770) (Wade, 1944: 80). Becoming a Fellow of the Royal Society was, and still is today, an election through a peer review process. Hewson was elected as a fellow on the recommendations of William Hunter, John Pringle, Benjamin Franklin, M Maty, J Turton and James Ferguson (Gulliver, 1846: xvi). Being a Fellow (F.R.S) allowed Hewson to present his own papers independently of William Hunter, who had presented three papers on his behalf prior to Hewson's election. Being awarded the Copley Medal was undoubtedly a further opportunity for Hewson to become an independent researcher. The medal was awarded for a paper read to the Society in 1769 on the lymphatic system in birds, fish and amphibians (section 5.5). Hewson's recognition at the Royal Society must have afforded Hunter very little choice but to allow Hewson to give some of the lectures at Windmill Street associated with his research, further encroaching into what Hunter considered his domain.

The turbulent end to their partnership brought out their personalities on public display. Hunter came across as very controlling and protective of his investments whereas Hewson was driven by an ambition to carve himself a niche in physiological research. An anonymous contributor to the Evening Post on 7 November, 1772 described both men with some exasperation over their petty squabbles "…. *The Doctor is, with the Othello, getting into the Vale of years, and, with a jealousy truly Turkish, can bear no Rival near the anatomical throne, much less one who aspires at independent reputation….Mr H[ewson] is young and ambitious; could not brooke a subserviency to another's Reputation, as he imagined; and certainly was too inattentive to the Terms of their association*" (Burney: Issue 1831). For someone to publish such condemning descriptions of their characters in the public media reflect the lengths to which the dispute was taken. The notice clearly reflected the differences between the two men. Hewson was keen to establish his own name independent of Hunter, who had undoubtedly overshadowed Hewson's career since their partnership commenced. Hunter on the other hand did not appreciate the lack of gratitude from Hewson and his craving for independence. Despite this, Hunter had more often than not acted as an important enabler, allowing Hewson to progress in his career. He agreed to present papers on Hewson's behalf, he introduced Hewson to respected medical men and was one of the five men who recommended Hewson for election as a Fellow of the Royal Society. Their relationship was therefore clearly more complex than may initially appear through their numerous final communications in 1772 (Brock, 2008: 73-87). The reason given for the final split between Hewson and William Hunter in 1772 has frequently been cited as Hewson's inability to dedicate himself to the school following his marriage (Gulliver, 1846; Lettsom, 1810; Wilson, 1993; Doyle 2006). As discussed above it is doubtful that this was the sole reason, Hewson and William Hunter had intermittent disagreement throughout the final seven years of their partnership. Their personalities clearly clashed, despite their admiration for each other's work, and in the end the two men continued to show respect for each other's research and achievements after their split (Gulliver, 1846: xvii).

It is interesting to observe that Hewson was never a registered member of the Company of Surgeons, and as a consequence would have practiced surgery without a license (Simon Chaplin *pers. Comm*., 2009). Though this was not illegal Hewson did not have any experience of consequence with patients or practicing as a surgeon, and had very little opportunity to pursue this side of the medical professions whilst with William Hunter. In fact Hewson expressed discontent with William Hunter over his lack of support for his desire to gain patients as an additional income to his share of the profits at the anatomy school; "*Dr H[unter] ......made me at different times the most liberal promises of helping me into business etc. But the fruits of these promises have not yet been considerable, he has been 9 years my Patron, & has in that time recommended me only one medc'y patient who gave me two Guineas. Patients whom I bled for him of whom I gained two Guineas more*" (Notes by William Hewson on William Hunter c1772. Cited/Brock 2008: 79). Hewson then described an incident where William Hunter's reluctance to provide him with patients was further demonstrated; "*.....These with my not getting [?practice] by his recommendation, as I had to expect from his friendship especially as I had known him called out for dinner whilst I was sitting with him, been asked to attend people who cld not come up to his price who he had refused without ever once mentioning me on the occasion."* This reluctance of William Hunter to provide Hewson with patients may have been driven by a desire to make Hewson dependent on his position at the anatomy school, though it was William Hunter and not Hewson who wished to dissolve their partnership in the end (Notes by William Hewson on William Hunter c1772. Cited/Brock 2008, 80). From Hewson's publications on his research it is apparent that he did draw parallels with living patients. In his publication in 1767 on the "*Operation on the paracetesis thoracic*", Hewson's evidence appeared to rely on evidence provided by other surgeons and not from his own personal experiences (Hewson, 1767: 374). In his publication "*Into the properties of the blood*" 16 of his experiments involved living patients who were all bled for various reasons, but he never stated that he himself carried out the procedure (Hewson, 1771). Hewson did attend the sickbed of William Stark, his friend, in 1770 relating a series of bleedings and provision of medicine to alleviate the patient's discomfort. Further evidence of Hewson's possible connection with treatment of patients could be found in *The Morning Chronicle* (August 5, 1773. Burney: Issue 1311) where he questioned the treatment of a young woman by a surgeon (Morning chronicle July 29, 1773. Burney: Issue 1305) and offered to treat her himself (The correspondence was signed "July 30, Strand W.H, most likely to be William Hewson). On July 17, 1766 Hewson's name was used in an advert for "Mr. Brand's trusses" claiming he (Hewson) had used them on patients with great success, and signed the statement "W Hewson, Surgeon". It is not known whether the advert was written with consent, but Hewson's profession was most likely elevated to surgeon to promote the product as in no other circumstances did Hewson claim he was a surgeon; at the Royal Society he was addressed as "Teacher of Anatomy" (Appendix 3). It appears that Hewson's opportunities to practice as a surgeon were very limited at least prior to termination of his contract, though it does appear that Hewson may have acquired some opportunities to practice once he settled at Craven Street.

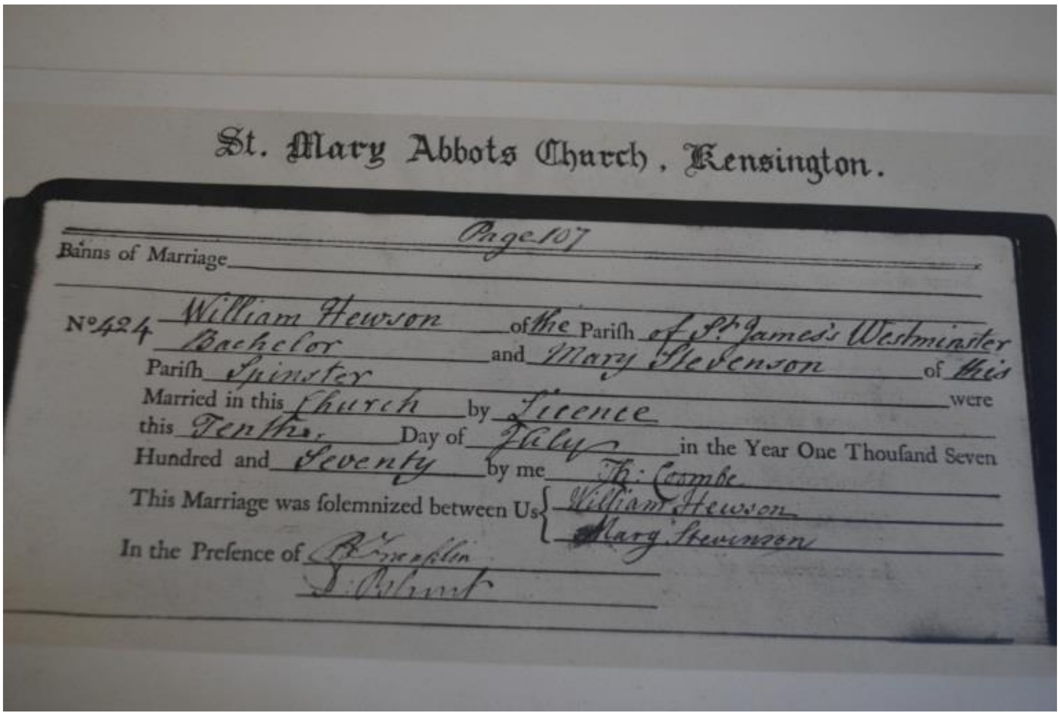
5.3 Hewson's personal life

Hewson's life outside professional circles is well documented thanks to his wife Mary (Polly) Stevenson (Figure 14) and her extensive communications with Benjamin Franklin (Figure 15) between 1759 and 1789 (Franklinpapers, 1988). Benjamin Franklin was a lodger at the Stevenson household for around 15 years, and remained a family friend until his death in 1790. Hewson's marriage to Mary Stevenson significantly influenced both his private and professional life. Establishing himself as a family man gave William Hunter an excuse to dissolve their partnership but as a consequence Hewson had to find an alternative method of providing for his family. Hewson's school was housed in Craven Street at the residence of Mary's mother (Margaret Stevenson) doubling up as the home of the family.

Figure 14 pastel of Mary (Polly) Stevenson (1739-1795) c1770 (Source: Collection of Theodore E. Wiederseim, Photo courtesy of Conservation Center for Art & Historical Artifacts. (Source: benfranklin300.org, 2008)

Figure 15 Benjamin Franklin (1706-1790) (Coloured aquatint 1790 by C.P.A Van Loo after P.M. Alix.) (Wellcome Library, London)

Hewson's wife Mary Stevenson was born on the 15 June 1739, the only child of London merchant Addinell Stevenson and Margaret (Rooke) Stevenson. Her father passed away when she was a child, though the exact date is unknown. She resided with her mother at 27 Craven Street until her marriage to Hewson in 1770. Margaret Stevenson also owned another property on the street, most likely number one, across the road, where she and Benjamin Franklin moved to in c.1772 when Hewson and Mary took over the house at number 27. Mary's mother had three sisters and was described as being a forthright and prickly personality (Srodes, 2002: 156). Mary's life is well documented through her 173 communications with Benjamin Franklin. She was highly intelligent and had many discussions with Franklin on his scientific discoveries. Franklin was purported to have had an intimate relationship with Mary, though through the letters between the two it appears that he was more likely to have pursued a relationship with her mother (Srodes, 2002: 188). The first letters between Mary and Franklin date from 1758 when Mary was around 19 years of age. She appears to have lived for some time with elderly relatives, Mrs Tickle, Mrs Rooke and Miss Piff, in Wanstead, in order to care for them (Srodes, 2002: 188). Still unmarried at the age of 30, Mary met Hewson whilst staying with a Mr Coleman in Margate on 31 August 1769. On 1 September, 1769 she wrote a letter to Franklin where she described their meeting. "*I met with a very sensible Physician yesterday, who prescribes Abstinence for the Cure of Consumption. He must be clever because he thinks as we do. I would not have you or my Mother surpris'd, if I should run off with this young man; to be sure it would be an imprudent Step at the discreet Age of Thirty but there is no saying what one should do if sollicited by a Man of an insinuating Address and good Person, tho he may be too young for one, and not yet establish'd in his Profession. He engag'd me so deeply in Conversation and I was so much pleas'd with him, that I thought it necessary to give you Warning, tho' I assure you he has made no Proposal*." (Letter written to B. Franklin by M. Stevenson on 1 September, 1769. Cited/Franklinpapers, 1988). It is almost certain that Hewson was the "Physician" that Mary referred to, whether Hewson had presented himself as a physician or Mary decided to elevate Hewson's professional credentials to make him appear more eligible remains uncertain. It is not known what Hewson was doing in Margate at the time, but it is not unlikely that he was there for professional reasons, such as pursuing his interest in the lymphatic system of fish (section 5.5.6). It is clear from Mary's communications with Franklin, that he did not know Hewson personally. On 31 May, 1770 Franklin wrote "*I assure you that no Objection has occur'd to me; his Person you see, his Temper and his Understanding you can judge of, his Character for any thing I have ever heard is unblemished; his Profession, with that Skill in it he is suppos'd to have, will be sufficient to support a Family; and therefore considering the Fortune you have in your Hands, (tho' any future Expectation from your Aunt should be disappointed) I do not see but that the Agreement may be a rational one on both sides* (Letter written to M. Stevenson by B. Franklin on 31 May, 1770. Cited/www.franklinpapers.org, 1988**)**. Franklin stood in for Mary's father and gave her away at a ceremony on 10 July 1770 at St. Mary Abbot's church in Kensington. The marriage register (Figure 16) was signed by Benjamin Franklin and Dorthea Blunt, a close friend of Mary's and later of Franklin (Letter written to B. Franklin by D. Blunt on 26 July, 1770. Cited/Franklinpapers, 1988)



St. Mary Abbots Church. Kensington.

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Banns of Marriage

N°424 William Hewson of the Pariſh of St James's Westminster Bachelor and Mary Stevenson of this Pariſh Spinster Married in this Church by Licence were this Tenth Day of July in the Year One Thouſand Seven Hundred and Seventy by me Th: Coombe.

This Marriage was ſolemnized between Us { William Hewson, Mary Stevenson }

In the Preſence of B Franklin, J. Blunt

Figure 16 The marriage certificate of William Hewson and Mary Stevenson (Private collection: Melissa Hewson, Philadelphia) (Photo: Melissa Hewson)

Their marriage was followed by a journey to Hexham to visit Hewson's mother and only surviving sister (Letter written to B. Franklin by M. Hewson on 18 July, 1770. Cited/Franklinpapers, 1988). On their return they moved into Hewson's apartment in Broad Street near the anatomy school where they had their first son William Hewson in 1771. They remained there until October 1772, where alterations to 27 Craven Street had been completed to accommodate both the anatomy school and themselves. After moving to Craven Street, Mary gave birth to their second son on 9 April 1773, Thomas Tickell Hewson and fell pregnant with their third child in December 1773 a daughter born on 9 August 1774. Through Mary's letters their marriage was loving and good-humoured. Hewson appears to have been prone to irony and commented on his wife's eccentricities. He teased Mary by saying to her "*don't forget to mention the boy*" in a letter she was writing to Franklin, knowing that she would mostly do very little else. He also claimed "*scribblers do not make good housewives*" possibly meant ironically, though he did allegedly lock up all her writing paper (Letters to B. Franklin by M. Hewson on 2 November and 8 July 1772. Cited/Franklinpapers, 1988). It appears that there is no surviving communication between Franklin and Mary between November 1772 and May 1775, but this may be due to Mary at the time looking after two children, or perhaps Franklin was in London on a regular basis at the time.

Hewson's death was tragic and unexpected, their marriage ended prematurely as in April 1774 when Hewson cut himself whilst dissecting a cadaver and came down with a fever from septicaemia. On 18 April he had high fever and had to stop lecturing. On 20 April Hewson gave his last lecture (Lettsom, 1810: 58) and on 28 April, 1774 Franklin wrote to his wife Deborah *"Mr. Hewson is down with a terrible Fever, and till yesterday his Life was despair'd of; we now begin to hope his Recovery* (Letter to D. Franklin by B. Franklin on 20 April, 1774. Cited/Franklinpapers, 1988). Hewson died on 1 May, 1774 aged 35; leaving behind his pregnant wife and two sons. He was buried at St-Martin-in-the-Fields church on 6 May 1774 but there is no known monument and his gravesite remains unknown. The Church Records only read "William Hewson, a man" (TWS, 1934: 361). There is no record on the events following Hewson's death, whether he was autopsied or even dissected, like John Hunter at his death in 1793 (Payne, 2007: 146). On 5 May, 1774 Franklin wrote *"Our Family here is in great Distress. Poor Mrs. Hewson has lost her Husband, and Mrs. Stevenson her Son-in-law. He died last Sunday Morning of a Fever which baffled the Skill of our best Physicians. He was an excellent young Man, ingenious, industrious, useful, and belov'd by all that knew him. She is left with two young Children, and a third soon expected. He was just established in a profitable growing Business, with the best Prospects of bringing up his young Family advantageously. They were a happy Couple! All their Schemes of Life are now overthrown!*" (Letter to D. Franklin by B. Franklin on 5 May, 1774. Cited/Franklinpapers, 1988). After Hewson's death Mary stayed in Surrey for some time and later moved to Philadelphia by invitation of Benjamin Franklin, where she remained unmarried until her death on 14 October, 1795. The oldest son William Hewson died in 1802 at the relatively young age of 31. The second son Thomas Tickell Hewson became a physician in Philadelphia and the daughter, whom Hewson never met, married a Mr Caldecott (Lettsom, 1810: 58). Following Hewson's death at least two poems were written about his skills and untimely death.

<u>On the death of Mr Hewson, the Anatomist</u>

Nature submitted for a-while to try
The penetration of a Hewson's eye;
Saw him a-while contentedly explore
The human frame, scarce known to man before
But, when she found he quickly would betray
Her every mystery to the eye of day,
To check th' aspiring youth's praise-worthy pride,
She said, "Let darkness be,"- and HEWSON died!

(Universal Magazine of Knowledge and Pleasure, 54:378 (1774: June) p.315

On the later Mr Hewson, the Anatomist by Dr. KENRICK

Of spirit true, of soul sincere,
To Science as to Virtue dear,
Through Nature's veil, with piercing eye,
so boldly did his genius pry;
With Doctors and diseases at strife,
A real friend to human life,
Death, fearing left in time his skill
Should take away their power to kill,
Raising his own revengeful dart,
Struck his foe, Hewson, to the heart!

Westminster Magazine, (1776: July) p.386

The poems reflect the upheaval surrounding Hewson's unexpected and premature death and the recognition of a great loss to science. On his deathbed, he allegedly requested Magnus Falconar as his successor to the anatomy school (Lettsom, 1810: 59)

5.4 Hewson's successors

Magnus Falconar (6 November, 1752- 24 March, 1778) was a close friend and colleague of Hewson and became his brother-in-law in 1774 when he married Hewson's only surviving sister Dorothy Hewson. At the age of 26 years, Falconar had two children; Jane (born: 1775) and John (born: 1777) who both died in infancy (Robertson 2012, 37). Falconar continued to run the school for a period of four years from May 1774 until his death from tuberculosis on 24 March, 1778 (Dobson, 1961: 185). On 7 July, 1774 Falconar gained a diploma of the Surgeon's Company and was elected professor of anatomy at the Company of Surgeons on 3 July, 1777 (Morning Post, 10 July 1777. Burney: Issue 1472). He was dedicated to Hewson and to the anatomy school. In 1777 he published a "*Synopsis of a Course of Lectures on Anatomy and Surgery*" as a study aid to students (Falconar 1777b). In the same year he also published "experimental enquiries into the formation of the red particles of the blood" based on Hewson's research on the subject (Falconar 1777c). There is no evidence that Falconar managed to carry out any research independent of Hewson's experiment, though this is most likely due to his premature death rather than lack of ingenuity. The family resided at Craven Street until Falconar's death, where after it is uncertain what became of Dorothy. On 28 December, 1775 Magnus Falconar was assigned to the mortgage of a property in Watford which appears to have gone into administration in 1813 and it is possible that Dorothy moved to Watford following Falconar's death (Hertfordshire Archive and Local Studies: number 43226 and 43237/43238). Falconar's career may well have had a different focus to Hewson's. He had spent time authoring a book on anatomy to aid the students at the school and had become professor of anatomy at a very young age, suggesting he may have chosen to dedicate his life to teaching and surgery rather than to research.

The Craven Street School is much less well documented following the death of Falconar. When he died in March 1778 when a course would still have been running at the school. It appears that Falconar's post was advertised and it was filled by a young surgeon; Andrew Blackall (14 August, 1754- 1780) after Falconar died (Duncan, 1783: 114 and Simmons *et al.*, 1983). His tenure at Craven Street was short lived, as he is recorded as lecturing with John Sheldon at his theatre in Queen Street during the season 1778-1779 (Chaplin, 2009: Appendix 1). This means Blackall most likely completed the 1778 season and possibly the summer course at Craven Street before taking up the post at Queen Street. In 1779 Blackall opened his own anatomy school in Thavie's Inn where he also resided, but unfortunately he too died of tuberculosis at the very young age of 27 and his anatomy schools saw the same fate as Craven Street, with the entire content sold off at auction (Chaplin, 2009: 142).

5.5 Hewson's research

Hewson's list of publications is impressive for his short life (see appendix 3), he was gifted with the ability of systematic deduction through experimentation. His ability to build on his results and logical approach to relatively new scientific methods such as the use of microscopes distinguished him from his contemporaries (Falconar, 1777a: vii). The main focus of Hewson's research was the circulatory system; he conducted investigations into the morphology of red blood cells and the blood's ability to coagulate (he discovered fibrinogen), earning him the title of "Father of Haematology" in contemporary scientific research (Doyle, 2006). He also investigated the lymphatic system's absorbency and the function of the thymus and the spleen in their role of fighting infection as well as proving the system's existence in birds, fish and amphibians. It was the latter that earned him the prestigious Copley Medal in 1770, at the young age of 30 years at the anniversary meeting of the Royal Society (Gulliver 1846, xxiv). The medal is today curated at the College of Physicians in Philadelphia (Figure 17) (Wade, 1943: 179). On 8 March 1770 he became a Fellow of the Royal Society, only three years after his teachers and sponsors William and John Hunter (F.R.S. 1767) (The Royal Society, 2007: 182).

Figure 17 Copley medal awarded to William Hewson (Photo from Wade 1943, 180)

The Royal Society was a prestigious forum for the elite pursuing natural knowledge, a place where new ideas could be discussed amongst the likeminded (Lawrence, 1996: 216). For Hewson, the recognition he received would have elevated his position in society. It provided him with the opportunity to interact on an equal footing with the cultural and intellectual elite of London at the time, including Franklin (F.R.S 1756). His first three scientific papers had been presented on his behalf to the Society by William Hunter, as Hewson at this point was not yet elected a Fellow (Doyle, 2006a: 378). This greatly benefitted Hewson as Hunter was well respected and spoke with much eloquence (Hawkins, 1884: 535). The first paper was presented on 15 June 1767 describing "*The Operation of the paracentesis Thoracic for air in the chest; with some Remarks on the Emphysema, and on the Wounds of the Lungs in general*". The second and third paper were presented on 8 December 1768 (lymphatic system in birds) and on 9 November 1769 (the lymphatic system in fish and amphibians). The latter was submitted five months earlier, suggesting that the papers were reviewed prior to presentation. Though Hewson received the ultimate recognition of the Copley Medal for the latter paper, he also experienced a barrage of accusations of plagiarism from his peers, including Alexander Monro *Secundus* and John Hunter. For many young scientists this would have caused a displacement of confidence, but if this happened to Hewson, he did not give his peers the satisfaction of retreat. Instead he launched a ferocious counter response, even on the points where his peers were proved right.

5.5.1 Operations of the Paracentesis Thoracic

Hewson's first research paper was presented 15 June, 1767 at the Royal Society. He set out to prove that emphysema (damage to the air sacs in the lungs) did not always produce dyspnea (breathlessness) or follow a wound in the chest wall. He noted that pneumothorax (air trapped in the pleural space next to the lungs) could follow even minor or absent injuries to the wall and could be easily relieved by inserting a small trocar (tube) into the chest on the right side and mid-axially on the left side to protect the heart (Hewson, 1767; Doyle, 2006a: 378). Hewson proved this through a series of five experiments on living rabbits and dogs. The paper caused an outrage from Monro *Secundus* who claimed that this was a discovery he had made years earlier in company of Johannes Friedrich Meckel the Elder (1724-1774) in Berlin and had taught Hewson this himself, whilst he was attending his classes in Edinburgh in 1761 (Doyle, 2006a: 378). Hewson's response was one of surprise, though ultimately he provided Monro *Secundus* with a public apology (Hewson, 1774: 164). "*...Having since learnt, from other Gentlemen attending your lectures before the time of my publishing the paper (and who, at my request consulted their notes) that you had really mentioned it. I can now not doubt that you made the observations before me. At the same time I must assure you, to suppose I knew it at the time of publishing that paper, was doing me injustice*". Hewson proceeded to defend his ignorance of the matter by relating to Monro that he had, previous to reading the paper at the Society, presented the paper to physicians from Guy's and Middlesex Hospitals as well as to Dr Stark and Dr Parson from Christ Church College Oxford. He persisted that none of them had mentioned that this had been previously discovered, despite some of them attending Monro's courses at Edinburgh (Hewson, 1774: 166). Hewson's first attempt at presenting new research thus ended in little else than a heated dispute over rights of first discovery. This affair did not however deter him and he went on to make a great number of physiological discoveries relating to the circulatory system.

5.5.2 The circulatory system – the blood and the lymphatic system

Following the much disputed discovery of the operation of the thorax, Hewson focused on physiological discoveries rather than subjects of direct clinical relevance, in particular the circulatory system and more specifically the blood and the lymphatic system. Hewson's interest was fuelled by his associations with the Hunter brothers who had a keen interest in the same subject matter (Eales, 1974: 280). Hewson's work on the blood focused on two main topics; namely the morphology of the red blood cell (RBC) and on the blood's ability to coagulate. His interest in the lymphatic system was focused on tracing the system fully in humans and proving its existence in birds, fish and amphibians, as well as discussing the function of the spleen and the thymus in association with both the blood and the lymphatic system. Through a great number of experiments and application of the microscope, Hewson made significant discoveries resulting in the ultimate accolade of being named "the father of haematology" (Doan, 1954). Despite this, the path to getting his discoveries accepted was long and some were not recognised until well into the mid nineteenth century.

5.5.3 Hewson and the microscope

The eighteenth century has been considered the "dark age" for microscopy due to the lack of progress in optics (McCormick, 1987: 14). There was also limited progress in refining and using the instrument and there were only very limited improvements in image quality from the previous century. The images were seen as imperfect and not particularly suitable for histological work until the 1820s (Bracegirdle, 1978: 193). Opinions on microscopes however differed greatly: some maintained that they could demonstrate as yet "undiscovered secrets of species"; others saw them as no more than a source of entertainment. There is very limited evidence of glass slides being used for histological observations and Hewson's slides are amongst the earliest known, providing a rare glimpse of the techniques used (Allen & Turk, 1982: 415). Both the simple single lens microscope and the compound double lens microscope were available during Hewson's time, though they did not develop a great deal until the nineteenth century, where the microscope improved sufficiently to become an integral part of scientific research. One significant contribution to the promotion of microscopes in the eighteenth century was the famous book of Henry Baker (1742) "*Microscopes made easy*". This publication was the foundation of Hewson's knowledge and research and he applied the techniques and instruments promoted by Mr Baker (Hewson, 1770. Cited/Gulliver, 1846: 214).

On 17 and 24 June 1773 William Hewson presented a paper to the royal society "On the Figure and Composition of the Red Particles of the Blood, commonly called Red Globules", in which he firmly expressed his belief in the microscopes as a scientific research tool. These instruments were met with great skepticism amongst Hewson's peers, including John Hunter but this did not deter Hewson who believed that with the right approach and understanding the instrument proved a valuable tool. Hewson produced a large collection of microscopic slides clearly demonstrating his confidence in its uses. The publication provides excellent insight into Hewson's use of the microscope. "*Some have gone so far as to assert, that no credit can be given to the microscope, that they deceive us, by representing objects different from what they really are...these assertions, though not entirely without foundation when we speak of one sort of microscopes [the compound microscope], are very unjustly applied to them all...No such circumstances take place when we view the object through a single lens, all who use spectacles agree that the figures appear the same through them, as they do to the naked eye*" (Hewson, 1773: 304). Hewson was very aware of some of the pit falls of the compound microscope but failed to see some the flaws of the single lens microscopes. He appeared to blame failed attempts on the users rather than the instruments. "*it is by microscope alone that we can discover these particles [red blood cells]; and some dexterity and practice are required in the use of the instrument,* *there have not been wanting of men of character and ingenuity, who, having been unsuccessful in their own experiments, have questioned the validity of those made more fortunately by others*" (Hewson, 1773: 304). Hewson opted for the single lens microscope as promoted by Mr Baker (Figure 18).

Figure 18 Mr Baker's pocket microscope fixed to a scroll and given light by speculum (mirror) (Baker, 1743: 14 and plate II)

Magnification and quality of the images was obviously of great concern to Hewson, who had the lenses made especially for his research "*almost all the observations were made with lenses, as they are prepared by some of our more skilful workmen in London*". He explained that the greatest magnification achieved by makers in London was 1/50th of an inch focal distance, in comparison with 8 inches as the focal distance of the naked eye. This provided a magnification of 400 times the object's original size. He was aware that this magnification had been far exceeded on the continent, with a Father de La Torre achieving magnifications of 640 and 1280 times by using glass globules but claimed that the lesser magnification power was more "*superior in distinctness*" due to the higher quality of glass used by the London makers (Hewson, 1773: 305). John Hunter (1828: 42) (Figure 19) objected to Hewson's confidence in the instrument and, he argued that even simple microscopes could result in deception when viewing three dimensional objects and transparent bodies, such as red blood cells. Hunter openly disputed Hewson's findings and in his treatise (1828) he commented; "*Mr Hewson has been at great pains to examine the blood in the microscope, and has given us figures of the different shapes of those globules; but there is reason to think he may have been deceived* ..." (Hunter, 1828: 50). He clearly thought Hewson's observations were flawed due to misinterpretation of what he was able to observe using his single lens microscope.

Figure 19 John Hunter (1728-1793). Oil painting after Sir Joshua Reynolds (Wellcome Library, London)

John Hunter's own detailed observations on blood must also have been made using a microscope, but his interpretations were very different due to his lack of confidence in the instrument. John Hunter (1828) made some important observations on their limitations and effectively described the biggest defects of eighteenth century microscopes by highlighting what we today know as spherical and chromatic aberration, as described by McCormick (1987: 13). Chromatic aberration describes the coloured fringes that outline objects in the image and this problem was not resolved in lens design until the 1830s. Spherical aberration makes it difficult to focus sharply on the edges of the object being observed so the image appears fuzzy. Hunter likened this effect to the naked eye observing the moon, which he quite rightly noted as being only partly visible depending on the light (Hunter, 1828: 43). Despite Hewson's confidence in his observations using a relatively low magnification of 400 times, this must have limited greatly what he could see and it is a far cry from the magnifications used today. Despite his scepticism, at the sale of the Craven Street museum in 1778 John Hunter purchased a large number of Hewson's slides to add to his own museum collection though he is not known to have prepared his own microscopic slides (Allen & Turk, 1982: 415). Due to this purchase, some of Hewson's slides survive to this day at the Royal College of Surgeons in London. The slides were advertised in the 1778 auction catalogue as; "*An elegant mahogany inlaid cabinet with 16 drawers containing about 300 microscopic objects from various anatomical preparations spread upon glass, and enclosed in tubes hermetically sealed*" (Parsons, 1778, 22/10/1778- lot 87). Dobson (1960: 188), formerly a curator at the anatomical museum at the Royal College of Surgeons, suggested that Hunter bought at least 217 of the slides (70 wet specimens sealed in glass tubes and 147 dried specimens spread on glass slides). 67 were later discarded and the museum today has around 103 slides left (55 in tubes and 48 on slides). Bracegirdle (1994) examined Hewson's specimens at the Royal College of Surgeons. Some of the dried specimens were membranes in which the blood capillaries had been injected with coloured media, dried on the glass plate and then varnished. These are still so well preserved that they can be viewed under the microscope today. This method was apparently also used in the seventeenth century and in the early eighteenth century. Preparations in glass tubes were not common at the time, but was a technique promoted by Mr Baker in "microscopes made easy" (1742: 19). These tubes preserved in the Royal College of Surgeons demonstrate a unique mounting technique in which the tissue is mounted on a metal strip, preserved in alcohol, and hermetically sealed in the glass tube.

5.5.4 Hewson's observation of the Red Blood Cells (RBC)

On research into the Red Blood Cells (RBC), John Hunter (1828: 14) wrote "*Like other things which are discovered to be of great use, the blood has frequently attracted the attention of mankind, as an object of curiosity only, from which some have proceeded to a more critical enquiry into its nature and properties*". In the eighteenth century blood physiology was at a basic level, limited by the microscopes and other scientific instruments available at the time. Many of Hewson discoveries are in direct contradiction to what we know about RBC today, yet he made some significant observations that would lead to a much greater understanding on the physiology of the blood. His enthusiasm for the microscope perhaps slightly obscured his critical thinking, but despite this he was able to make many valid observations. When Hewson presented his paper on the morphology of the RBC in 1773, he was adamant that the microscope was the only way to make observations on the chemical properties of the blood. He set out to challenge the notions previously made on the blood by dismissing van Leeuwenhoek's interpretation that the RBC were spherical (Hewson, 1773). He maintained that the biggest flaw in previous observations was the use of water in separating the RBCs, as water diffuses into the RBCs, which are naturally flattened discs in form and turns them spherical. He noted that the blood's own serum was more appropriate, as this retained their original shape. Using serum rather than water, Hewson observed that RBCs were "flat as a guinea" and had a darker center, which he interpreted as being a "nucleus" and not a hole as interpreted by Father de La Torre (presented at the Royal Society in 1766) (Gulliver, 1846: 214). Hewson made his observations using a technique originally devised by Jean-Baptiste de Sénac (1693-1770) (1749), slightly tilting the microscopic slide so that the RBC would travel downwards and thereby observing them in motion. Hewson most likely learnt this technique directly from Sénac when he travelled to France in 1765, but he completely failed to attribute this to him (Kleinzeller, 1996: C2). Flatness of globules was described prior to Hewson by Swammerdam (1658) in the seventeenth century and later seen again by Sénac in 1749 and after Hewson by De La Torre in 1776 (Robb-Smith, 1962: 701). Despite this, the idea that they were globules was maintained for decades after Hewson's death. John Hunter described them as globules in his treatise on gun-shot wounds and generally opposed Hewson's findings (Hunter, 1828). Today's microscope images of RBC show that Hewson's observations were obscured by the limitations of the equipment he was using. They are indeed biconcave discs with a concave centre, which in mature RBC does not contain a nucleus (Peate & Nair, 2011: 374-377). Cavallo (1798, 252) questioned Hewson's results and put it down to an optical illusion of the microscope; "*When particles of blood are magnified 400 times, an imperfect image of the candle, which is placed before the microscope, may be seen within the inner circle of each particle. This image becomes even clearer at 900 times magnification [using a glass globule]. They show that Mr. Hewson's idea of their containing a central body or nucleus movable within the small external shell, arose from the apparent change of place which the various direction of light produces on the central spot or inner circle of the particle*". It is uncertain whether this was indeed what Hewson saw, or whether he saw the central concavity in RBC as a dark spot, either way Hewson was mistaken on the "nucleus" theory and this led him to draw further erroneous conclusions about the formation of the RBC. The "nucleus" theory was perpetuated, if not globally accepted, until 1838 when it was universally recognised as an optical illusion (Kleinzeller, 1996: C2).

The theory did, however, lead Hewson to make an observation which has subsequently proved to be correct. It was based on the apparent movement of the "nucleus" and changes in the shape of the RBC when they entered smaller veins. From this Hewson concluded RBCs were not solid but membranous (Kleinzeller, 1996: C4). Current observations confirm that the shape is maintained by a protein network, which allows the RBC to change shape as they travel through the vessels (Peate & Nair, 2011: 374-377). Once again, John Hunter disagreed, maintaining instead that RBCs were fluid: "*they can adapt to the size of the vessels and were therefore fluid with and attraction to themselves, yet without the power of uniting with one another, which may arise from their central attraction…*" (Hunter, 1828: 41). Hewson, like Leeuwenhoek, observed that in some animals they were oval and not round. Hunter acknowledged that this was in direct contradiction to his fluid theory but explained the discrepancy by arguing that the different shapes were yet another optical illusion of the microscope "*Hence the less credit is to be given to those who have described the globules as being of oval figure in some animals, for they have also described them as being different and strange shapes in even the same animal*" (Hunter, 1828: 42). There is little doubt that Hunter was referring to Hewson's observations on the subject; "*…these vesicles are different sizes in different animals. I have also observed, that they are not all of the same size in the same animal…*" (Gulliver, 1846: 232) "*I have likewise [seen], in that animal where they are elliptical, move with one end foremost*" (Gulliver, 1846: 228). Hewson however continued to believe in what he saw and paid very little heed to the problems of spherical and chromatic aberration, despite being aware of these shortcomings of the microscope, and he did not in public question his observations. He continued to publish observations on the size of RBCs in different species and reported that they were larger in young children than adults (Doyle, 2006: 376). His descriptions of the variations were meticulous (Hewson, 1773: 307) and he made similar conclusions to those of Leeuwenhoek, that the size of the RBC had no relation to the overall body size of the animal (Hewson, 1773: 323, table XII).

5.5.5 Clotting of the blood

Benjamin Ward Richardson (1858: 42) once wrote of Hewson "*A fact observed is often far more valuable than the inference made by it from the observer….so we may accept the observations of Hewson without binding ourselves strictly to his deductions*". He was referring to Hewson's observations on the coagulation of blood.

Blood clotting is a complex process which minimizes loss of blood when the vessels are damaged. There are two clotting factors; platelets which form "white clots" and fibrin which forms "red clots". Platelets are the primary clotting agent in arteries and fibrin the primary agent in veins, though they both work together to form a strong clot in both types of vessels. Fibrin forms a strong mesh of proteins which adheres to the wall of the blood vessels and entangles RBC (Peate & Nair 2011, 382-383). Hewson observed that coagulation was caused by what he called "coaguable lymph" (this would nowadays be called fibrin) and though the fibrin mesh had been observed as far back as Plato (c. 427-347 BC), in Hewson's time it was still believed that RBCs were the source of it (Anning, 1957: 33; Doyle 2006: 376). Hewson stressed the importance of "coaguable lymph" on aneurisms and heart disease: "*In a word, this lymph is supposed to have a great share in the cause of several diseases, that it would be desirable to ascertain what brings on that coagulation either in the body or out of it*" (Hewson, 1770: 376).

Bleeding was a frequently applied treatment for many ailments despite it being founded in the ancient medical ideas of Galen. From Hewson's descriptions in "Inquiries into the Properties of Blood…" first published in 1770 and later in 1774, it appears that 8-9 ounces (~250ml) of blood was the norm in one sitting, usually drawn into 3-4 cups (Hewson, 1774). A number of his peers had observed that the first blood drawn from an individual was more prone to clotting than he last blood in a single treatment (Hewson, 1774: 52). Hewson instead noted in a number of experiments that the blood's ability to coagulate in some cases depended on the state of a patient or experimental animal. He noted, contrary to common belief that if the patient/animal became progressively faint or weakened during bleeding the speed of coagulation would increase. He put this down to an alteration of the blood vessels (Hewson, 1774: 61). In the eighteenth century it was common practice to ensure patients stayed awake during treatment, whether bleeding or amputation and Hewson (1774: 64) advised that in cases of haemorrhaging it was not advisable to revive patients as this could prevent clotting of the blood. He stated that arteries in this state were more likely to contract and blood would thus more readily coagulate (Hewson 1774: 63). Hewson used his findings in the treatment of patients and when he attended his friend Dr Stark who died from malnutrition in February 1770 he made observations on the rate of coagulation from blood he extracted; "…..*I took away nine ounces of blood, which was received into four cups; the two first had an inflammatory crust. The blood, at five o'clock, P.M. had very little serum, which I ascribed to it having stood in a cool place, as the coagulum felt very firm, and as one cup which was removed into a warm room, had more serum separated the day following…*" (Hewson's account 1770. Cited/Carmichael Smyth 1788, 186). From this extract it appears that Hewson's experiments on the rate and variability of coagulation were far from concluded, as he put the differences he observed down to room temperature rather than Stark's health. Stark died whilst experimenting on the influence of different foods on the body, with the encouragement of both Dr John Pringle and Dr Benjamin Franklin who helped design the experiments. An autopsy was subsequently carried out by Hewson and William Hunter (Carmichael Smyth, 1788: xi).

The primary aim of Hewson's experiments was to establish the causes of coagulation but he ultimately failed to explain it, or to understand why certain conditions were necessary for the blood to coagulate (Richardson, 1858: 5). He examined several environments and combinations of conditions including temperature, the effect of motion/rest and exposure to air. First, he set out to disprove the ancient beliefs of Plato, Aristotle and Hippocrates who believe that the blood coagulates as a consequence of cold (Richardson, 1858: 6), and he successfully dismissed the idea that freezing blood could halt coagulation (Hewson, 1770: 378). Hewson likewise dismissed "rest" as being a cause of coagulation by tying up the jugular vein of living dogs to halt the movement. He noted that the blood remained fluid for several hours (Hewson, 1770: 377). Rest did, however, appear to have some influence in cases of amputation where coagulation could occur above the ligatures where no air would be present (Hewson, 1770: 382). To test the effects of air, he tied up the jugular vein of a rabbit and added air. Within fifteen minutes, the coagulation had taken place and from this he concluded that air was a strong coagulant of the blood (Hewson, 1770: 378). In the latter experiment Hewson also noted that the blood, when it came into contact with air, turned florid red. He had already noted that arterial blood was bright red whilst venous blood was much darker in colour. He was convinced through experiments that the change in colour was produced by the blood passing through the lungs, though many of his peers had failed to note this in their own experiments. Hewson attributed this to failure of the arteries to open before the lungs collapsed (Hewson, 1770: 373 and Hewson, 1774: 7-9). Today it is common knowledge that arterial blood is oxygenated and venous blood is deoxygenated, so Hewson was right in at least some of his conclusions. His ideas, however, were not well received by other physiologists and he knew that his theory had flaws (Richardson 1856, 10 and Hewson, 1770: 382). Hunter (1828) disproved Hewson's theory that air was the cause of coagulation by showing it could occur in a vacuum (Doyle, 2006: 376) and instead introduced a new "principle of vitality" in which coagulation would only occur if the blood was still alive, a theory that Hewson did not address (Hunter, 1828: 86 and Richardson, 1858: 14)

5.5.6 Lymphatic system in Birds, fish and amphibians

Hewson's Copley Medal was awarded for his discoveries of the lymphatic system in birds, fish and amphibious animals. It appears that Hewson referred to turtle and crocodiles as amphibians and not reptiles, which is the classification they belong to today. The main discoveries of the lymphatic system had largely already been made in the seventeenth century, during which it had been proved that they existed in mammals. The Danish anatomist Bartholin (1616-1680) saw and named the lymphatic system and recognised that it was independent of the veins and arteries that carried the blood. The British physician Glisson (1599-1677) recognised them as being an absorbent system - "*The lymphatics carry back to the blood vessels lymph which had lubricated the cavities of the body, and their function is to absorb; in contrast to those who thought they were merely continued from small arteries*", a fact that both Monro *Secundus* and William Hunter later claimed to be the first to discover. William Hunter later recognised he could not maintain the claim and after reading Glisson's account he wrote "*I have several times met with my own observations in books, after having long believed them peculiar to myself. It* *must be the case with every man which is more entertained by nature than with books*" (Hunter, 1777: 61). In any case, the absorbent theory was received with much scepticism from their contemporaries. Hewson's presentation of the presence of a lymphatic system in birds, fish and amphibious animals helped dismiss the firmest argument of the critics; that there was no lymphatic system in oviparous animals and absorption in such animals occurred in the blood vessels. It was stated that if this was the case then it was most likely also true of humans and mammals as "*the author of Nature never could have formed two sets of vessels to do the same thing*" (Cruikshank 1790, iii). Hewson himself wrote; "*after being convinced that the use of one branch [the lacteals of the intestines] of the system is to absorb, we cannot at first sight but wonder that any anatomist should have hesitated to attribute a similar office to the other*" (Hewson 1774. Cited/Gulliver, 1846: 182) Hewson first traced the full system in a young living goose, acknowledging that John Hunter some years earlier had traced lymphatics in the neck of a bird (Hewson, 1768: 220). He later used the same methods to trace them in fish and a turtle. He went to Brighton in order to be able to carry out his work on large living fish such as skates, cod, monkfish and halibut as in London he had only been able to obtain smaller fishes. He rightly concluded that both birds and fish did not have any lymphatic glands (also known as lymph nodes) and turtle and fish had very few valves (Hewson, 1767 & 1768)

Hewson's claim of tracing the lymphatic system in birds, fish and amphibians was received with mixed feelings, and he was yet again exposed to accusations of plagiarism. According to Cruikshank, William Hunter noted in his lectures; *"....Mr. John Hunter ....found some lymphatics first in birds and then in crocodile....Mr Hewson, I say, by continued course of observations and experiments made in this house, discovered and fully demonstrated, the lymphatics and lacteals, both in birds and fishes...in comparative anatomy ...one of the greatest improvements which could have been made, to establish the universality of Nature's law in animal bodies....Mr Cruikshank traced the ramifications of the system to almost every part of the body*" (Cruikshank, 1790: v). William Hunter, according to Cruikshank, omitted to credit Hewson for the discovery of the lymphatic system in amphibians. He also omitted to mention any claims of discovery by Monro *Secundus* who had traced and depicted the lymphatic system in a turtle in 1765 (Hewson, 1774: 191). It is possible that William Hunter felt this credit went to his brother John, who in 1764 had dissected a five foot crocodile he acquired from a show in London, as well as another some years previously. John Hunter had shown Hewson the crocodile and read his description of the lymphatic system to demonstrate to Hewson that he had made this discovery in amphibious animals (Dobson, 1960: 180). William Hunter also alluded to John Hunter's discovery of the lymphatics in the neck of birds some years earlier (Cruikshank, 1790: v) but accepted that Hewson had managed to complete this discovery by tracing the whole system. John Hunter himself wrote; "*In the beginning of the year 1764-5 1 got* *a crocodile which had been in a 'show' for several years in London before it died. It was at the time of its death perhaps the largest ever seen in this country, having grown to my knowledge above three feet in length and was above five feet long when it died. I sent to Mr. Hewson and before I opened it, I read over to him my former descriptions of the dissections of this animal, relative to the 'absorbing system ', both of some of the larger lymphatics and of the lacteals, with a view to see how far these descriptions would agree with the appearances in the animal now before us, and on comparing them they exactly corresponded. This was the crocodile from which Mr. Hewson took his observations of the colour of the chyle. The intention of my showing this crocodile, and also reading my former dissections to Mr. Hewson was, that he might see that I had a tolerable description of this system in the Amphibia; because I found him busy in the pursuit of this system in various animals and hinting himself to be the discoverer of it even in birds, and to convince him that this description must have been written some considerable time before, in all probability before my going abroad. As crocodiles are seldom to be had in this country, I could hardly have dissected two crocodiles besides this, between May 1763 (the time I returned from Portugal), or the autumn of 1763, when the turtle was dissected, and the beginning of the winter 1764-5. Mr. Hewson at the time appeared satisfied, or at least made no remarks.*" (Dobson, 1960: 180). John Hunter's reference to the dissection of a turtle in 1763 was mentioned by Hewson in his letter to Monro, when he claimed to be the first observer of the lymphatic system in amphibious animals (Hewson, 1774: 191). It is however clear that John Hunter in his letter was referring to the dissection of another crocodile prior to 1763. In an undated letter (post 1774) John Hunter disputed Hewson's rights to claim any significant discoveries on the lymphatic system. He conceded that William Hunter should have been recognised as a fellow discoverer on the lymphatic system in fish and that he himself had discovered them in birds and amphibians prior to Hewson. He stated Hewson's more general publication "A description of the Lymphatic System in the Human subject and other animals", written in 1774 and dedicated to Benjamin Franklin, was not original work but based on discoveries made by his brother William Hunter "*whatever Merit Mr. H[ewson]. may have derived from this publication, should not in strict justice have been given him, and when consider'd in another view should go against him as a Plageerist*" (John Hunter on William Hewson, post 1774. Cited/Brock 2008: 87). John Hunter clearly felt a lot of hostility towards Hewson, despite the fact that Hewson did mention John Hunter's discovery of the lymphatic system in a bird neck, if only as a footnote (Hewson, 1768: 220). It seems that Hewson did not feel much inclination to reference previous research, even when evidence was clearly laid before him. It is possible that the resentment towards Hewson's claim of discovery was fostered by the award of the highly prestigious Copley Medal. Alternatively it may be that Hewson's supporters ensured that he gained recognition for his work after a barrage of accusations against him by recommending him for the Medal. After all, he did have powerful friends.

5.5.7 The extent of the lymphatic fluid (chyle)

According to Cruikshank (1790) Hewson also examined the nature of the lymph fluid itself believing it to be the same fluid present in the body cavities surrounding the lungs, heart, abdomen and pelvis. "*He used to scrape, with a wet spoon, the surface of the peritonaeum or pleura, till he had collected some considerable quantity of fluid; on letting it stand, he found that soon after it coagulated; and he considered this strong proof of the lymphatic absorbing surfaces, as the chyle being white and coagulating in the intestines, and being the same colour, and having that property, in the lacteals, was proof of their absorbing it from the intestines*" (Cruishank, 1790: 104). Cruikshank was not convinced that Hewson had conducted the experiments correctly and believed that in scraping the surface he had ruptured some vessels containing coagulating fluid (small blood vessels?). Hewson never published these findings himself and may have recognised that they did not stand up to further scrutiny, Cruikshank must have seen Hewson at work when he was still William Hunter's partner and hence this observation must have been made prior to 1772.

5.5.8 The lymphatic system and the WBCs

Hewson has in modern medicine received recognition for his discoveries of the white blood cells (WBC), though he did not strictly recognise that the white globules he saw under the microscope were a separate component of the blood but thought they were part of the red blood cells (RBC). Hewson and Falconar were the first to accurately discover the white blood cells (WBC) and their relations with the lymphatic system by diluting them in serum rather than water (Doan, 1954: 416; Robb-Smith, 1962: 703; Coley 2001: 2167), but due to lack of staining he was unable to distinguish the different types of WBC (Doyle, 2006: 376).

The experiments leading to these observations were carried out at Craven Street, but Hewson never succeeded in publishing his findings, and three years later Falconar published an account of their research, having repeated the experiments by Hewson several times (Falconar, 1777c: ix). They believed that their research proved that the RBCs were formed in the lymphatic system (lymphatic vessels, lymph nodes, thymus and spleen) (Falconar, 1777c; Cruikshank, 1790: 201; Smith & Smith, 1976: 169; Doyle 2006: 379). Unfortunately, their theories were founded in a misinterpretation of the "central particles" they observed in all parts of the system, which they mistook as being the "nuclei" of the RBCs (Damshek, 1963: 516). They believed that these "central particles" were produced in the thymus and the lymphatic glands, as this is where they had observed them. Today it is well known that all RBCs develop in red bone marrow and once matured they live 100-120 days and are then recycled by macrophages in the liver and spleen. In fact WBCs of the type called granulocytes (60-70%) are also formed in the bone marrow, as are the platelets involved in clotting. The lymphatic system generates a different type of WBCs called leucocytes, constituting 20-30% of all WBCs (Peate & Nair, 2011: 374-377). From this it must be deduced that Hewson's "central particles" were indeed leucocytes and not as he imagined the "nucleus" of the RBCs.

Hewson and Falconar maintained the "central particles" formed part of the RBC and in support of this they reported that they reflected the size and shape of the "nuclei" in different animals. "*It may be objected by some, that the appearance of central particles may be a deception, for that appearance may be seen in many fluids; but the uniformity of their figure in the same sort of animal, and the difference of their size and shape in different animals, will put this matter out of dispute*" (Falconar, 1777c: 126). Cruikshank (1790: 106) opposed this idea as he claimed that the "central particles" they had observed were non-existent. "*That they [lymphatic glands] serve to form central particles of the globules of blood, as Mr. Hewson and Falconar contended, is improbable, since these central particles have not been seen by the first microscopic observers in the world; I have never seem them; Haller says he once saw it, but supposes it a morbid appearance*". There is little doubt that Hewson and Falconar did see something and it is possible that other observers did not copy their methods exactly. Falconar (1777c), plate IV figure 3 was described as a depiction of particles viewed using "*strong sunlight*", suggesting that they could only be viewed in very favourable conditions.

Hewson and Falconar also speculated on how the "vesicle" (the outer part of a RBC) was formed. Having seen complete RBC in the lymphatic vessels and in the spleen, they assumed that these were the areas where RBCs were completed (Falconar, 1777c: 122). This conviction was supported by a series of observations. Firstly, the blood from the splenic veins did not contain any "nucleus". Secondly, the spleen was only present in animals with red blood and was not present in animals without red blood. One of their experiments involved removing the spleen from a dog, which did not suffer any immediate ill effects (Smith and Smith, 1976: 169). They therefore speculated that the spleen was an auxiliary to the lymphatic vessels, which they thought could also produce the "vesicle" of the RBC.

The thymus continued to fascinate both Hewson and Falconar. Having falsely established that it produced "central particles" for the RBC, they tried to establish why the thymus atrophied during life. It was well known, since the time of Galen, that the thymus was largest in newborns and then became progressively smaller to eventually being completely atrophied in the elderly. Falconar and Hewson observed that the thymus formed in the embryo at around three to four months gestation and continued to grow until birth. They also observed that the thymus could vary in size in humans of similar age but was generally the size of a walnut. After the first year of life it would decrease in size and by 10-12 years it would be much smaller. They concluded that the thymus was an appendage to the lymphatic glands and indeed had the same function (Falconar, 1777c: 85) and postulated that the thymus became defunct when the animal grew larger and the lymphatic system more extended. Though their observations were misguided it is significant that they grasped the co-dependency of the blood and lymphatic systems.

One of Hewson's students James Hendy (1775: 14) commented that "*There have not been wanting persons who have affirmed, that the use Hewson attributed the lymphatic system was no real discovery; and have placed it amongst the ridiculous opinions of the ancient*". Hendy himself did not agree with this statement and supported Hewson's research. He went on to state that "*Mr Hewson, in his CIII lecture of anatomical course, made it appear extremely probable, that the lymphatic vessels themselves were capable of forming both these parts [the nucleus of the RBC and the surrounding membrane].; but that for the more compleatly performing this function, the lymphatic glands, were found in more perfect animals*" (Hendy, 1775: 33). It is noticeable that Hendy wrote this is 1775, two years prior to Falconar's publication on the topic, suggesting that the theory on the function of the lymphatic had been made public a considerable time prior to the publication.

5.5.9 Observation on the "Whiteness" in the serum

Another interesting and perhaps more successful investigation into blood was initiated when Hewson received samples of blood from a number of apothecaries in London. The serum of the samples all had the same milky appearance which was believed to be caused by blood evacuation straight after a meal or before "*the chyle converts to blood*" (Hewson, 1774: 147). Hewson had made similar observations on geese, where he saw "*Small globules like those present in milk*". When he examined them he found them to be highly flammable and concluded they were oily in nature. "*…the fat is not merely the oily part of the chyle or of the food; but is a new substance, or a new combination of the principles or elements, which is made probably in the secretory organs of the adipose membrane: the form of oil being made use of by Nature in preference to any other for the nutritious substance of the body, from it being the least liable to putrefaction, and from its containing the greatest quantity of nourishment in the least bulk*" (Hewson, 1774: 141)

On comparing samples from three patients he noted that all three had symptoms of plethora (excess of red blood cells), a loss of appetite, abdominal pains and a tendency to obesity. Through experimentation with geese Hewson concluded that the accumulation of fat in the serum was not due to hunger but due to fat being absorbed faster than it was used and hence accumulated in the blood vessels when re-absorbed from the "adipose membrane" (Hewson, 1774: 154). He concluded that the fat accumulation was the cause of the complaints by the patients and not the effect. He stipulated that it was therefore advisable to check the serum in cases of stomach complaints and went on to suggest that patients with this condition should not receive "*remedies to strengthen the stomach*" but instead be treated by bleeding. Hewson did not explain how exactly bleeding would alleviate the accumulation of fat in the serum but regular bleeding of the patients in question appeared to make the serum progressively more transparent. He referred to his friend Dr Stark who had carried out a great number of experiments on the effect of different foods on the body and found much lower quantities of fat than any other food were required to maintain body weight. From this, Hewson concluded that the build-up of fat in the blood was due to excess consumption of fatty foods (Hewson, 1774: 152). The condition Hewson described is most likely an accumulation of triglycerides in the blood, a condition far from uncommon today. Left over calories consumed are turned into triglycerides and stored in fat cells for later use. Excess triglycerides may be caused by very high carbohydrate diet, obesity, diabetes, diseases of the liver and kidneys, hypothyroidism and excessive alcohol consumption. To lower triglyceride levels, exercise, weight loss and consumption of omega 3 fatty acids are recommended (Weatherby & Ferguson, 2004: 13).

It is interesting how accurate Hewson was in his conclusions on the appearance of "milky white serum". He was right to assume that the fat entered the blood system from the adipose tissue and that the fat accumulation was not the cause but the consequence of the condition. His conclusion that the excess fat in the blood was caused by overconsumption of fats in the diet was less fortunate, because modern research suggests that a diet high in carbohydrate and refined sugars is the main cause of high triglyceride levels (Weatherby & Ferguson, 2004: 13).

Hewson's research covered many different avenues of the circulatory system. He was clearly a highly skilled experimenter and microscopist. In his presentations to the Royal Society, he compared his experimental findings with his experiences of living patients and drew conclusions from a series of case studies. His research on blood and lymph resulted in a number of misinterpretations, but he nevertheless clearly understood the codependency of the two systems. He also realised that blood was made up of several components and that it was not the red blood cells that were responsible for clotting but what he called coagulable lymph (fibrinogen).

Hewson used a wide variety of animals for his research. According to his papers, experiments were mainly carried out on rabbits and dogs, though animals such as calf, bullock, frog, lobster, sheep, chicken and eel were also mentioned (Hewson, 1774; Falconar, 1777c). He also mentioned the use of goose to represent birds, turtle for amphibians and haddock, cod, turbot and skate for fish (Hewson, 1768 &1769). In one publication Hewson (1774) described a total of 33 experiments including three rabbits, eight dogs and one sheep. Of these experiments, at least four were vivisections. Similarly in his experiments on "air in the chest" or emphysema (Hewson, 1767) he described five experiments involving live dogs and rabbits. We do not know where he acquired his animals, though more common species such as dog and rabbit would have been readily available on request or even as strays on the streets of London. The larger farm animals such as the bullock, calf, sheep and goose may have been purchased at Hungerford Market which was next to Craven Street. In fact one sheep was never purchased; Hewson simply went to the market to observe it being slaughtered (1774: 61). At least one sickly turtle was acquired from a Lady Hertford (Brock 2008: 79), suggesting such creatures may not have been as readily available to a middle class anatomist despite Hewson carrying out several experiments on turtles (Hewson, 1769: 204). Hewson described one turtle as being large; measuring 82.30 cm from the lower to the upper part of the shell and 67.06 cm from side to side, but did not specify the species (Hewson, 1769: 199). Given the size of the animal it must have been an adult turtle weighing close to 300lbs. Plumb's thesis (2010) has demonstrated the large number of exotic animals available in London in the eighteenth century. It appears that marine turtles were not uncommon, but must have been relatively expensive, being imported live from areas such as the West Indies. They were retailed as close to Craven Street as Covent Garden at "Ward's Original Turtle Warehouse" (Plumb, 2010: 77). Unlike his experiments on animals, Hewson never described any dissections of humans in his papers presented at the Royal Society. His papers were clearly laid out and each experiment described separately, but any involving humans had according to his publications derived from living patients (Hewson, 1767 & 1774). Falconar (1777a) provided illustration on the thymus of a stillborn child, proving that both men also carried out research on human individuals. It is however clear that most of Hewson's research was on animals or required vivisections as a point of proof.

Accusations of plagiarism were an ever recurring problem for Hewson's research. It is not clear whether Hewson deliberately ignored the research of his peers but it does seem that his publications on occasion did not refer to research already carried out by others in a proper manner. Ironically Hewson himself was wary of plagiarism and used it as a reason for withholding information from William Hunter on his experiments on the lymphatics in birds. He claimed he was not fearful of William Hunter "stealing" his ideas, but was worried about him accidentally relating it to others who may not be as honest in pursuit of recognition. Hewson related his conversation with William Hunter in a letter; *"[you] might be tempted to say Mr. H[ewson] had such or such an idea about it & for such reasons the greater your friendship for me the more you are likely to mention my idea like the partiality of a parent who can conceal noth' that reflects credit on their child. Some of those who hear you may –dly mention it again without knowing it of any conseq'ce till at last it comes to the ears of Prof Chm who takes the hint & prosecutes it & publishes before me (as was in case w your lymph)....*" (Notes by William Hewson on William Hunter c1772. Cited/Brock 2008, 78). In this letter it appears that Hewson places the potential blame on some unspecified third party to avoid any direct impugning of William Hunter's character. Nevertheless, it is a clear expression of distrust towards William Hunter in what was by then a very fragile relationship. In reality it is difficult to gauge whether William Hunter would have claimed recognition in Hewson's experiments, because certainly he appeared willing to let Hewson take the credit for the papers he read for Hewson at the Royal Society. None of these papers have ever been associated with William Hunter other than as the speaker. Disputes of this kind were in fact far from rare and were a product of eighteenth century society. The rapidly developing scientific world thrived on self-promotion. Individual scientists frequently became involved in disputes over their discoveries and launched criticisms at their colleagues in an environment that would have deterred some whilst stimulating others (Lawrence, 1996: 222). John Hunter's claim that Hewson's discoveries on the blood had failed to gain recognition at the time may well have been true, but certainly, his discoveries on the blood and and fibrinogen (coagulating lymph) have today assured his recognition as an eminent scientist (Damshek, 1963; Doyle, 2006) and despite all the animosity towards his publications, Hewson remained well regarded amongst his peers. His character allowed him to persevere in a world where many would have faltered. He was described as "*young and ambitious [a man who] could not brooke a subservience to another's reputation*" "and he was noted for "*his diligent performance of his professional duties*" (Lettsom, 1810: 51) but also as "*beloved by all who knew him*" (Gulliver, 1846: xix). There is little doubt that Hewson had a relentless drive and desire to succeed and it appears that he was ambitious and hungry for recognition above riches; as ultimately described by John Pringle (Gulliver, 1846: xv). This characteristic was needed in his pursuit of the means to support his family though he may not have been as astute with money as he was with the scientific world

5.6 Summary

Hewson's associations with prominent figures such as Franklin and the Hunter brothers as well as his own extensive research papers have provided a unique insight into both his private and professional life. He followed a traditional path towards a career in medicine but he never gained a diploma from the Company of Surgeons which would have allowed him to further his career as a surgeon. Instead, it seems he went down the path of physiological research; an interest that appears to have been fostered during his time with William and John Hunter in London. His relationship with the Hunter brothers remained something of a double edged sword. His partnership with William Hunter allowed him to carry out research and become acquainted with prominent medical men, even though in later years the relationship turned sour. Hewson's research was firmly based on experimental research with an ability to build on his results and test his hypotheses, for which he gained the ultimate accolade in form of a Copley Medal. Despite or perhaps even because of this, his research caused a lot of controversy amongst his peers. John Hunter and Monro *Secundus* accused him of plagiarism several times and it appears that at least on some occasions Hewson failed to acknowledge the previous research of his peers. It is not clear whether this was due to his ambition to carve a niche for himself, a disregard for the quality of work carried out by others, or the result of a relatively crowded field of research in which many people had a potential claim. With his marriage to Mary Stevenson in 1770 his life took a significant turn as he was shortly afterwards released from his partnership with William Hunter. Hewson was then free to pursue his own research but also had new financial responsiblities, with a wife and two sons to provide for. Hewson's next venture became the Craven Street anatomy school to which the next chapter is dedicated.

6 The Craven Street anatomy school

The following chapter provides an account of the Craven Street anatomy school based on historical information. The lack of governing bodies for anatomy schools means there is no official documentation on private anatomy schools prior to the anatomy act (section 3.2.5). Yet it is possible to amalgamate information on the school from a range of historical sources to provide a fair account of how the school was established and run in its short life span from 1772 to 1778.

After the end of his partnership with William Hunter, Hewson was left without a secure income with which to support his family. With his father's death in 1767 there was no family business to fall back on. With his ten years of experience of running an anatomy school with William Hunter, the most logical career route for Hewson was to set up a similar business of his own. The cost of setting up an anatomy school cannot have been inconsiderable and how Hewson financed his business venture is not clear from any records. With his relatively modest wage and lack of extra mural work it must have been difficult for him to accumulate any significant savings. His wife Mary Hewson described herself in a letter as *"[having] no pretensions to beauty, nor any splendid fortune*" in the same letter she noted, "*His father died in 1767; and having had so large a family it will be readily supposed he could not give much to his son, so that Mr Hewson's advancement in life was owing to his own industry*" (Letter to Dr. Simmons from Mary Hewson August 30, 1782. Cited/Simmons et.al 1983: 17). Hewson had to call upon the generosity of Mary Hewson's mother Margaret Stevenson, to allow him to open his anatomy schools at number 27 Craven Street. Hewson appears to have changed the architecture of the house to accommodate an anatomy school.

6.1.1 Building the Craven Street Anatomy School

Gulliver (1846: xvi) stated that Hewson "*had built a theatre adjoining a house which he intended for the future residence of his family".* No architectural drawings exist of the property during this time and it is uncertain where the lecture theatre, museum and the dissection room were located. For practical reasons the dissection room must have been separate or an extension to the house. John Leake (1729-1792) (man midwife) occupied the house next to Hewson, number 26 Craven Street. Leake ran an anatomy school at this property at the same time as Hewson's anatomy school was active. Their courses were advertised in the same newspapers adjacent to one another in the Public Advertiser (September 25, 1772. Burney: Issue 11711) and yet there is no historical evidence that the two men were acquainted with each other. The fact that they advertise separately suggest they may have run parallel courses but it is not possible to establish whether the two men would have shared any facilities (Chaplin, 2009: 202) though it was not uncommon for anatomists to do so for lecturing (Lawrence, 1996: 170)

Due to the paucity of architectural design of the school and its location renders, it is difficult to gauge the actual size of the school and the number of students it was able to / accommodate. The original deeds of the house (London Metropolitan Archive:O/141) showed the exact size of the plot where the house stood, measuring 49.3ft (15.0m) to the north, 46ft (14.02m) to the south and 23ft (7m) to the east and west. This area would have included both the premises and the court yard. Recent architectural drawings suggest the original house measured approximately 6.49mx10.12m (65.68m²) pr. floor (including walls). This would not have included the later addition in the form of a "closet wing", which appeared on Jones' map dated 1793. The yard itself would have measured 44.14m² (including boundary walls) in its original form without the closet wing (Figure 20).

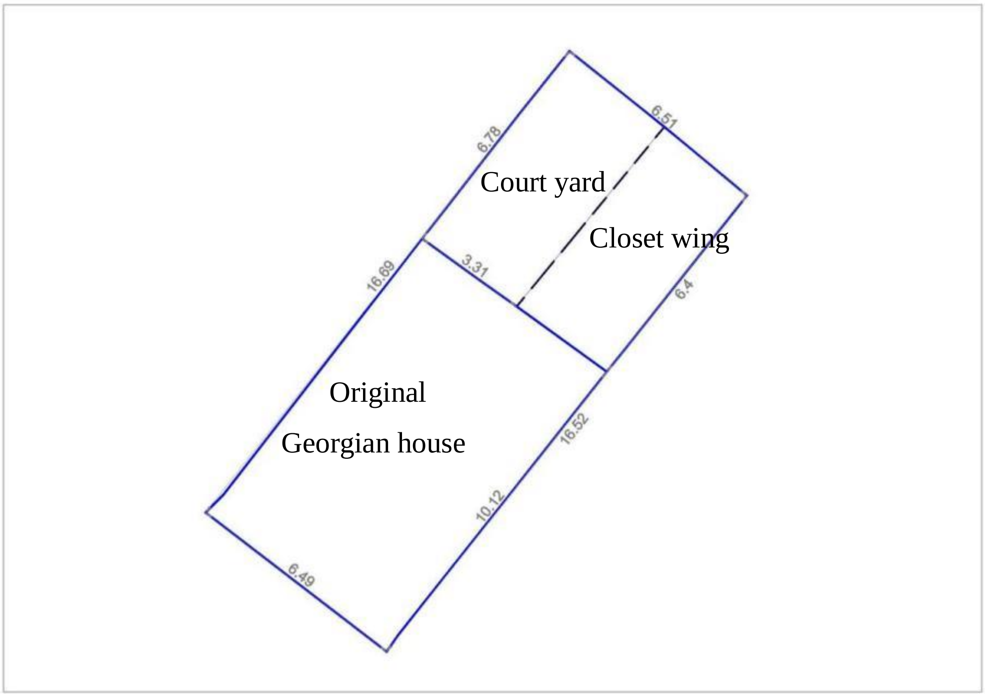

Figure 20 plan of 36 Craven Street based on modern survey map, showing the dimensions of the house closet wing and court yard as it is today (drawn by Richard Holden based on dimensions from the original deeds of the house. London Metropolitan Archives: O/141).

The house had a relatively simple structure with a kitchen in the basement whilst the ground, first and second floor were made up of two rooms each. Documents from Benjamin Franklin house (Figure 21) suggest that the ground floor contained the parlours of Margaret Stevenson, the entire first floor was leased to Benjamin Franklin and the third floor was Mary Hewson's rooms before she married Hewson. Balisciano (2006: 1) suggests that Franklin maintained these rooms even when, in 1772 he moved to number one Craven Street. The fourth floor (attic) was most likely used to house domestic servants. It is unknown when the "closet wing" of the house was added; it was not shown on the original lease of the house and the oldest illustration of the extension is on Jones' map dated 1793.

Srodes (2002: 157) offered a version of the lay out of the property as; Ground floor front room for receiving visitors, room behind for dining, tea and cards and a pantry behind that. 1st floor; Franklin's 4 room suite dominated by 14x12ft room with three windows. The room behind was Franklin's library and laboratory, behind was a smaller room for his clothes and Peter (his slave) and to the very rear was Franklin's bedroom. On the 2nd floor was Mrs. Stevenson and Mary's rooms. The 3rd floor was for transient tenants and the garret for William and King (Franklin's servants) until they left (Srodes, 2002: 157). Srodes describe Franklin's area of the house as having four rooms, which seems to suggest that the extension was present when Franklin resided at the premises, unfortunately Srodes offered no reference in support of this statement.

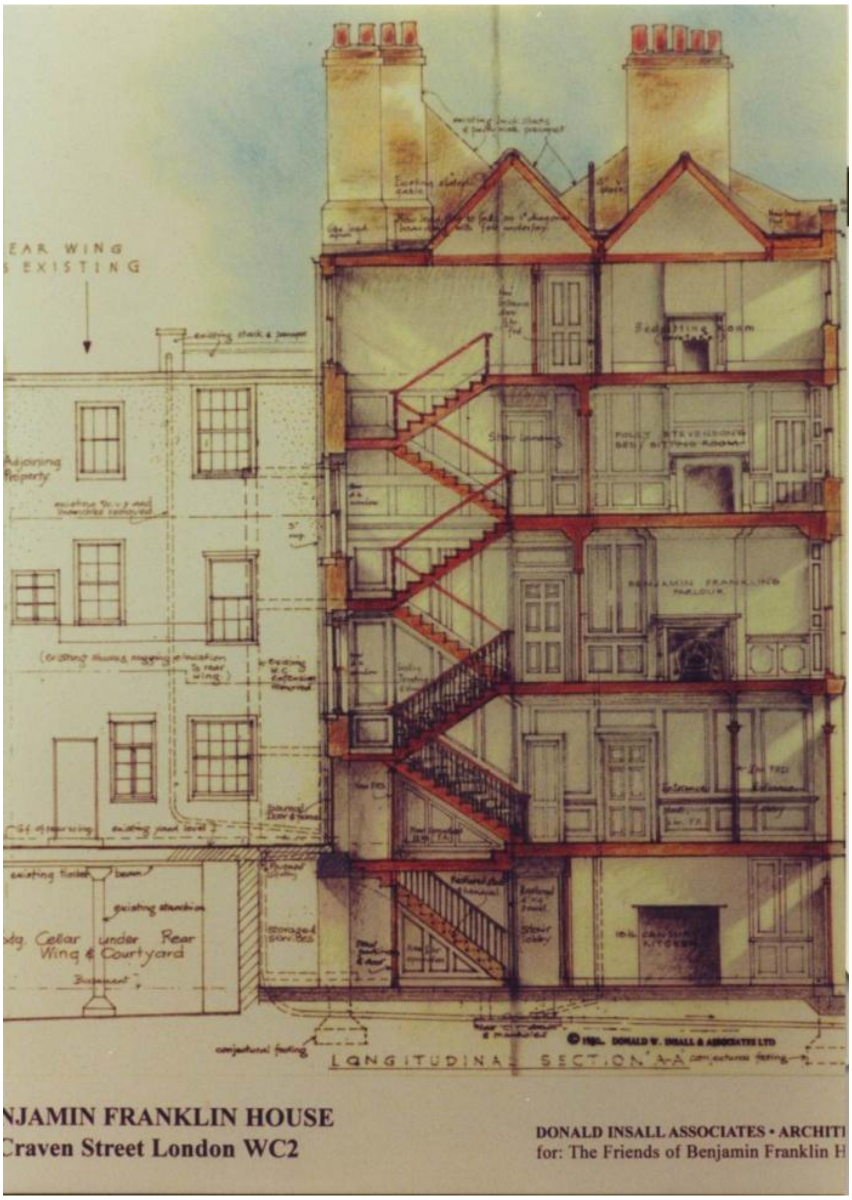

Figure 21 cross section of Benjamin Franklin house. (Source: Drawn by Donald Insall Associates, for Benjamin Franklin House)

6.1.2 Location of the anatomy school

Since the renovation of 36 Craven Street a discussion has been ongoing as to the location of the anatomy school itself. It has been suggested that the school was not actually located on the premises and that Hewson may have been teaching elsewhere (Benjamin Franklin House, *pers. Comm*. 2009), but historical documents seem to suggest otherwise. On July 6, 1772 Mary Hewson wrote in a letter to Benjamin Franklin; "*my mother I must tell you went off last Friday week, took our little Boy with her and left Mr. Hewson the care of her house. The first thing he did was pulling down a part of it in order to turn it to his purpose and advantage we hope. This Demolition can not affect you*." (Letter to B. Franklin by M. Hewson July 6, 1772. Cited/Franklinspapers, 1988). Presumably Mary referred to the alterations of the house in order to make space for the anatomy school, suggesting at least some modification to the original part of the property. Perhaps the most convincing evidence for its location was presented in the Daily Advertiser on 25 August 1778 (Burney: Issue 14870). "*By order of administration, the unexpired term of 11 years of the much improved lease of a genteel and commodious house, in good Repair, with Coach-house and Stabling for two Horses, ... consisting of two rooms and light closets on each floor, with out-buildings in the Yard, a Museum, a Compleat Theatre, and other conveniences..... in particular well adapted for any Gentleman of the faculty, or otherwise, who proposes giving public lectures in Medicine or Philosophy, subject to an annual rent of 521l 10s...*". Chaplin (2009: 202) therefore suggested that it appears the house was altered, prior to 1778 where the house was auctioned; the architectural description indicated a custom made anatomy school. Chaplin argued that Craven Street may have had a similar architectural design as William Hunter's anatomy school in Covent Garden, where the school was separate to the main house at the end of the garden. The property at Craven Street was smaller than that in Covent Garden with significantly less space at the back, and such an outbuilding would have provided very limited outdoor space, if it accommodated stables, a coach house as well as a dissection room, museum and a theatre. When advertised the outdoor space was described as "the yard" suggesting that this was a functional space to accommodate the horses and deliveries to the property.

The mention of "outbuildings" for the first time in the advertisement indicates that Hewson added an extension or additional building(s) to the property to accommodate his anatomy school, with those mention of these outbuildings before the museum and the theatre seems to suggest that the museum and theatre may have been located adjacent to the house rather than inside the original property. Mary's mention of demolition suggests that these out-buildings were linked to the house and perhaps even accessible through the house itself. The advert stated that the museum and theatre and most likely the dissection room (*other* *conveniences*) were located in the extension, though there is no mention whether this was a single or multi story addition to the house. If Srodes (2002: 157) was correct in his description of the house the extension was present when Hewson and his family moved in. Mary Hewson mentioned Franklin's rooms on the first floor were not affected by the demolition, but it is possible that the extension or conversion spanned both the basement and the ground floor. It is not unlikely that the anatomy school was later converted back into a residential extension of the house, though naturally this is speculative. If the extension appeared later, it would be a logical progression to use the foot print of the school to extend the building once the school had served its purpose. If this was the scenario and the footprint of the "closet wing" mirrors the footprint of the anatomy school, it would have measured 2.6mx6.5m (16.9m²) on each floor (Figure 20). It is unlikely that the school would have been much larger than this as the relatively small yard apparently also accommodated "coach-house and stabling for two Horses", at the same time, though Jones' map of 1793, indicated stables belonging to 27 Craven Street may have been available outside the yard (Figure 22)

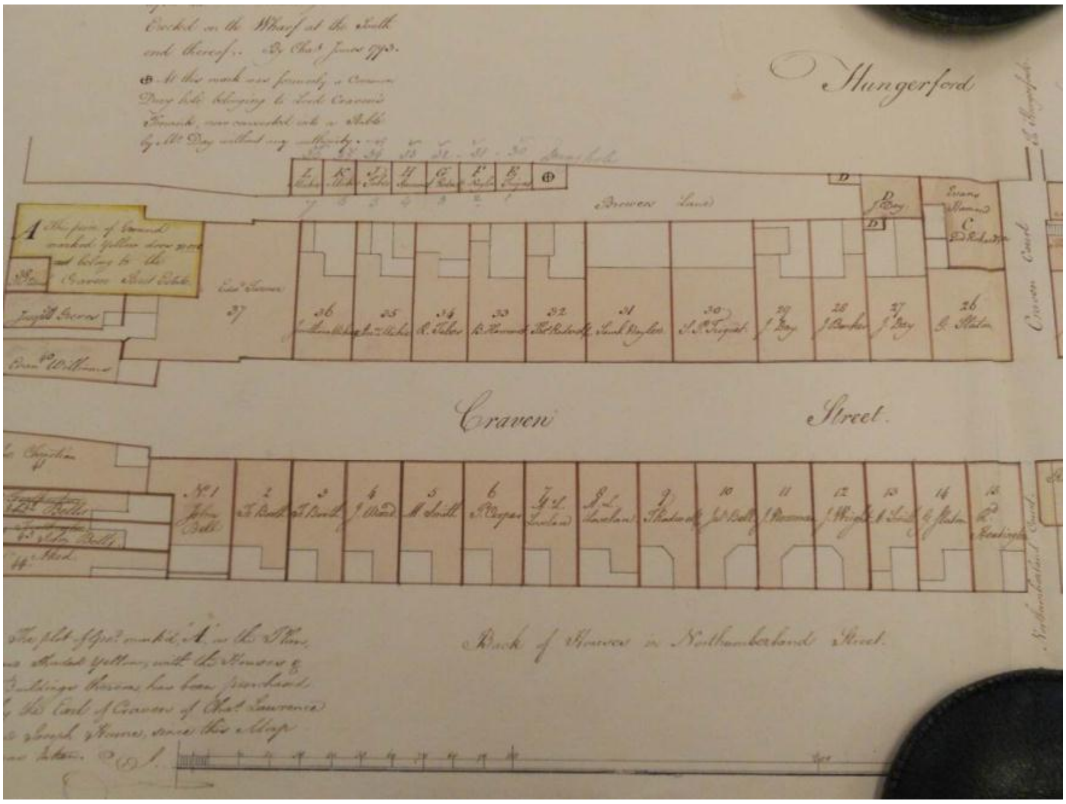

Figure 22 Craven Street in 1793, showing buildings to the rear of the property belonging to the same J. Day who lived at number 27 (Jones 1993). (Photo: Ryan Smith, Benjamin Franklin house) (London Metropolitan Archives: O/141). (For a larger image please see attached CD)

In terms of the archaeological discoveries this means the area of the excavation trench (chapter 7) would have been situated inside the school building rather than outside in the court yard. This is perhaps not as unlikely a scenario as first perceived. The excavation at medical college Georgia (Blakely, 1997: 6), showed that remains of both humans and animals "*had been tossed on the earthen floor*", covered with a layer of dirt, then capped with quicklime to reduce the stench (Blakely, 1997: 6), suggesting that the dissection rooms were relative simple in construct with an earthen floor rather than one of timber or stone. This in turn would indicate that at least the dissection room was situated at basement level. Srodes (2002, 231) wrote that historical evidence suggests Hewson took over the first floor dining room for his operating theatre "…*resurrection men would bring the bodies down the river and up the short distance to the basement kitchen in the dead of the night*". Assuming the "operating theatre" was the dissection room, it seems unlikely that the central part of the property would have housed this facility as this was the family home and the activities were less than conducive to family life, with the odours and the transport of bodies to and from the room. It is much more likely that the less salubrious part of the business would have been located in the outbuildings/extension and more likely that part of the original house would have been converted into the library and museum, though the advert in the Daily advertiser appeared to state otherwise. The hypothetical location of the school's facilities suggests that it was at least partly located in the extension. The sizes of the rooms were small each measuring 16.9m², which seems a very small area to accommodate a medium sized school. It appears unlikely that Hewson would have been able to create anything like John Hunter's school (Chaplin, 2009: 187) or indeed match the facilities of William Hunter's school in Great Windmill Street (Hunter, 1784: 111), given his limited means and space.

6.1.3 The cost of a school

The annual rent of the property was advertised at £521, 10s in 1778 (Daily Advertiser August 25, 1778. Burney: Issue 14870), which was a significant sum considering Hewson only made half this amount at the end of his ten year partnership with William Hunter (Notes by William Hewson on William Hunter c1772. Cited/ Brock 2008, 76). It is possible that the cost of the accommodation was significantly less for Hewson as it was leased to him by his mother-in-law, though they must have paid some rent to allow Mrs. Stevenson to take up residency in a different house. The cost of transforming the property to accommodate his business cannot have been insubstantial and yet he appears to have been able to do this in a relatively short time period between July and October 1772. Hewson knew for some time that William Hunter wished to terminate their partnership and Hewson may have started to plan his business venture at that point. It is not unlikely that he may have been able to secure sufficient funds from his savings to transform the house to accommodate an anatomy school.

Hewson had asked William Hunter for recompense after the split (Notes by William Hewson on William Hunter c1772. Cited/ Brock 2008, 85). Whether he received this is unknown, but it appears that William Hunter accused Hewson of breach of contract, as he claimed that one of the Articles in their agreement prevented Hewson from beginning to lecture for himself (Notes by William Hewson on William Hunter c1772. Cited/ Brock 2008, 85). It is therefore not unlikely that William Hunter succeeded in not paying Hewson any financial compensation. According to Mary Hewson, he had expressed concerns over their financial situation on his deathbed; "*His last moments of recollection were embittered by the idea of leaving me with three children scantly provided for; the loss of affluence I did not feel for myself, and I thought I could bring up my children not to want it*" (Letter to S.F.Simmons by M. Hewson, 1783. Cited/ Simmons et.al 1983, 17). John Pringle poignantly described Hewson's lack of interest in financial gain and summed up the picture that is emerging of Hewson's character and business acumen. "*Mr. Hewson's manners were gentle and engaging; his ambition was free from ostentation, his prudence was without meanness, and he was more covetous of fame than of fortune*" (Letter to S.F.Simmons by M. Hewson, 1783. Cited/ Simmons et.al 1983, 17). Despite Hewson's apparent lacking of business skills, the property was not taken into administration after his death, Hewson's brother-in-law Magnus Falconar was able to continue running the school for a further four years. In 1778 the contents of the house and the anatomy school was auctioned off by a Mr. Paterson right down to linen, china and books (Morning Post 21 August, 1778. Burney: Issue 1823 and 5 September, 1778. Burney: Issue 1836). It was "*By order of Administration*" which was commonly made to cover any outstanding debts. A further advert was placed in *St James' chronicle* (7 April, 1778. Burney: Issue 2653), by Greenwollers and Darlington, Clifford's inn, London inviting creditors to contact them about any outstanding payments. This advert was placed only shortly after Falconar's death on March 28, 1778. It appears that the anatomy school may have been in debt when Falconar died and most likely prior to this. This would also explain why Falconar's successor, Andrew Blackall seemingly only taught at Craven Street until the end of the course in 1778. The cost of converting the property and acquiring sufficient equipment and preparations to establish a school on his own may have proved beyond Hewson's means. The auction catalogue is testament to the amount of equipment required in order to lecture, carry out research and make preparations with the 10^{th} day of the auction almost entirely dedicated to furniture and equipment (Paterson, 1778: 36pp). Hewson's family fortune was non-existent and according Mary Hewson, she was equally of limited means (Letter to S.F.Simmons by M. Hewson, 1783. Cited/ Simmons et.al 1983: 17). Any new business is created at a huge expense and the lifespan of the Craven Street School may simply not have been sufficient to recuperate the initial outgoings of the business. There is little to contest that both Hewson and Falconar were young men of limited fortune and limited business experience, whose priorities were first and foremost their families and their contributions to science. The school was a method of making a living and generating a space where it was possible to carry out research.

6.1.4 Opening the school and admitting students

Craven Street opened its doors to students for the first time on the 30th of September 1772. The success of the school was dependent on the number of students Hewson could attract (Chaplin, 2009: 135). The market for students was highly competitive and Hewson advertised his course in the daily newspaper as was customary. "*The Partnership between Dr. Hunter and Mr. Hewson after continuing 10 years, being now dissolved, Mr Hewson on Thursday the 1st of October, will begin a course of Anatomy, which he will endeavour to adapt not only to the students of Medicine and Surgery, but to such philosophical Gentlemen as wish to require the Knowledge of Animal Oeconomy.....*" (Public Advertiser 12 September, 1772. Burney: Issue 11700). Hewson's reputation within the world of medical education was governed by his associations with William Hunter, and he could not afford to distance himself completely from his peer. Hewson clearly felt that the success of the Craven Street Anatomy School relied on students recognising him as the previous partner of the great William Hunter. It was further important that Hewson lectured in subjects from which he had gained recognition whilst with William Hunter. His very first lecture at Craven Street was on the spleen and the thymus (Lettsom, 1810: 57). His first course went so well that he had more than half the number of students than at Great Windmill Street (Gulliver 1846, xvii). In a letter to Franklin dated 22 October, 1772, Mary Hewson provided a perhaps more concrete figure of around 50 students for his first course, "*Lectures go on briskly; a fresh pupil today who makes up halfhundreds whose name aren't enter'd beside some others who have promis'd, among whom are your Friends Mr. Walsh and Mr. Bancroft*" (Letter to B. Franklin by M. Hewson 22 October, 1772. Cited/www.franklinpapers.org, 1988). It was stated by one of his students in a letter to John Hunter in 1774 that "*we have with pleasure seen Mr. Hewson exceed your brother in the number of his pupils*" (Middlesex Journal 13 January, 1774. Burney: Issue 749). Based on these accounts Hewson was very successful in acquiring students for his course and these most likely increased in numbers over the years. However, how many students Hewson could accommodate at Craven Street must have been limited compared to William Hunter's facilities.

6.1.5 Course timing

The Craven Street anatomy school was in direct competition with other schools in the capital. Figure 4, section 3.1 provided a summary of schools advertising in the daily newspapers between 1772 and 1778. Between eight and eleven schools advertising every year on subjects of anatomy, midwifery, physics and chemistry. The courses started around the same time in September/October, whilst the actual time of the day varied from 9 o'clock in the morning at Guy's hospital to seven o'clock in the evening by John Hunter. Hewson and Falconar advertised lectures at two in the afternoon throughout the years, which was the same time as William Hunter's courses at Windmill Street, though not necessarily on the same day. Evidently the hours advertised in the newspapers would have been for the introductory lecture and not necessarily the only time they would have commenced, and some days would have had more than one lecture (Chaplin, 2009: 358). Lettsom (1810: 55) in his "Memoirs of Hewson" noted that lectures at Great Windmill Street were delivered in the morning and Olmsted (1941: 88) observed that William Hunter's courses in 1775 consisted of lectures two hours daily including Saturdays and some evenings. Falconar (1777b: 2) advertised some lectures being held in the evening between 6pm and 8pm.

Students would sign up for courses at the private anatomy school as well as attending one of the hospitals, such as one of Hewson's students who signed up to be a student under John Hunter at St George's hospital but found himself disappointed when John Hunter refused to teach any students who did not attend his brother's course in Windmill Street (Middlesex Journal 13 January, 1774. Burney: Issue 749). The timing of lectures at the private anatomy schools would have had to fit around the hours at the hospital to accommodate the students. It appears from the advertisements in the daily papers that courses at hospital were taught either early mornings or in the evenings. Not only did the private anatomy schools have to fit hours of lecturing around other courses but likewise accommodate the hours it was possible to carry out dissection. This would have taken place in the day time hours to ensure sufficient lighting, which in the winter months would have been relatively limited. The two o'clock lectures seem to interfere with this strategy, as this would have been in the hours of optimum lighting.

6.1.6 Course outline and cost

Hewson outlined a lecture series of around 100 lectures; the course offered four overarching subjects of; anatomy, surgery, midwifery and comparative anatomy, but it was not specified how much time was dedicated to each of the topics (Table 7). After Hewson's death it appears that Falconar wished to improve on the teaching at Craven Street or perhaps put his own stamp on the anatomy school, though at no point did he dismiss any of Hewson's undertaking (Falconar, 1777b). Falconar published a synopsis of courses in 1777 to provide students with a study aid of his lectures as he thought published anatomy books would cause too much confusion (Falconar, 1777b: 5). Falconar's book received mixed reviews and in Monthly review in 1779; "*Mr. Falconar printed those very copious heads of lectures,* *which contain a full and complete reference of every object described or exhibited, and every opinion advanced, either speculative or practical during his course*" (Monthly review 61. December 1779, 477). In a publication of John Sheldon's lecture notes the author felt very differently about Falconar's book and remarked; "*It contained scarce more than the head of the subjects, of which he was to treat, of course so dry and unentertaining as not to be read either previous to attending lectures or after*" (A Professor of Anatomy, 1784: vi).

	Lecture series subjects
1	To explain the structure and Functions of the several Parts of the Human Body
2	To apply this Knowledge to the Cure of Diseases, particularly such as require manual Operation; and to shew the various Operations of Surgery, and the manner of applying bandage
3	To examine the Structure of the impregnated Uterus, and its Contents; in order to facilitate the Study of Midwifery.
4	To compare the Structure of the Human Body with these of Quadrupeds, Birds, Fish, and Insects.

Table 7 Subject matters at Craven Street Anatomy school as outlined by William Hewson in 1772 (Source Hewson, 1774: 219-220)

Falconar's synopsis (1777b) provided a detailed account of anatomical observations, but no description of surgery, making of preparations or comparative anatomy, all of which were offered as part of the course according to the "*Syllabus of Course Lectures*" compiled by Falconar the same year (Falconar, 1777a). The syllabus outlined 120 Anatomical and Chirurgical lectures, which Falconar had divided into ten groups based on the topic covered (Table 8).

	lecture no.	No of lectures	Sections of lectures
0	1	1	Introduction
1	2-12	11	General view of the composition of an animal body
2	13-25	13	Osteology
3	26-42	17	On Myology and the male organs of generation
4	43-46	4	Angiology
5	47-63	17	On Splanchnology, and the female organs of generation
6	64-79	17	Nervous system and organs of sense
7	80-93	14	Chirurgical operations
8	94-106	13	On the application of medicine to the practice of surgery
9	107-113	7	On the impregnated uterus, and the obstetrician art

10	114-120	7	Comparative anatomy

Table 8 Division and number of lectures at Craven Street (Source Falconar, 1777a)

The number of lectures showed an unequal distribution amongst the different subjects (Figure 23). Anatomy made up 66.11% of the course with chirurgical lectures making up 22.31%, and obstetrics and comparative anatomy each covered 5.79%. As different subjects could be booked over a series of five courses, it must have been necessary to ensure that each topic was finished within a single or two courses (Hewson, 1774: 220).

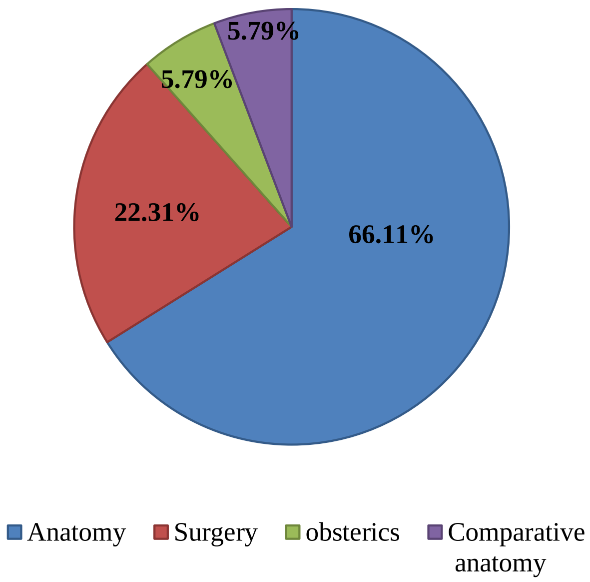

Figure 23 percentage distribution of subjects by number of lectures given (Source: Falconar 1777c)

It is slightly unclear what Hewson meant by five courses (Table 9), but he noted that two courses were to be given over the winter season, one from early October to mid-January and one from late January to mid-May. It therefore appears a complete course would run over two winter season and one summer season, as Hewson had included a summer course in "Applying the Bandages upon a machine and performing Chirurgical Operations" (Hewson, 1774: 220). John Sheldon (c1780) published an almost identical course outline to that of Hewson, being somewhat clearer in his description of the five courses, he stated that the first course was on anatomy (price of 3 guineas), second course Surgery (price of 3 guineas), third course on "bandages on a machine resembling a human body" (price of 2 guineas), fourth course on midwifery (price of 2 guineas) and finally the fifth course on comparative anatomy (1 guineas). This means that each topic would have run over the same length of time, but the lectures given in that space of time would have been much more frequent in the first and second term. William Hunter (1784: 109) advised against students dissecting in the first part of the course as they would have little idea what they were looking at, perhaps explaining the unequal distribution of lectures and we can assume

Hewson and Falconar would have adopted a similar policy. The later courses would therefore have had to accommodate time in the dissection room.

Price in Guineas	No of lect*	Allowance
3 guineas	80	Course 1 *(anatomy) (5 October 1772- mid january 1773)*
3 guineas	27	Course 2 (*Surgery*) *(end January 1773-mid May 1773)*
2 guineas	?	Course 3 *(Bandages and operative surgery) (Summer course)*
2 guineas	7	Course 4 *(Obstetrics) (October 1773-mid January 1774)*
1 guineas	7	Course 5 *(Comparative anatomy) (End January 1774-mid May 1774)*
10 guineas		Free access to Lectures
10 guineas		free access to dissection room
20 guineas		Free access to lectures and dissection and a summer course in bandages and performing chirurgical operations
6 guineas		3 months in dissection room
2 guineas		Dissection of one subject and inject any part at a moderate expense
5 guineas		Perpetual visitors to the dissection room without dissecting
3 guineas		3 months visit to dissection room without dissecting
5 guineas		gentlemen who do not belong to the faculty but wish to attend lectures on anatomy and animal oeconomy on an occasional basis
5 guineas		Gentlemen established in London already and only wish to attend occasional lectures.
Free		Students who have signed up for 4 courses at William Hunter's whilst the partnership was still ongoing
Free		Signed up for 1-2 courses at Hunter's can attend the same number of terms at Craven Street

Table 9 prices of the Craven Street lectures and dissection (Source Hewson, 1774: 220pp and Sheldon, c1780) (*Falconar, 1777b)

The first two courses in anatomy and surgery would have required a large number of cadavers for demonstrations, whilst the subsequent courses would have been less intensive and require less human subjects. This is most likely what the prices reflect, with the two first courses costing three guineas and the subsequent courses costing two guineas and one guinea. It was possible to sign up for any combination of lectures and access to the dissection room with the students receiving a "ticket" stating which course combination they had opted for (Figure 24).

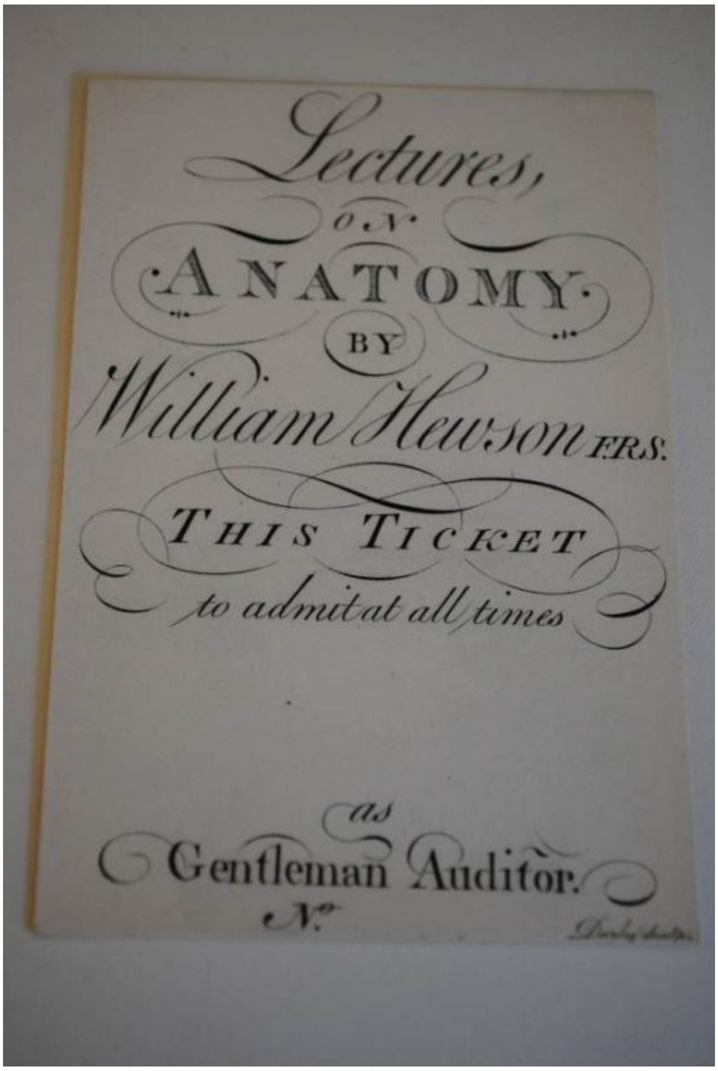

Figure 24 course attendance tickets provided at Craven Street stating this student was permitted to attend at all time (Photo: Melissa Hewson)

It appears a very limited number of lectures were given on midwifery and comparative anatomy, but it is possible that these courses were mainly taught in the dissection room. It is further conceivable there may have been an overlap of courses, so courses one and two were taught during the same period as courses three and four every year or that in fact courses four and five were much shorter as the advert did not state that these were taught as a full course each lasting 3.5 months (Figure 25). If the courses did overlap as indicated, a total of 5.5 courses were taught at Craven Street before it went into administration. Hewson would have taught the first course and the first half of the second course. The remaining courses were taught by Falconar until around March 1778, where after Andrew Blackall taught the remainder of the courses, which appears only to have run from March until May 1778 and perhaps the summer course.

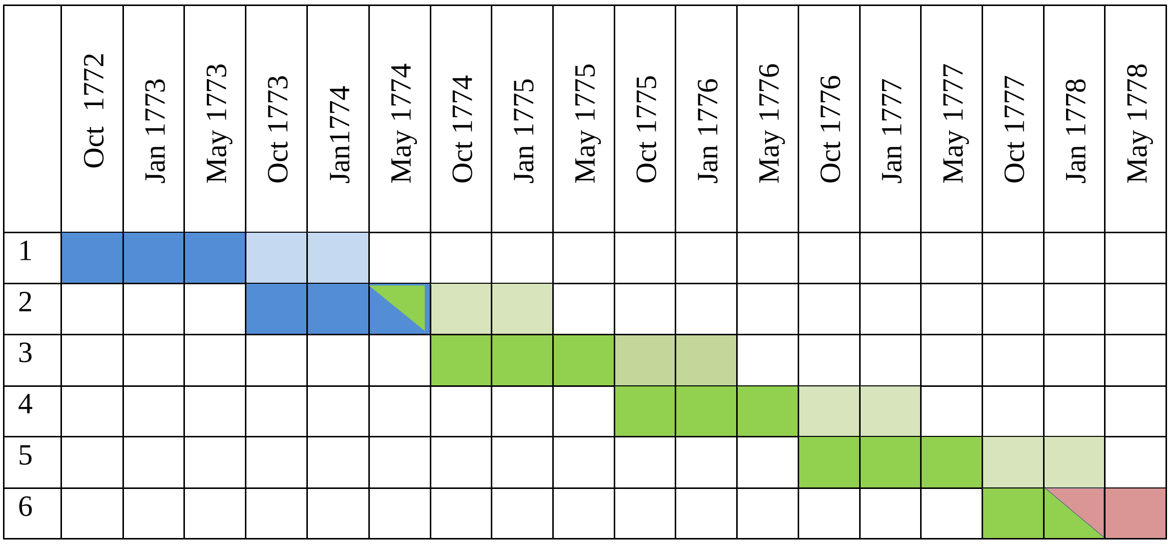

Figure 25 timing of the series of courses given at Craven Street 1772-1778, months indicating the start of the course (Blue: Hewson, green: Falconar and red: Blackall)

6.2 The lecture theatre

On 30 September 1772 he gave an inaugural lecture in his new lecture theatre, to which he invited the leading London men of science, the subject being the Spleen and Thymus (Dobson, 1961: 181). The lecture theatre was the heart of the anatomy school where students would receive lectures including demonstrations on cadavers and animals as well as viewing preparations from the museum. Lettsom (1810: 57) wrote of the Craven Street lecture theatre, "*The theatre in which he [Hewson] delivered his lectures, and expounded his discoveries, was crowded with men of science, as well as with pupils, to listen to a youth grown sage by experimental research*".

The skill of lecturing could not be underestimated when it came to attracting students, with a highly competitive market it was not sufficient to be an accomplished researcher. The lecturer's personality and ability to convey information was equally important to maintain a reputation. William Hunter was revered for his ability to lecture, a view shared by many of Hunter's students (Brodie, 1837: 8). His nephew Matthew Baillie said of his uncle. "*He excelled very much any lecturer whom I have ever heard in the clearness of his arrangements, the aptness of his illustrations, and the elegance of his diction; he was perhaps the best teacher of anatomy ever lived*" (Hawkins, 1854: 536). Alexander Monro Secundus on the other hand was much less admired for his personality and ability to lecture. A young student, Alexander Coventry, wrote of Monro in 1785; "*Monro was certainly a first-class anatomist, and for that day an excellent physiologist…… He was not a pleasant lecturer. There was nothing shining or brilliant or eloquent. He always began his lectures with a 'Hem,' as if to clear his throat, and among the students he went by the name of old*

'Grumpy.' His lectures were, however, useful, and remarkably well attended. The theatre was always full by the hour and he was punctual" (Ligett, 1904: 106).

Hewson's own ability to lecture had been highlighted during his partnership with William Hunter, though the comments were undoubtedly influenced by their less than amicable relationship at the time. According to William Hunter's complaints against Hewson in 1772, Hunter was reluctant to allow Hewson to lecture with the reason that he knew Hewson was averse to public speaking. William Hunter, according to Hewson, noted that "*He had been informed the pupils were not well satisfied with Mr. H[ewson]'s lecturing at least at some points*" (Notes by William Hewson on William Hunter c1772. Cited/ Brook 2008: 74). It is possible that Hunter's complaints were unfounded and a reflection of his reluctance to give up his "anatomical throne". Adams (1818: 35) also highlighted Hewson's lack of ability to lecture writing about John Hunter and Hewson *"…as lecturers, neither had any claim to superiority*". Brodie (1783-1862) wrote of William Hewson, "*Hewson partook in no small degree of his master's zeal and industry and his works show how much may be accomplished by means of these acquaintances when infused into a mind of moderate dimensions, Cruickshank over-sensitive and hypochondriacal as he was from disease, was much superior to Hewson*" (Brodie, 1837: 28). Brodie did not expand on the source of his knowledge regarding William Hunter and Hewson, other than mentioning that he had spoken to many "older men" who had been taught by Hunter. Whether his disregard for Hewson's talents was based on his lecturing or his research is unclear, but describing Hewson as having a "mind of moderate dimensions" was certainly no accolade to Hewson's talents. Lettsom (1810, 56) appeared to be of a different opinion in his memoirs of William Hewson; describing Hewson's lectures full of medical men and students wishing to learn of his discoveries. In the Middlesex Journal (January 13, 1774. Burney: Issue 749) one of Hewson's former students likewise praised Hewson, preferring his lectures over William and John Hunter's lectures. He wrote an open letter to John Hunter stating his discontent; "*…for your brother, I knew, if not employed in business, was at least too much engaged in the pursuits of virtue to attend his pupils…I never yet repented of my preference for Mr. Hewson, whose instructions I shall always remember with the warmest gratitude…*". It was perhaps Hewson's skills as a researcher and not those of teaching that gave him success, though views on his teaching were very mixed. Hewson continued to experiment whilst at Craven Street and it is not unlikely that teaching was simply a way of generating an income to allow him to support his family and his research. Hendy (1775: 12) indicated that Hewson would share his experiments with his students, which would undoubtedly have inspired the keener ones. Falconar may all together have been the better teacher, as following Hewson's death he dedicated time to publish a synopsis of his courses (1777b). It was said of Falconar that he was "*a man of outstanding ability and a very good speaker; during the next four years he made good use of the bequest that had been made to him and amply justified Hewson's confidence in his merit*" (Dobson, 1961: 185).

Fragmented yet tangible evidence is available on the actual teaching of the courses at Craven Street through communications in the local media. The course outlines (Table 9) provided an excellent overview of what was taught but very little about how the courses were taught. In *The Morning Chronicle* 1774, Falconar responded to a letter regarding concerns on how Hewson had taught the subject of drowning. Hewson had purportedly stated that "no animal can live under water above two minutes", when in fact the Society for the Recovery of Drowned Persons were of the opinion that it was possible to recover a person after fifteen and even twenty minutes. Falconar responded as follows; "*Mr. Hewson always urged the necessity of attempting every method which art could suggest, or experiments had confirmed to be successful…I have endeavoured always strongly to inculcate the same doctrines, upon a presumption that the human subject might possess some properties in that respect, different to what we observed in brute…*" (Morning Chronicle Nov. 17, 1774 Burney: Issue 1712). The communication richly illustrated not only the relationship between student and lecturer but also the impact of teaching in the wider community. The Society for the Recovery of Drowned Persons as a newly established authority had the inclination to question the teachings of young students and the experiments which had appeared to contradict their own experiences. It was in consequence imperative for the lecturers to ensure that their students became reputable and competent medical men.

Lectures were frequently supported by demonstrations using cadavers, living animals or preparations from the museum. Falconar demonstrated concern for his students, during the winter as the lecture theatre was deliberately kept cold to facilitate the need for cadavers during demonstrations. Falconar (1777b: 5) said of note taking, "…*a practice not less painful and disagreeable in the Winter month*…" and discouraged students from spending all their time taking notes during lessons. Hewson and Falconar were dependent on being supplied with the right subject for demonstrations and it was at times necessary to alter the order of the lectures to accommodate the supply of cadavers to the school. Falconar (1777b: 5) made this very clear to his students; "….*he will endeavour to pursue the Order laid down as closely as possible, yet he may sometimes be under necessity of deviating a little from procuring sooner than expected, a subject which will shew to Advantage, some Parts to which he may not be arrived agreeable to the order of the Course; and at other times from being disappointed of a proper subject at the time he expected one*", revealing that the structures of the lectures were dependent on the correct supply of corpses. Cadavers were prepared prior to the lectures; Hewson's wrote "*…I make all the dissections necessary even for his lectures…*" (Notes by William Hewson on William Hunter c.1772. Cited/Brock 2008: 76). Anatomical preparations were probably the most commonly used and essential method of visually demonstrating topics to the students, as they would have been prepared well in advance allowing lectures to follow their original structure. Good preparations were essential to the lectures and would have been used next to the demonstrations to highlight special topics addressed (Chaplin, 2009: 132). Living animals were also used for demonstrations of lecture topics. The letter regarding drowning (Morning Chronicle 17 November, 1774. Burney: Issue 1712) provides insight into the use of animals as a method of demonstrating subjects taught, suggesting both Hewson and Falconar used live animals in their lectures. Hewson demonstrated that animals could not live beyond two minutes under water and Falconar commented "*When I had the occasion to repeat these experiments in my anatomical lectures*", showing that these experiments would have been carried out in front of students during classes.

The image generated of the Craven Street lecture theatre are compelling, the small space would have been crowded with students trying to get a glimpse of the cadavers, animals and preparations used in the lectures. The rooms had to be kept cold to minimise the putrefaction of the cadavers rendering it difficult to remain seated for longer periods of time. There is little doubt that the two young men would have drawn in the students with their enthusiasm for scientific research.

6.3 The museum

Most private anatomy schools adhered to a format of having a museum as well as a lecture theatre and a dissection room (Chaplin, 2009).The museum formed an important part of the school, not solely as a repository for teaching materials but equally as an outward and visible demonstration of the standing of the school. Making preparations was an art form that was costly, time and space consuming, but most of all required patience and skill. Collections demanded constant curation, but were to the owner a valuable commodity (Pole 1790). Schools could not openly advertise their skills in dissection but the objectification of what was once living made it acceptable to display their talents in an outwardly fashion to both the medical profession and the general public (Chaplin, 2009: 229), in a way that did not require academic insight. The entire contents of the Craven Street School were sold at an auction during ten days from the 12th of October to the 22nd of October 1778, consisting of a total of 1030 lots (Paterson, 1778). The catalogue is testament to Hewson's skills and perseverance and provides tangible insight into content of the museum and the species and objects available to Hewson.

6.3.1.1 Building up a collection

Hewson would have required a reasonable selection of preparation to start up his anatomy school, as they would have been required to use them for teaching in the lecture theatre. Following the termination of his partnership with Hunter a well-documented dispute over preparations followed, where Franklin was asked to mediate. The disagreements eventually ended up being commented on by an anonymous contributor in the local newspaper "*I hope now for their own Sakes, that every Thing will be buried in Oblivion, and that Mr H[ewson] will have the Grace not to spoil as many Dinners as Dr H[unter] did last Saturday.*" (St James' Chronicle 10 November, 1772. Burney: Issue 1831). It is likely the letter was written by Franklin who wrote to the paper to make the two men see sense and put an end to a pointless dispute. Hewson eventually acquired a number of preparations via Franklin who responded to William Hunter; *"....you had some preparations which you could spare and were dispos'd to give me, desiring I would call and look at them; I did so, and accepted them. I apprehend it to be your supposition in giving them to me, that as I had no use of them, I should probably give them to Mr Hewson, which I immediately did*." (Letter to W. Hunter by B. Franklin 30 October 1772. Cited/ Brock 2008: 73). It is not known how many preparations Hewson acquired from William Hunter, those he received were most likely a reluctant gesture of reconciliation, as Hewson himself believed he was within his rights in requesting some; "*He had freqtly told me when I had been mak'ng prep's to make dupli'ts for this amongst other reasons that he might wish to give me some on our separating*" (Notes by W. Hewson on W. Hunter c1772. Cited/ Brock 2008: 80). He allegedly spent his final months in Windmill Street making preparations for his course at Craven Street (Lettsom, 1810: 56).

Hewson and Falconar managed to build up a substantial museum collection, encompassing a great number of species, during their short time at Craven Street. When Hewson established the school his seeming lack of finances would have prevented him from simply purchasing ready made preparations. The auction catalogue (Parsons, 1778) stated, "*By the joint Labour and Ingenuity of those two young Anatomists, the Museum, now offered to Public Sale, was formed, enlarged and extended to its present State.*". It seems reasonable to suggest that the museum at Craven Street contained preparations made by either Falconar or Hewson built up over a period of six years if including the final year of Hewson's and Hunter's partnership. Hewson was particularly skilled in making preparations, having refined this art during his ten year partnership with William Hunter.

Building up a museum collection also required a steady supply of human cadavers and animals. Hewson's collection did not only contain physiological preparation of assumingly healthy individuals it also contained examples of different human pathologies and disfigurements which would have been even more difficult to acquire than the average cadaver. William Cooper for example described "the delivery of a very curious acephalus Monster". On 8 October 1773 a Mrs Brackett of Clarkenwell Close, aged 23 years, gave birth to twins; one healthy baby girl and one deformed child. "*A very singular Monster. And as the late ingenious Mr. Hewson injected its Blood Vessels, and dissected it, I am enabled to attempt a short anatomical description of it ...... When first born it was very plump, but soft and flabby, and the Bones remarkably small and tender. It has neither Head, Neck, Hands or Arms. In the place where the neck should originate, is a little Mamilla, somewhat larger than a Womans nipple, but quite soft. And on each side in the Place when the Arm should begin, there is a small Papilla, about the Bigness and very much like the extremity of a common quill. – the Spine seems perfect but ends abruptly at the upper vertebra Colli – Below the Navel the parts are nearly intire, except the feet where the toes are of an irregular Form and Size, and some of them united together. – The external Parts of Generation, which indicate it was a female are also perfect.*" (Letter to W. Hunter by W. Cooper, 6 June 1774. Cited/Brock 2008: 142). Hewson dissected the child and injected its blood vessels, whether this was with the mother's consent is unknown. Hewson appears to have retained the child for his collection though this was not mentioned in Cooper's letter. The foetus in question was most likely one of Lot 107 or108 sold for £1.17.0 and £1.1.1 respectively, at auction on 20th October 1778 (Paterson, 1778). One cast and drawing of one of these foetuses was sold to a Michael Underwood (1737-1820) on the following day (21/10/1778-81) together with a cast of a "double monster" (21/10/1778-82).

Another unusual preparation acquired by Hewson was Lot 82 sold on the 15 October 1778, which was brought to public attention in *The Public Advertiser* on November 5, 1778 (Burney: Issue 13752) because the auction catalogue stated, the 6 weeks old child was "*opened before death*". Both Hewson and Falconar were accused of child murder but a counter response was published in the same newspaper on December 18, 1778 (Burney: Issue 13789) suggesting that the child was not dissected prior to death but a tumor associated with the Spina Bifida was opened "*with the intent of relief*" whilst the child was still alive, but unfortunately the child did not survive this operation. In this case it is unclear who the operating surgeon was and whether Hewson or Falconar actually made the preparation themselves, but this is clearly the assumption of the writers. The preparation of the child was bought by William Hunter at a price of £1.2.0. (Paterson, 1778).

Acquiring individuals with pathological or unusual conditions was a question of diplomacy and connections. On January 13, 1770 (Letter to W. Hewson by A Fothergill, 14 January 1770. Cited/ Private letter of the Hewson family, Philadelphia) when Hewson was still in partnership with William Hunter, he appears to have written a letter to A. Fothergill to request his help in acquiring a pair of conjoined twins held by an apothecary. Fothergill was unsuccessful in his quest and wrote to Hewson; "*He has a son who is Pupil at Barthol[emews]: whom I supposed he would be glad to have introduced to your acquaintance. I urged this as a fine opportunity of obliging Dr. Hunter & you, But even this argument, which appeared to me a powerful one, with him had no weight. From this you'll judge the nature and disposition of the animal….where [were ever?] they be so properly placed [as in] your stupendous Collection of anatomical rarities? …. In the Phil. Trans. 1748 you'll meet with the description of twins nearly similar to the present ones…*" Fothergill was referring to a description of conjoined twin girls, by a James Parsons; the description saw two girls joined "by their abdominal Integuments, from the umbilicus up to the *Cartilago ensiformis*, in such a manner, as to form between them but one abdomen (Parsons, 1748: 539). The letter from Fothergill to Hewson reflects the urgency and competitive nature of collecting and though these particular twins were meant for Hunter's collection, similar transactions were likely to have taken place in Hewson's quest to expand his own museum collection. It is evident individuals displaying pathological conditions were traded as a commodity to the highest bidder and not emotive of the preparations. The auction catalogue (Paterson, 1778) revealed that at least 384 (384/1447) (26.53%) included some form of pathology or abnormality. It cannot have been inexpensive for Hewson to add these cases to his collection. It is possible that the human individuals were acquired through post mortem examinations or in a capacity as surgeon, but it is also likely that Hewson and Falconar may have made preparations with the view to sell in order to finance the purchase of special individuals or preparations.

6.3.2 The museum collection

The auction catalogue (Paterson, 1778) offers a unique insight into the contents of the Craven Street museum, particularly as it appears to be the entire contents. Figure 26 shows the overall distribution of what was sold at the auction based on the number of preparations.

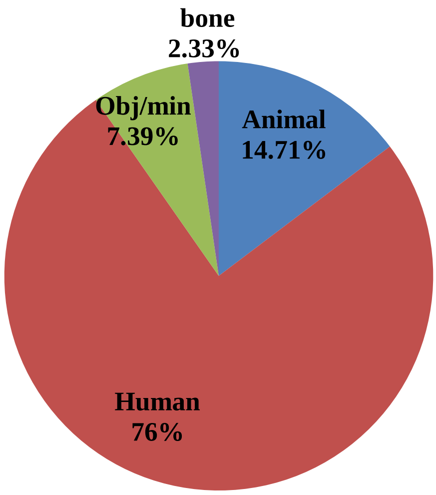

Figure 26 distribution of museum contents, based on auction catalogue (N=1447) (Paterson, 1778)

The largest group in the catalogue was human remains (75.33%, 1090/1447) followed by animals (14.86%) with objects such as drawings, casts, equipment and furniture making up 7.26% of the content sold. The remaining 2.33% were noted as bone without clarifying whether these were from human or animal.

6.3.2.1 The humans

It was possible to determine the gender of the individuals in 171 preparations (10.73% (171/1090)) showing a division of 67.25% (115/171) females and 33.33 %(57/171) males. This division is perhaps not totally representative as the gender of the individuals were rarely mentioned and the majority of sexed specimens were represented by placenta and uterus of the female (87/115) and testes and penis of the male (51/57).

Of the humans 531 (48.72% (531/1090) were given an overall age group of adult, child or foetus (not including pre-foetal individuals). It was attempted to estimate the Minimum Number of human Individuals (MNI) in the collection but this posed a considerable challenge due to the nature of the preparations. Several preparations could have been made from the same individuals whilst others may have represented more than one individual. Evidently the MNI will hence be a vast underestimation of the actual number of individuals present, but will none the less provide a palpable comparative with the skeletal remains from the archaeological excavation. The dried bones provided the best opportunity of determining at least a minimum number of individuals in the adult cohort. It was estimated that the most frequently represented elements were those of the lower skull elements and jaw representing at least 18 individuals, classified as adult or unknown age. Adding the eight whole adult skeletons to this provided a total of at least 26 adults/unknown age individuals.

It was somewhat unclear how pre-foetal, foetus/newborns and children were classified into age groups. Children older than neonates were represented as two complete child skeletons and one whole body with arteries injected and a minimum of two individuals based on jaws and teeth (assumed intact on the whole skeletons). This in total provided a minimum number of five individuals. Only two entries provided an actual age, one was 12 years old and the other 12 months old.

Actual ages of foetal and pre-foetal individuals were only provided in a few cases. It is uncertain that the modern classifications of ovum, embryo and foetus were maintained in the catalogue, such description were most likely only a loose indicator of the developmental stage. A group of wet preparations of parietal and temporal portions of the skull, made to demonstrate ossification were noted as being from “embryos”, suggesting that the term “embryo” was used more loosely than the tight “pre-eight weeks gestational” classification used in modern medicine (World Health Organization, 2001). Three spines of foetuses were also described as having been derived from individuals of 6 and 9 months gestational age and one simply classified as “very young”. There were at least two other full term foetuses; one an acephalic twin and the other a wet preparation of an injected skull. From the classification of preparations it appears that most parts of the body were represented either within complete individuals or to demonstrate specific parts of the anatomy. It was decided that the “foetal” category should be calculated on skeletal remains in order to present a more compatible comparison to the archaeological skeletal remains, which were added to complete individuals in the non-skeletal categories.

The most well represented skeletal elements were skulls (8), teeth/jaw (7) and spines (5), including at least one whole skeleton of a foetus, to these were added three “monstrous” foetuses, and one individual with *Spina bifida*, providing an estimated MNI of 13. It was also possible to make some calculations on the pre-foetal individuals. One section of the catalogue was called “preparation of the foetus” divided into ovum, embryo, foetus and abortion, demonstrating that all stages of pre-birth development were represented in the museum collection. These appeared from the catalogue descriptions to be wet preparations of complete examples and thus categorised as such in the MNI, totaling a number of 35 pre-foetus individuals (Table 10). This provided a total number of 79 individuals including all age categories.

Age category	Modern explanation of term age	MNI
Pre-foetal		
Ovum	Fertilised (zygote)?	7
Embryo	< 8 weeks gestation	5
Foetus	> 8 weeks gestation	17
Abortion	Ovum, embryo or foetus?	6
Total pre-foetal		**35**
Foetal/neonate		
Skulls		8
Whole skeleton		1
Complete on-skeletal foetal prep.		4
Total foetal/neonates		**13**
Total MNI		**48**

Table 10 Pre-foetal and foetal/neonate MNI (Based on Paterson, 1778)

A total of 44 individuals would have been used in the making of human preparations, not including pre-foetal individuals. Adults were most frequently represented at 59.09% followed by foetal/neonates (29.55%) and children (11.36%) (Figure 27). These figures appear consistent with the mortality distribution in London cemeteries, seeing a high death rate amongst neonates and lowest amongst children (chapter 3)

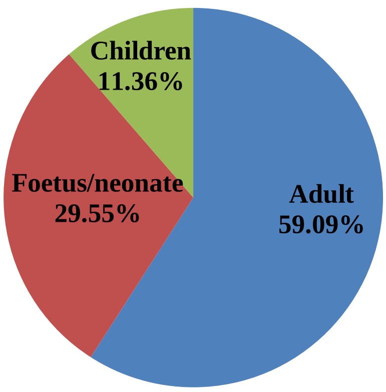

Figure 27 Distribution of adults (26), children (5) and foetal/neonates (13) (N=44) (Based on Paterson, 1778)

The humans in the catalogue were divided into sections depending on the type of preservation; “Dried bone”, “Dried preparations” and “Wet preparations in glasses”. Dried bone represented skeletal preparations and constituted 13.76% (150/1090) of the collection, the dried preparation (generally varnished) represented 17.61% (192/1090), wet preparations (in spirits) 67.89% (740/1090) and finally a small collection of corroded specimens 0.73% (8/1090). A small number (41) of skeletal elements were not categorised as “dried bone” with (23/41) in “wet preparations” and (18/41) in “dried preparations”. Some of the wet preparations such as the patella (4/23) would still have been in a cartilaginous state and had been injected, probably to demonstrate the blood flow.

6.3.2.2 The animals

A wide cross section of animals was represented in the collection in a total of 215 preparations (Table 11). A Minimum Number of Individuals (MNI) was estimated from the 44 different species represented, totalling at least 125 animals in the collection. Categorised by class, mammals were most frequently represented both in form of species (21) and minimum number of individuals (41). The preparations were divided into preparations of parts of animals, complete animals and skeletonised animals to provide an idea of how different types of animals were represented in the museum collection.

Class	Minimum no. of species	No. of preparations	Partial preparations	Complete animals	Skeletons/ bones	MNI
Mammalia	21	93	70	5	18	41
Reptilia	3	18	1	17	0	18
Insecta	2	11	0	11	0	12
Perciformes	5	13	4	8	1	10
Aves	4	16	4	6	6	9
Amphibians	1	12	5	7	0	8
Testudines	2	20	19	0	1	2
Other	6	32	10	22	0	25
Total	**44**	**215**	**113**	**76**	**26**	**125**

Table 11 Distribution of animals in the catalogue by class (Paterson 1778)

Figure 28 shows the representation of different classes of animals, with mammalia (32.80%) showing the highest representation followed by reptilia (14.40%), insects (9.60%), perciformes (8.00%), amphibians (6.40%) and testudines (1.60%)

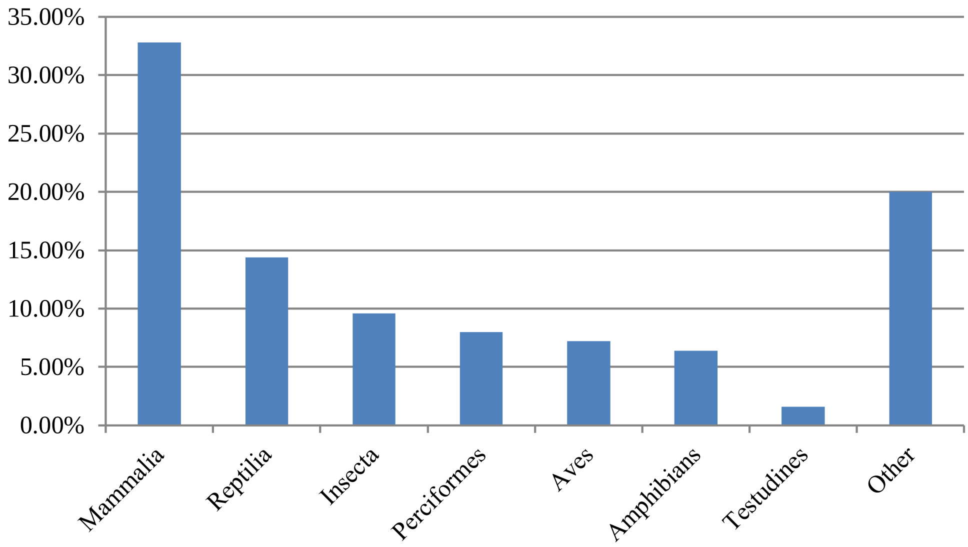

Figure 28 Percentage minimum number of Individuals distribution by class (N=125)

Table 12 lists the species represented within each of the classes. The most frequently represented species in terms of preparations were ass and cat, though these were mainly represented by partial elements, as was generally the case in the mammalian category with only five complete animals and 18 skeletons. Only testudines showed a similar predominance in partial preparations. Partial preparations would have been made in order to show specific anatomical features of an animal but the choice of making partial preparations as opposed to complete may also have been influenced by factors such as size and price of the animals.

Auction description	Class	Total	Partial	Complete	Skeleton
African antelope	Mammalia	1	0	0	1
African goat	Mammalia	1	0	0	1
Ass	Mammalia	15	14	0	1
Bat	Mammalia	2	0	1	0
Brute	Mammalia	7	6	0	1
Buffalo	Mammalia	1	0	0	1
Calf	Mammalia	2	2	0	0
Camel	Mammalia	1	0	0	1
Cat	Mammalia	14	10	2	2
Chick	Mammalia	1	0	1	0
Cow	Mammalia	2	2	0	0
Dog	Mammalia	7	3	1	3
Hedgehog	Mammalia	1	0	0	1
Horse	Mammalia	2	2	0	0
Lion	Mammalia	1	0	0	1

Mole	Mammalia	1	0	0	1
Monkey	Mammalia	1	0	0	1
Ox	Mammalia	7	7	0	0
Porpus	Mammalia	5	5	0	0
Quadruped	Mammalia	14	14	0	0
Rat	Mammalia	1	0	0	1
Sea cow	Mammalia	4	2	0	2
Sheep	Mammalia	2	2	0	0
Lizard	Reptilia	3	0	3	0
Rattle snake	Reptilia	1	1	0	0
Snake	Reptilia	13	0	13	0
Viper	Reptilia	1	0	1	0
Beetle	Insecta	1	0	1	0
Caterpillar	Insecta	10	0	10	0
Cod	Perciformes	1	0	1	0
Eel	Perciformes	1	0	1	0
Fish	Perciformes	7	4	2	1
Flying fish	Perciformes	2	0	2	0
Remora	Perciformes	1	0	1	0
Torpedo	Perciformes	1	0	1	0
Bird	Aves	3	0	2	1
Bird of prey	Aves	1	0	1	0
Birds	Aves	>4	0	0	>4
Common fowl	Aves	2	0	1	1
Goose	Aves	4	3	1	0
Hen	Aves	1	1	0	0
Sparrow	Aves	1	0	1	0
Frog	Amphibia	12	5	7	0
Tortoise	Testudines	1	0	0	1
Turtle	Testudines	19	19	0	0
Frog fish	Actinopterygii	3	0	3	0
Scorpion	Arachnid	4	0	4	0
Oyster	Bivalvia	3	0	3	0
Centipede	Chilopoda	4	0	4	0
Scolopendra	Chilopoda	1	0	1	0
Lobster	Malacostraca	4	3	1	0
Sea horse?	Syngnathiformes	1	1	0	0
Frogs/fish	Mixed	4	0	4	0

Ess??	Mixed	2	0	2	0
Unk	?	6	6	0	0
Total		215	113	76	26

Table 12 Distribution of animals by species as described in Paterson's catalogue (1778) (Total = number of preparations) (Paterson, 1778)

The majority of species represented were native to the British Isles but Hewson managed to acquire some more exotic species including African antelope, African goat, camel, lion, monkey, sea cow, turtle and rattle snake. It was interesting to observe that these were predominantly represented by skeletons, which suggests that Hewson would have acquired these more exotic species as already skeletonised.

Hewson's collection of complete preparations insects and other small animals were most likely used in his classes of comparative anatomy (Table 13). He also made a number of preparations of the lymphatic system, predominantly turtle, goose, fish and ox, consistent with his research. The high representation of preparations of cat seems to be linked to the reproductive system with female cat with foetus and monstrous kittens. It is not certain why Hewson would have selected cat for this purpose, but it is possible that they were sufficiently small (smaller than dog) and easy to come by. The high number of ass preparations, were mainly of the intestines, and may have been demonstrations of the absorbency of the smaller intestines, certainly William Hunter (1777: 42) had favoured this animal in his experiments on the absorption of the lacteals. It was however stated in the catalogue that they were diseased, but no further description was available.

Falconar's division of lessons	Explanations	Organs	Entries	Animals represented
Osteology	skeletal system	Bones	21	Ass, bird of prey, bird, buffalo, dog cat, common fowl, dog, fish, hedgehog, lion, mole, monkey, rat, tortoise.
		Teeth	17	Quadruped, sea cow, unkown.
		Horns	2	African antelope, African goat.
Myology	Muscular system	Muscles	3	Ass, dog, sea horse.
Angiology	Blood and lymphatic system	Blood and lymph, spleen	17	Calf, fish, goose, ox , shark, turtle.
Splanchnology	Viscera (internal organs)	Liver, heart, stomach and intestines	53	Ass, cat fish, frog, goose, horse, lobster, ox, porpus, quadruped, sheep, turtle, unknown.
Nervous & sensory system	Nervous & sensory system	Brain, spine, eye, ear, gill	4	Fish, ox, turtle.

Reproductive system/obstetrics	Reproductive system/obstetrics	Uterus, embryo, vagina, foetus, egg, placenta	16	Ass, brute, cat, cow, dog, frog, goose, hen, quadruped, sea cow, seahorse, viper.
Diseases	Diseases		21	Ass, dog, horse, kitten, ox.
Comparative anatomy	Whole and partial animals with no specific description	Parts of	80	Bat, beetle, bird, cat, caterpillar, centipede, chick, cod, common fowl, dog, eel, ess/eff, fish, flying fish, frog fish, frog fish, frog, goose, hippocampi, lizard, lobster, oyster, remora, scolopendra, scorpion, sea cow, snake, sparrow, torpedo, viper.

Table 13 representation of species by preparation type (Paterson 1778)

Hewson's collection of animals was large but perhaps not as exotic as the more affluent collectors such as William and John Hunter (Chaplin, 2009; McCormack, 2010), and reflects the limited means Hewson had at his disposal. Though many exotic species were available in London, they must have been costly. It is not clear whether Hewson, like John Hunter had a separate room for making preparations, but they would have required a large amount of space, especially when dealing with complete bodies and body portions, which could take months to prepare in vats of water and chemicals (section 4.3). When the collection was ulitmately sold at auction the prices reflected the quality of the collection (Paterson, 1778).

Hewson, like most anatomists desired that the collection was kept complete. Unfortunately this wish was not accommodated and the collection was split up and sold to the highest bidder at auction. The preparations must have been highly valued amongst Hewson's and Falconar's colleagues, because when their preparations were auctioned off in 1778 (Paterson, 1778), John Hunter anticipated that some preparations would go at a very high price (Letter to E. Jenner by J. Hunter, September 25, 1778. Cited/Dobson, 1961). The preparations sold at a very good price nearing £800 for the entire collection including inventory (Morning Chronicle and London Advertiser, October 21, 1778. Burney: Issue 2939). This was not insignificant for a smaller anatomy school, but as a perspective William Hunter's final collection amounted to a value of £100,000 (Hawkins, 1884: 535). William Hunter naturally had many more years of collecting than Hewson and could afford to pay people to make preparations for him, he also bought specimens for his museum at auction, a privilege Hewson was most unlikely to have enjoyed. When Hewson's and Falconar's collection was finally auctioned a minimum of 60 buyers were present during the ten day auction, comprising around 100 lots sold per day. Around 42% of lots sold had recorded buyers (Paterson, 1778); out of these John Sheldon (13%), William Hunter (10%) and John

Hunter (7%) were amongst bidders purchasing the highest proportion of specimens. The quality of the preparations must have varied as two items described as the same in the catalogue went for very different prices. The preparations of the lymphatics in turtle were all described similarly but sold at very different prices, from 12 shilling to 2 pounds 13 shillings. The most expensive items sold were those of the male reproductive organ fetching sums upwards of £21, whilst the most expensive animals were the head of a sea cow also fetching a sum of £21 and skeleton of a camel sold for £18.

Over a period of six years Hewson and Falconar built up a rich and varied collection, encompassing humans and a wide variety of animals. It would have taken a substantial amount of time, money and space to prepare such a large collection, with the amount of individuals encompassing a minimum of 79 humans and 125 animals. The financial predicament of the anatomy school may be a reflection of the huge investment required to make and purchase such a large collection. John Hunter's collection was accumulated over 30 years (1763-1793) and fetched a total of £15000 when sold in 1799 (Flower, 1881: 205). This would have amounted to £500 for each year of collecting. Hewson and Falconar collected for a period of six years and sold the collection for around £800 when sold in 1778, amounting to £133 for each year of collecting making Hunter's collection almost four times more valuable even though it was sold as a single lot rather than to the highest bidder. It is almost certain that Hewson and Falconar's preparations were less spectacular than John Hunter's collection as John Hunter had the finances to buy unique preparation and acquire interesting specimens for preparation.

6.4 The dissection room

The dissection room formed the core of practical anatomy teaching at the Craven Street School. Hunter advised that students should not start dissecting until they had completed at least one course (Hunter, 1784). It was optional whether the students wished to attend and could do so in an active or passive capacity (section 6.1.6). The room would have required low temperatures in order to slow down the rate of putrefaction and would have been crowded with students dissecting the bodies whilst other chose to gain knowledge as spectators. A total of six dissection tables and seven stools were sold off at the auction, as well as a large number of instruments and cabinets (Table 14) (Paterson, 1778: 39). It seems plausible that all six tables may have been used in the dissection room given the number of students attending the school allowing a maximum of eight students for each table. If around 62% out of 50 students opted to dissect (section 3.2) this would have amounted to around 31 students dissecting at any one time, suggesting five students may have used a table at a time. It was suggested that the dissection room at Craven Street may have been of moderate proportions measuring 6.40x3.20m (16.9m²) (section 6.1.2), which would have proved very tight if all six dissection tables were in use, as presumably it would also have housed a number of cabinets for the dissection equipment. A dissection table from the Science Museum in London dated from the eighteenth to nineteenth century measured 1.80m in length, 0.50m in width and had a height of 0.55m. The tables were compact and light and could easily be folded up and stored if necessary. They had a large hole to support the head and perforations along the side for the bodily juices to vacate the table during dissections (Figure 29).

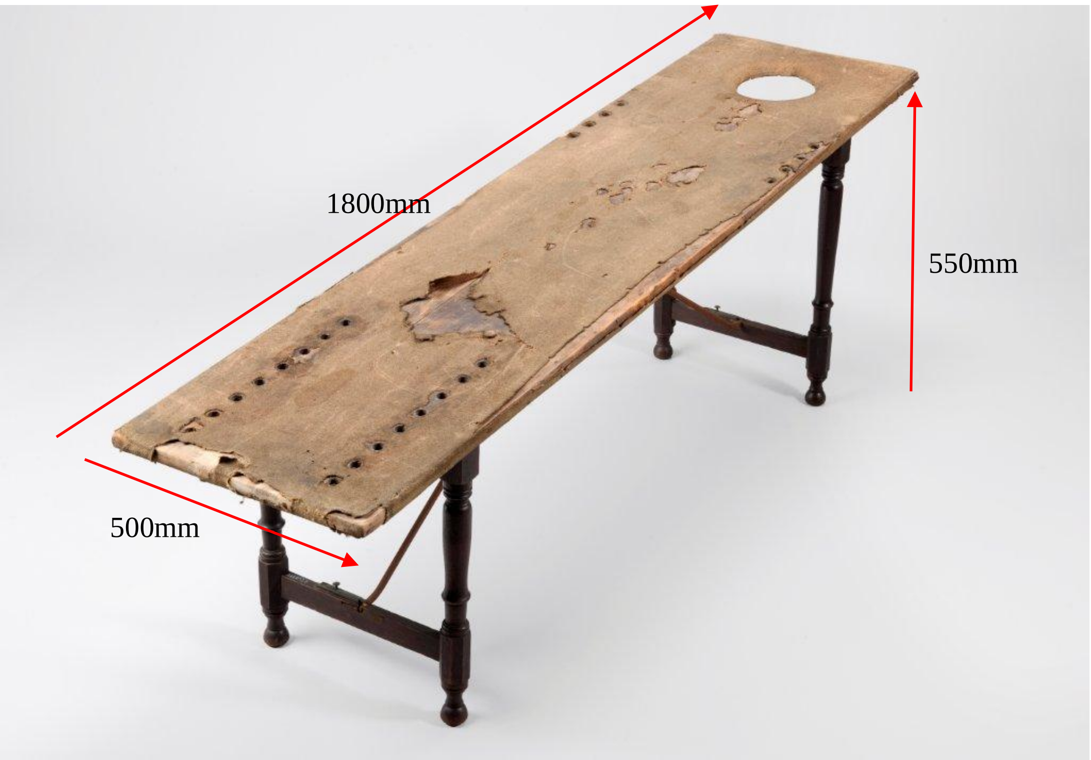

Figure 29 dissecting table (18-19th century) (Science Museum Collection, London)

The large amount of equipment was sold at auction, testament to the requirements of maintaining a dissection room and museum (Table 14). The number of knives and saws available suggest that students may have been able to make use of Hewson's equipment. Surgical instruments were used in practicing surgery with over 12 trepanning instruments. Interestingly only one microscope was sold at the auction and no glass sheets for making of microscopic slides.

	No.	Description
Preparation	>1	Rolls of plaster
	>1	Resin
	>1	Wax
	>1	Spreading Iron
	>1	Varnish
	>1	Colour pots

	>1	Brushes
	>1	Pallets
	>1	Stone bottles
	>1	Gally pots
	3	Pestle and mortar (marble, glass and metal)
	1	Copper scales w. brass weights
	240	preparation glasses (various sizes)
	>1	Bell shades
Surgery	1	Bougie
	1	Bougie roller
	2	Teeth extraction instruments
	>1	Cupping glasses
	6	amputation knives
	4	Amputation saws (incl, metacarpal saw)
	19	Dissenting knives
	12	Forceps (steel, leather)
		Hooks
	11	Instruments for couching (?)
	>1	Scissors
	>1	Needles
	1	Polyp instrument
	>12	Trepanning
	5	Staves
	2	Gorgets
	4	Instruments for operating the stone
	4	Silver catheters
	5	Trocars
	>1	Probes
	21	Lancets
	>1	Compressing instrument
	>1	Trusses
	>1	Splints
	1	Tobacco syringe
	1	Lay figure for bandage application
	31	Syringes
	1	Blow pipe
Other	1	Double barrelled injection engine
	1	Mathematical instruments

	1	Steel Press
	1	Hand weights for exercising
	1	Refraction telescope (3 feet) mahogany – Ayscough
	3	Magnifying glasses
	1	Fahrenheit thermometer
	1	Electrifying machine
	1	Table air pump
	1	Microscope (3x magnifiers, 2 luminators, 8 object glasses)
	2	Microscopic slide cabinets
	1	Glass machine for making artificial spaw water
	1	Mahogany cabinet with glass top
	12	Mahogany trays
	6	Dissecting tables with seven stools
	1	Long painted dresser (9 drawers and 3 cupboards)
	1	Painted shelves
	4	Glass cases with shelves

Table 14 instruments, equipment and furniture sold at auction (Paterson 1778, 38pp)

6.4.1 Human subjects

William Hunter related to his students that the circumstances of teaching (dissecting cadavers) were best not discussed outside the school (Illingsworth, 1967) despite the fact it was publicly known that such practices took place. Students would have used human cadavers in a number of different ways but mainly for anatomical study and surgical practice, as John Hunter mentioned, dissection was important in order to know where to cut a living body during surgery (Payne, 2007: 154). Cadavers would also have been used for practicing surgery such as the use of the trephine, performing amputations and other chirurgical operations which was taught in a series of 14 lectures (Table 15) (Falconar, 1777b: 17-19). Embalming and making preparations was also offered as part of the course. Hewson offered students the opportunity of injecting part of a body at a moderate extra expense (Falconar, 1777b: 19; Hewson, 1774: 220).

	Lectures in surgery
1	Healing of wounds
2	Dropsies
3	Hernias
4	Conditions of the penis (hydrocele, hematocele, sacrocele, phymosis, paraphymosis and amputation)
5	Lithotomy
6	Suppression of urine, fistula in perineum, fistula in ano, obliterated uteri

7	Breast amputation, paracentesis throracics, bronchotomy, wry neck, har lip
8	Extirpation of uvula, tonsils, polypus of the nose and removing catract
9	Operation of fistula lachymalis
10	Trephine - oppression of the brain
11	Aneurysms
12	Limb amputations
13	Embalming
14	Bandages of trunk and in cases of fractures and dislocations
	Midwifery
1	Diseases of the uterus
2	Methods of delivery
3	Diseases of mother and child

Table 15 Lectures on surgical procedures at Craven Street (Falconar, 1777c: 17-19)

6.4.2 Animals

Animals formed an important part of the teaching course with comparative anatomy lectures given on quadrupeds, birds, reptiles, fish and insects and would almost certainly have involved some practice dissections (Falconar, 1777b: 22). Hewson performed a great number of vivisections in his research on the circulatory system, using mainly dogs and rabbits for general demonstrations and experiments (section 5.5). Students would probably also have had the opportunity also to perform both dissections and vivisections on animals as the course offered a series of lectures in comparative anatomy (section 6.1.6). The dissection room at Craven Street would in all probability have been very similar to any other private dissection room in London. William Stuckley in 1720 (Stukley & Lukis, 1885: 33) wrote in his memoirs that his tutor had provided him with a room for dissecting animals and described it as; "*The wall was generally hung with guts, stomachs and bladders. Here my Associates often dind upon the same table as our dog lay upon*". From descriptions of Hewson's experiments he certainly let animals roam freely, "*Having pushed a sharp knife into each side of the chest of the dog...I then allowed him to run about the house. The experiment I made about eight o'clock in the morning; about ten he appeared less lively, and about twelve seemed to chuse to be at rest*" (Hewson, 1767: 381). Similar remarks were made about a rabbit, "*....the animal [rabbit] gradually recovered it's natural manner of breathing. It was then allowed to run about the house for a few days, and seemed none the worse for the operation*" (Hewson, 1767: 383). Although these particular experiments having taken place at Great Windmill Street, it confirms Hewson had no aversion to having animals running around freely, and would probably have continued this practice at Craven Street where he also performed vivisections on animals (Falconar, 1777c). Hewson, unlike William Hunter, appeared undeterred by the use of animals in the dissection room where he and his students would have made use of both living and dead animals. Hewson wrote of

William Hunter; "*Dr. Hunter told me it hurt him that I had not invited him to assist me in the Discovery [of lacteals in birds] and I seemed jealous of his robbing me of it. My answer to this was that my discoveries were made on liv'g animals I had never once tho't of inviting him from knowing his dislike of such expts. He knowing the truth seemed satisfied...*" (Notes by W. Hewson on W. Hunter c1772. Cited/Brock 2008: 77). Whether or not students agreed with Hewson's frequent use of animals in his experiments and demonstration, animals remained an integral part of Hewson's and Falconar's teaching. Hewson would have had good reason on using animals for much of his work; firstly, they were readily available, secondly relatively inexpensive compared to humans and thirdly it was not illegal to perform any kind of experiments on them and finally they could be experimented on alive or dead.

6.5 Body procurement and disposal

There is very limited direct historical evidence on procurement and disposal of cadavers for dissection at Craven Street. Like other anatomists, Hewson would have relied on the resurrection trade for a steady supply of bodies from cemeteries around London. This would have been costly and probably make up a large proportion of the schools outgoings. Hewson would have needed bodies for four main aspects of his business

1. Practice by students learning anatomy and surgery.
2. Preparations for the museum.
3. Prosections/Demonstration in the Lecture theatre.
4. Research.

One body may have been used for multiple purposes, although the use of the body for one task may have prevented it being used for another. For instance preparations often required a complete body when injected (section 4.3) but it is only possible to loosely speculate how many bodies were needed for each of these applications.

6.5.1 Bodies for student dissection

An estimated 31 students wished to dissect at Craven Street (see above) and historical evidence indicated students should have at least three bodies for dissection over a period of ~18 months (two seasons). If William Hunter's directions were followed, the first course would not have included any student dissection. It appears the summer course did include some human cadavers with "*bandaging and performing chirugical operations*" (Table 9). Inspector of Anatomy, Somerville (1835: 756) also highlighted that practice of surgical operations were carried out in the summer as the bodies were not required to last as long as during a course of dissection. The comparative anatomy course may have predominantly consisted of dissection of other animals than humans and museum preparations used to compare different species. If three bodies were used per student during a series of courses they seemingly would have been used in course two, three and four and Hewson would have had to purchase 93 bodies to cover one series of courses. Due to the scarcity and the cost of cadavers, this seems to be a very high figure and it is much more realistic that one student would have one body during their time at the school, dissecting different parts at different times. It would have been possible to divide a single body into a number of components so that a group of students would have been able to attend a body part at the time, or body parts could have been purchased from the resurrectionists when needed (section 3.2.1). With the lower figure being more realistic with a supply of 31 cadavers over a full set of courses (5 courses), this would equate to the school needing around 170 cadavers (31 x 5.5) between 1772 and 1778 as they succeeded in teaching six seasons of courses or 5.5 sets of course (section 6.1.6).

6.5.2 Bodies for making museum preparations

Making museum preparations would also have required purchasing of cadavers. The prices of these would have varied dramatically depending on the nature of the body (cadavers with congenital or pathological conditions would have cost substantially more). It was estimated that the auctioned museum collection (Paterson, 1778) consisted of a minimum number of 44 individuals and 35 pre-foetal specimens (section 6.3.2.1). The 44 individuals were made up of 26 adults, five children and 13 foetuses/neonates. In this instance omitting the pre-foetal individuals as more than one could have derived from the same woman and would not have been an individual in their own right for the purpose of body purchase. If the collection was accumulated over a period of six years as suggested (one year being whilst with William Hunter) Hewson would have required a total of 7.3 bodies a year (44/6) for his museum collection, assuming he made all the preparations himself. Using price estimations based on Naple's diary (1812), as this provides a breakdown of prices of adults, children and foetuses (section 3.2.1) the purchase of bodies would have been a total of 125 guineas 3 shillings and 6 pence (Table 16), a not insubstantial amount equating to close to 15% (*l* 125/ 840) of the price fetched at auction in 1778 estimated at £800 (*l* 840).

Age	**MNI**	**Average 1812 price***	**Cost of preparations**
Adult	26	4/4/0	108/20/0
Child	5	2/0/0	10/0/0
Foetus	13	0/10/6	6/4/6
Total	44	-	125/3/6

Table 16 Price estimation of bodies for making of museum preparations (*Naples diary 1811-1812) (Bailey 1896)

Purchasing power of the pound in between 1755-1815 fell 2.5 times so that the value more than halved during this period, but this decrease was not linear, the nature of the trade would have meant that it would have been unlikely to follow the pattern of everyday commodity prices (O'Donoghue & Goulding, 2004). Richardson (1988: 57) and Goodman (1944: 808) both provided a price of 1-2 guineas for an adult around the turn of the century suggesting the price might be half that of the prices in the early nineteenth century and therefore closer to *l*63 in total and therefore 7.5% of the entire auction purchasing price.

6.5.3 Bodies for the lecture theatre

From Falconar's course synopsis (Falconar, 1777b) a total of 120 lectures were given over a period of five courses (section 6.1.6). It is unlikely that all 120 lectures were supported by prosections, many would have been taught using preparations from the museum or animals. According to Monro *Primus* (1747) anatomy lectures required two bodies in order to demonstrate all parts of the anatomy.

The pure anatomy section of the course consisted of 78 lectures running over a period of 3.5 months a body might have lasted several lectures as the dissection progressed to reveal both the deep and the surface anatomy. Courses in surgery (27 lectures) and obstetrics (7 lectures) totalling 34 lectures would also have been likely to entail the occasional prosections, whilst the the course in comparative anatomy was least likely to have made use of cadavers. It was indicated that one body would be dissected over a series of lectures lasting a week and during anatomy courses this would ideally be two bodies per. week. with the anatomy course lasting approximately 14 weeks this would have amounted to 28 bodies for the anatomy course alone (2 bodies x 14 weeks = 28 bodies). The relatively few lectures given in surgery and obstetrics during a course suggest that these might have been compacted into a shorter period of time rather than lasting a full 14 weeks. It is therefore difficult to gauge how many bodies were needed during these two courses, particular as the lectures in obstetrics may have needed specific bodies such as pregnant women and foetuses.

6.5.4 Bodies for Research

Hewson's own account of his research mainly focused on experiments carried out on animals, in fact he never mentioned any dissections of humans though Falconar (1777c) did provide an image of the thymus of a newborn individual. Hewson's research would most certainly have entailed studying a great number of humans, particularly his studies on the lymphatic system, spleen and thymus. His research on the thymus would have required a significant number of new born individuals, as he observed the variation in size even in new born babies (section 5.5.8). Despite the very high death rate of still born babies in London at this time, it would have been difficult to ensure a constant supply of bodies, as the supply of foetuses was less than adult and children according to records by Naples (section 3.2.1). Foetuses only made up 9.75% of the total supply in a year and it would have been difficult for Hewson to obtain a large amount over a short period of time, as may have been required for his studies on the thymus. The location of Dr. Leake's school of midwifery next door makes it plausible that Hewson may have been able to generate some contacts and acquire stillborn babies through Dr. Leake, but there is no evidence of any associations between the two men. Given Hewson's lack of information on dissection of human cadavers for his research, it is impossible to even estimate the number of individuals he required for this purpose.

It is not known whether it was possible for Hewson to be specific about the number and types of bodies he required. Falconar (1777a) remarked that the order of lectures may be dependent on the type of bodies arriving to the school, suggesting it may have been difficult to ensure the correct supply of bodies. No doubt some lectures would have required a specific gender or age group. Historical evidence suggests that orders were taken by the resurrection men and supplied if possible (section 3.2.1). How the bodies were brought to Craven Street once purchased would have depended on the geographical amenities in the area. Craven Street is located right on the river Thames and it may be construed that the bodies were brought to Hewson via the Thames and brought through Brewers Lane into the back yard of the property. Accounts of body snatchers do seem more favourable of transporting the bodies with horse and cart, which again is entirely plausible. The bodies would seemingly have been brought to the property during the hours of darkness, through the back where the neighbours would have been less likely to observe the undertakings.

Disposing of the bodies would have proved an almost equally laborious undertaking and historical evidence offers very little clarification on this subject. It seems that disposal could occur either by getting the ressurectionists to rebury the bodies or to dispose of them privately and most likely locally (section 3.2.4). Employing ressurectionists to dispose of the bodies may have proved another expense incurred by the school, if no other option was available. At Craven Street it is known some body parts were buried at the premises but this would have accounted for a very small percentage of the bodies dissected. Perhaps the river Thames would have offered the most likely solution as it would have been relatively easy to get rid of the body parts using a weighted bag thrown into the Thames, but with the paucity of information on this topic in a historical context it seem much more likely that archaeology may be able to shed some light on this subject.

6.5.5 Summary

The anatomy school at Craven Street was a traditional extramural private establishment following the format of William Hunter's schools, with an ethos of practical anatomy. The school would have been more humble than those of both William and John Hunter, who boasted purpose built lecture theatres and grand museums with thousands of curiosities. Hewson's school would have been relatively compact with its strengths in Hewson's reputation as a researcher. The school was located in a residential area in the west end of London and seconded as a family home for Hewson and his family. Hewson had great success in attracting students with some 50 men signing up for his classes in the first year, despite Hewson's dubious reputation as a lecturer. Hewson worked hard to build up his school as well as his museum collection and in 1778 he had over 1400 preparations. Hewson's tragic death in 1774 saw his assistant and brother-in-law Magnus Falconar take over the business but following his equally premature death from tuberculosis in March 1778 the final courses were taught by Andrew Blackall. The school survived from September 1772 to May/September 1778 teaching five full courses (series of five courses) and one half course at which point John Sheldon offered to continue to teach Hewson's students at his own premises at Queen Street. The school went into administration with all the contents of the house and the school was sold at auction. Despite the school's apparent success it did not manage to make Hewson or Falconar wealthy men. The cost of setting up the school and running it would have been substantial, requiring large amounts of equipment, preparations and cadavers. It is most likely the school was not in existence for a sufficient amount of time to recuperate the initial outgoings. Neither Hewson or Falconar were from wealthy families and would not have had significant inheritance to fall back on, they solely relied on their own ingenuity.

7 The excavation and materials

In 1998 Professor Simon Hillson from The Institute of Archaeology at University College London was contacted by the developers of Benjamin Franklin House and asked to carry out the excavation of the basement at 36 Craven Street. The area of excavation was agreed between the developer and the Institute of Archaeology and did not form part of the PPG16, usually employed in cases of developer led excavations. The area selected for excavation was dictated by the constraints and the timeframe of the building works and the area of most dense visible archaeological activity was identified and excavated by Professor Simon Hillson himself and his colleagues Professor Tony Waldron, Dr Louise Martin and Dr Daniel Antoine.

7.1 Stratigraphic description of archaeological contexts

The excavation was confined to a very small area in the basement extension of the later closet wing added to the original Georgian part of the house (Figure 30). The excavation area measured 112x134cm with an overall depth of 75cm reaching natural London clay at this level.

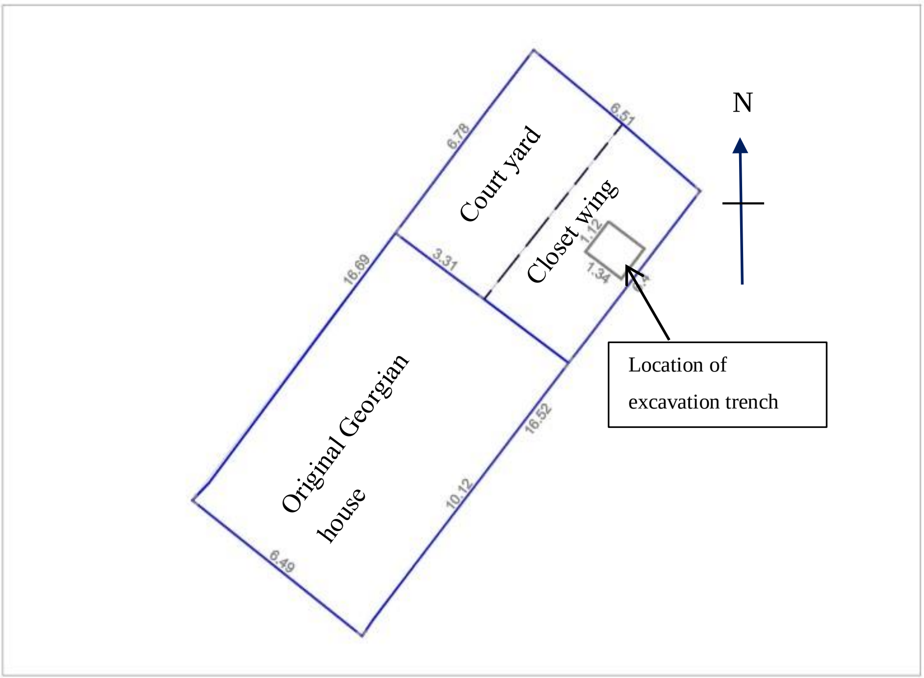

Figure 30 location of trench, situated in the basement area of the closet wing (arrow showing size and location of trench) (Drawing by Richard Holden)

Major disturbances had occurred prior to the archaeological excavation, by the machinery and tools of the workmen. There was additionally an attempt to salvage the remains by a concerned member of the Benjamin Franklin trust (Dr Brian Owen-Smith (1938-2013)). The un-stratified remains made up a high percentage of the total number of finds (36.82% (1586/4308), as during the initial salvage recovery a trench was opened down to the top of layer 7, which meant any layers above were truncated and could have contained a much higher frequency of artefacts and bones than it appeared from the stratigraphic information.

All the remains uncovered prior to the actual excavation form part of the assemblage and have been classified as un-stratified material. The outline of the excavation area was arbitrary, which resulted in some contexts not being fully excavated. The section drawings illustrate that the contexts continued in at least a southern, eastern and western direction outside the defined excavation area. The northern part of the excavation did not have a clear section and was excavated leaving a baulk, which was taken down in spits at the end of the excavation. No drawing was produced of the North baulk section (Figure 31).

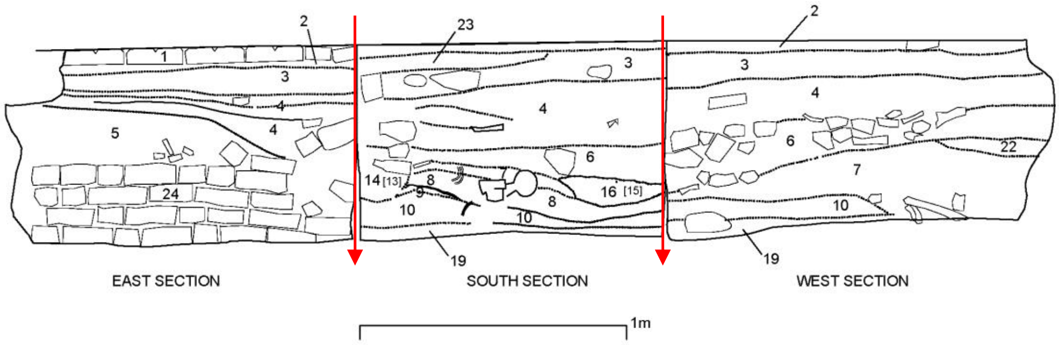

Figure 31 section drawings showing the east, south and west section of the trench (please note there are not in direct extension of each other but form three sides of the trench) (Drawing by Professor Simon Hillson)

The most north eastern area of the excavation according to the plan drawings did not produce any finds, though the excavation gradually encroached on this area as the lower levels of layers (10) and (19) were reached. It is possible that this was the area where the pre-archaeological salvage attempt was carried out, and the large number of un-stratified remains may predominantly have derived from this location. A Harris Matrix was produced post excavation based on the information on the drawings and the context sheets showing the most plausible stratigraphic sequence of the excavation (Figure 32)

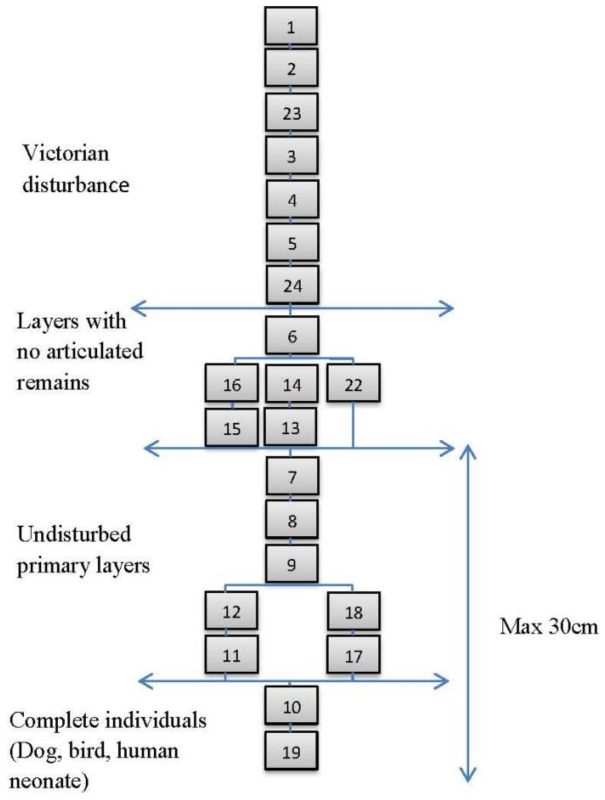

Figure 32 Harris matrix of the Craven Street trench showing the stratigraphic sequence.

A plan of each spit was drawn and groups of skeletal remains were allocated finds numbers. A total of eleven plans were drawn at a scale of 1:20 and the south, east and west sections were drawn at a scale of 1:10 (Figure 31). A total of 13 stratigraphic layers and four pits were observed and sub sectioned into spit numbers. For the purpose of this report the spit numbers were not adopted as these were arbitrary sections through the actual stratigraphic layers. Context sheets were recorded for each layer stating depth, Munsel colour and texture as well as providing a basic Harris matrix.

7.2 Matrix description

Above the London clay was layer (19) the primary layer of the sequence and the densest layers in terms of finds. This was an approximate 8cm deep friable sandy silty layer densely packed with bones and other sporadic artefacts. Many of the bones were articulated containing the remains of a complete neonate [20] as well as a dog [21] and a number of birds and some partly articulated remains (Figure 33).

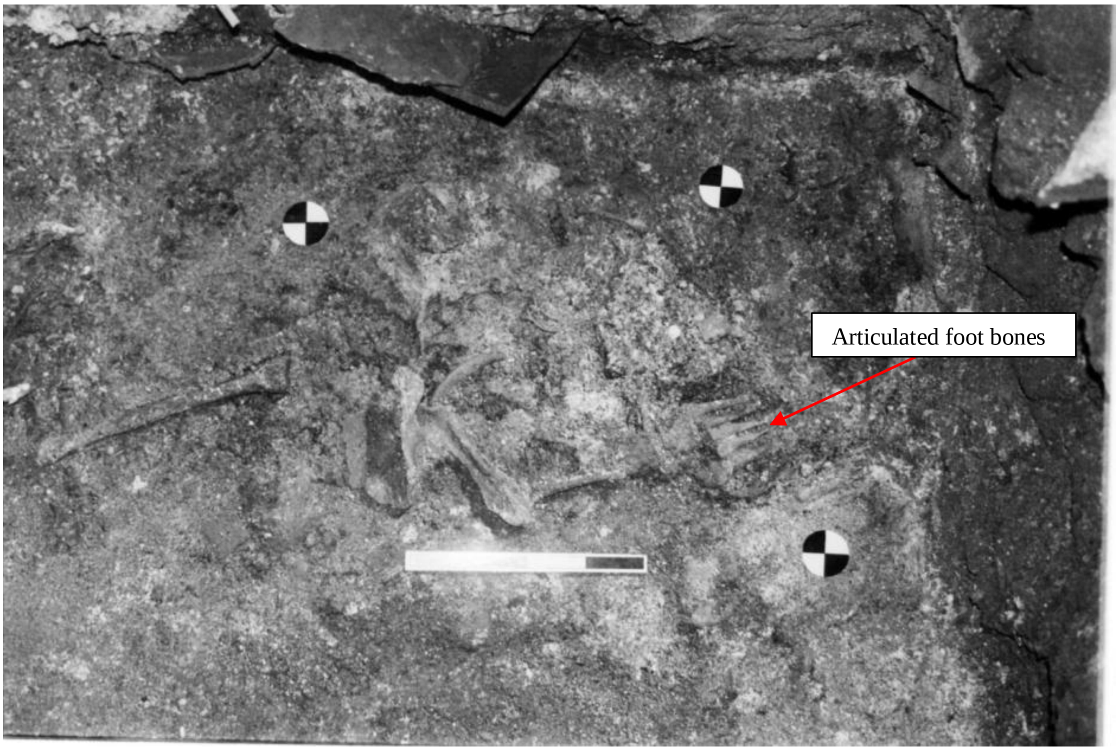

Figure 33 view of partially articulated human foot in layer 19 (Photo: Professor Simon Hillson)

Layer (10) overlay layer (19) and was a 3-14cm deep sandy silty layer mixed with lime, forming an L-shape along the south and west section of the excavation area. This layer contained mainly disarticulated remains and a few partially articulated human bones. Layers 19 and 10 appear to be closely linked as the neonate [20] uncovered in context 19 was partially present in context 10 according to the context sheets. Above layer 10 were two shallow pits [11] and [17] containing a smaller number of human and faunal skeletal remains as well as a small amount of glass and pot. The smaller of the pits [11] measured approximately 8x20cm filled (12) with a very dark friable sandy silt with scatters of lime chips (<0.5cm) whilst the larger of the pits [17] measured 24x40cm and was predominantly a lime filled sandy cemented layer containing a number of human and faunal remains; some partially articulated. Overlying the pits was a small layer (9), a very thin layer measuring 86x40cm containing scattered disarticulated human remains and parts of cat, bird and dog, with the cat possibly articulated. Layer (8) overlying layer (9) was more extensive, visible in the south section, the extent of the layer was not recorded but the depth was approximately 10cm. This layer contained a relatively small number of faunal and human skeletal remains and other material goods; none appeared to have been uncovered articulated. Layer (7) overlying layer (8) sloped from south to west measuring approx. 10-25cm in depth. The layer was predominantly made up of cemented slacken lime and contained a relatively large amount of skeletal remains and other materials. A number of skeletal remains appeared to have been articulated such as a group of adult human ribs and lower vertebrae as well as ribs of a dog. Overlying layer (7) were two smaller pits [13] and [15].

The smaller pit 13 measured 18x18cm with a depth of 15cm and contained friable silty clay (14) with a very limited number of disarticulated human remains and glass was situated in the most south eastern corner of the excavation area. The larger pit [15] measuring 24x40cm contained friable sandy silt as well a number of smaller disarticulated human bone and disarticulated elements of bird and sheep/goat. To the North West was a shallow small 8cm deep sandy layer (22) containing no archaeological remains.

Overlying the pits [13] and [15] and layer (22) was layer (6), a sandy silty bone layer with a depth of 10-25cm running in an L-shape along the southern and western sections measuring 112x120cm. This layer had a large number of bricks in the fill and contained a number of disarticulated faunal and human remains and glass fragments. The layers and pit [13] described in the above text all butted up against a red brick construction [24] in the south section appearing to be a Flemish bond wall, that may have been partly destroyed by the overlying layer (5) where large pieces of brick were present in the context. The layer was made up of brick and rubble measuring 22cm in depth spreading across the entire excavation. It contained a smaller amount of disarticulated human bone as well as remains from sheep/goat, medium mammal and two elements of turtle. A further wide spreading layer (4) was above layer (5) with a depth of 8-30cm. The two layers were of similar colour but the texture of layer (4) was that of sandy silt. It contained a small number of human and animal bone, all disarticulated. The majority of the faunal remains were that of sheep/goat. Above layer (4) were layers (3) and (23) both pebbly layers with slightly different consistency and colour. Layer (3) contained no human remains and a few faunal remains, mainly sheep/goat and one element of turtle. Layer (2) overlying layer (23) was a cemented layer containing bricks, with no archaeological finds in this layer. The final context (1) was the bricks of the basement flooring.

The above section described the contexts recorded in a stratigraphic sequence. The restrictions of the excavations area meant the contexts were not fully excavated and it was therefore not possible to determine whether the layers were confined within a pit or random layers scattered on the surface.

7.2.1 The eastern brick construction

One of the key features to understanding the excavation area was the red brick construction seen in the east section of the excavation. Brick constructions are particularly difficult to date in a post medieval archaeological context as many different construction techniques were used during this period. The Flemish bond system was certainly used in the early 18th century. Red bricks were used from the 14th century, whilst yellow bricks were introduced from 1800 and used as well as red bricks. The brick construction ran in an east west direction along the trench area, situated approximately 140cm from the original Georgian wall of the main building to the west (Figure 34).

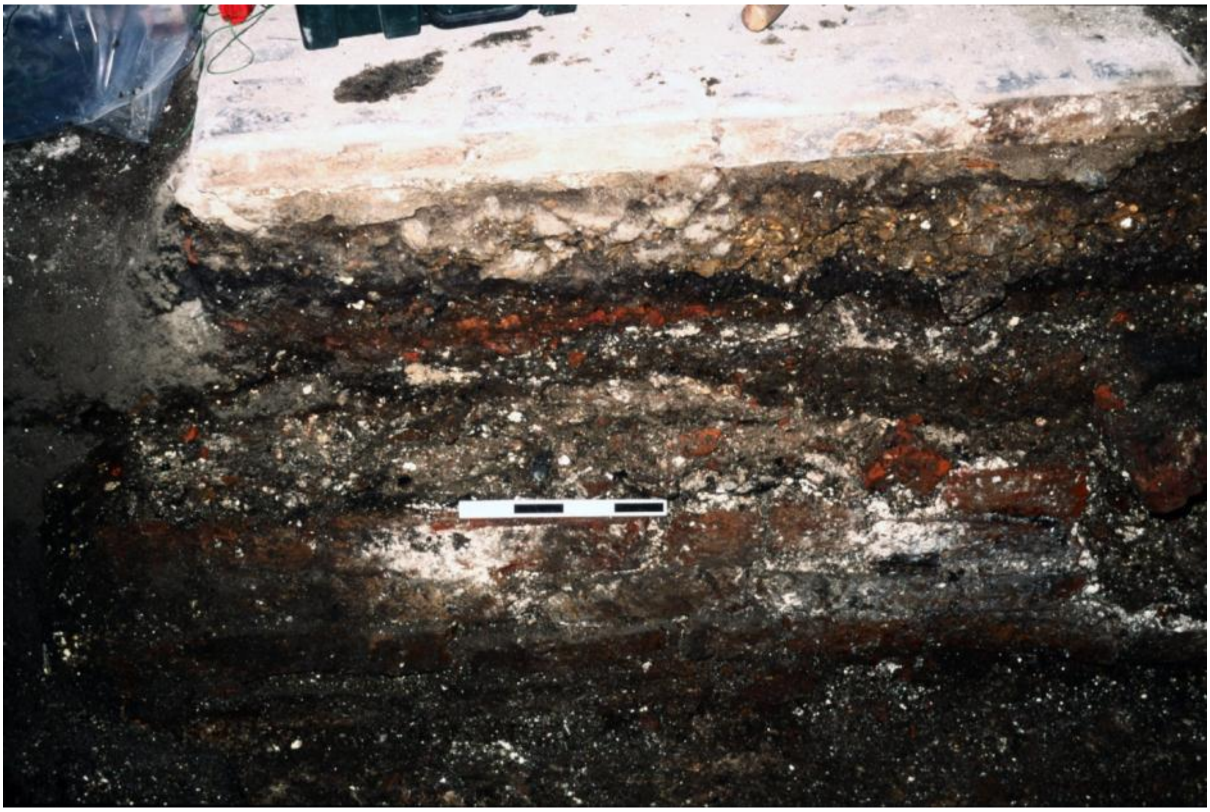

Figure 34 East section of trench showing the brick wall and overlying layers of disturbance (photo: Professor Simon Hillson)

It was suggested the wall formed part of a later Victorian sewage system possibly constructed in the between 1858 and 1865 as part of a major effort to overcome the “great stink” of the city. Constructions of such sewers were carried out using a stretcher and header bond system as seen on the wall in the south section. If the brick construction, as suggested, dated to the nineteenth century the overlying layers (1-5) must post date the sewer and were therefore later in date than the Craven Street anatomy school. This has been confirmed by dating of pottery from the site, with nineteenth century pot uncovered from layer 1-5 (section 7.6). The remaining layers (6-19) had been truncated by the wall with no nineteenth century pot was uncovered from these layers.

7.2.2 Layers 1-5

Layers (1-5) provided evidence for the destruction of a brick construction and the lack of finds in these layers as well as their makeup suggested that they were layers laid down to allow for an overlying construction such as the basement extension at a later date. These truncated the underlying layers, allowing skeletal elements and material artefacts to become incorporated. There were no articulated remains from these layers, suggesting the remains were not in a primary burial context. The faunal remains revealed species more typical of domestic refuse than those of an anatomy school, including chopped bone and fragments of sheep/goat. It is reasonable to assume that the layers post dated the underlying layers and the brick construction as a *Terminus post quem* dating to the nineteenth century or later as suggested from the dating of the pottery.

7.2.3 The pits

The four pits [11], [13], [15] and [17] were uncovered in the lower layers of the excavation with overlying layers undisturbed, suggesting they formed a part of the original deposition of remains. The pits were of varying size. Cuts [11] and [17]were lime filled pits and relatively small suggesting they may simply be concavities formed in the layers perhaps by shovels when adding the lime. Pit [15] was the largest and contained the highest number of skeletal elements; this pit was questionable as the south section drawing indicated that the wide but shallow pit may have been part of layer (6) rather than a separate construction, despite the variation in soil colour between the two. The position of pit [13] in the stratigraphic sequence was somewhat uncertain. The role of the pits is unclear in the wider context. Their apparent random size and content suggest that they were not purpose dug but may have been formed in a coincidental manner when the layers were deposited.

7.2.4 Primary layers (6-19)

The interpretation of the overlying layers suggested they postdated the anatomy school. Deposits 6-19 were most likely truncated by the brick construction. The main concern with the remaining layers was to establish whether they were contemporary with the school and whether primary or secondary in nature and to determine the timeframe of deposition.

Based on the matrix description layers 7 and 10 were made up of slacked lime, which appeared to be interspersed between the other layers. Slacken lime is formed when quick lime comes into contact with moisture and was in the eighteenth- and nineteenth centuries believed to accelerate decomposition of cadavers and certainly alleviated the smell from putrid bodies, it is therefore not surprising it was found scattered throughout the deposits.

In the area of archaeological excavation the layers appeared undisturbed and lay in a neatly stratified formation of varying density. The presence of slacken lime deposits was indicative that fleshed remains were buried. This suggested that they had been left undisturbed since their deposition. The skeletal remains were co-mingled and often disarticulated or partially articulated which could be indicative of burial disturbance, but in this type of deposit this is perhaps less likely, given the pre burial treatment of the remains. A number of remains were at least partially articulated throughout these deposits and were unlikely to be so, had they been disturbed post burial. The primary deposit (19) revealed a complete human neonate and a complete articulated dog, suggesting that the deposit was their primary burial site. It should be kept in mind, articulated or partially articulated individuals may not necessarily be uncovered in primary graves, their articulation depends on time of removal and the condition in which they were buried.

The primary layers appeared to be undisturbed or at least partially undisturbed deposits, solely pertaining to the anatomy school. Due to the incomplete excavation and possible truncation of the layers it was not possible to establish whether they were contained within a larger pit deposited on the surface. The current surface level of the basement may be higher than the level in the 18th century and it is in principle possible that the remains were deposited on the surface and later incorporated into the soil, though the remains would most likely have been interred as the lime suggest that the remains had to be covered to alleviate the smell of decomposition. It would further be more conducive to bury the waste as the space would have been at a premium and perhaps more importantly the decaying remains would have been near the kitchen area of the main house.

7.3 The finds

There were four major types of finds in the excavation; human remains, faunal remains, ceramics and glass. Other finds included metal (31 fragments) and shell/coral (41 fragments) but these were not recorded in this instance. The distribution of the finds across contexts forms an important part of the interpretation of the excavation and its construct. To this purpose the finds were presented as number of identified specimens (NISP) by layer. The inherent problem of using NISP, to investigate distribution pattern is the lack of discrimination of completeness, meaning that the actual relative distribution of skeletal remains according to body groups cannot be calculated. None the less such an overview serves to highlight general trends rather than specific patterns in the layers. In Table 17 the main finds groups were quantified and percentage distribution calculated to provide an overview of the distribution of finds throughout the stratigraphic layers and pits. The layers in the table have been presented in “near” stratigraphic sequence, to allow a greater visual appreciation of the distribution. A total of 4308 fragments were uncovered within the four major finds groups. Human remains composed the largest finds group at 46.38% (1998/4308), followed by faunal remains at 40.13% (1729/4308) whilst the smaller groups were ceramics (6.85% (295/4308)) and glass (6.34% (286/4308)). Whilst the osteological groups were poorly represented in the Victorian layers, both pot (28.47% (84/295)) and glass (55.24% (158/286)) had a relatively high representation in the disturbed Victorian layers of the trench. The primary layers (10 and 19) contained a large proportion of the human (34.28% (685/1998)) and faunal remains (64.72% (1119/1729)). Lime layer (7) also saw a cluster of both human (6.91% (138/1998)) and faunal (3.99% (69/1729)) skeletal remains, as the largest representation outside the primary bottom layers.

Context	Human	%	Faunal	%	Ceramics	%	Glass	%
Victorian disturbance								
1	0	0.00%	0	0.00%	0	0.00%	0	0.00%
2	0	0.00%	2	0.12%	0	0.00%	0	0.00%
23	0	0.00%	0	0.12%	0	0.00%	0	0.00%
3	0	0.00%	14	0.81%	48	16.27%	95	33.22%
4	8	0.40%	24	1.39%	36	12.20%	63	22.03%
5	10	0.50%	24	1.39%	14	4.75%	16	5.59%
Layers with no articulated remains								
6	67	3.35%	43	2.49%	11	3.73%	19	6.64%
22	0	0.00%	1	0.06%	6	2.03%	3	1.05%
14/13	4	0.20%	0	0.00%	3	1.02%	1	0.35%
16/15	35	1.75%	10	0.58%	4	1.36%	7	2.45%
Undisturbed primary layers								
7	138	6.91%	69	3.99%	15	5.08%	88	30.77%
8	33	1.65%	2	0.12%	6	2.03%	6	2.10%
9	50	2.50%	12	0.69%	14	4.75%	11	3.85%
12/11	3	0.15%	1	0.06%	0	0.00%	0	0.00%
18/17	22	1.10%	2	0.12%	1	0.34%	3	1.05%
Complete burials of dog, bird and neonate								
10	130	6.51%	8	0.46%	12	4.07%	10	3.50%
(20)*	100	5.01%	16	0.93%	0	0.00%	0	0.00%
(21)*	10	0.50%	182	10.53%	0	0.00%	0	0.00%
19	445	22.27%	913	52.81%	5	1.69%	48	16.78%
Unstratified	943	47.20%	409	23.48%	120	40.68%	117	40.91%
Total	1998		1732		295		286	**4308**

Table 17 finds distribution of the main finds groups by context with percentage distribution of remains within each finds group. (* Context (20) and (21) were finds numbers for complete individuals).

7.4 Human remains

A total of 1998 specimens of human remains were uncovered from the basement excavation. The remains were present in both the unstratified, disturbed and the primary contexts of the excavation, with the largest concentration found towards the bottom of the trench. The actual osteological analysis has been presented in chapter 9, whilst this section places the human remains within the context of the excavation.

The results of the analysis allows for consideration to be made of how the human skeletal remains were deposited and how the layers of the excavation were formed. The human remains made up 37.85% (1055/2787) of the stratified remains. The layers disturbed in the 19th century (1-4, 23) contained very limited amounts of human remains (0.4% (8/1998)) whilst the primary contexts showed there were four layers of concentrated human remains (6, 7, 10 and 19).The primary layer of the trench (19) showed the biggest concentration of stratified remains (22.27%

(445/1998)) by far. A large proportion of the human skeletal remains uncovered were unstratified (47.19% (943/1998)) and could not be integrated into a discussion on distribution patterns.

The distribution of body portions was considered to be of possible significance to the formation of the site (Table 18). The body parts were divided into four main groups; crania, appendicular, thorax and hands/feet but the results revealed no significant clusters of any of these groups of body parts in any specific layers or any variation of content between layers and pits apart from a slightly higher concentration of crania in pit (15).

	Crania	%	Appendicular	%	Thorax	%	Hands/feet	%	Other	%	Total	%
1	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
2	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
23	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
3	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
4	4	1.1%	0	0.0%	4	0.4%	0	0.0%	0	0.0%	8	0.4%
5	2	0.5%	2	0.7%	3	0.3%	2	0.5%	1	7.7%	10	0.5%
6	14	3.7%	9	3.1%	25	2.7%	17	4.5%	2	15.4%	67	3.4%
22	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
(14/13) pit	1	0.3%	0	0.0%	2	0.2%	1	0.3%	0	0.0%	4	0.2%
7	30	7.9%	22	7.7%	51	5.4%	33	8.7%	2	15.4%	138	6.9%
8	2	0.5%	4	1.4%	19	2.0%	7	1.8%	1	7.7%	33	1.7%
9	7	1.9%	3	1.0%	17	1.8%	22	5.8%	1	7.7%	50	2.5%
(16/15) pit	15	4.0%	1	0.3%	10	1.1%	9	2.4%	0	0.0%	35	1.8%
(12/11) pit	0	0.0%	1	0.3%	2	0.2%	0	0.0%	0	0.0%	3	0.2%
(18/17) pit	1	0.3%	5	1.7%	16	1.7%	0	0.0%	0	0.0%	22	1.1%
10	27	7.1%	19	6.6%	76	8.1%	6	1.6%	2	15.4%	130	6.5%
(20)*	25	6.6%	17	5.9%	56	6.0%	2	0.5%	0	0.0%	100	5.0%
(21)*	1	0.3%	1	0.3%	6	0.6%	1	0.3%	1	7.7%	10	0.5%
19	94	24.9%	46	16.1%	179	19.0%	126	33.2%	0	0.0%	445	22.3%
Unstratified	155	41.01%	156	54.55%	475	50.48%	154	40.53%	3	23.08%	943	47.20%
Total	**378**		**286**		**941**		**380**		**13**		**1998**	

Table 18 Distribution of fragments within the stratigraphic layers by element groups (* Context (20) and (21) were finds numbers for complete individuals).

A total of 15 partially articulated remains were uncovered from the stratified layers and from the pre archaeological excavation removal. The articulation was mainly partial, not forming a whole body part, such as a complete foot, hand or thorax (Figure 35).

Figure 35 Group [5288] block lifted torso uncovered from the North Baulk.

The dominant portions of body were from the thorax consisting of clusters of ribs and vertebrae (66.67% (10/15)) whilst four clusters were parts of feet (26.67% (4/15)). Only one complete individual was uncovered from the trench; a neonate [5140] situated immediately above or in layer (19). A total of 53.33% (8/15)) of the articulated remains derived from layer (19), 13.33% (2/15) from layer (7) and 33.33% (5/15) were unstratified (these had been collected and bagged together during the initial rescue attempt by Dr. Owen-Smith). The presence of partially articulated remains from the unstratified fragments suggest that articulated remains may have been present in layers overlying layer (7), most likely these derived from layer (6) though it cannot be dismissed that they were removed from the top of layer (7).

7.5 Faunal remains

A total of 1732 faunal fragments were uncovered from the basement and in this section distribution of the remains across contexts have been considered in relation to species. The results of the faunal analysis have been presented in chapter 10.

Table 19 shows the distribution of identified species across the stratigraphic layers of the trench. The re-deposited layers revealed a very low density of faunal remains (3.1%), predominantly medium mammals and sheep/goat fragments. The primary layer of the trench (19), similar to the human remains, saw the highest density of faunal elements at 64.71% (1119/1729). Due to the extensive disturbance of the pit fill it was unclear how many associated body groups or partially articulated remains were present in the assemblage. From the records it was possible to distinguish at least 10 body portions belonging to dog, cat, mallard and reptile, all located in the primary layers of the trench (10 and 19)

.

Layer	Dog	Cat	Cattle	Pig	Red Deer	Sheep/goat	Horse	Rabbit	Squirrel	Mouse	Rat	Tortoise	Lrg. Mammal	Med. Mammal	Sml. Mammal	Unidentified mammal	Bird	Fish	Turtle	Amphibian	Unidentified	Total (NISP)
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	**2**
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	1	0	0	0	5	0	0	0	0	0	0	0	5	1	0	2	0	0	0	0	**14**
4	2	2	0	0	0	6	0	0	0	0	1	0	1	6	0	0	3	3	0	0	0	**24**
5	2	0	0	0	1	5	0	1	0	0	0	0	0	11	0	1	0	1	2	0	0	**24**
6	4	4	0	0	0	1	1	0	0	0	0	0	2	16	6	0	5	1	0	0	2	**42**
22	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**
(14/13) pit	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
7	11	16	0	0	0	4	0	0	0	0	1	0	1	23	2	1	7	1	2	0	0	**69**
8	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	**2**
9	1	7	0	0	0	0	0	0	0	0	0	0	0	3	0	0	1	0	0	0	0	**12**
(16/15) pit	0	0	0	0	0	1	0	0	1	0	0	0	0	1	1	0	6	0	0	0	0	**10**
(12/11) pit	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	**1**
(18/17) pit	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	**2**
10	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	1	0	0	0	**8**
(20)*	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	**16**
(21)*	62	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	117	2	0	0	0	**182**
19	123	187	4	0	4	21	0	0	0	0	0	0	0	50	49	49	241	106	56	18	5	**913**
Unstratified	75	79	3	4	6	56	3	2	0	1	6	1	9	36	35	2	45	31	6	1	9	**410**
Total (NISP)	**283**	**297**	**8**	**4**	**11**	**99**	**4**	**3**	**1**	**1**	**8**	**1**	**14**	**154**	**94**	**53**	**449**	**147**	**66**	**19**	**16**	**1732**

Table 19 Stratigraphic distribution of species (* Context (20) and (21) were finds numbers for complete individuals).

7.6 Ceramics

A total of 295 fragments of clay pipes and pot were uncovered during the excavation. A basic analysis was carried out by Clive Orton at the Institute of Archaeology, University College London providing information on date and pottery type. A total of 136 fragments could not be dated, 42 fragments of pot were dated to the 19th century, all from layer (3) except from one small shard recorded as being from layer (19) and most likely to be an intrusion during excavation. One complete ink pot dated to the nineteenth century contained remnants of mercury, which was widely used in medical treatment during this period. Dating to the same period were two fragments of fisherman's lobsterpot with a polychrome transfer print showing a gentleman smoking a clay pipe (Figure 36). There was no indication that any of the layers were later than the nineteenth century.

Figure 36 fragments of a fisherman's lobsterpot dated to the nineteenth century

A total of 117 fragments were dated to between seventeenth and late eighteenth century and uncovered across all layers in the trench and some unstratified (23), including 16 clay pipe fragments. The wide dispersal of 18th century pottery suggests that the upper Victorian layers had been mixed with the layer below, most likely with layers (5) and (6). The eighteenth century finds included chamber pots, flower pots and typical domestic waste, such as glossy redware (Figure 37); one chamber pot had been used as a paint pot for white paint. The ceramic remains revealed a mixture of coarse domestic pots and fine white china. There was no direct indication that any of the fragments were from the anatomy school itself, though an association could not be dismissed either.

Figure 37 Glossy marbled redware dated to the mid eighteenth century, recovered from layer 7

7.7 Glass

An Excel Spreadsheet was generated as an inventory of the glass fragments, intended to be a basic insight into the nature and quantity of glass material in the assemblage, from which to propose further research questions. Each bag of glass was recorded separately. The number and type of fragments for each bag were counted and described, generating a rough estimate of number of fragments and hue. The glass was further noted as being either flat or curved. Where possible the more complete pieces were described (i.e. bottle neck, bottle base, microscopic slide *etc.*). Each group of glass fragments was roughly measured. The longest side of the largest and smallest fragments was measured and the approximate thickness of the glass was estimated using a sliding caliper. A total of 487 glass fragments were recorded (Table 20). The vast majority of the fragments were clear/colourless glass or green glass. The glass size varied from 10mm to 94mm with a thickness range of 0.3mm to 7.7mm. The thinnest curved glass was noted amongst the clear glass whilst the thickest glass was green.

Colour	N=	%
Clear	264	54.20%
Green	218	44.80%
Brown	4	0.80%
Reddish	1	0.20%
Total	487	

Table 20 Colour distribution of glass fragments

The preservation varied with some glass having disintegrated or dissolved in the soil forming an opaque coloured film on the surface. Other glass was completely clear and exhibited no apparent sign of prolonged burial. A number of fragments were glass working debris, in form of irregular opaque pieces of smelted glass, suggesting that glass shapes were manufactures on the premises whilst other fragments had been etched with patterns or letters embossed (Table 21).

Modified glass	N=
Glass working waste	16
Decorated (etched)	3
Embossed	3
Microscopic slide	109
Microscopic tube	4
Total	135

Table 21 variations of glass modifications

A total of 109 fragments of clear glass were flat with a thickness varying from 1.5-2mm, some shaped as microscopic slides. The fragments of flat glass varied in size, with some larger than an average microscopic slide. Flat slides containing dry specimens made by Hewson, now in the possession of the Royal College of surgeons in London, also showed different shapes and sizes modified to suite the subject of interest (Figure 38). This supports the theory that the glass for microscopic slides was purchased as large sheets and cut to the required size by the user.

Figure 38 Microscopic slide containing a human intestine (photo: RCS Surgicat RCSHC/Hewson/M1)

A total of four microscopic tube fragments were further uncovered (Figure 39). These tubes were elongated and slightly flattened to contain the specimens within an enclosed space and used for larger or more fragile wet specimens. The tubes were consistent with the slides by Hewson, curated at the Royal College of Surgeons (Figure 40)

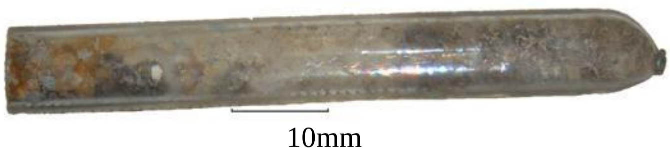

Figure 39 William Hewson's microscopic slide recovered from layer (7)

Figure 40 Microscopic tube (RCS) containing a human eyelid (most likely foetal) (photo: RCS Surgicat RCSHC/Hewson/29)

The glass uncovered at Craven Street reflects a variation of traditional domestic and specifically produced glass for medical research. Glass production waste was also uncovered, suggesting that some of the glass shaped may have been manufactured on the premises.

7.8 Summary

The Craven Street excavation was confined to a very small area of the basement within Benjamin Franklin house with the goal of salvaging some of the archaeological findings. The excavation yielded a wide array of finds including faunal and human skeletal remains, ceramics, glass, metal and shell/coral fragments. The layers in the trench had been disturbed in the nineteenth century by a wall cutting through it and later by some overlying layers of rubble and refuse. These layers had disturbed the primary layers of the anatomy school down to layer (7). Layers (7) to (19) appeared to be undisturbed primary layers, based on the presence of partially articulated remains and the absence of pottery dating later than the eighteenth century. The construct of the layers suggested that these were laid down in close sequence with the bottom layers, contained a large amount of skeletal remains, including a complete neonate, dog and mallard and other partially articulated human and faunal remains. The layers were interspersed with slacken lime suggesting that the remains were fleshed at the time of burial. There is no evidence from the finds that these layers were not laid down in close sequence, constituting a single event (either all disposed of at one time or keeping the pit open over a period of time for gradual disposal), certainly the primary layers appeared undisturbed including the lime layers (7) and (10). The finds strongly suggested the remains were part of William Hewson’s anatomy school; the flat and tube microscopic slides were consistent with those currently curated at the Royal College of Surgeons whilst the faunal remains were found to be consistent with Hewson’s research interests.

8 Methodology for the analysis of skeletal remains

The osteological assemblage consisted of a mixture of disarticulated, partially articulated and fully articulated human and faunal skeletal remains. All skeletal fragments were recorded onto an EXCEL 2007 spreadsheet. The human and faunal skeletal remains were recorded in separate spread sheets but to the same specifications.

8.1.1 Identification of skeletal remains

An initial assessment of the skeletal remains was recorded into an EXCEL spreadsheet with the human skeletal remains identified by Professor Simon Hillson and Professor Tony Waldron and the faunal remains by Dr Louise Martin in 1998/99. During the assessment phase 72.29% (1252/1998) of the human remains and 14.49% (251/1732) of the faunal remains were recorded. The subsequent analysis of the remains was carried out independent of these records by the author and was only compared after analysis to assess the compatibility of results. No inter observer error test was carried out due to the different nature of the analyses, the first being at assessment level.

In this thesis the terms “animal” and “faunal” have been applied to include all remains. The distinction between faunal and human remains was made by morphological variations of the bone. In cases of smaller fragments where no distinct morphological features were present the density of the bone was used as guidance, with mammal bones generally being more compact than human bones (Adams *et al.*, 2009).

The Identification of human remains was carried out using the Institute of Archaeology (IOA) reference collection, UCL and the collection of human remains from the Centre for Human Bioarchaeology (CHB) at the Museum of London as well as using the bone identification manual by White and Folkers (2005).

It is commonplace to identify faunal remains in accordance to geographical location as a starting point of narrowing down specific species. For Craven Street this was only applied as an initial starting point as historical sources showed clear evidence of the inclusion of exotic species in museum collections and it had to be assumed that remains of such species may be present in the assemblage. The assemblage was roughly sorted into mammals, birds, fish, amphibians and reptiles using the comprehensive reference collection at IOA, UCL. Reference books were also used to aid identification:

- Mammals were identified using the UCL reference collection and bone identification manuals (Boessneck, 1969; Schmid, 1972; Hillson, 1996), further assistance was provided by Dr Louise Martin.

- The bird remains were identified using the UCL, IOA reference collection together with Cohen and Serjeantson (1996). Further identification of species was carried out using the skeletal reference collection at the Natural History Museum at Tring.
- The fish remains were separated from the other remains by the author using Watt, Pierce and Boyle (1997) and Wheeler and Jones (2009), these were then sent to Dr Hannah Russ, Honorary Research Fellow at University of Sheffield for further identification and entered into an EXCEL spreadsheet
- Turtle elements were identified using a variety of guides on archaeological and modern assemblages (Olsen, 1968; Sobolik and Steele, 1996; Charette, 1999; Wyneken and Witherington, 2001). The identification was further aided by the IOA, UCL reference collection.
- Amphibians and rodents were identified using the IOA, UCL reference collection with assistance of Yvonne Edwards (Honary Research Fellow at IOA, UCL)
- Any unidentified fragments of animals were recorded as large- (horse/cattle size), medium- (sheep/goat, dog or cat size) or small mammal (rodent size), unidentified bird or unidentified faunal.

8.1.2 Taphonomy

Taphonomic factors are modifications of remains following death (Lyman, 1994). For the purpose of this thesis a distinction was made between pre- and post-depositional changes. Pre depositional modifications have been described separately as they encompass a major part of the analysis on anatomical dissection (section 8.1.6). Post depositional changes include modifications to the bone caused by processes in the burial environment such as trampling, soil conditions and moisture, and the treatment of bones after their disposal but prior to burial by indicators such as animal activity and exposure to weather.

Skeletal completeness was recorded in 20% intervals as a finer division would prove less accurate and not enhance the understanding of the assemblage. Skull elements were recorded as percentage of completeness of the individual element (i.e. parietal, occipital, frontal, maxilla *etc.*). Unfused bones were recorded as the percentage present of a complete element (i.e. an unfused epiphysis of a long bone would be 0-20% complete). Unfused bodies such as the scapula and shafts of long bones were recorded as 80-100% complete.

Fragmentation of bone may occur in a number of different ways depending on the nature of the natural and cultural factors. All ends of incomplete bones were recorded, some bones exhibited more than one of these break categories, in which case the lowest applicable number was recorded and a comment made (Table 22)

Score	Category	Explanation
1	Severed	Breaks exhibiting saw marks on the surface
2	Helical	Breaks on fresh/green bone
3	Old	Breaks on dry bone occurring before or during deposition (soiled edges)
4	New	Breaks during or following excavation (un-soiled edges)

Table 22 recorded breaks

Preservation of the remains was recorded in four categories; Excellent – No erosion and fully observable cortical bone, Good – slight suface moderation but not sufficient to obscure any observations, Moderate – mild erosion, possibility obscuring observations on the surface and Poor – extensive damage to the bone resulting in a large amount of porosity, pitting and flaking of the surface.

The assemblage displayed marked colour variations based on visual assessment and recorded as; dark brown, mid brown, light brown, dark yellow, light yellow/ ivory.

Indicators of animal activity by rodents or carnivores may be observed on bone. Carnivores leave marks on the bone from their dentition, such as puncture marks, Pits, scoring or furrows (Haglund, 1997: 374)

1. Puncture marks – perforation of bone, with the appearance that the bone has "collapsed" under pressure
2. Pits – indentation caused by tips of the teeth
3. Scoring – teeth slipping and dragging over the surface of the bone, following the contour of the bone, and
4. Furrows – channels of bone produced by molars extending from the end of the bones into the cavities

Rodent marks may have been produced in both dry and fresh bones (Haglund, 1996: 406) and are seen as distinct parallel grooves made on the bone typically in pairs (Figure 41). Carnivore and rodent damage are relatively easily distinguished in cases of marginal damage; carnivore damage tend to be less regular and often rounded in shape whilst rodents tend to gnaw at the margins from the inner to the outer table (Haglund, 1996: 407 and Haglund, 1997: 379). Animal activity was recorded, as present or absent and the location on the bone was also noted.

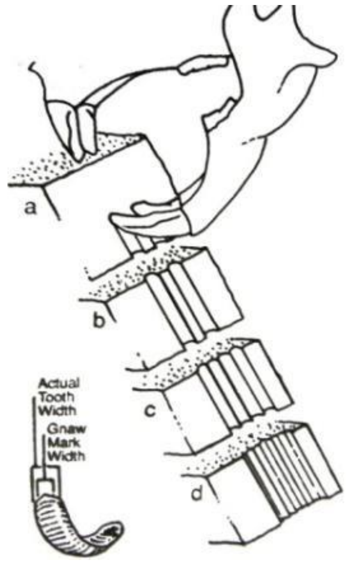

Figure 41 Parallel grooves as a result of rodent gnawing (Haglund, 2002: 406)

8.1.3 Recording bone presence

Methods for recording skeletal remains to achieve the most accurate estimation on representation of individuals in terms of quantitative measures has been addressed in both a zoo-archaeological and human remains context (O'Connor, 2000; Outram *et al*., 2005).

Recording methods have evolved from recording the proximal central and distal ends of long bones and ribs and individual elements of the skull to include a more comprehensive method of recording diagnostic zones. It is argued that recording diagnostic zones provides a higher accuracy in quantification of the assemblage by dividing bone into smaller zones each providing a separate number with this method adapted for both faunal (Dobney & Reilly, 1988) and human skeletal remains (Knüsel & Outram, 2004). This method is particularly useful for sites with highly fragmented remains and also lessens descriptive requirements when recording.

The human remains from Craven Street assemblage were initially recorded using the more traditional method of proximal, shaft and distal portion and recording the skull by element. A similar approach was also used for the faunal remains in order to maintain consistency in recording.

Due to doubts over this decision the author recorded a sample of human remains by zonation using Knüsel and Outram (2004) to observe any variation in result but found no discrepancies in subsequent quantification calculations. It was concluded that this was predominantly due to the small sample size allowing matching of elements and the low level of fragmentation. This test was done purely to identify the problems of not using this method for this particular assemblage and it should not be understood to be the case of other disarticulated sites. The author would recommend zonation in future works simply for the ease of filtering the results afterwards and the consistency in recording.

All remains were examined under a low power microscope using x10 and x20 magnifications, due to the importance of identifying modifications to the bone. Digital Photographic images were produced of all fragments with cuts, pathologies or other modifications of interest. Matched elements were likewise photographed for documentation.

8.1.4 Quantification

Quantification of disarticulated skeletal remains has always been highly debated and figures produced by any number of methods currently used are prone to a large margin of error (Ringrose, 1993; O'Connor, 2000). The problem with many methods is firstly; understanding what they actually mean and how they represent events in a living population. Secondly methods are compared across sites in percentages without regard for the mathematical errors entailed in doing this (O'Conner, 2000: 54 and 60). It seems that quantification methods are stuck in a circular argument, where everyone knows they are inadequate but no one is able to come up with a practical and viable solution. The problem presents itself with cross comparison of site as using an alternative method would make comparisons very difficult and it is often considered better to analyse sites in a consistent manner as it would be time consuming to re-visit the raw data from all comparative sites in order to make them compatible.

The most commonly adapted method of recording entails a three step approach representing different aspects of the data. The lowest denominator is a simple count of the Number of Identified Specimens (NISP) representing the number of fragments present in the assemblage for each identified taxa. This method does not take into account the extent of fragmentation or indeed the number of bones present of different species (O'Connor, 2000: 56). This problem is present in both faunal and human remains; variation in number of skeletal elements in faunal remains may cause differential representation in an assemblage. For both human and faunal remains the variation in number of bones between sub adult and adult remains provide another misrepresentation in the results. A young sub adult human skeleton has approximately 23% more bones than an adult; as an example, the vertebrae are in three sections (two laminae and one body) as opposed to a single bone and each long bone is represented by three elements due to unfused epiphyses instead of a single element with fused epiphyses.

From the NISP it is possible to make an estimation of Minimum Number of Elements (MNE) present. This method relies on the single most frequent portion of bone present for each element and naturally assumes that all remaining fragments belong to one of these. This is in many ways a better estimation as it to some extent accounts for the problem of fragmentation. What it does not do is to account for the variability of identifiable fragments within the different species and indeed within the single skeleton. The method allows for an estimation of body part distribution (BPD) to gauge the completeness of skeletal remains in the assemblage. This can naturally also be done to estimate the minimum number of proximal portions compared to distal portions of any anatomical group, which may be of interest to examine butchering and dissection patterns. When calculating body part distribution it is necessary to consider the frequencies of elements for each anatomical group and divide by the number of elements to achieve a reliable distribution (Reitz & Wing, 1999: 215).

The final denominator is the estimation of Minimum Number of Individuals (MNI), providing a proposed method of calculating species distribution within a site. The method builds on the MNE count by estimating which single element from the whole skeleton is the most frequently represented for each identified species and using this to represent the least number of individuals present. This method, however, has lots of problems, not taking into account taphonomic factors such as survival of different bones. For instance neonate bone are more porous than those of an adult causing them to be more prone to decomposition, with some arguing that this to some extent is the cause of the void of infant remains in cemeteries (Guy *et al*., 1997). Another problem is the lack of accountability for the NISP fragments, if one species is represented by 200 fragments and another by two fragments they may still both be represented by two individuals (Reitz & Wing, 1999: 194; O'Connor, 2000: 59).

The list of problems within these three categories of quantification is evident but it is not within the purpose or scope of this thesis to cover them all but simply to highlight some of the inherent problems associated with the methods applied. It should be highlighted that when calculating the MNE and MNI these represent the absolute minimum number of elements and individuals present on site, and are likely to be unrepresentative of the actual number. It is often the application of these methods that create the biggest problems and it is important to highlight the weaknesses of using these traditional methods. In summary the NISP predominantly provide information about the site formation but does not provide any representation of species other than presence (absence cannot be included as this would assume that at least one bone from all species ever present on site had survived).

Due to the nature of the Craven Street assemblage any calculations were made across the recorded stratigraphic layers in the pit. This decision was made on the grounds that some elements matched across the different layers making them indistinguishable from an osteological viewpoint.

For Craven Street the calculations of these three categories were made by first dividing the element into three wide age groups for the humans (see section 8.1.8.1), then elements for both human and faunal remains were then matched (see section 8.1.5) and from this an MNE and MNI calculated. This approach was only possible due to the small sample size and nature of cuts in the assemblage.

In some instances an “adjusted” distribution of elements were presented. This entailed calculation of the number of anatomical elements present against the actual number of elements in the body (i.e. thoracic vertebrae were divided by 12 and femora were divided by 2 etc), this figure was adjusted in the CH and INP groups to include unfused elements (i.e. the thoracic vertebrae in the INP group were divided by 36 due to the presence of one body and two laminae for each of the 12 vertebrae).

8.1.5 Visual matching

The relatively small size of the assemblage allowed matching of some of the disarticulated elements. Matching was possible by a number of different features;

1. New breaks
2. Severed surfaces
3. Size and morphological features
4. Fusion stage

The Scientific Working Group for Forensic Anthropology (Anonymous, 2011: 1-7) and Ubelaker (2002) outlined some cautions to be made in terms of visual pair matching. They did not recommend matching different articulating elements such as the femur and the tibia as this method has proved highly unreliable they also urged not to match elements by their proximity in the soil.

Matching of human remains at Craven Street was carried out following age assessment (section 8.1.8.1) and due to the limited number in the CH group an attempt to match elements across the skeleton was attempted. There were some inherent problems in attempting this even with a small assemblage. Firstly an assumption of number of individuals was made from individual elements and that this number would be true of all the elements present. Secondly ageing of different elements occurs through a number of different methods of varying degree of reliability and age range, with fusion and metric data being less accurate than dental eruption. Matching by size also proved difficult in particular if some elements were incomplete. The AA and INP groups were not cross matched due to the presence of higher number of bones of similar age and size categories.

An attempt was made to match some of the faunal remains both as pairs and across elements. This was done by size and fusion with a particular focus on mammal remains such as dog and cat. The variation in size of dog made it possible to distinguish some animals but cat proved very difficult due to similarity of size.

8.1.6 Recording pre-depositional modifications

Modifications made on the skeleton peri- or post mortem, prior to disposal have been recorded in great detail in both a forensic (Symes, 1992; Symes *et al*. 2010) and zooarchaeological context (Binford, 1981; Seetah, 2006). Analysis of marks on the bones as a result of sawing and knife impact have been studied to varying degrees of detail from including macroscopic observations (Symes, 1992; Symes *et al*., 2010), low power microscopes (Symes 1992; Symes *et al*., 2010) and high power microscopes (Scanning Electron Microscope (SEM) (Shipman & Rose, 1981; Bromage & Boyde, 1984; Aluni-Perret *et al*., 2005 and Saville *et al*., 2007). Each of these levels produce different magnification and it is generally conceded that the use of a SEM allows for identification of a specific tool in a forensic context (Saville *et al.*, 2007; Symes *et al*., 2010: 6), whilst lower power microscopes are sufficient in the identification of tool type (Symes *et al*., 2010). Identification of cut marks over other modifications such as animal activity may be relatively easily distinguishable macroscopically (Blumenschine *et al*., 1996). Smith and Brickley (2004) highlighted the usefulness of the SEM in the distinction of "new" marks on the bone from those made by tools such as flint knives.

Macroscopic recording can identify marks of broad types of tools such as a knife or saw, as well as allowing the identification of cut direction and general quality of cuts. In this thesis the bones were examined under a low power microscope at x10 magnification in order to ensure the identification of more subtle knife marks on the bone surface. Maheshwari (1981) noted the importance of the angle of severed surfaces in the analysis of cut mark procedures but this approach appears to have been generally neglected in subsequent works in favour of more sophisticated approaches. Recording of pre-depositional modifications was carried out using forensic techniques (Symes, 1992; Reichs & Bass, 1998; Haglund & Sorg, 2001; Symes *et al*., 2010). A total of 18 different modification identifiers were recorded following guidance by Symes (1992) and Symes *et al*. (2010) (Table 23) and (Figure 42).

	Recording	**Explanation**
1	Cut location	Position of the severed surface
2	Cut quantity	Number of severed surfaces
3	Cut type	Saw-, knife- or chop mark
4	Cut tool	Suggested tool of cut (saw, knife, cleaver)
5	Kerf floor	Presence of kerf floor in cut (Figure 42)
6	Kerf wall	Presence of kerf wall in cut (Figure 42)
7	False start kerf	Grooves from saw adjacent to cut surface
8	Break away spur	Marks the end of the cut where it snaps as a protuberance
9	Break away notch	Marks the end of the cut where it snaps as a concavity
10	Staining	Coloured stains from dyes (i.e. Vermillion)
11	Exit chipping	Flakes of bone breaking off due to forward and backward movement of the saw

12	Parallel striae	Striae present on the cut surface is cases where a saw has been applied
13	Slip marks	Marks on the periosteum near the cut there the saw has slipped during sawing
14	Knife marks	Fine striae on the periosteal surface
15	Skinning marks	Fine parallel striae on the periosteal surface of the bone made with a knife to remove soft tissue.
16	Cut direction	Noted based on the presence of false start kerf and/or break away spur/notch and the direction of the parallel striae
17	Insertions	Any foreign objects inserted in bone, such as metal or lime
18	Angle of cut	Degree of angle of cut based on cut direction

Table 23 modifications recorded (Adapted from Symes 1992 and Symes *et al*., 2010)

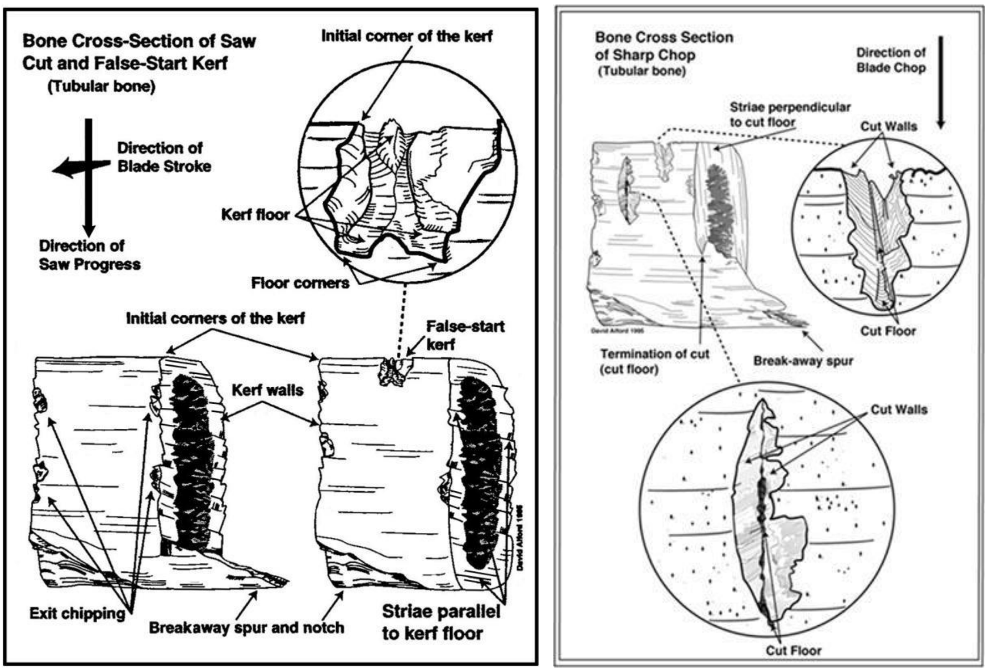

Figure 42 Saw and knife kerf showing walls and floor of a false start and complete cut (Symes *et al*., 2010).

8.1.7 Methods specific to human skeletal remains

Methods of ageing and sexing as well as recording pathologies and trauma are generally applied to articulated skeletons. This section highlights some of the difficulties in using standard human remains recording methods on disarticulated remains, and assesses the application of recent research in methods of ageing and sexing individual bones in a forensic context.

8.1.8 Metric analysis

Metric analysis of human remains was carried out on both subadult and adult remains. The adult metric data was carried out according to a list compiled in Powers (2012, 17-20) of cranial and post cranial measurements based on Brothwell (1981), Bass (1987) and Buikstra and Ubelaker (1994). Measurements of subadult remains were devised using Buikstra and Ubelaker (1994) and Scheuer *et al*., (2000), and applied to ageing and sexing. Considerations of stature and race were omitted from the analysis due to insufficient number of suitable elements for analysis.

8.1.8.1 Human ageing method

Generating an age profile using single isolated elements is associated with gross inaccuracies. Lovejoy *et al*. (1985a: 12) stated that age profiles should not be generated using single elements. From a blind test of multifactorial age determinants on adult skeletons in the Herman-Todd collection they found both inter-observer error and accuracy to be very poor when using single elements but this greatly improved when correlating multiple elements (pubic symphysis, auricular surface, x-rays of proximal femur, dental wear and suture closure). They also concluded that archaeological assemblages were more accurate than anatomical collections due to greater uniformity in the former.

The author of this thesis argues that post medieval assemblages do not display the uniformity Lovejoy *et al*. (1985a) assigned archaeological assemblages; this is in particular true for urban sites. London was already in the eighteenth century a multicultural metropolis, showing large variations both culturally and genetically (White, 2012). Social status, nutrition, profession, child birth and diseases would have affected the way in which degenerative wear manifested in the individual and it is therefore argued that post medieval populations are closer to modern populations than those prior to the Reformation.

Given the predominantly disarticulated nature of the assemblage it was necessary to age the individual elements separately despite the inherent inaccuracies in this application. It was possible to provide age estimation for individual elements by using appropriate ageing methods. In sub-adults ageing may be determined through dental eruption (Gustafson and Koch, 1973; Moorees *et al*., 1963), epiphyseal fusion (Scheuer *et al*., 2000) or metric analysis (Buikstra & Ubelaker, 1994: 41 and Scheuer *et al*., 2000). In adults ageing methods are much less reliable depending entirely on degenerative wear of the pelvis; the pubic symphysis (Brooks & Suchey, 1990; Buikstra & Ubelaker, 1994: 24-32) and the auricular surface (Lovejoy *et al*., 1985b; Buikstra & Ubelaker, 1994) and the sternal rib ends were aged according to Isçan (Bass 1995). Traditionally methods of ageing include dental attrition (Brothwell, 1981) and cranial suture closure (Buikstra & Ubelaker, 1994). Lovejoy *et al*. (1985a) argued dental wear was the best indicator of age, but the author argues against this for post medieval population with the emergence of high carbohydrate diets, processed foods and activities such as smoking resulting in lower rates of dental wear and a higher rate of tooth loss. Post medieval assemblages show a high rate of ante-mortem dental loss, in particular of the permanent first molar due to its early eruption. Cranial suture closure has long been known to be highly inaccurate in its application for ageing and has been dismissed by numerous authors (Brothwell, 1981; Krogman & Iscan, 1986; Novotny *et al*., 1993). For these reasons it was not considered practical to record dental wear or suture closure for the purpose of ageing in the Craven Street population.

For a fragmented disarticulated assemblage such as Craven Street it seemed unfeasible to maintain the relatively tight age groups developed for ageing articulated remains (Table 24) as it would be impossible to allocate most of the skeletal fragments into any one of those age groups. It was possible for a number of elements to determine age and these were placed within the traditional age categories and applied in more specific discussions on particular features.

For the purpose of more general analyses such as taphonomy, quantification, body part distribution and pre-depositional modifications it was of interest to allocate as many skeletal fragments as possible to a specific age group. For this purpose it was thought viable to divide the collection into three main categories grouping together perinatal, neonatal and infants into one category of <11 months (INP group), children age 1-11 years (CH group) and adolescents and adults aged >12 years (AA group). This division was specifically devised for the Craven Street assemblage based on the aged fragments in the assemblage (Table 24).

Craven Street age groups	**Description Age range**	**Age range**
Infant/neonate/perinatal (INP)	Perinatal	<38 weeks in utero
	Neonate - infant	1–6 months
	Infant	7–11 months
Child (CH)	Early child	1–5 years
	Later child	6–11 years
Adults/Adolescents (AA)	Adolescent	12–17 years
	Sub-adult	<18 years
	Young adult	18–25 years
	Early middle adult	26–35 years
	Later middle adult	36–45 years
	Mature adult	46 years
Unknown (UNK)	Adult	>18 years
	Subadult	<18 years

Table 24 Description of age groups from Powers (2012: 12) showing the adapted division used in the general analysis of the Craven Street assemblage.

The distinction between the INP and CH groups was based mainly on the movement from infancy into childhood. Biologically this is a continuous process without specific markers to distinguish the two groups. The sorting of elements between these groups relied on the morphological appearance of aged elements; such as size and shape and thickness of fragmented long bone and skull elements. Once entering into the CH group the skeletal elements appear morphologically more distinct, with sharper contours of the bone.

In biological terms adulthood commences at the point of sexual maturation and though this may vary between population and indeed individuals this is usually marked at 10-11 years in females and 11-12 years in males, despite lack of skeletal maturation. It may therefore be argued that the distinction between adolescent and adult individuals from a cultural viewpoint is less clear cut between different populations. In regards to the assemblage from Craven Street it may be considered that cadavers from this age onwards would have been treated in a similar manner due to body size and level of biological maturation. In an attempt to lessen the problems of fusion, with proximal fusion of long bones commencing before the distal fusion it was considered acceptable to group adults and adolescents, to lessen the risk of placing the same individual in two different age categories. Traditionally disarticulated remains pose a two way problem as fused long bones may belong to either adolescents or adults, with fusion commencing at the age of 12 years (Table 25). In terms of fusion, this means all fused remains could be placed into a single age category but the problem persisted with the unfused remains, which could effectively be placed into either the CH group or the AA group thereby not entirely eliminating the problem of placing fragments of the same individual into different age categories. Like the distinction between the INP and CH group, the most logical approach to this issue was to compare the morphology and size of the bones to those aged in either group and allocate them accordingly. In terms of dental development the distinction between the CH and the AA group could be made with the absence of any deciduous dentition in the latter. In loose dentition the distinction was less clear cut in teeth fully developed at this age such as the incisors and first molars but this did not prove a major obstacle in the majority of analyses.

	Epiphyseal fusion Timing	**Male**	**Both**	**Female**
Skull	Mandibular synchondrosis		<12 months	
	Spheno-occipital synchondrosis	13–18 years		11–16 years
	Fusion of tympanic plate (Weaver 1979)		< 2.5 years	
	Fusion: petrous bone (Baker et.al 2005,37)		<1 year	
Vertebrae	Neurocentral synchondroses		3–4 years	
	Thoracic neurocentral synchondroses		3–4 years	
	Lumbar neurocentral synchondroses		2–4 years	
Clavicle	Medial epiphysis		16–21 years	
Scapula	Coracoid process		15–17 years	
	Acromion		18–20 years	
Humerus	Proximal epiphysis (composite)	16–20 years		13–17 years
	Distal epiphysis (composite)	12–17 years		11–15 years
	Medial epicondyle	14–16 years		13–15 years
Radius	Proximal epiphysis	14–17 years		11.5–13 years
	Distal epiphysis	16–20 years		14–17 years
Ulna	Proximal epiphysis	13–16 years		12–14 years
	Distal epiphysis	17–20 years		15–17 years
Metacarples	Proximal epiphysis (base) MCP 1	16.5 years		14–14.5 years

	Distal epiphyses (heads) MCP 2–5	16.5 years		14.5–15 years
Pelvis	Ischio-pubic ramus		5–8 years	
	Os coax iliac crest		20–23 years	
	Ischial epiphysis		20–23 years	
Femur	Proximal epiphysis (head)	14–19 years		12–16 years
	Greater trochanter	16–18 years		14–16 years
	Lesser trochanter		16–17 years	
	Distal epiphysis	16–20 years		14–18 years
Tibia	Proximal epiphysis (plateau)	15–19 yrs		13–17 years
	Distal epiphysis	15–18 years		14–16 years
Fibula	Proximal epiphysis	15–20 years		12–17 years
	Distal epiphysis	15–18 years		12–15 years
	Calcaneum epiphysis	18–20 years		15–16 years
Metatarsals	Proximal epiphysis (base) MTS 1	16–18 years		13–15 years
	Distal epiphyses (heads) MTS 2–5	14–16 years		11–13 years

Table 25 Fusion stages adapted from Powers (ed.) (2012: 13)

Some inherent problems were observed when ageing the human assemblage, such as cranial elements with no age indicators, and it was considered whether it was possible to place these within one of the three broad age groups devised for this site relying on visual estimation of thickness. Lynnerup (2001) attempted to distinguish age, sex and stature by the thickness of skulls in an adult forensic sample but no correlation was noted. Oshuki (1977) looked at the development of bone thickness in the foetal period and found a positive correlation between growth and skull thickness. Shashanka (2011) concluded there was a strong correlation between age and cranial thickness in individuals 0-15 years of age. It may be suggested from this that skull growth and thickness are correlated with maturation of the skull. Due to the high fragmentation of the un-aged skull elements it was not possible to locate the exact position of the fragment; it was therefore thought that metric analysis of the thickness might yield false results, though the element could generally be determined. With the broad age categories adapted, a much more basic approach was attempted by simply comparing skull fragments to a cohort of skulls aged by dental eruption from the Museum of London collection of human remains. The age estimated skulls were grouped into the broad age categories to see if there was a demonstrable difference in appearance and thickness within each of these ages. Though the aged skull appearance did show some overlap, a number of Craven Street skull fragments could be placed within the different age groups.

For sternal rib ends methods devised by Isçan, Loth and Wright (1984) were applied, which uses the right fourth ribs only. It is difficult even in articulated remains to determine the rib number with precision as the central ribs exhibit a very similar morphology. Yoder, Ubelaker and Powell (2001) tested Isçan's model of ageing on the 2nd to the 9th rib and found no significant differences in age results compared to Isçan's results on the 4th rib, apart from the 2nd rib. This unfortunately did not entirely resolve the problem in disarticulated remains as it was not possible to determine which ribs belonged together or to distinguish particular ribs, meaning a reliable age profile could not be generated.

To conclude, specific ageing was recorded in elements when available and placed into the traditional age divisions for articulated remains. In order to attribute as many fragments as possible into specific age categories a division of three main age groups was generated to allow more general analysis of the remains and include as many age element groups as possible.

8.1.8.2 Sexing of human remains

Determination of sex in disarticulated remains is done with a high degree of inaccuracy due to the limited number of sexually dimorphic features on each fragment. Each feature was scored as either; female, female?, indeterminate, male? or male.

Sexing of the skull generally produces a high degree of accuracy, though naturally this accuracy lessens when scoring is made on singular features.   The skull and mandibular fragments were scored using eight sexually dimorphic features; Temporal bone -zygomatic process and zygoma root, frontal bone -supra orbital ridge and glabella, occipital bone - external occipital protuberance and nuchal crest and on the mandible - the mental eminence and mandibular angle. This method allowed, almost consistently two features to be scored for each of the fragments.

There is no shortage of papers on sexually dimorphic features and metric analysis of the post cranial skeleton alongside the traditional methods using head circumference of the femur and humerus and morphological features of the pelvis. The pelvis was recorded by seven discreet features; on the pubic bone – Ventral arc, medial portion of the pubis, sub pubic angle, sub pubic concavity and median isiopubic ridge and on the ilium – the greater sciatic notch and the pre-auricular sulcus (White & Folkens, 2005).

Investigations were made into the applicability of White & Folkes (2005) forensic methods for determining sex in individual bones such as long bones, hand- and foot bones. For the larger long bones the tibia was the preferred element producing a high degree of accuracy with the application of discriminate function analysis though this decreased when the number of measurements decreased (Isçan & Miller-Shavits, 1984; Holman & Bennett, 1991; Steyn & Isçan, 1997). Smaller bones such as hand and foot bones have likewise been subject to extensive testing as they often survive better the larger long bones, generally applied to metapodials and the calcaneus. Again discriminate function analysis was applied to a number of variables (4-9 measurements) for each bone with a reasonable high degree of accuracy (Scheuer & Elkinton, 1985; Lazenby, 1994; Falsetti, 1995; Smith, 1997; Robling & Ubelaker, 1997; Bidmos & Asala, 2003).

Although they appeared to produce a high level of accuracy they relied on discriminant function analysis of upwards of four measurement per bone, making them less applicable on fragmented remains. It was generally accepted that the results were population specific and less accurate when tested on smaller populations, in particular on hand and foot bones. One study of the distal humerus (Rogers, 1999) used morphometric variations rather than metric analysis, showing a high degree of accuracy particularly on the angle of the medial epicondyle and the shape of the olecraneon fossa. Naturally such observations are highly subjective and inter-observer error likely to be high, but the description of the features was thorough and it was felt this method was sufficiently accurate to apply to fragmented remains

It was determined that although a large number of studies exhibited a high degree of accuracy for singular elements the application would not produce significant results in a small sample such as Craven Street, with no way of testing the accuracy on single individuals. Each element group in Craven Street was relatively small with only a small number of complete bones in the adult sample and would not have produced a larger cohort of results than those of the skull and pelvis bones. Post cranial sexing was as a result carried out using the pelvis, femoral head maximum diameter and maximum epicondylar width and the maximum diameter of the head of the humerus as well as applying the morphometric variations on the distal humerus as described by Rogers (1999)

8.1.8.3 Pathology

It is widely acknowledged that recording of paleopathological conditions and analysing results are far from straight forward. Identifying a specific disease is problematic in itself and requires good knowledge of skeletal pathology in general. The interpretation of these diseases is even more complex and has been grouped together as "the osteological paradox" addressed by a number of different authors (Wood *et al*., 1992, Wright & Yoder, 2003 and Siek, 2013). The general consensus is; some diseases do not show on the bone (particularly acute conditions that cause the afflicted to die before any such manifestation may occur), bony lesions are evidence of prolonged life, and by this better health than those who died quickly from the disease, and there is therefore no correlation between frequency of skeletal lesions and frequency of the disease in the past. These statements are widely accepted but difficult to circumvent, though Wright and Yoder (2003) believe that with the emergence of more sophisticated technologies such as DNA and staple isotope analysis the gauge on the health of a population may prove more accurate. In disarticulated remains the problem of interpretation is even more complex as specific diseases often rely on distribution patterns (i.e. arthritic conditions) or the presence of more features whilst other diseases (i.e. DISH or trauma) may be diagnosed by the presence of a single anatomical region. This may cause an over representation of conditions requiring only a single pathogenomic indicator for diagnosis. Pathology manuals such as Mann and Hunt (2005) have attempted to generate an aid for diagnosis of single elements, but also recognise the problems of diagnosis in such remains.

It may be argued that at a site like Craven Street, disease distribution is not of the greatest relevance to its interpretation and it was conceded that the presence and absence of pathologies was more important than the relative frequency. Pathologies and trauma have been recorded in accordance with Powers (2012: 27pp) with more specific reference applied to particular conditions observed.

8.1.8.4 Dentition

A limited number of teeth were present in the assemblage. Due to the small dental assemblage and disarticulated nature of the remains it was deemed of limited value to apply any findings to speculations on the nature of the population. It was considered more pertinent to consider the role of teeth in an anatomy school context. For this purpose it was thought valid to record the condition of the teeth and which teeth were absent. Dentition was recorded following Hillson (1996b) as seen in Powers (2012: 23)

1. Teeth present
2. Ante mortem tooth loss – alveolar closure
3. Post mortem tooth loss – socket present with no tooth
4. Carious lesions – record of location and severity
5. Calculus
6. Alveolar resorption
7. Dental wear
8. Anterior alveolar bone loss (Henderson *et al*., 1996)
9. Dental enamel hypoplasia

8.1.8.5 Parturition

It was considered whether the female pelves could reveal any information on parturition, though highly controversial in current osteological literature. Features of observation were presence of; pre-auricular sulcus, pitting on the pubic bone, osteoitis pubis, osteoitis ilii and extension of the pubic tubercle (Ubelaker & De La Paz, 2012). It is however now widely acknowledge that these features may occur in the general population and not predominantly relating to child birth (Ubelaker & De La Paz, 2012).

8.1.9 Methods specific to faunal skeletal remains

Faunal skeletal remains are commonly analysed as a disarticulated assemblage and methods are thus well established for this purpose. Generating much less debate than seen on disarticulated human assemblages in current literature, the shortcomings of methods are still recognised (Ringrose, 1993; O'Connor 2000)

8.1.9.1 Metric analysis faunal remains

Metric analysis of faunal remains was based on Von den Driesch (1976) for mammals and birds. Measurements for turtle and Tortoise were according to Sobolik and Steele (1996: 59). Wither's heights for dog was calculated according to Harcourt (1974: 154)

8.1.9.2 Ageing of faunal remains

Ageing of faunal remains was done though epiphyseal fusion, dental eruption and wear and metric analysis. The vast majority of the remains were aged by fusion. Dentition made up a mere 0.05% (10/1732) of the assemblage.

Fusion was recorded as un-fused, fusing/just fused (visible fusion line) or fully fused.

Mammals were aged using Silver (1969) for sheep/goat, horse, dog, cattle and pig whilst Smith (1969) was used in ageing cats.

Birds were aged through metric analysis and fusion, with mallard aged using long bone length according to Dial and Carrier (2012).

Turtle was aged through measurements of the diameter of the mid humerus (Goshe *et al*., 2014) which was used to calculate the size of the carapace (Zug *et al*., 2002).

8.1.9.3 Sexing faunal remains

Sexing was only possible in one dog by the presence of a baculum. Mallard were sexed using metric results outlined by Meints and Oates (1987) and Woelfele (1967)

8.1.9.4 Pathology

Observations of skeletal and dental pathological conditions were made and a description and location of any changes recorded.

8.2 Comparative sites

In recent years a number of archaeological excavations have been carried out on sites associated with anatomy schools and hospitals (Table 26). Consistent for the sites were the presence of a large amount of disarticulated skeletal remains with evidence of medical intervention. A total of eight excavations were selected for comparative analysis based on accessibility and level of information.

Date ranges for archaeological excavation are generally significantly wider than that of Craven Street, spanning a period both pre- and post the anatomy act of 1832 (section 3.2.5), only the ASM, TCD and IFS could be placed firmly in the period prior to the anatomy act.

Geographically the sites selected span large parts of the British Isles and one site MCG was situated in the USA, but was included due to high level of information offered and the similarities in type of site. The closest site geographically is RLH situated in Whitechapel, East London.

Deposition of remains varied significantly from site to site. The ASM and MCG were the sites that appeared closest in nature to that of Craven Street. They were both dump deposits with no directly associated complete burials and were not linked to any hospital. TCD was not associated with any hospital but had both inhumation and disarticulated burials associated with the school. WRI had no inhumations and were purely dump deposits but associated with a hospital. RLH, BRI, NRI were all associated with hospitals and had a mixture of complete inhumations and disarticulated dump deposits. Finally IFS yielded only six inhumations, no disarticulated remains were reported. For comparative purposes the nature of the schools and the deposition were important to the understanding Craven Street. For comparatives between the human remains, MCG, ASM and TCD were considered to be the closest as they were all extramural anatomy schools and therefore did not have direct access to unclaimed cadavers from the hospitals. Though WRI was associated with a hospital there was no cemetery, suggesting the remains may have been dumped in pits following dissection, though the acquisition of cadavers may have be sourced through the hospital and some remains pertain to surgical waste rather than dissection waste. The excavation at UCL has unfortunately not yet yielded any appropriate comparative data and has therefore been omitted from the text, but was included in the table to generate awareness of the London site.

Site	Abb.	Location	Date range	Burial type.	Intervention	Assemblage type	No/ NISP	M	F	Adult	Child	MNI	Faunal (non-Human) (NISP)	Reference
Royal London Hospital*	RLH	London	1825-1841/42	Hospital	Dissection/ autopsy/ surgery	Inhumations	173	80	30	110	13	173	1974	Fowler and Powers, 2012
						Partially articulated	463	72	27	99	20	(7)		
						Disarticulated	7517	39	15	54	7	79		
						Total		191	72	263	40	259		
Ashmolean museum	ASM	Oxford	17 cent-1767	Dumped deposit	Dissection?	Disarticulated	2050	?	?	15	3	18	852	Hull, 2003
Trinity College Dublin	TCD	Dublin	1711-1825	Hospital	Dissection/ autopsy/ surgery	Disarticulate/ partially articulated	24979	40	77	206	27	233	yes (NA)	Murphy, 2010
Newcastle Royal Infirmary	NRI	Newcastle	1753-1845	Hospital	Dissection/ autopsy/ surgery	Inhumations	210	97	47	190	20	210	yes (NA)	Boulter *et al.*, 1998
						Disarticulated	?	105	101	384	23	407		
						Total		202	148	574	43	617		
Worcester Royal Infirmary	WRI	Worcester	18-19th cent	Hospital Waste pits	Dissection/ autopsy/ surgery	Disarticulated	1825	5	3	19	8	27	20	Western, 2011

Bristol Royal Infirmary	BRI	Bristol	1757-1854	Hospital	Autopsy/ surgery	Inhumation	107	42	29	90	17	107	yes (NA)	Witkin, 2011
						Disarticulated	9117	208	29	552	43	595		
Medical College Georgia	MCG	Augusta, USA	1835-1912	Dumped deposit	Dissection	Disarticulated	9808	69.10 %	30.90 %	96%	4%	?	297	Blakely and Harrington, 1997
13 Infirmary Street	IFS	Edinburgh	1749-1803	Hospital	Autopsy	Inhumation	6	2	4	6	0	6	Yes (NA)	Henderson *et al.*, 1996
						Disarticulated	?	5	4	11	3	14		
						Total		7	8	17	3	20		
UCL, quad**	UCL	London	Pre 1826	Dumped deposit	Dissection	Disarticulated	7000	n/a	n/a	n/a	n/a	n/a	Yes (NA)	Robinson, 2012

Table 26 Sites with comparative human skeletal remains (*Open area A only) (NA=not analysed) (not included in text due to lack of appropriate analysis)**

Faunal remains were present at RLH, ASM, MCG, IFS and WRI, but in much smaller amounts than the human remains; making up 1-29% of the assemblage. WRI and IFS were excluded from the general analysis. At WRI the faunal remains from this site appeared to be incorporated into the site by being present in the soil when the human remains were disposed of, and do not appear to have any clear association with the anatomy school or the hospital. At IFS there was no detail on the animals other than being those of a young bear and a young seal.

The information, size of assemblage and method of presentation varied significantly between sites and in some instance it has been necessary to reduce the data to the lowest common denominator. Throughout the text the sites will be referred to by their abbreviations (Table 26).

9 Results - The human skeletal assemblage

In this chapter the results of the recording of the human skeletal remains have been presented with the purpose of identifying the unique and shared traits of the school with other excavated anatomy schools and to allow a comparison with the historical documentation of medical teaching and the Craven Street anatomy school itself. A total of 1998 fragments of human bone were uncovered from the trench. The results of the human assemblage has been divided into six main sections; taphonomy, quantification and body part distribution, ageing and sexing, pre-depositional modifications (anatomical research), pathology and dentition, with a comparison with other anatomy schools compiled at the end of this chapter. Due to disarticulation the overall analysis has been divided into three main age groups in which 1908 fragments could be placed, whilst 90 elements (4.50% (90/1998)) could not be allocated a specific age group. These un-aged specimens were omitted from the analysis of demographic profile and body part distribution. Three main age categories have been applied throughout the analysis; adult/adolescent (12 years-old adult) (AA), Children (>1year-11 years) (CH) and Infant/neonate/perinatal (foetus-< 1 year) (INP). From here onwards the abbreviations will be used throughout the text, figures and tables (Please see section 8.1.8.1 for further clarification on age groups).

9.1 Taphonomy

Taphonomic processes form an important part in understanding the events leading up to the deposition of the remains and the manner in which the remains were disposed. This is particularly true of disarticulated and comingled remains. As stated in the methodology the word taphonomy in this thesis encompasses events following disposal of the remains. Modifications due to activities at the anatomy school prior to disposal have been presented separately in section 9.5. This section includes results on fragmentation, preservation and faunal activity, considering how each of these observations reveals information on treatment of the remains from the anatomy school.

9.1.1 Fragmentation

Skeletal remains may become fragmented in a number of different ways depending on the treatment and environment before, during and after burial. Incomplete skeletal elements were recorded according to four criteria; severed, helical, old breaks and new breaks.

In the whole assemblage there were 744 complete bones, 168 complete unfused bones and 1086 incomplete fragments. Completeness was calculated in 20% intervals (Figure 43) showing overall good preservation of the remains. The high frequency of 81-100% completeness was dominated by the high level of smaller bones in the adult group, in particular vertebrae and hand/foot bones.

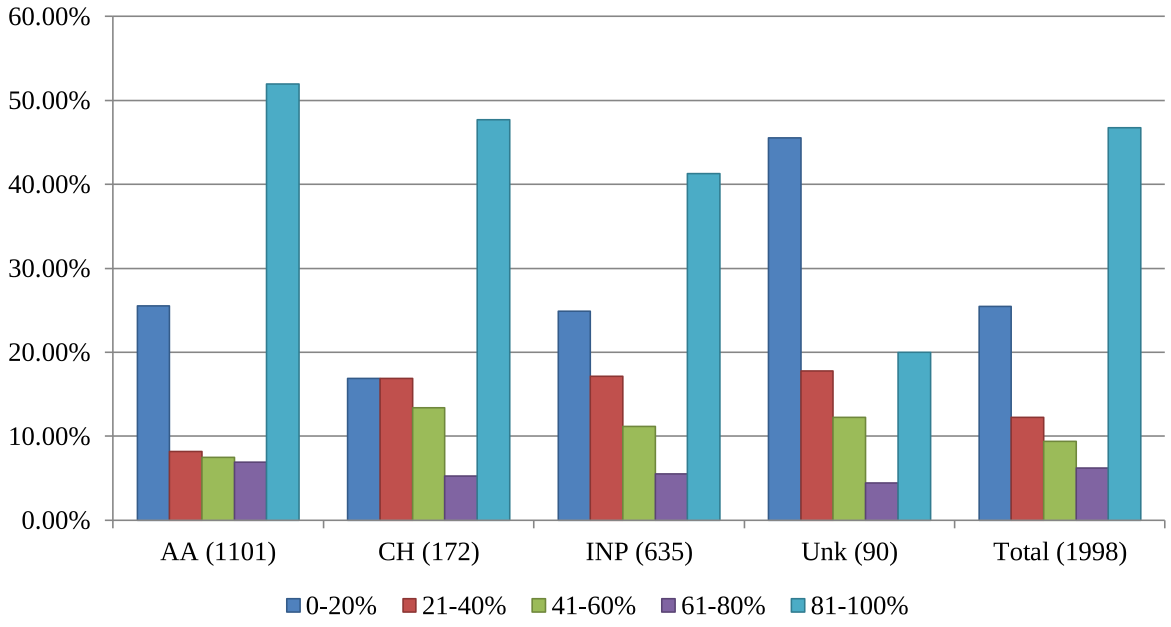

Figure 43 skeletal completeness by age groups including both post depositional damage and pre depositional damage

Figure 44 shows a total of 263 (13.16% (263/1998) fragments had been severed with 76.01% (200/263) derived from the AA group. The percentage of severed fragments compared to the total number of fragments made up 18.16% (200/1101) of all AA fragments, 14.53% (25/172) of all CH fragments and 4.72% (30/635) of all INP fragments, further details have been presented in section 9.5.

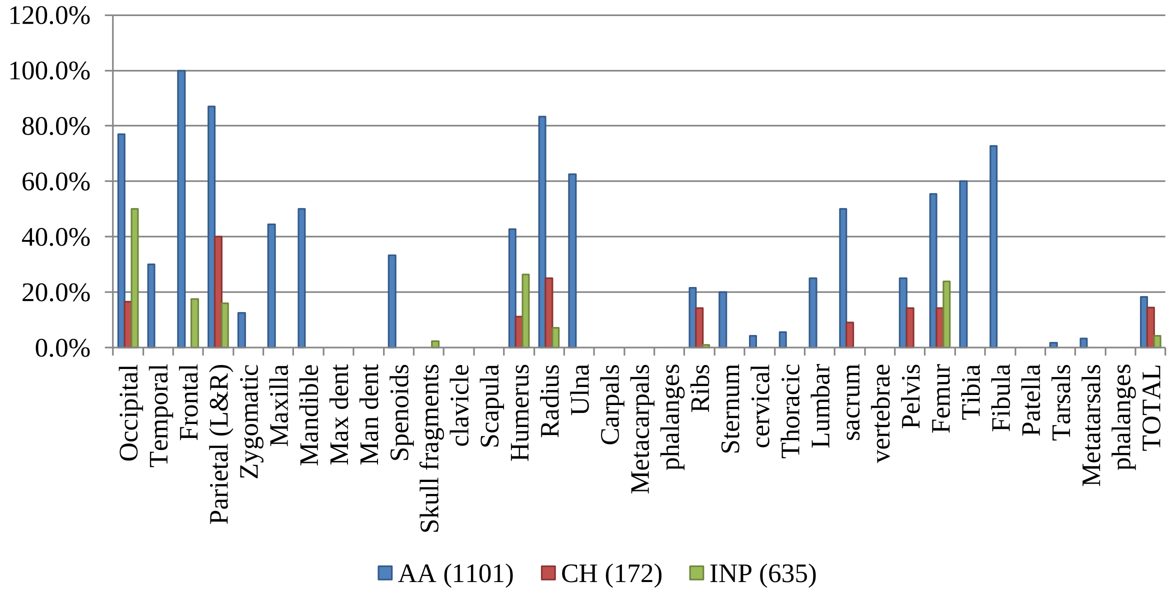

Figure 44 percentage distribution of severed fragments severed within each element group

Helical breaks were only noted in the AA group (1.09% (12/1101)). The absence of helical breaks in the CH and INP group was not necessarily due to differential treatment but more likely a result of difficulties in observation, certainly in the INP group. Post depositional bone fragmentation as a primary feature of fragmentation was noted in 811 bones with 34.90% (283/811) exhibiting new breaks caused by excavation damage whilst the remaining breaks would have been caused by damages post deposition after the bone had started to mineralize.

9.1.2 Preservation and colour

Surface preservation of the bone can help establish burial patterns and to what extent bones were discarded on the surface prior to burial (Ubelaker, 2006: 79). If the remains had been left unburied and exposed to the elements it would be expected that the remains exhibited poor preservation with exposure to weathering. Table 27 show the extent of surface preservation of the bone by age categories

	AA (N=1101)	JUV (N=172)	INP (N=635)	Other (N=90)	Total (N=1998)
Poor	0.7%	0.6%	6.0%	4.4%	4.4%
Moderate	9.4%	0.0%	2.2%	5.6%	5.6%
Good	1.1%	0.0%	0.9%	4.4%	4.4%
Excellent	88.8%	99.4%	90.9%	85.6%	85.6%

Table 27 shows the percentage distribution of preservation by age group in four categories; poor, moderate, good and excellent (N=1998)

The very low percentage of poor and moderately affected bones (10.00%), showing signs of flaking and warping suggest limited exposure to the elements. None of the remains were warped as would be expected when exposed to moisture and sun, suggesting only limited, if any exposure to sunlight. This could have been due to a number of factors such as; the bones were not left on the surface prior to burial, the bones were not exposed to prolonged heat causing the bone to dry out (maybe during the winter months) and/or the bones were fleshed during surface exposure. A small number of bones (0.45% (9/1998)) were flaking indicating that some surface exposure must have occurred prior to reburial, though bones can weather to a lesser degree in sub surface contexts (Lyman, 1994: 360).

It was thought the colour of the skeletal elements may provide some indication on the burial environment and it was hoped that difference in tone would act as an indicator to the pattern of burial environment. Table 28 shows the range of colours recorded showing variations from dark brown to ivory, with the dominant colour being mid brown in all three age groups.

	AA (N=1101)	CH (N=172)	INP (=635)
Dark brown	12.72%	4.07%	4.72%
Mid brown	59.95%	50.58%	59.37%
Light brown	8.27%	5.23%	20.00%
Yellow	10.17%	34.30%	14.80%
Light yellow	2.09%	3.49%	0.31%
Ivory	6.81%	2.33%	0.79%

Table 28 Percentage colour variations in the assemblage by age group (N=1908)

Matching up elements showed colour variations between a small number of elements matched by severing (Figure 45). None of the elements matched by post depositional damage showed the same stark contrast in colouration, suggesting that the severed elements were exposed to differential treatment either outside or within the burial environment. The proximity of the bone to the lime layers (chapter 7) in the stratigraphy may account for some of these variations, but it seems likely that the difference in colours also may have been caused by differential treatment prior to burial; such as being either fleshed or de-fleshed, treated with chemicals to enhance the colour of the bone for exhibition, or fragments of the same individual were buried at different times in different parts of the trench. Unfortunately this could not be confirmed by looking at the stratigraphy as the elements exhibiting this strong contrast all derived from the unstratified assemblage.

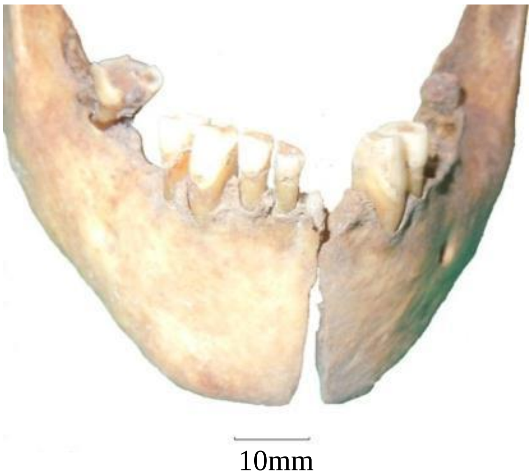

Figure 45 Severed mandible of adult individual showing stark contrast in colour between the two portions of the same bone [1009/1101]

9.1.3 Faunal activity

Another indicator of surface exposure is faunal activity such as gnawing and chewing of bone by carnivores and rodents, mainly for consumption and maintenance of dentition (Murad, 1996; Haglund 1996). The percentage of bones affected was relatively low at 1.40% (28/1998) but none the less important in the interpretation of disposal methods. The markings on the fragments affected by carnivores were very distinct with deep circular perforations (Figure 46) and the ragged chewed margin with triangular shaped perforations in the innominate bone

(Figure 47) other evidence was seen in form of scoring (furrows) on the bone surface and “scooping out” of the trabecular bone, leaving a hollow surface at the bone ends. Rodent gnawing was distinct with a series of parallel lines as seen on the pelvis fragment or shortened paired striae on the surface of the bone as noted on the series of ribs (Figure 48 and Figure 49)

Figure 46 Unfused head of humerus [1223] exhibiting classic carnivore puncture markings

Figure 47 innominate bone [1509] of a 6-7 year old child showing carnivore tooth marks along the iliac margin

Figure 48 Pelvis [1185] showing typical rodent gnawing pelvic fragment of an adult

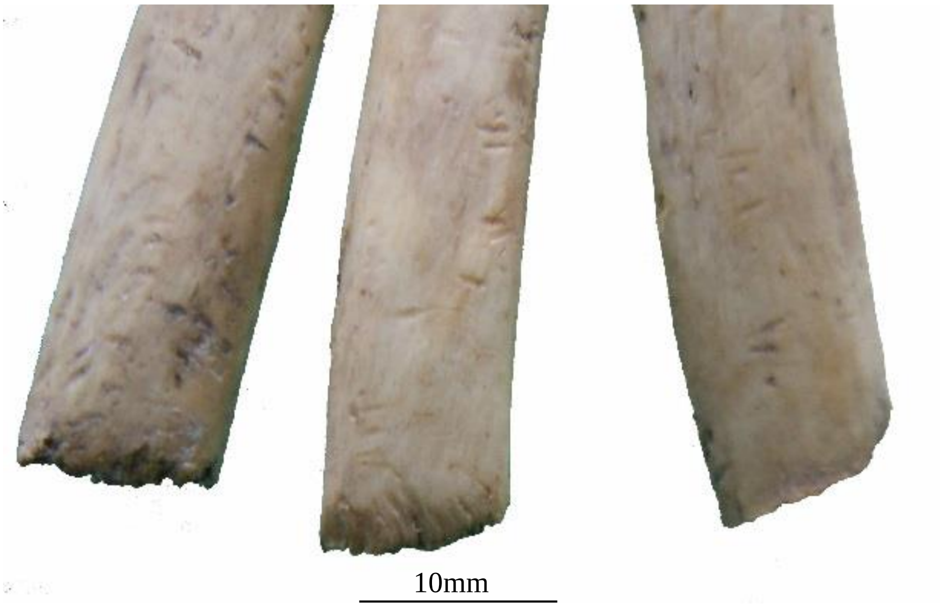

Figure 49 Three ribs of adult showing clear paired striae from rodent gnawing [1/365/1455]

Figure 50 shows the categories of bones affected and the percentage of bones within their element group affected by carnivores (50.00%) (14/28) and rodent gnawing (50.00%) (14/28). Of the affected bones thirteen AA fragments (67.86%) (19/28), Eight CH fragments (28.57%) (8/28) and one INP fragment (3.57%) (1/28) were affected. If compared to the number of fragments for each age group the CH group was the most frequently affected at 4.65% (8/172), with the AA group at 1.73% (19/1101) and the least affected group were the INP group at 0.15% (1/635). It is perhaps not surprising the AA and CH groups showed a higher frequency of faunal activity than the INP group. In a forensic context it has been observed that smaller bones such as hand and foot bones were consumed completely or not affected at all (Haglund, 1989: 594; Micozzi, 1986 and 1991; Byers 2011: 392). It is likely that the small bones from the INP group would have been consumed completely if eaten by carnivores being the same size as hand and foot bones and significantly more porous and easy to digest. The low frequency observed in the INP group may also be explained by the difficulties in observing the patterns recorded in adults, infant bones are significantly more fragile and porous than fully mature bone.

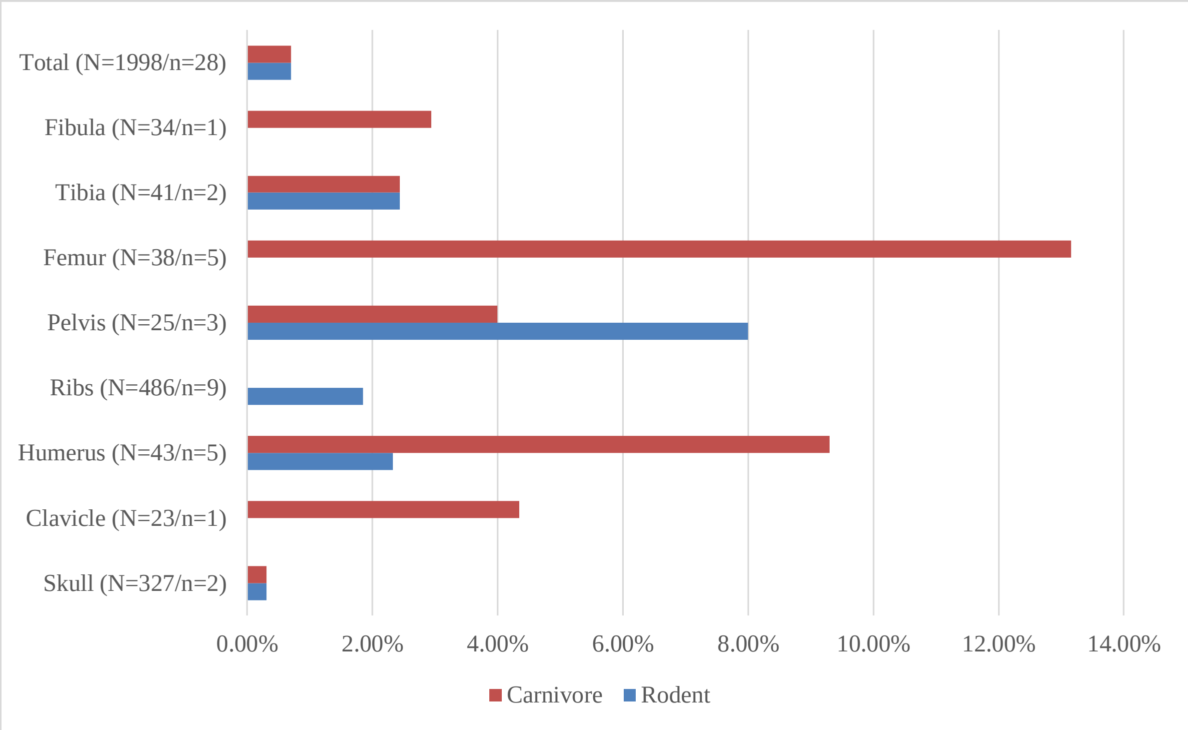

Figure 50 percentage distribution of fragments of bone showing evidence of gnawing or puncture marks by elements (N=1998 n=28)

The distribution pattern of the location of faunal activity (Figure 51) matched those described by Byers (2011: 393). He stated the most frequent locations for carnivore and in particular canid gnawing was the epiphyses of the long bones, the ribs and the innominate bones. The absence of carnivore activity on the ribs may be due to the extent of the damage they cause rendering identification difficult. Byers also noted that the head was often the least affected due to its large size. At Craven Street the skulls affected had previously been severed by anatomists and were therefore easier to "handle" for consumption. The pattern of carnivore activity was predominantly on the appendicular portions of the skeleton and it is entirely possible that the internal organs were removed during a dissection and consumed separately giving the carnivore very little reason to chew the ribs and vertebrae to get to the internal organs. Rodent gnawing tended to affect the central portions of the shafts rather than the ends except in the ribs. One child aged 5-7 years [561], rearticulated post excavation, displayed carnivore gnawing on at least four elements (two innominate bones, one proximal left femur and one left fibula), suggesting that the child must have been at least partially articulated when consumed by carnivores with none of the vertebrae or any of the bones above pelvis level affected.

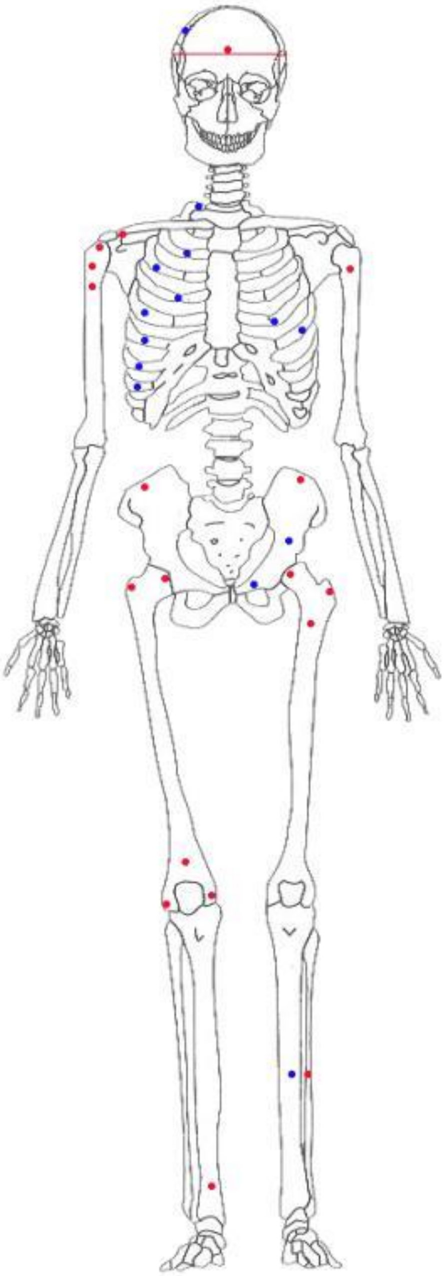

Figure 51 Distribution of non human faunal activity markers (red=carnivore, blue=rodent)

Despite the infrequency of faunal activity, the patterns in the assemblage are revealing. At least some of the human remains were not interred immediately following dissection and remained exposed to carnivores and rodents. Some remains were still at least partially articulated and most likely fleshed. Though the patterns of carnivore and rodent activity matched those described by Byres (2011: 392), it is very likely that the frequency of faunal activity would have been much higher, only obscured by other post mortem damage or complete consumption of elements, which may explain the low prevalence rate in the INP group.

9.2 Quantification and Body part distribution (BPD)

As a disarticulated assemblage it was of interest to quantify the remains in order to establish the body part distribution (BPD) and the number of individuals present in the trench. The results in this chapter present the data in a three tier approach to allow different evaluations of the data; as Number of Identified Specimens (NISP), Minimum Number of Elements (MNE) and Minimum Number of Individuals (MNI).

The excavation was of sufficiently small scale to warrant an attempt to match skeletal elements, despite being time consuming; this was considered a valuable exercise. This means the terms MNE and MNI are used in the sense that the numbers calculated are the minimum number of elements present, but the manner in which these results have been reached differ from the standard methods usually applied to achieve these results.

9.2.1 Adjusted NISP

The Number of Identified Specimens is the lowest denominator in which distribution of elements may be calculated. The term specimen encompasses fragments of bone identified and therefore provides information relating to the site formation and fragmentation patterns rather than information on the population prior to disposal. Figure 52 shows the percentage adjusted NISP by age group, having accounted for the relative frequency of elements in the body and the variation in number of bones in the body between the mature and the immature skeleton. The results show a differential distribution of specimens between the AA group and the CH and INP groups.

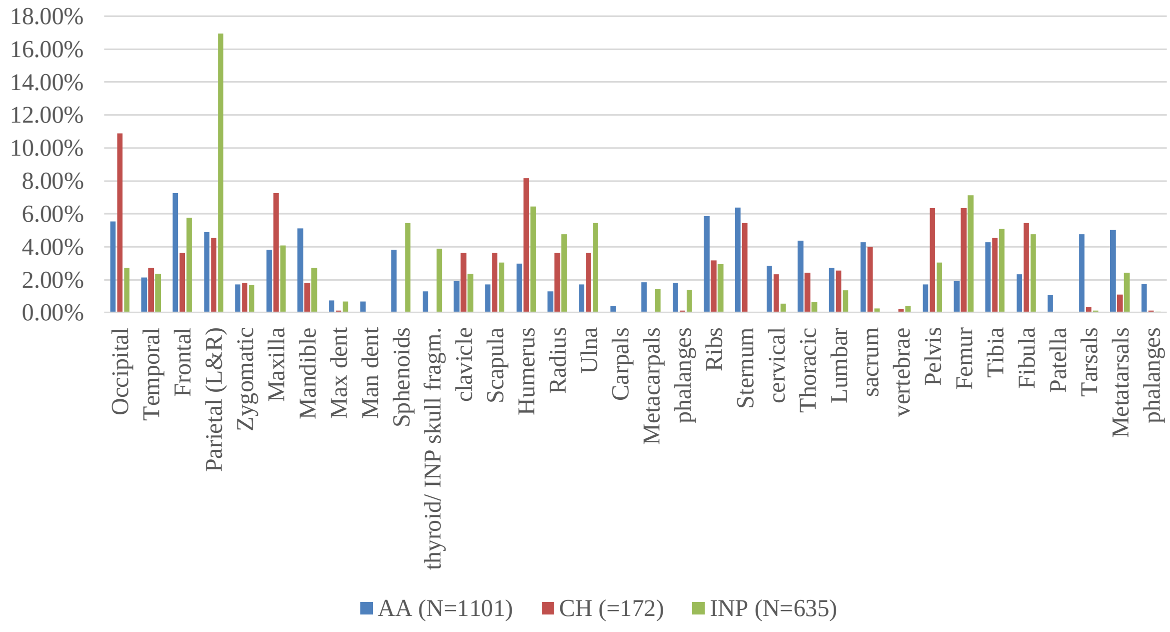

Figure 52 adjusted percentage distribution of specimens within each age group (un-aged individuals (N=90) not included NISP=1908)

The adjusted NISP was grouped together in anatomical portions (Table 29) showing the percentage distribution within set anatomical categories, suggesting a higher rate of skull elements in the INP group (46.29%) than the CH (32.78%) and AA group (35.73%), which may suggest a higher fragmentation rate in the INP group. The rate of long bones were higher in the two sub adult groups (INP = 39.01% and CH=39.02%) compared to the AA group (19.17%), whilst the foot bones were found at a higher rate in the AA group (11.53%) compared to only 2.63% in the INP group and 1.58% in the CH group (Table 29).

	AA (N=1101)	CH (=172)	INP (N=635)
Skull	35.73%	32.78%	46.29%
Upper Long bones (incl. scapulae and clavicles)	9.58%	22.69%	22.05%
Hand	4.08%	0.13%	2.83%
Ribs	5.86%	3.18%	2.94%
Vertebrae	14.25%	11.51%	3.25%
Lower Long bones (incl. patellae)	9.59%	16.33%	16.96%
Foot	11.53%	1.58%	2.63%

Table 29 adjusted percentage distribution of NISP frequencies within anatomical groups

9.2.2 Adjusted MNE

A more accurate method of retrieving information on body part distribution is calculating the minimum number of elements (MNE) for each anatomical area, though this still only provides an estimate by giving a *minimum* number. Table 30 provides the number of elements estimated for each of the age groups. A minimum of 1296 elements were estimated; 64.89% (841/1296) in the AA group, 10.03% (130/1296) in the CH group and 25.078 (325/1296) in the INP group.

	AA	CH	INP	total
Occipital	13	3	3	19
Temporal	9	3	7	19
Frontal	8	1	6	15
Parietal (L&R)	10	6	2	18
Zygomatic	8	2	5	15
Maxilla	11	2	6	19
Mandible	12	1	8	21
Max dent	33	1	10	44
Man dent	32	0	0	32
Sphenoids	8	0	6	14
Thyroid	3	0	0	3
Clavicle	8	4	5	17
Scapula	7	4	9	20
Humerus	8	4	18	30
Radius	4	2	10	16
Ulna	7	4	13	24

Carpals	14	0	0	14
Metacarpals	43	0	21	64
Phalanges	60	1	29	90
Ribs	138	30	45	213
Sternum	5	3	0	8
Cervical	45	9	6	60
Thoracic	111	16	10	137
Lumbar	28	7	9	44
Sacrum	5	4	2	11
Vertebrae	2	3	32	37
Pelvis	5	5	8	18
Femur	9	5	16	30
Tibia	10	4	11	25
Fibula	11	2	9	22
Patella	5	0	0	5
Tarsals	56	1	0	57
Metatarsals	56	2	18	76
Phalanges	57	1	1	59
Total	841	130	325	1296

Table 30 MNE by age groups

Figure 53 shows the adjusted MNE to gauge the relative frequency of elements showing the AA group had a high prevalence rate of cranial elements, foot bones and vertebrae whilst the INP group showed a higher frequency of long bones and the CH group a more even distribution. This variation in recovery rate may have been influenced by different factors; firstly taphonomy may play an important role in this distribution; preservation and excavation of infant remains allow for poor recovery of skull, rib, vertebral and hand/foot bones in disarticulated assemblages. In terms of recovery the small scale of the excavation may not have allowed for retrieval of the entire assemblage. Secondly the relative frequency may be explained by disposal, the small pit may not have been conducive for burying larger bones or articulated portions of adults, resulting in disposal of elements that have been severed as well as smaller element of the extremities and torso. Thirdly, the distribution of elements represents the type of elements brought to the anatomy school.

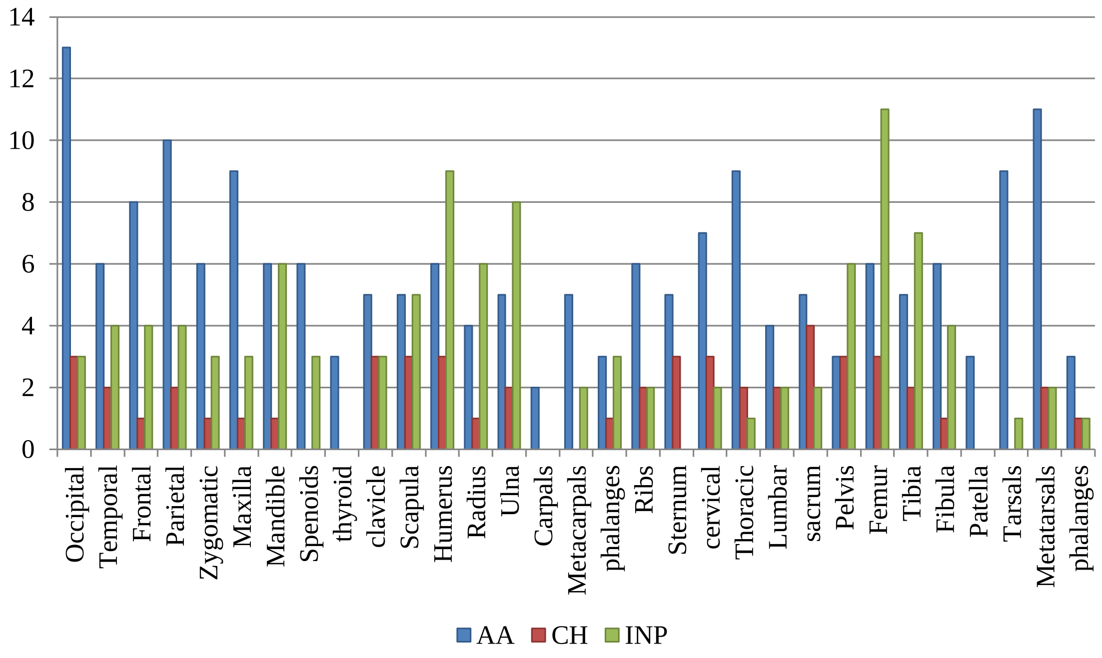

Figure 53 adjusted MNE.

Due to the number of factors possibly influencing the distribution of elements, it was of interest to compare Craven Street with another disarticulated assemblage from a post medieval cemetery believed to be representative of a population buried complete and later disarticulated. In 2003 the author excavated St. John's church in York and recorded a large amount of disarticulated human remains. These remains had been churned up from the cemetery during the renovation and expansion of the church and had been used in an attempt to raise the ground level. It was thought that such an assemblage would be relatively indiscriminate of body parts and therefore reflect the distribution of elements that had derived from complete individuals. It was hypothesized that the distribution at Craven Street would be similar to that at St John's if they had both derived from individuals buried complete. It was possible to do this comparison by number of elements (MNE) as opposed to number of specimens (NISP) minimising the problem of differential fragmentation patterns (see above).

Figure 54 shows the relative distribution of the remains was very similar though it was also immediately evident that St. John's church had a higher proportion of long bones present than Craven Street, whilst Craven Street had a slightly higher proportion of skulls, ribs, thoracic vertebrae and phalanges.

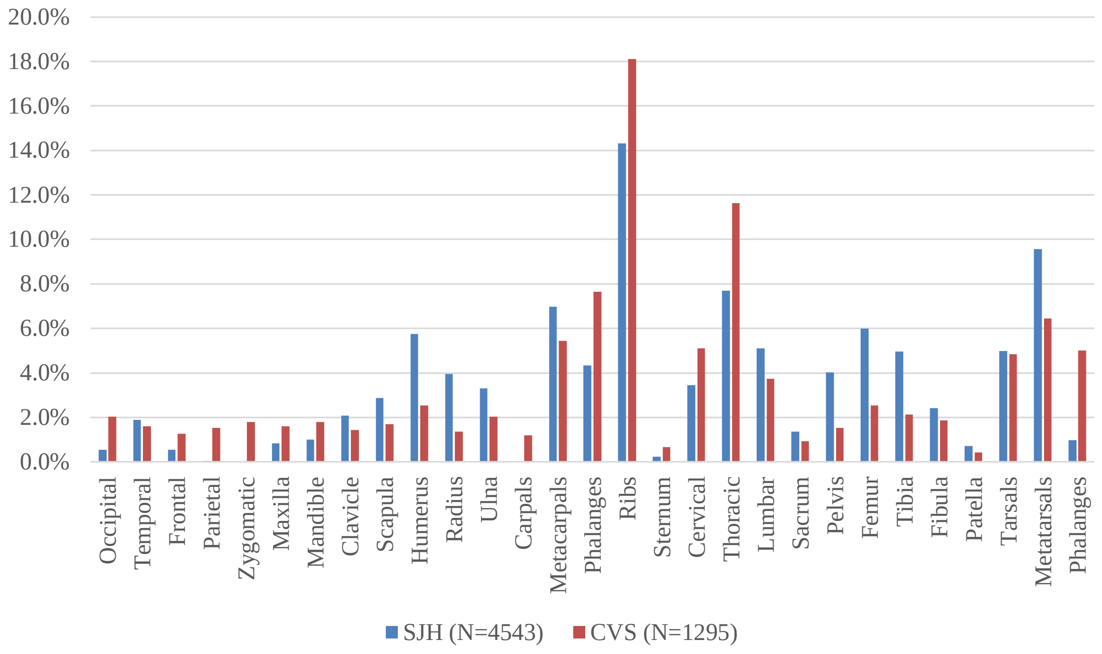

Figure 54 Percentage distribution of MNE comparing Craven Street with the disarticulated cemetery assemblage from St. John's church in York.

Comparing the Craven Street assemblage with St John's suggested that the body part differed slightly from that of an assemblage from a traditional cemetery that had later become disarticulated. The absence of long bones is conspicuous as the Craven Street assemblage included all age groups and therefore the higher prevalence rate of long bone in the INP group. From this comparison it appears that lack of long bone elements and the dominance of elements of the thorax was particular to Craven Street.

9.2.3 Minimum Number of Individuals (MNI)

It was possible to estimate a minimum number of individuals from the MNE looking at the single most frequent element for each of the age groups. Figure 53 shows that the occipital bone was the most frequent element in the AA group (13), whilst the sacrum (4) was the most dominant in the CH group and the femur (11) in the INP group.

This meant a minimum of 28 individuals were identified from the Craven Street sample (Figure 55). The prevalence of sub adults (53.58%) (15/28) was slightly higher than the AA group (46.43%) (11/28)

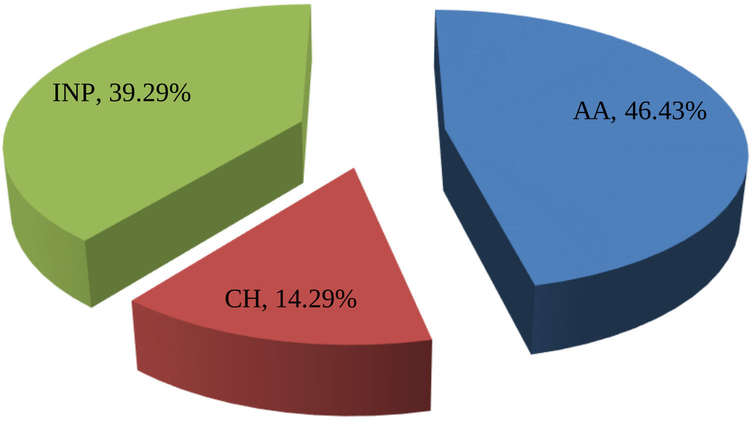

Figure 55 percentage distribution of the three age groups (N=28)

9.3 Age and sex distribution

This section provides a further break down of the age groups used throughout this chapter. Age distinction was made within each of the three main groups whilst sexing was only attempted in the AA group.

9.3.1 Age

It was possible to provide a further breakdown of age groups based on the methods described in chapter 8. Due to the inherent problems of ageing across elements the range was established on a single element group, within each of the age groups, unless obvious differences could be established (i.e. marked variation in size) (Figure 56). The INP group age range was established by long bone length from which it was possible to establish the presence of four perinatal individuals, five neonates and two individuals aged 6-11 months, providing an age for a total of 11 individuals. In the CH group one individual was almost complete following matching of elements and had been aged at 6 years by dental eruption [561grp]. This individual was removed from the count, which saw two individuals aged 1-4 years old and one individual aged 7-8 years based on the femoral length, ageing a total of four individuals. The AA group saw an age range from 12->46 years with a total of four individuals aged mainly on degenerative wear of the pelvis. The ribs seemed to suggest that there were at least two individuals aged >46 and one aged 36-45 years, but due to the unreliability of ageing of ribs in disarticulated remains these figures could not be included in the definite age groups.

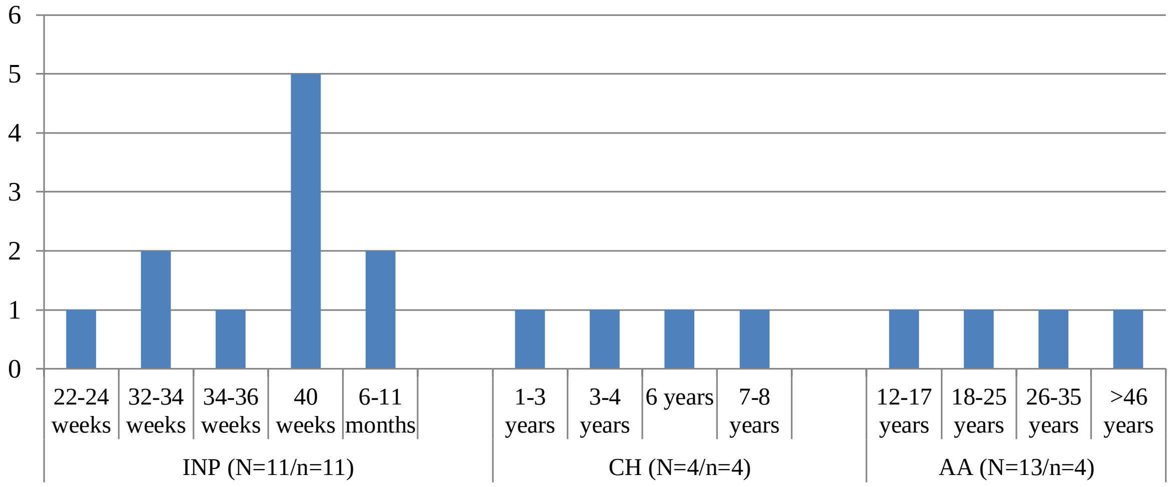

Figure 56 minimum number of individuals estimated within a further refinement of the age groups

The rate of ageing in the sub adult groups was noticeably more successful than in the AA group. Ageing based on degenerative wear is available in fewer elements and reliability of these makes age ranges less distinguishable.

9.3.2 Sex

Determination of sex was only possible in the AA group by application of morphological and metrical variations in the skull and post cranial elements. The methods of this application have been discussed in chapter 8. The majority of elements where determination of sex was possible only exhibited a single feature resulting in reduced accuracy.

9.3.2.1 Cranial sexing

High fragmentation of the skull made sex determination less reliable depending on one or two features per element, though a number of skull elements could be matched making sexing more reliable (Appendix 4). Scoring each morphological variation independently resulted in a female to male ratio of 1:2, showing the presence of at least two females and four male individuals (Table 31)

	F	F	F	F?	F?	F?	M?	M?	M?	M	M	M	F	M
	L	C	R	L	C	R	L	C	R	L	C	R	MNI	MNI
Mastoid process/ zygomatic root	1		2				2			2			2	4
Ext.occ. prot/nuchal crest		2									3		2	4
Supraorbital ridge/glabella		1						1			2		1	2
Mental eminence	1							1			4		1	4
Mandibular angle					1						3	1	1	4

Table 31 Determination of sex from the skull and mandible in the AA group (NISP=25) (there were no indeterminate sexually dimorphic features in the skull elements). (F= female, F? = possible female, M? = possible male and M=Male) (L= left, C=central, R=right)

9.3.2.2 Post cranial sexing

The most reliable method of post cranial sexing is on the pelvis, but it is possible to gain additional information on sexing from metric analysis and dimorphic features of the distal humerus. It was only possible to determine sex from very few elements and the post cranial exercise did little but to serve as a confirmation of the results on the crania. Elements of low frequency or unreliability of results were omitted. A total of four pelvic elements (N=8/n=4) could be sexed, revealing the presence of at least two male and one female individual. Sexing was possible of four humerie (N=14/n=4), with three distal portions sexed by dimorphic features (Rogers, 1999) as two male, one possible male whilst one proximal humerus was estimated as female. Sexing of the femoral head was attempted in five elements (N=9/n=5) revealing two male, one female and two indeterminate. These results suggested the same female to male ratio (1:2) as seen in the skull.

9.4 Pre-depositional modifications (post mortem human intervention)

This section covers the modifications in the skeleton prior to disposal in the attempt to uncover the manner in which the cadavers were utilised at the anatomy school. The purpose of this exercise is to establish the processes applied to the assemblage and whether these might be interpreted with the aid of historical evidence on different techniques of treating the body.

The analysis of the modifications was carried out from the NISP count despite the inherent problem in identifying the frequency of their occurrence in individual bones. This approach was adapted for a number of reasons; firstly in the majority of comparative excavations yielding dissected remains, modifications had been calculated using NISP. The calculated MNE did not include all bones exhibiting modifications and thirdly the purpose of this section was to carry out a qualitative examination on the type and location of modification and to a lesser degree to establish the frequency of these.

9.4.1 Prevalence rate of pre-depositional intervention

Prevalence rates were calculated from number of identified specimens (NISP) as not all severed surfaces could be confidently matched to form an element. A total of 354 specimens exhibited one or more of the recorded post mortem modifications (17.72%) (354/1998) (Figure 57), with a total of 391 modifications present, this exceeded the number of bones as some specimens exhibited more than one modification. The most frequently observed modification was severing (67.00% (262/391) followed by staining (18.67% (73/391) and knife marks (10.74% (42/391)). Trepans were observed in 13 (3.32% (13/391)) specimens often with multiple examples in the same bone and finally drilling was observed in one specimen only (0.26% (1/391)).

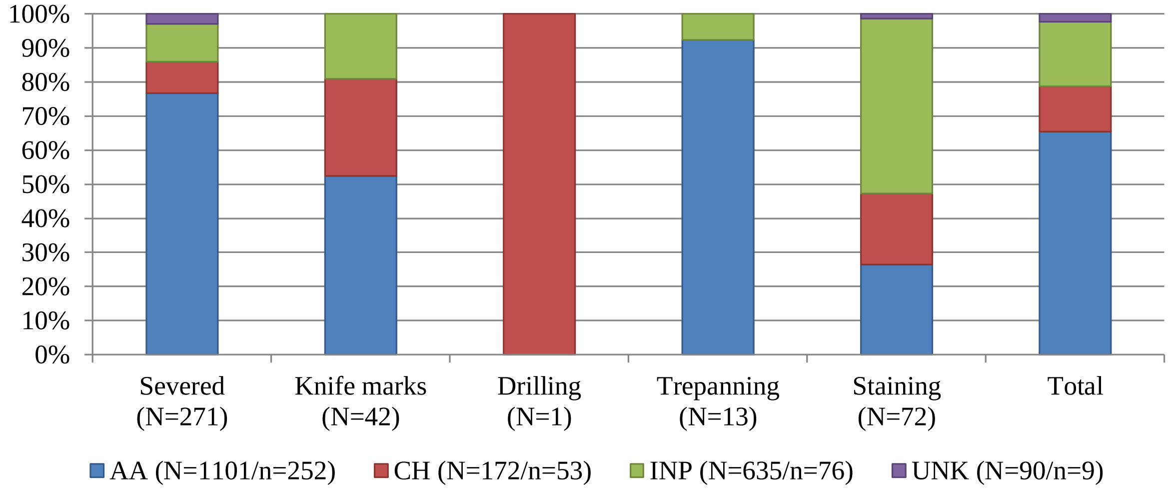

Figure 57 Modification categories show in proportion to age.

The rate of modified bone in the AA group was 22.89% (252/1101) and 30.81% (53/172) in the CH group with a much lower rate noted in the INP group at 11.97% (76/635). This variation in modification rate may be due to a number of factors; firstly, higher fragmentation in the INP group providing an inflated number of fragments compared to number of modifications; secondly, modifications may be less visible on the bone, particularly if different methods were applied to smaller bones or cut surface fragments and thirdly a lower modification rate may be due to infant remains being dismembered at the joints and unfused sutures.

The distribution of severed remains by element portions was summarised in Figure 44 (section 9.1.1) showing the highest prevalence rates of severed bones for the AA group was skulls (63.4%) (64/1101) followed by lower limb bones (55.6%) (25/45). The INP group showed a slightly different pattern with the lower limb bones (11.1%) and upper limb bones (9.2%) most commonly affected.

9.4.2 Staining

Staining was mainly seen as red residue on the surface of the bone. This was believed to be residue of vermillion, commonly used as a dye injected into the arteries when making anatomical preparations. Vermillion staining was predominantly noted on bones in the CH (8.3%) and INP group (6.7%). It was believed that such staining was evidence of individuals injected, though the random patches of red staining on the bones was more indicative of post depositional staining, which could have occurred if remnants of vermillion had been discarded in the soil (Figure 58). One skull [35] in the INP group did show very slight traces of red staining along the grooves for the meningeal vessels, which could indicate deliberate injection.

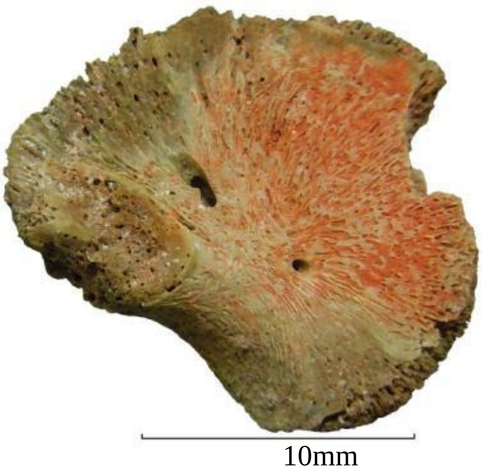

Figure 58 Vermillion staining on ilium of a 22 week old foetus [5028]

9.5 Sawing and knife marks

Cuts were made to both the cranial and post cranial skeleton in all age groups. Severing relates to the cut marks made on the bone with the purpose of dividing the bone into two or more portions, predominantly by sawing. Severing may be carried out for a wide variety of reasons in the context of medical education; student dissections, prosections for teaching, museum preparations and surgical practice. Other procedures which may require skeletal intervention are autopsies, in-vivo surgery and embalming, though these are less likely to occur in the context of an anatomy school but should not be entirely dismissed.

Many of the specimens were severed multiple times, some associated with typical dissection procedures, whilst others were more specialised and may have been performed for other purposes. Knife marks have also been addressed in this section relating to the removal of soft tissue.

9.5.1 The skull (AA group)

Specimens from the cranium and mandible were the most heavily affected by pre-depositional modifications, in particular severing. Table 32 summarises cut types and locations of the cranium in the AA group with a visual presentation of cuts present at Craven Street seen on Figure 59. This group was the most heavily affected seeing 62.38% (63/101) of all skull specimens severed. A majority of the skull elements remained disarticulated but three skulls could be at least partially assembled [285grp], [1209grp] and [1074grp] showing that multiple cuts were performed on the same skulls (Appendix 4:7-9). The most heavily cut skull was [285grp] with a calvarium cut, a bisection along the sagittal plane, an occipital wedge and at least two orbital wedges. Skull [1209grp] had at least four separate trepans with cuts linking the trepanned holes but this skull had no calvarium cut performed. Skull [1074grp] had a calvarium cut performed followed by removal of at least one orbital wedge and an occipital wedge. It was not possible to match up any of the the skull caps with elements from the lower portion. This does not necessarily mean they did not belong to the same individuals a wider saw may have caused the gap between the two elements to be too large to confidently match them.

	NISP (all fragments)	**NISP cut fragments**	Severed	knife marks	Multiple (whole bone portion)	Calvarium (skull cap) (superior)	Calvarium (Inferior)	Occipital wedge	Orbital wedge	Sagittal cut	Coronal cut	Transverse cut (not calvarium cut)	Oblique cut	Trepan
Frontal	17	16	16	2	9	4	7	0	7	6	0	0	3	7
Parietal	23	20	20	2	9	5	6	6	0	3	0	0	2	4
Temporal	10	5	3	0	2	0	2	0	0	0	0	0	1	0
Occipital	13	8	8	0	5	0	5	8	0	0	0	0	0	0
Zygomatic	8	2	1	0	0	0	0	0	0	0	0	1	0	0
Sphenoid	0	2	2	0	0	0	0	0	0	2	0	0	0	0
Maxilla	9	4	4	0	0	0	0	0	0	2	0	1	0	0
Mandible	12	6	6	0	0	0	0	0	0	5	0	1	0	0
MNI	**13**	**8**	**8**	**0**	**6**	**5**	**6**	**5**	**6**	**3**	**0**	**1**	**2**	**4**

Table 32 Types of cut performed on skull specimens from the AA Group (please note one bone fragment may be counted several times if more than one anatomical aspect or cuts present (please see Figure 59 and appendix 4 for visual clarification)

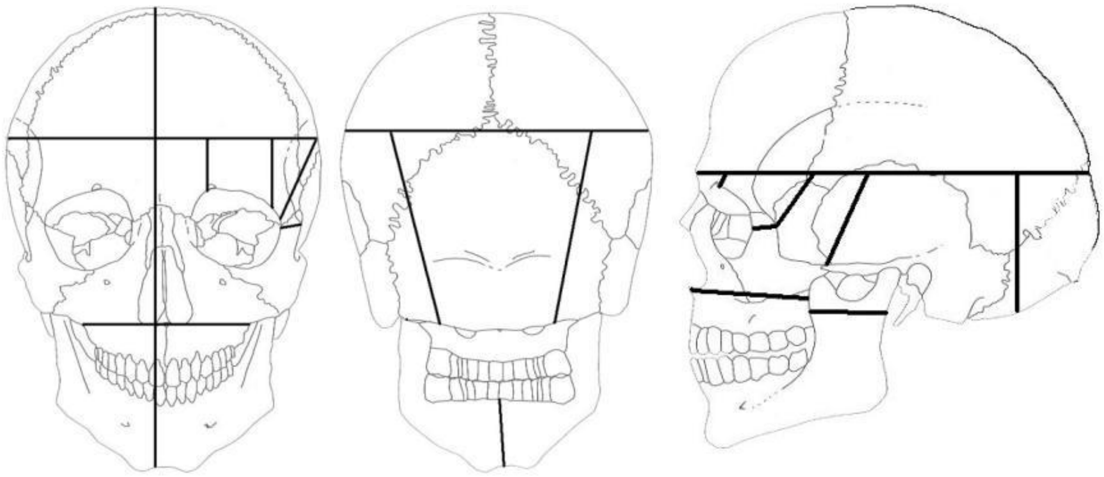

Figure 59 directions of cuts present on group AA Craven Street skulls

The cuts seen on the reassembled skulls appear to have been consistently repeated and were evident in many of the disarticulated fragments. It was estimated that at least 8 individuals out of an estimated 13 (61.53% (8/13)) had severed skulls.

9.5.1.1 Craniotomy (removal of the skull cap)

In order to remove the skull cap it would have been necessary to first pull back the skin from the skull. This would have been done using a sharp knife and it would be expected that scoring marks would be present on the skull. Such skinning marks were noted on the parietal and frontal bones of four individuals running in a horizontal line near the margins of the skull cap on the frontal bone and obliquely across the posterior portion of the parietal bones. Horizontal lines were noted to posterior of one skull just lateral of lambda on parietal bone [560] (Figure 60)

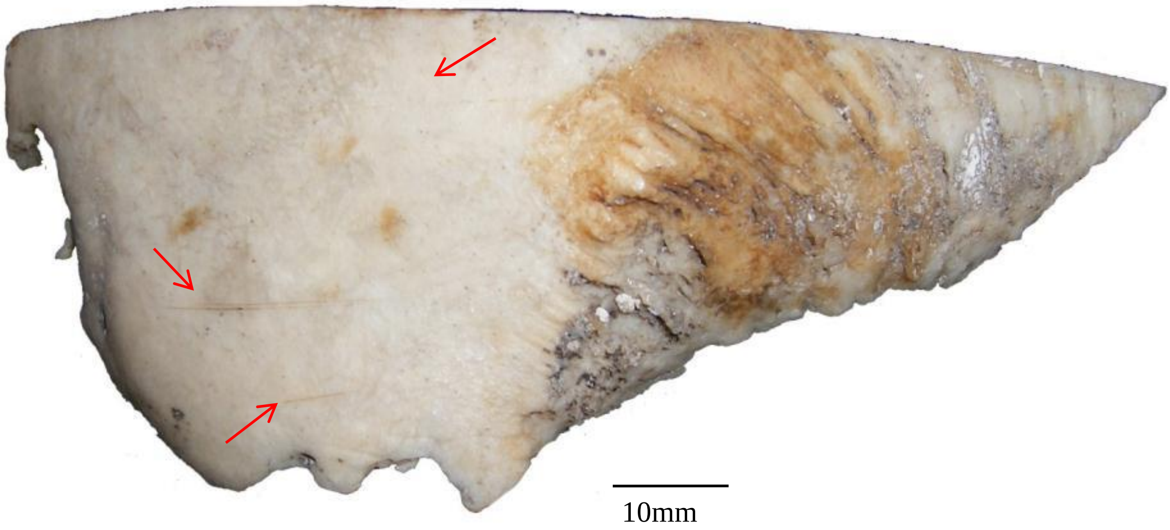

Figure 60 posterior inferior portion of right parietal bone displaying clear horizontal knife marks [560].

Once the skin had been removed from the scalp the skull cap could be removed using a saw. A minimum of six individuals (46.15% (6/13)) showed evidence of having the skull cap removed, these were typically cut from the frontal bone two centimetres above the glabella and extended to the supra occipital region just inferior of lambda. Break-away spurs were mainly present on the occipital bone but slip marks and false start kerfs were noted at more than one point of the circumferential cuts, suggesting the bones were not cut in a single action. The sawn surface revealed overlapping of striae from the saw on the cut surface, indicating a rotation of the skull during cutting rather than one clean cut from anterior to posterior, this would have been necessary to preserve the brain. The majority of the cuts were neat, though some had extensive slip marks present along the margins of the cuts such as [285grp] (appendix 4:7).

There was evidence of two different methods of removing the calvarium as at least three skull specimens [291], [1601] and [1071] showed evidence of sawing of the external table of the skull with raised margins on the inner table, whilst the remaining skulls had been sawn all the way through revealing a smooth cut surface (Figure 61). A single occipital bone [1062] exhibited chip marks along the endocranial margin of the cut, indicative of an instrument being inserted in order to lever of the skull cap.

Figure 61 fragment of calvarium cut with raised smooth outer table and raised margin on the inner table [1601]

9.5.1.2 Occipital wedge

A majority of the occipital fragments exhibited cuts associated with an occipital wedge (61.54% (8/13)), from at least five individuals. The cuts extended from the margin of the skull cap to the lateral borders of the foramen magnum allowing complete removal of the posterior portion of the skull (Figure 62). The striae from the sawn surface revealed cuts were performed superior to inferior at a slight oblique angle.

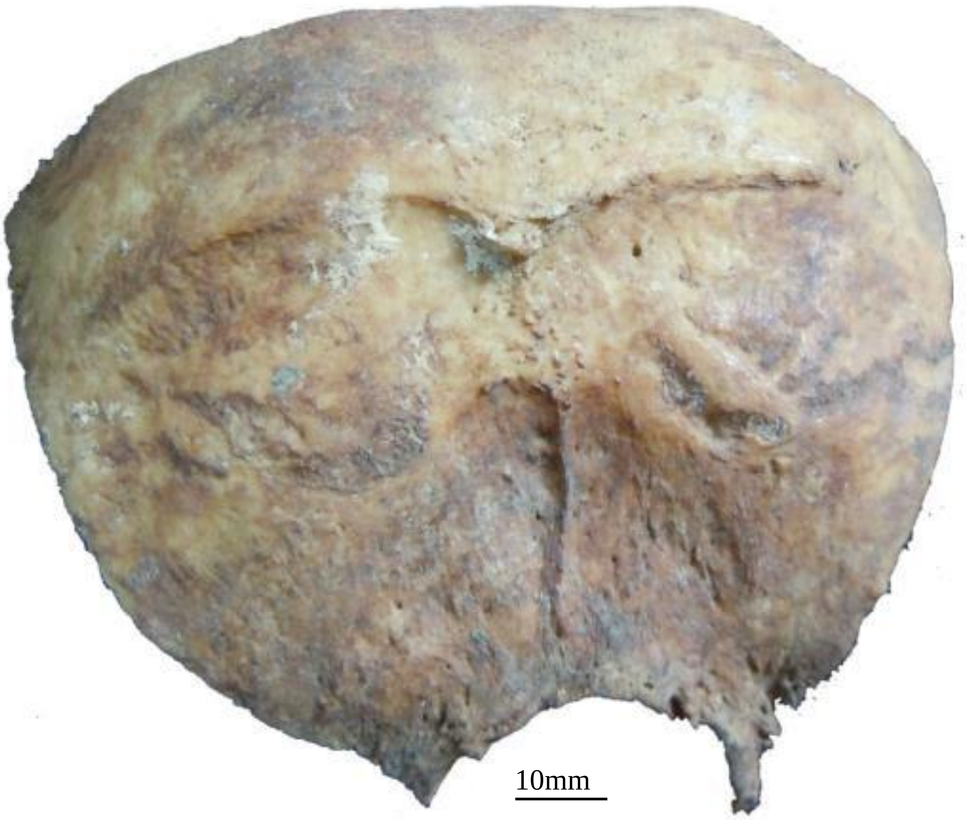

Figure 62 occipital wedge [1062]

9.5.1.3 *Orbital wedge*

Orbital wedges were likewise frequent at 41.18% (7/17), cut from the margin of the calvarium cut to the orbital roof or nasal bone either at a 90 degree or oblique angle. The location and size of these varied (Appendix 4:4, 7 & 9). At least three of the cuts were close to the sagittal plane including removal of one half of the nasal bone and the lacrimal bone [285], [1071] and [1844] whilst three extended across the orbital roof to the temporal lines [197], [558] and [5232]. One or more of these cuts were performed on a single skull with the direction of the striae suggesting the cuts were made cutting anterior to posterior or superior to inferior or a combination of both (Figure 63).

Figure 63 severed margin of frontal wedge showing multiple cut directions [558]

One cut was performed on the zygomatic bone [1064] below the fronto-maleara suture (Figure 64), which most likely formed part of the removal of a lateral orbital wedge.

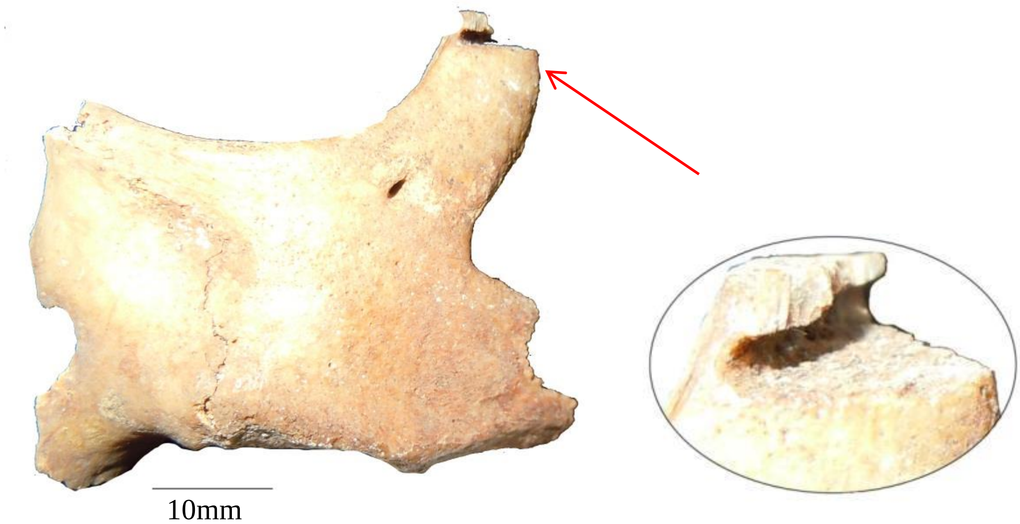

Figure 64 transverse cut by fronto-maleare suture [1064]

Likewise one temporal bone [589] (Figure 72) exhibited a diagonal cuts immediately posterior of the coronal suture, which may have been associated with the removal of an orbital wedge.

9.5.1.4 Sagittal cuts

Cuts in the medial sagittal plane were noted in both the crania and mandibles. Bisection of the crania was recorded in at least three individuals [195], [248] and [285grp] with all cuts performed to the lateral aspect of the sagittal suture. It appears that the sagittal cuts of the cranium were carried out after the removal of the occipital wedge as none of the occipital bones exhibited cuts to the central portion as seen in reassembled [285grp] (appendix 4:7).

A total of five mandibular fragments had been cut sagitally at the mental eminence deriving from three mandibles [1009/1101], [1580/153] and [293], two were severed between the central incisors and one lateral of the central incisor. All were cut from anterior to posterior or inferior to superior, to the lateral of the central incisors (Figure 65). Mandible [1009/1101] displayed a large break-away spur to posterior, indicating pressure was applied during sawing, causing the bone to snap before completed (Figure 66).

Figure 65 mandible severed in the medial sagittal plane [153/1580] anterior view

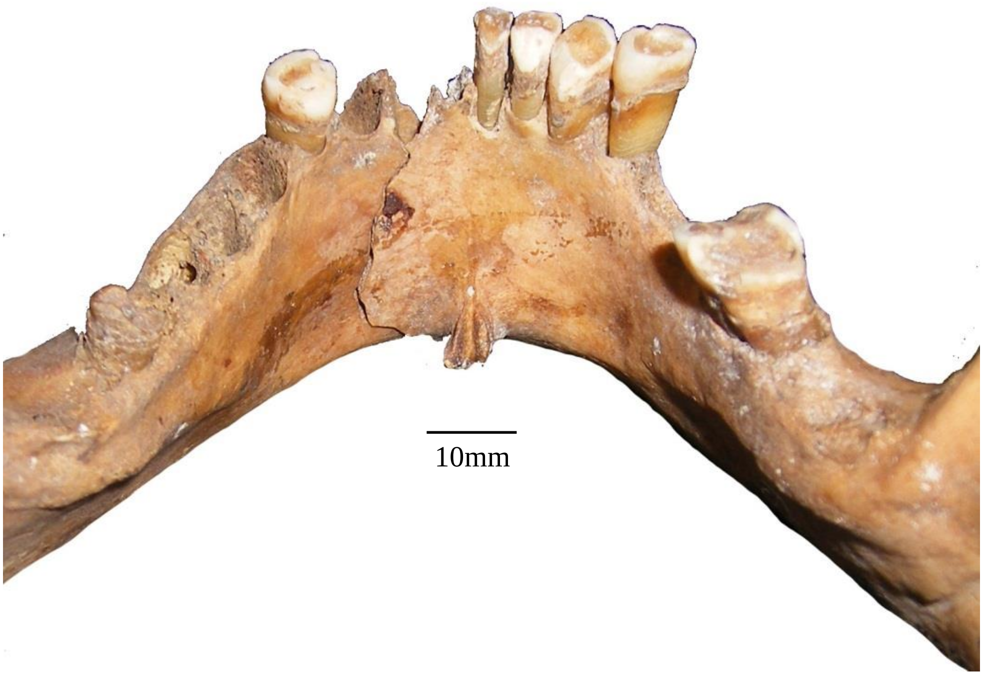

Figure 66 mandible severed in the medial sagittal plane [153/1580] anterior view

9.5.1.5 Transverse cuts

A small number of transverse cuts were not associated with the removal of the skull cap. These included a cut of a maxillary bone extending horizontally immediately below the nasal septum [921] (Figure 67) and one mandibular ramus [195] was severed transversely across the ramus below the mandibular notch and coronoid process. The remaining transverse cut was on the frontomalleare suture [1064] but thought to be associated with orbital wedge cuts (see above).

Figure 67 transverse cut on maxilla below nasal septum revealing inflammation of the maxillary sinuses [921]

9.5.1.6 Trepanning

A total of 17 trepans were recorded on frontal and parietal bones on four individuals [1209grp], [148/281], [291/928] and [953] (Figure 68). On two individuals the frontal bone trepans were incomplete [148] and [953] (Figure 69 and Figure 70). Two roundels from trepans [1453] would have been the discarded product of a trepan. Trepans on parietal bone [298/291] and frontal bone [1209] had associated oblique cuts extending from the trepanned perforations (Figure 71) (appendix 4:1 and 4:8). The trepan on [1209] exhibited internal bevelling, suggesting the trepan had not been drilled all the way through (Figure 71). Another trepan [148] exhibited clear tooth marks running in a clockwise direction on the outer table of the skull whilst the internal portion of the table was smooth.

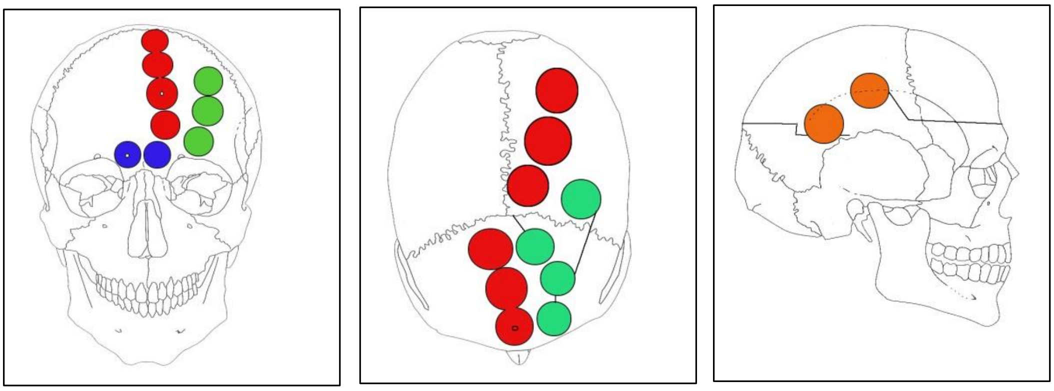

Figure 68 show the approximate location of the trepans (blue = [953], Red=[148/281], green=[1209grp] and orange = [928/291]

Figure 69 incomplete trepan on frontal sinuses [953]

Figure 70 incomplete trepan on frontal bone. Bone exhibiting seven trepans [148/281].

Figure 71 trepans with internal bevelling [1209]

9.5.1.7 Other modification to the skull

Temporal bone [589] had a white nodular insertion firmly embedded in the temporo-mandibular joint, which appeared to have been deliberately placed rather than being residue from the burial environment. The bone had a glossy ivory look suggesting that it had been handled extensively prior to burial indicating that this particular fragment was skeletonised at the time of disposal and most likely used for class demonstrations (Figure 72).

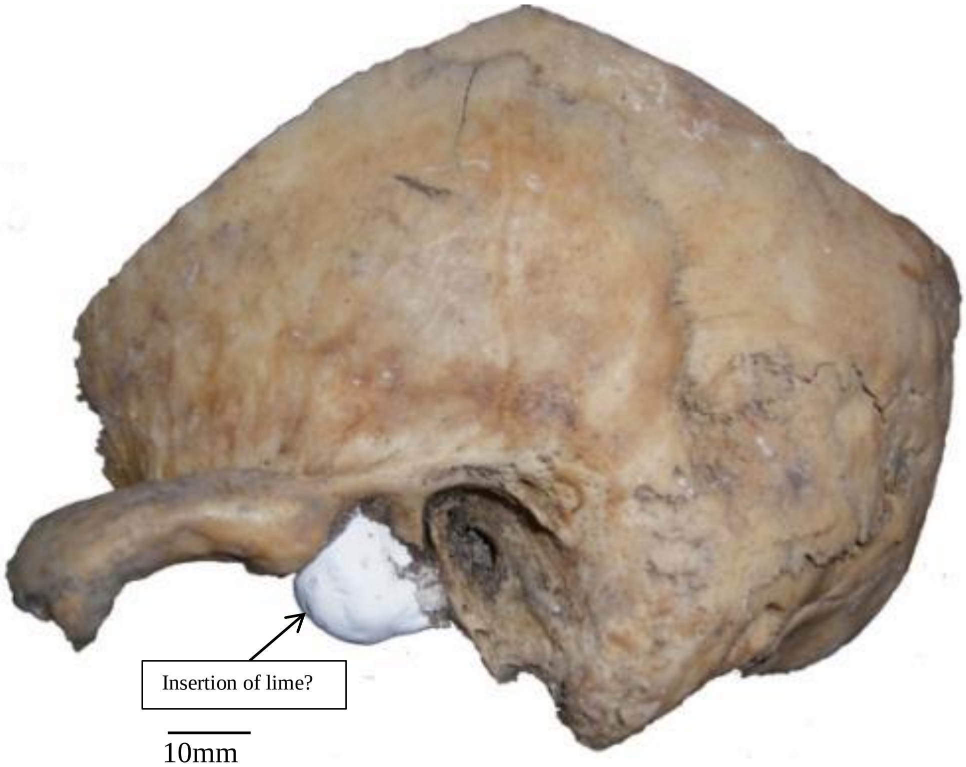

Figure 72 oblique cut on anterior aspect of temporal bone [589]

9.5.2 The appendicular skeleton (AA group)

The appendicular skeleton upper portion included clavicles, scapulae, humerie, radii, ulnae and hand bones and the lower portion included the pelvis, femora, tibiae, fibulae, patellae and foot bones. Upper limb bones were cut at a rate of 9.76% (16/164) overall and the lower limb bones at a rate of 11.11% (25/225) (Figure 73).

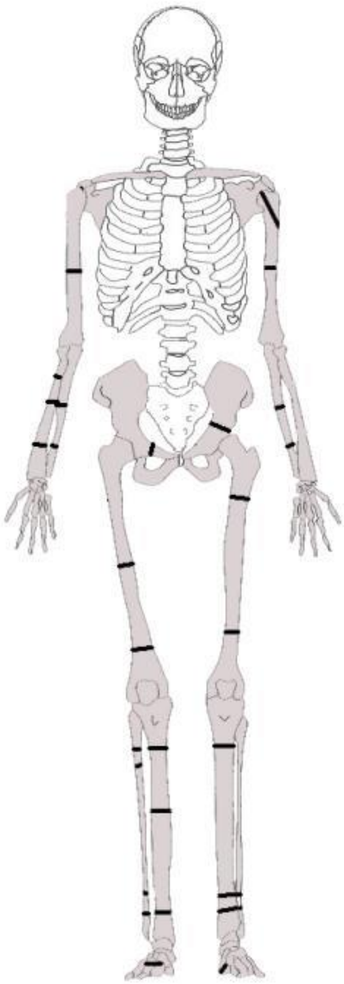

Figure 73 Location of cuts to the appendicular skeleton (grey area)

9.5.2.1 Long bones

Figure 74 shows the portions of bones present for both upper and lower severed long bones. A total of 59.92% (41/69) of all long bone fragments had been severed, with a slightly higher proportion of the lower long bones severed (62.50% (25/40)) compared to the upper long bones (57.14% (16/28)). The humerie had an equal distribution of proximal and distal portions whilst the remaining bones had a higher prevalence rate of distal portions present in the assemblage. Tibiae and fibulae were the only elements severed at both the proximal and distal portions. It was possible to match a number of bones by the severed surface to form complete bones. A total of 16 specimens could be matched forming six bones (Appendix 4:13-15).

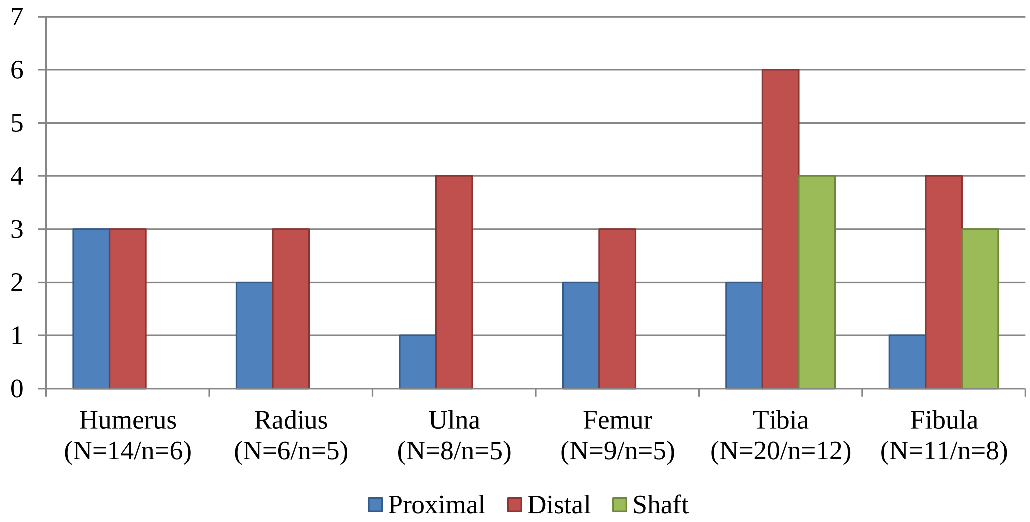

Figure 74 (group AA) Portion of bone present in the assemblage of the severed long bones (N=69/n=41).

Figure 75 shows which portion of the bone was severed divided into proximal-, mid- and distal shaft and both proximal and distal ends. The humerie were all severed on the central shaft except one cut located on the head of the humerus bisecting the epiphysis into a posterior and anterior portion (Figure 76). Mid shaft cuts were more prevalent in the upper limbs (62.50% (10/16)) than the lower limbs (20.00% (5/25)). In the lower limb mid shaft cuts were dominant in the femora, whilst distal cuts were the most common location in tibiae and fibulae.

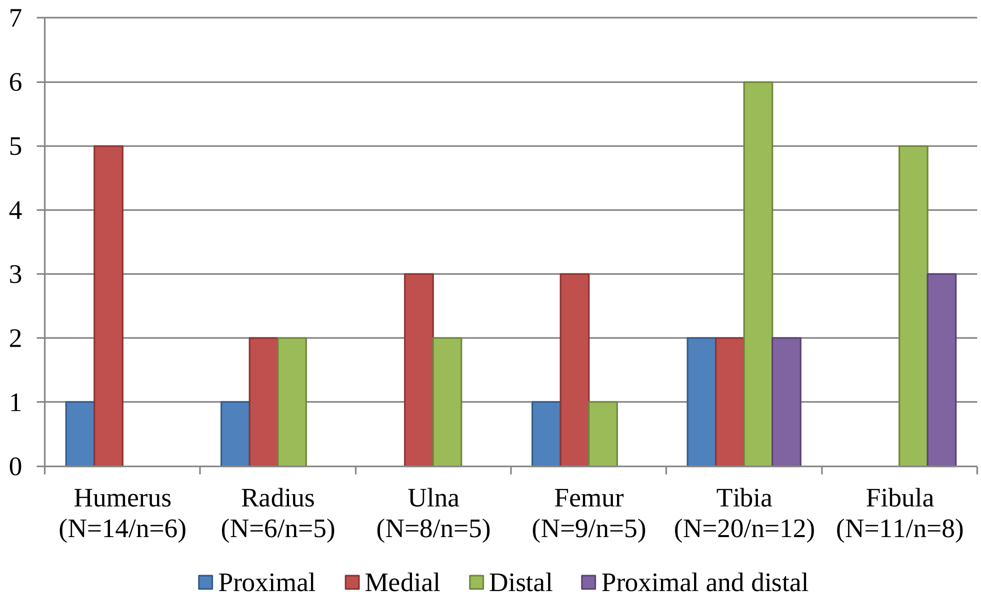

Figure 75 (group AA) Cut locations on the long bones (N=69/n=41).

Figure 76 bisected head of humerus [4]

Cut direction was recorded when visible (Table 33). The upper limb bones showed the highest variation in directions but were never seen cut posterior to anterior. The cuts anterior to posterior on the radie and ulnae indicated it was standard to cut these bones with the palm of the hand facing upwards.

	Posterior/ Anterior	Anterior/ posterior	Medial/ lateral	Lateral/ medial	Unknown	Total
Humerus Proximal	0	0	0	0	1	1
Humerus Medial	0	2	1	2	0	5
Humerus Distal	0	0	0	0	0	0
Radius Proximal	0	1	0	0	0	1
Radius Medial	0	2	0	0	0	2
Radius Distal	0	0	2	0	0	2
Ulna Proximal	0	0	0	0	0	0
Ulna Medial	0	2	0	1	0	3
Ulna Distal	0	1	0	1	0	2
Femur Proximal	0	0	1	0	0	1
Femur Medial	0	3	0	0	0	3
Femur Distal	0	1	0	0	0	1
Tibia Proximal	1	2	1	0	0	4
Tibia Medial	0	0	0	0	2	2
Tibia Distal	0	4	2	0	1	7

Fibula Proximal	0	0	0	2	1	3
Fibula Medial	0	0	0	0	0	0
Fibula Distal	0	4	0	1	3	8
Total	1	22	7	7	8	45

Table 33 (Group AA) cut direction of upper and lower limb bones (NISP)

An assessment of the quality of a cut was attempted, adapting a method devised by Witkin (1997, 47 and 2011, 264), which involved measuring the length and height of the breakaway spurs and notches on the severed surface. Testing the method it was found that it did not allow for an accurate indication of cut quality as matching spurs and notches did not produce the same results despite supposedly being a reverse image (section 8.1.6). The method did provide a relative indication of the size of the spurs and notches but it was believed that factors other than cut quality were dominant in determining the size, such as the shape and thickness of the bone and the location of the cut. This would affect the size of the spur/notch within each element group limiting the comparative value. Though not tested it was likewise thought that sizes of the spurs in paired bones (tibia/fibula and radius/ulna) would depend on cut direction and position during cutting. It was further evident that though measurements appeared relatively straight forward, repeated measurements on the same aspect varied, in particular the width of the notch and the height of the spur. It is possible that larger sample sizes would iron out such discrepancies in the data set but certainly for Craven Street this method was deemed of minimal value. The scatter diagram (Figure 77) did not yield any tangible results despite plotting them by bone type, it could be argued the humerie had a slightly higher tendency to produce larger spurs/notches. The lengths were measured between 3-17.9mm whilst the lengths were 0.7-6mm, with no consistency in proportions.

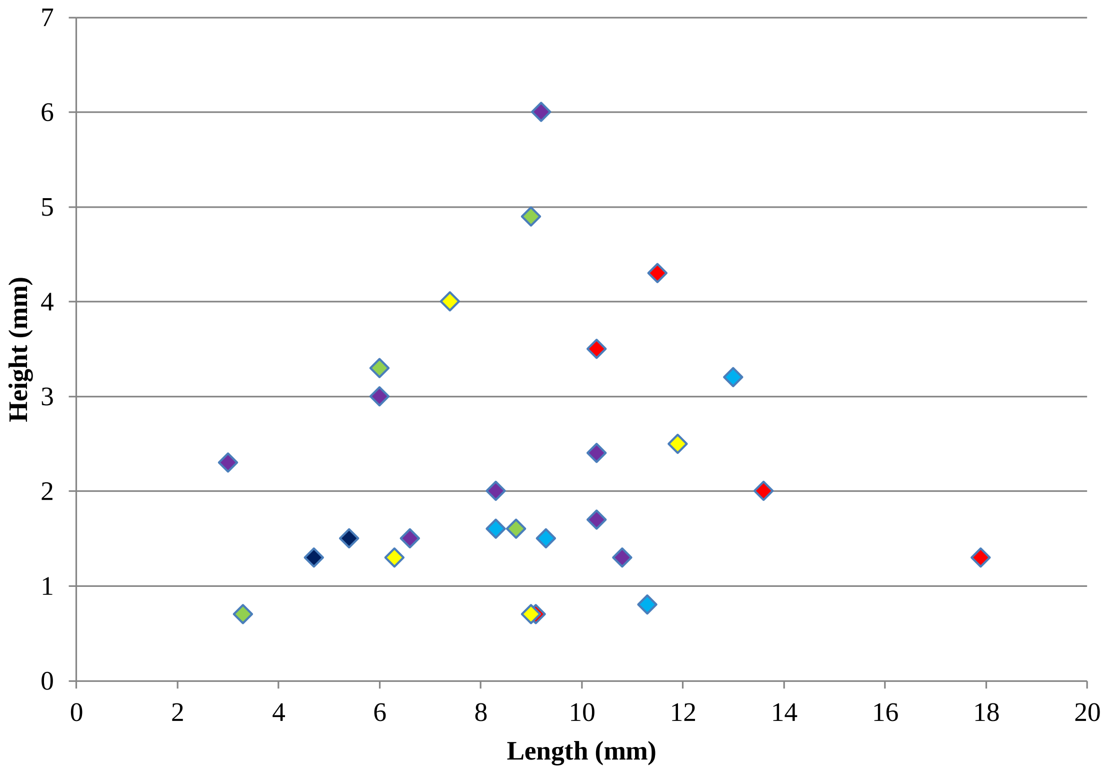

Figure 77 spur/notch dimensions on long bones plotted by length (x) and height (y). (red=humerus, yellow=radius, green=ulna, blue=femur, purple=tibia, dark blue=fibula)

9.5.2.2 Knife marks on long bones

A total of eight long bone fragments (11.76% (8/68) exhibited knife marks on the cortical surface of the bone. In the upper limb bones three humerie were affected and in the lower limb bones three femora, one tibia and one fibula. All the bones with evidence of knife marks were distal portions indicating that cuts to the soft tissue were made below the point of severing. In six instances (75.00% (6/8)) multiple short transverse cuts were situated immediately inferior of the severed margins suggesting soft tissue was cut prior to sawing the bone (Figure 78). The cut distance between the severed margin and the knife marks were insufficient for an amputation where the soft tissue would be cut at least five centimetres below in order for the soft tissue to be able to cover the stump (section 4.2.1).

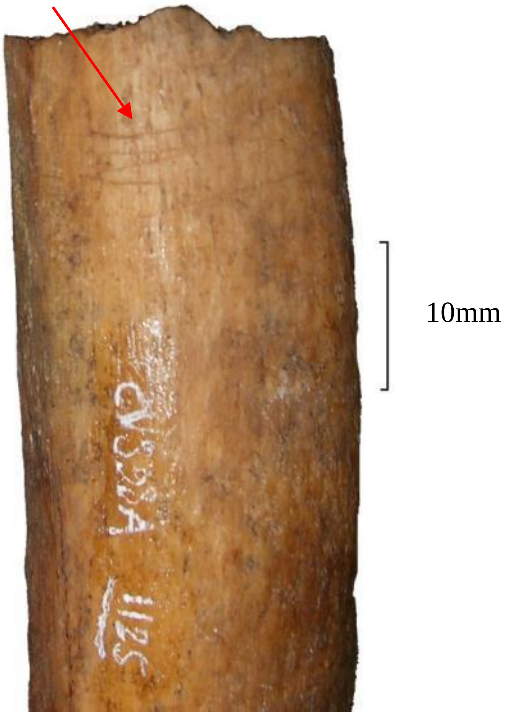

Figure 78 Humerus [1125] exhibiting multiple sort knife marks just inferior of the severed margin.

A much stronger indication of an amputation was seen in a distal portion of femur severed mid shaft [1225] (Figure 79). This bone exhibited a fine single circumferential cut 63mm inferior of the severed surface. This cut was a single neat line cut around the whole circumference of the bone as opposed to the multiple short lines seen in the other six bones. This further supported that this was an amputation as precision and minimal cutting would have been required in a living individual. Unfortunately there was no way of telling whether this was performed on a living individual or as a practice surgery. There was no evidence of healing on the bone and no evidence of pathology, supporting a live amputation, suggesting that this was performed as part of surgical practise. The presence of a saw line suggested the cut was first attempted at a 90 degree angle but finally to be cut a slightly oblique angle. The severed surface was neat but with a relatively small breakaway spur, cut in an anterior to posterior direction.

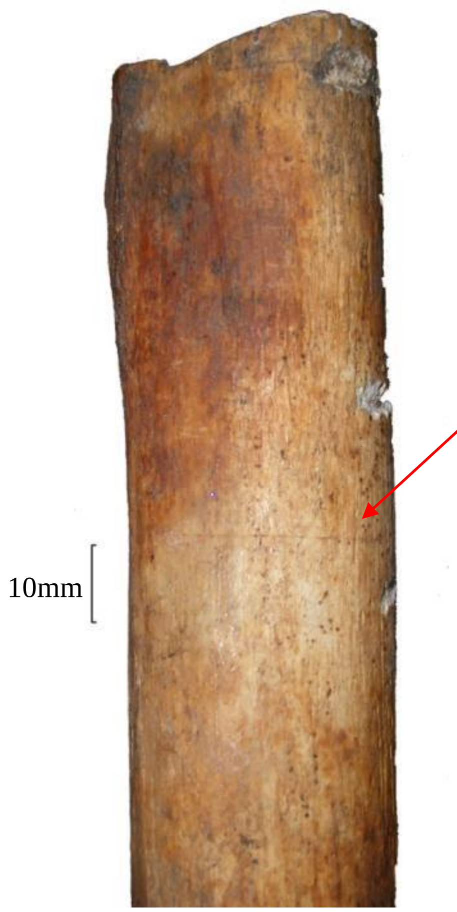

Figure 79 distal femur [1225] exhibiting one neat circumferential knife mark 63mm below the cut surface.

9.5.2.3 *Hands and feet*

Despite being one of the most dominating elements in the assemblage only three foot bones were recorded as having been exposed to post mortem intervention (1.74%) (3/172) (Appendix 4:17). No hand bones had any cut marks. One first metatarsal [42] and one other metatarsal [1706] had transverse cuts to the central portion of the shaft, both cut in direction mesial to lateral. One talus [490] had been severed sagitally in a superior to inferior direction, exhibiting fine slip marks on the head, indicating it may have been cut separately from the rest of the foot.

9.5.2.4 *The Pelvis*

Only two cuts to the pelvis were noted in the AA group (25% (2/8)). One Pelvis of an elderly male had been cut in a longitudinal direction across the left ischium [268] (Figure 80) and another fragment of pubis was severed along the superior portion of the right pubic ramus [2086]. Knife marks were recorded on the posterior portion of two pelvic bones [268] and [1185].

Figure 80 pelvis [268] of elderly male severed across the ischium.

9.5.2.5 Scapulae and clavicles

A total of eight fragments of scapula and nine clavicles were present in the AA assemblage but none had been severed or exhibited any knife marks. Staining was noted on the acromio-clavicular portion of one clavicle [890].

9.5.3 The Thorax and sacrum (AA group)

The thorax includes the vertebrae, ribs, sterna and sacrum. This part of the body would have been cut for the purpose of gaining access to the internal organs or dividing the body into smaller portions.

9.5.3.1 Vertebrae

A total of 10.78% (22/204) of all vertebrae had been severed showing a gradual increase in cut rate travelling down the spinal column (cervical 4.26% (2/47), thoracic 5.69% (7/123), lumbar 25.00% (8/32) and sacral 50%.00 (5/10)) (Figure 81) (Appendix 4:16 and 4:18).

Figure 81 Location of severed vertebrae observed in the spinal column (Drawing by spiderfingers86 (deviantart.com))

In the 3rd [698] and 7th [160] cervical portion of the spine two transverse cut across the tip of the superior facets were observed (Figure 82) and one on the left lamina portion [1306]. In the thoracic region three transverse cuts were made across the superior facets on a 1st [1348], inferior facets on 4th [1329] and body of a 6th [5313] vertebra and one across the body in a transverse direction and medio-lateral direction [5341], whilst three longitudinal cuts were made on the lamina on either side of the spinous process on [1529], [1654] and [1655]. In the lumbar region seven were severed in a longitudinal direction cutting through the superior and inferior articular process on either side, and on the transverse processes [252-255], [1371], [1372], and [1344] these had derived from at least three different individuals (Figure 83). One lumbar vertebra had further been cut through the left portion of the body from posterior to anterior [57]. All cuts on the sacral vertebrae were made in the medial sagittal plane, bisecting the sacrum (Figure 84).

Figure 82 Cervical vertebra severed along superior facets [698]

Figure 83 Lumbar vertebrae with removed neural arch [1371] and [1372].

Figure 84 Bisected sacrum [1822]

One articulated thorax [5288grp] consisted of ribs and the 5th cervical to 6th thoracic vertebrae, with the 6th thoracic severed in a transverse direction across the body. This would have caused the removal of the upper section of the chest just below the sternum. The sternum had been severed in a sagittal direction and six of the 16 ribs present had been severed at the sternal end suggesting a thoracotomy had been performed.

9.5.3.2 Rib and sternum

Out of 330 rib fragments 21.52% (71/330) had been severed, 1% exhibited knife marks and 5.3% were stained. A total of 16 rib groups had been identified with 10 of these showing evidence of severing. It should be stressed that these groupings were not exclusive and one individual may have been made up of one or more groups. It was estimated that the ribs would have derived from at least six individuals, though the matched rib groups suggest this figure was significantly higher.

Table 34 shows the cut locations divided into three main areas; head end, midaxillary line and sternal end, two groups of ribs were cut in two places making a total of 76 cuts on 71 fragments. The most frequent cut location was towards the sternal end (43.42 % (33/76)), followed by the midaxillary line (30.26% (23/76)) and the head end (26.32% (20/76)).

Grp No.	Age	NISP	NISP cut	Head/angle	Mid	Sternal	Twice	Knife marks	Cut direction
1	Young adult	23	15	9	0	8	2	0	H=PA, S=AP
2	Adult	5	1	0	0	1	0	1	PA
3	Young adult	3	2	0	2	0	0	1	SI
4	Adult	2	2	2	0	2	2	2	H=PA, S=?
5	Adult	8	8	0	0	8	0	0	AP
6	Young adult	4	4	0	4	0	0	0	AP/SI
7	Young adult	4	0	0	0	0	0	0	
8	Adult	18	0	0	0	0	0	0	
9	36-45 years	27	0	0	0	0	0	0	
10	36-45 years	24	6	0	0	6	0	0	AP
11	26-35	8	0	0	0	0	0	0	

	years								
12	Adult	5	3	0	3	0	0	0	Indeterminate
13	Adult	3	0	0	0	0	0	0	
14	Adult	5	0	0	0	0	0	0	
15	Adult	4	1	0	1	0	0	0	PA
16	Adult	16	6	2	4	0	0	0	Indeterminate
Total		**159**	**48**	**13**	**14**	**25**	**2**	**4**	
	Unmatched	171	23	7	9	8	1	0	AP=3 PA=6 SI=2 Indet.=13
Total		**330**	**71**	**20**	**23**	**33**	**3**	**0**	

Table 34 cut location and direction of severed ribs as seen in matched element groups and disarticulated ribs (estimate of age by sternal rib end provided in rib groups) (Cut directions: PA = posterior to anterior, AP = anterior to posterior, SI= Superior to in

A variation in cut direction was also observed and recorded in relation to cut location. This revealed that the cut direction at the sternal end was predominantly anterior to posterior (75.76% (25/33)) with one rib (3.03% (1/33)) cut from the visceral surface and seven of unknown direction. Cuts along the mid-axillary line saw 30.43% (7/23) cut anterior posterior/superior-inferior, and 13.04% (3/23) from the visceral surface. All observable cuts towards the head were severed from the visceral surface and out except on disarticulated rib cut superior to inferior (Figure 85). Knife marks were recorded on four ribs only three on the anterior central portion of the ribs whilst one displayed knife marks on the visceral surface.

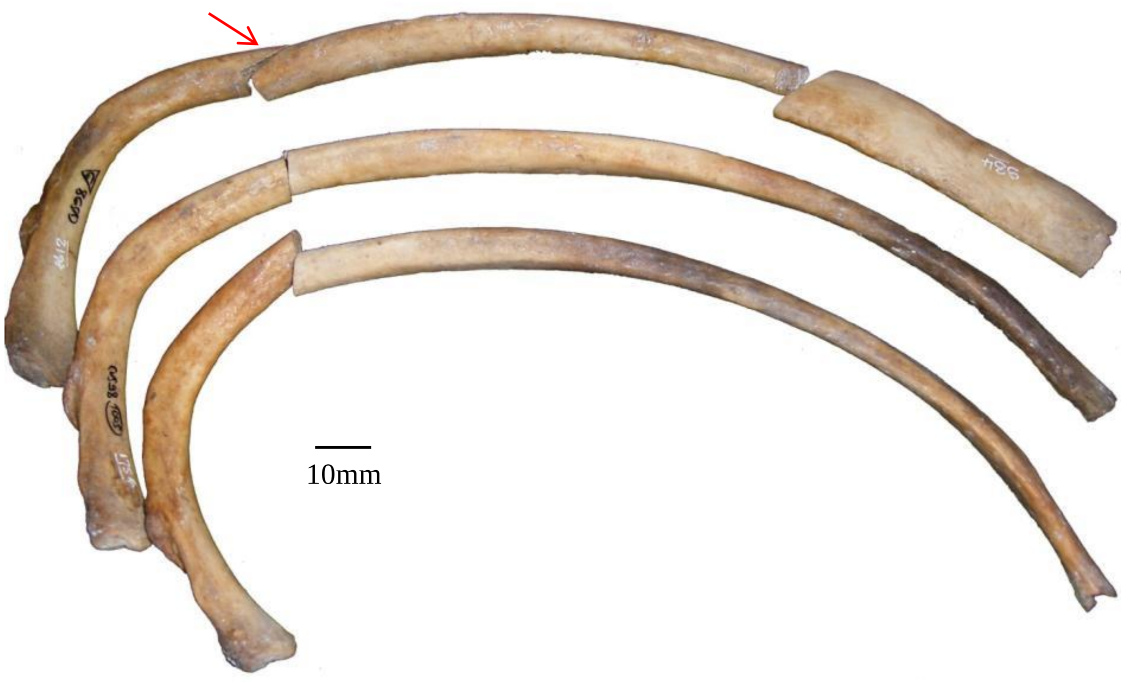

Figure 85 Rib from (group 1) showing multiple cut and severing from the visceral surface outwards.

A total of 16.7% (3/18) of fragments of the sternum had been severed, all from the AA group. The cuts were made in a transverse direction across the manubrium and one in a sagittal direction and were estimated to be remains of at least three individuals. No knife marks were noted on the sterna.

The main reason for cutting the ribs and the sternum is to gain access to the internal organs, this procedure is commonly known as a thoracotomy. This is predominantly carried out cutting the sternum either in a transverse or sagittal direction and cutting the ribs either towards the sternal end or the mid-axillary line. This does not always involve cutting the ribs as cuts towards the sternal end can be made by simply cutting the cartilage and bending the ribs backwards to open the chest cavity. It is possible the ribs were bent backwards and then cut at a position close to the head in order to remove the ribs to allow better access.

9.5.4 CH group

9.5.4.1 The skull (CH group)

The CH group revealed much less variation in cuts than the AA group with a total of 27.27% (8/26) of the skull bones severed (Table 35). The cut bones were estimated to have derived from at least two individuals. One skull [561grp] of a 6 year old child was almost completely reassembled and revealed a unique diamond shaped cut extending from the centre of the frontal bone to the posterior portion of the parietal bones. The diamond shape was removed by cutting two lines in a triangular fashion from the central portion of the frontal bone to the lateral portions of the parietal with another similar cut performed in the opposite direction starting at the posterior portion of the parietal bone with the two points finally chiselled to lever off the entire diamond shaped bone. Fine knife marks were observed running in an anterior posterior direction across the parietal bones and horizontally on the frontal bone (Figure 86).

	NISP (all bones)	**NISP cut fragments**	Severed	Knife marks	Multiple	Calvarium (skull cap)	Calvarium (Inferior portion)	Occipital wedge	Orbital wedge	Sagittal cut	Coronal cut	Transverse cut (other than calvarium cut)	Oblique cut	Trepan
Frontal	2	2	2	1	2	0	0	0	0	2	0	0	2	0
Parietal	5	5	5	4	2	0	0	0	0	2	0	0	4	1
Temporal	3	0	0	0	0	0	0	0	0	0	0	0	0	0
Occipital	6	1	1	1	0	0	0	0	0	0	0	0	1	0
Maxilla	4	0	0	0	0	0	0	0	0	0	0	0	0	0
Mandible	1	0	0	0	0	0	0	0	0	0	0	0	0	0

Zygomatic	2	0	0	0	0	0	0	0	0	0	0	0	0	0
Skull fragments	3	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	26	8	8	6	4	0	0	0	0	4	0	0	7	1
MNI	**4**	**2**	**2**	**2**	**2**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**2**	**0**

Table 35 Types of cut performed on skull specimens from the Juv Group. (NISP=26/n=8)

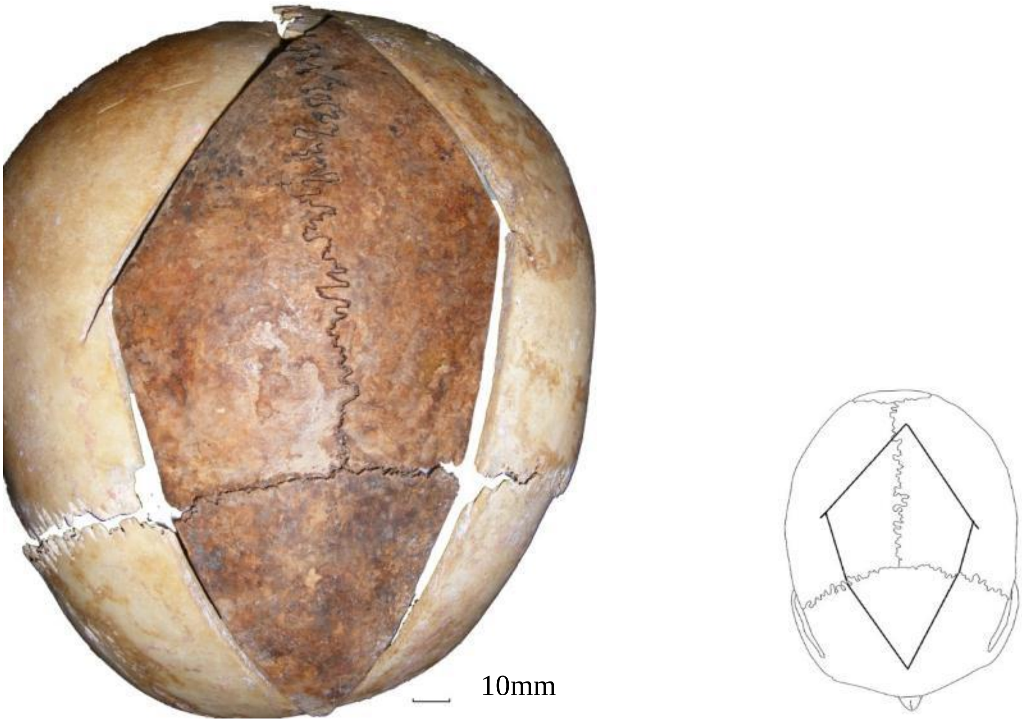

Figure 86 diamond shaped cut extending across the frontal and parietal bones [561grp]

The other skull [282grp] consisted of the parietal and occipital bones revealing an untraditional method of removing the skull cap. The cut was performed immediately posterior of bregma and extended to posterior at the point of the external occipital protuberance, appearing as an oblique posterior cut. Fine knife marks were observed running in a medio-lateral direction to the posterior portion of the parietal and occipital portions (Figure 87).

Figure 87 oblique calvarium cut endocranial view [282]

The cuts performed on the skulls were very different from those observed in the AA group. The traditional calvarium cut, removing the skull cap, occipital wedge and orbital wedge were all absent from this age group.

9.5.4.2 The appendicular skeleton (CH group]

A very limited number of appendicular bones were severed (7.14% (4/56)) with Figure 88 showing the location of the severed bones from both the appendicular and thorax.

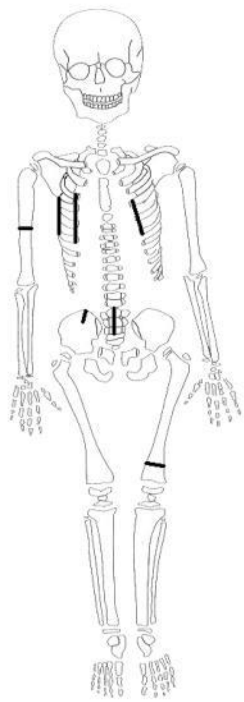

Figure 88 location of cuts in the CH group on the appendicular and thorax

One distal humerus [1188] of a 2-3 year old child was severed on the mid shaft cut mesial to lateral and one femur [1471] was severed on the distal portion of the shaft cut lateral to mesial, this femur belonged to child [561grp]. One distal epiphysis of a radius [11] had been drilled and showed a neat circular hole in the central portion of the bone (Figure 89).

Figure 89 drilled distal epiphysis of radius [11]

One right inominate bone [671] was cut along the posterior superior border, appearing to be a cut performed by accident during removal of soft tissue rather than a deliberate attempt at severing the bone (Figure 90) (Appendix 4:16).

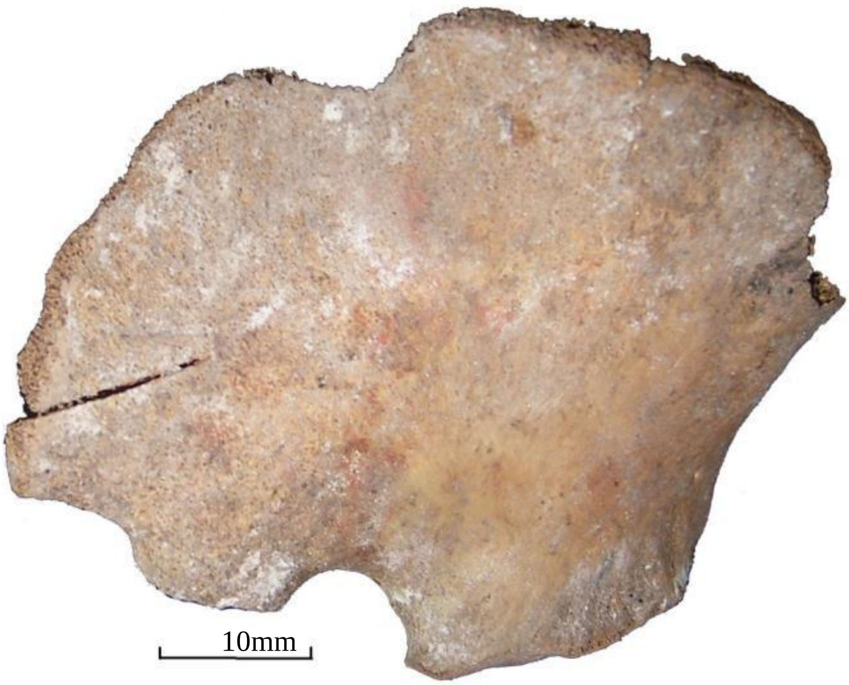

Figure 90 right inomminate bone [671] cut on the posterior superior margin.

9.5.4.3 Knife marks on long bones

A total of five long bones (14.29% (5/35)) displayed a series of parallel knife marks, indicative of removal of soft tissue. One humerus [1013] of a 2-2.5 year old child revealed a herring bone like pattern on the posterior distal portion of the shaft, the bone had not been severed (Figure 91)

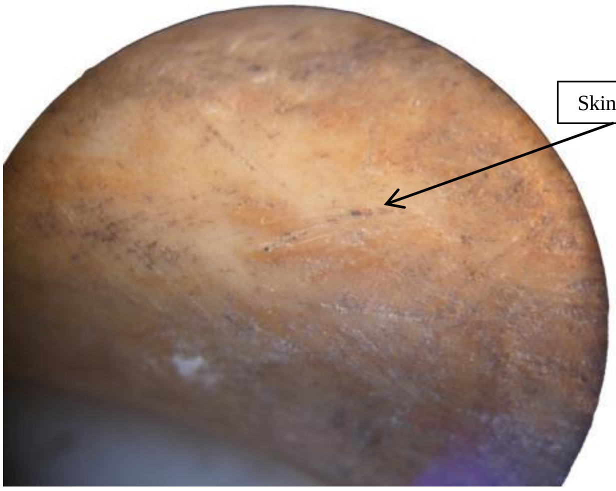

Figure 91 [1013] distal posterior humerus magnified x10 showing a herring bone pattern of knife marks (x10 magnification)

Another humerus [598] belonging to a 6 year old child [561] also had a series of parallel marks on the posterior distal portion (Figure 92). The right fibula of the same individual also exhibited six parallel diagonal marks on the distal mesial aspect.

Figure 92 humerus [598] showing diagonal knife marks to posterior distal aspect.

One tibia [2] and one ulna [609] shaft had similar knife marks to the central portion of the shaft, the tibia on the mesial aspect. It is of note, the type of knife marks observed in the CH bones differed from those observed on the long bones in the AA group. This suggests that the application of the knife was applied for a different purpose, perhaps a more extensive removal of soft tissue across the surface rather than cutting for the purpose of severing the bone.

9.5.4.4 The thorax and sacrum (CH group]

There were no cuts on the cervical, lumbar or thoracic vertebrae from this group (Nisp = 35) whilst 25.58% (11/43) of the ribs had been cut, deriving from at least two individuals. One individual was cut in the mid-axillary line anterior to posterior. One Rib group matched to [561grp], the 6 year old child, was an almost complete set of ribs cut sternally with no indication of cut direction. The cut ends did not display any saw marks and appeared to have been cut with a different instrument such as pliers or possibly a knife. One sacrum consisting of three right unfused sections (S1-3) [24/25/26], had been cut in the medial sagittal plane

9.5.5 The INP group

9.5.5.1 The Skull (INP)

The INP group had the least number of observable severed bones (8.6% (16/186)). The cuts were estimated to have derived from a minimum of four individuals (Table 36) and have been illustrated in Figure 93.

	NISP (all bones)	**NISP cut fragments**	Severed	Knife marks	Multiple	Calvarium (skull cap)	Calvarium (Inferior portion)	Occipital wedge	Orbital wedge	Sagittal cut	Coronal cut	Transverse cut (not calvarium cut)	Oblique cut	Trepan
Frontal	17	3	3	0	2	3	0	0	0	3	0	0	0	0
Parietal	50	7	7	2	3	4	1	0	0	2	0	0	3	0
Temporal	15	1	1	0	0	0	1	0	0	0	0	0	0	0
Occipital	20	2	2	0	0	0	2	0	0	0	0	0	1	0
Maxilla	6	0	0	0	0	0	0	0	0	0	0	0	0	0
Mandible	8	0	0	0	0	0	0	0	0	0	0	0	0	0
Zygomatic	7	0	0	0	0	0	0	0	0	0	0	0	0	0
Skull fragments	63	3	2	0	0	0	0	0	0	0	0	0	0	1
Total	186	16	15	2	5	7	4	0	0	5	0	0	4	1
MNI	**11**	**4**	**4**	**1**	**4**	**3**	**2**	**0**	**0**	**0**	**0**	**0**	**2**	**0**

Table 36 Types of cut performed on skull specimens from the INP Group.

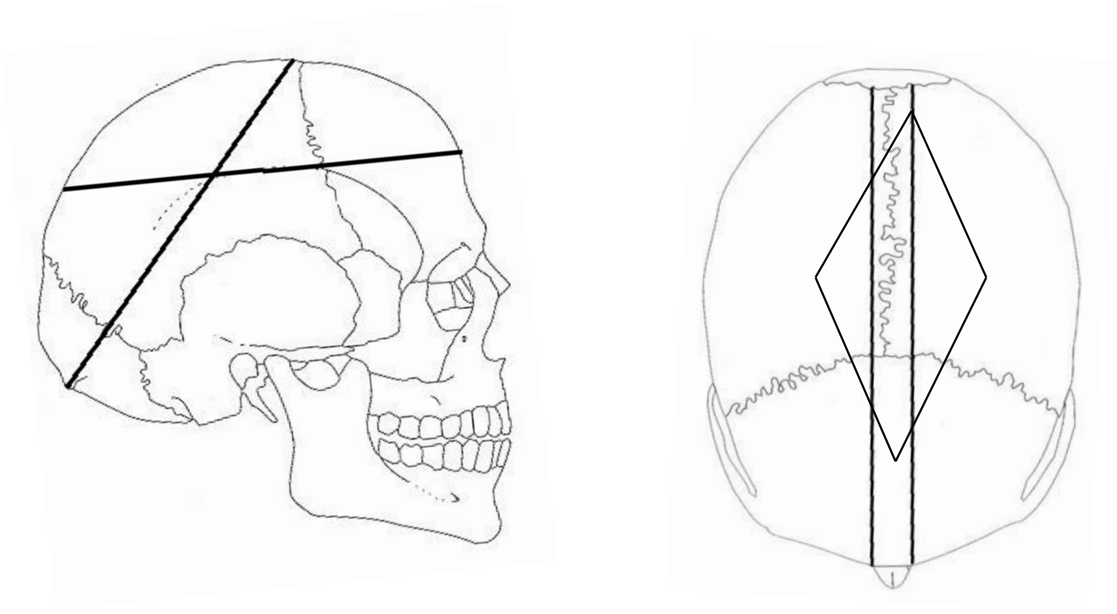

Figure 93 cut directions noted on INP skulls; calvarium cut, oblique calvarium and sagittal cuts

The traditional calvarium cut was noted in at least 3 individuals [1093grp], [1065/1085] and [192]. The two former individuals likewise exhibited cuts immediately lateral of the sagittal plane. The [1093grp] appeared to have been cut at an oblique angle not dissimilar to [561grp] in the CH group (Figure 94) (Appendix 4:12).

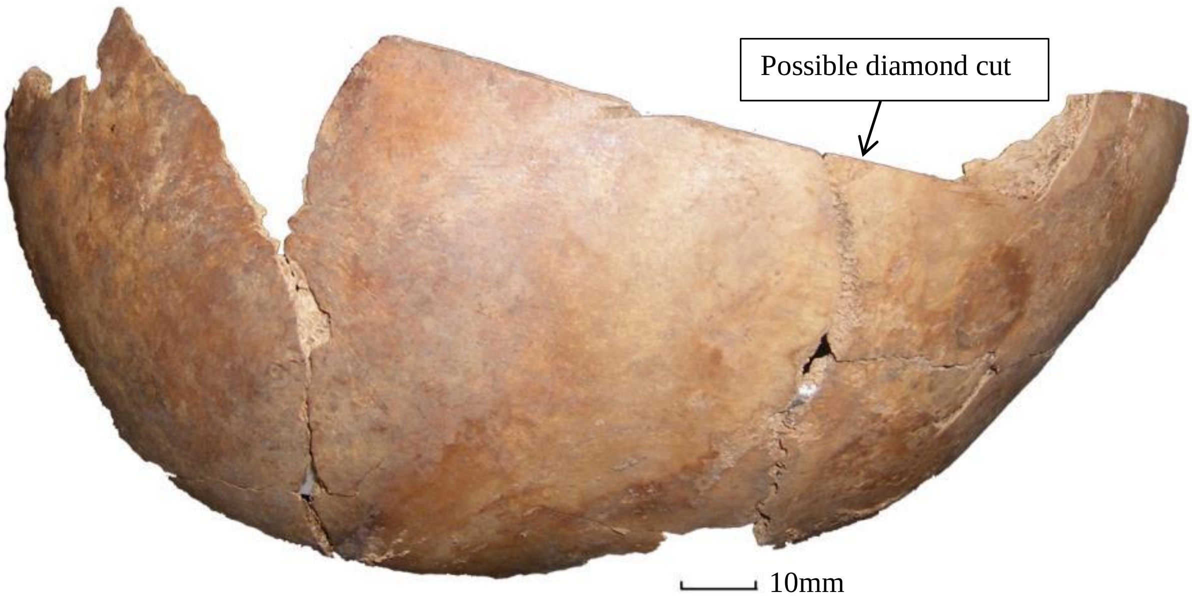

Figure 94 Possible diamond cut [1093grp]

The latter [192] had an oblique cut resembling that of [282] in the CH group, but in this case the lower portion was present rather than the cap. Similarly [1069grp] also had the lower portion present of an oblique cut extending from posterior of bregma to the external occipital protuberance with fine knife marks running in a diagonal direction on the parietal bone. One roundel from a trepan [5338] was small (12 mm) and performed on a very thin skull, believed to be from a parietal bone in the INP group though the location of the trepan could not be established (Figure 95).

Figure 95 roundel from trepan [5338]

9.5.5.2 The appendicular skeleton (INP sample)

A total of 12 (12.12% (12/99) long bones had been severed. Figure 96 shows the location of the cuts and Table 37 shows the portion of the bone present and the position of the cut. Transverse cuts on the bone were mainly seen in the humerie and the femora. All humerie had been cut on the mid shaft (Figure 97) whilst the femora had predominantly been cut mid shaft but cuts to both proximal and distal portions of the shaft were present. None of the elements had been cut twice as seen in the AA group. None of the tibiae or fibulae had been severed.

One clavicle (1/7) had been severed just posterior of the sternal, no saw marks were visible, suggesting pliers or a knife was used. None of the nine scapula fragments had been severed or exhibited any knife marks.

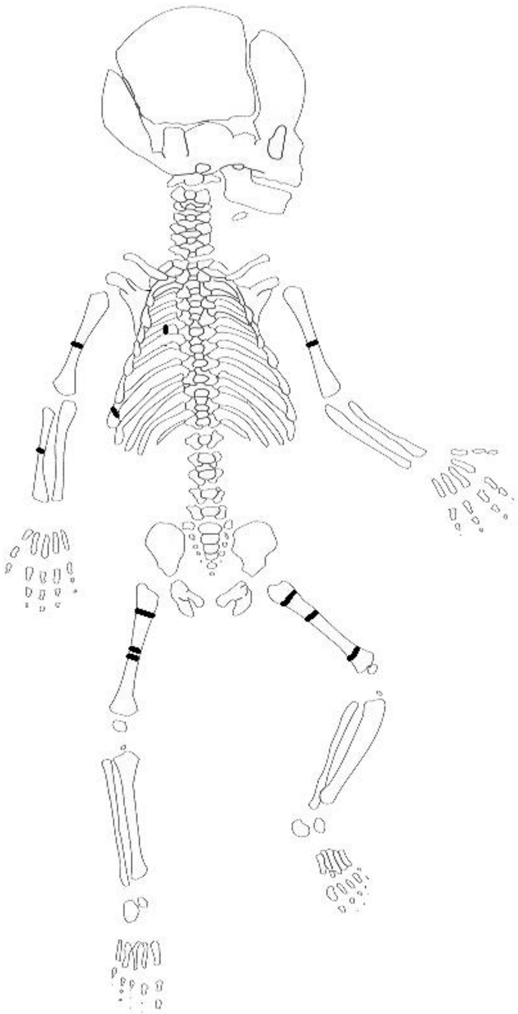

Figure 96 post cranial cut locations in the INP group

	NISP	Cut NISP	Portion of cut bones present			Portion cut			
			P	SH	D	P	M	D	D+P
Humerus	19	5	0	0	5	0	5	0	0
Radius	14	1	1	0	0	0	1	0	0
Ulna	16	0	0	0	0	0	0	0	0
Femur	21	6	4	0	2	1	4	1	0
Tibia	15	0	0	0	0	0	0	0	0
Fibula	14	0	0	0	0	0	0	0	0
Total	**99**	**12**	**5**	**0**	**7**	**1**	**10**	**1**	**0**

Table 37 Cut locations of INP group long bones, indicating the portions of the bones present and the location of the cut

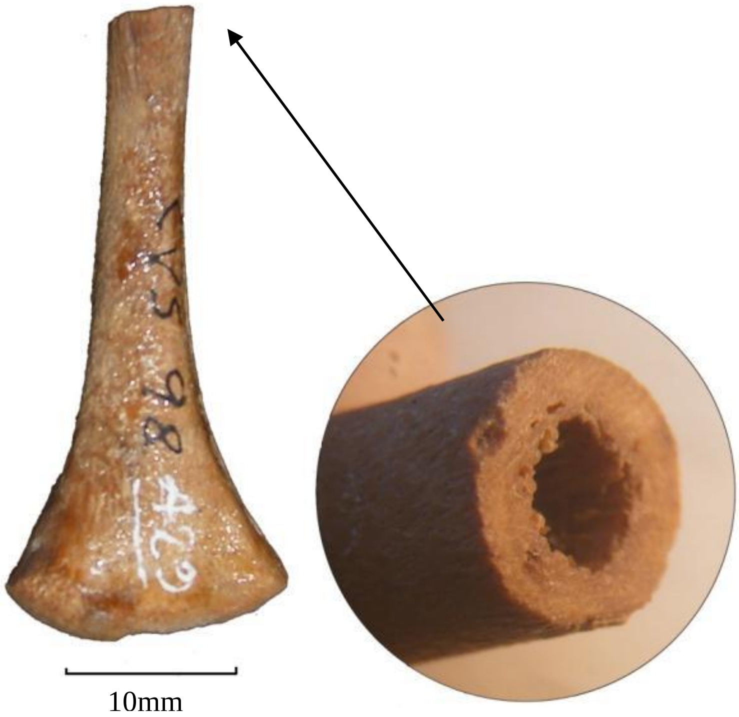

Figure 97 transverse cut on the mid shaft of a neonate humerus [429] (right image shows x10 magnification)

9.5.5.3 The thorax and sacrum (INP group)

In the INP group only 1.92% (2/104) of the ribs displayed any evidence of severing. One rib was cut to sternal and one in the mid-axillary area. The low frequency was not thought to be reflective of the actual number, as cuts in ribs from this age group were very difficult to observe. Historical literature suggests that dissection of infants was carried out with scissors and scalpels rather than sawn (The Lancet vol. 3 no.72 (Feb 12) 1825, 178). None of the sacral fragments (0/2) exhibited any cut marks. Though evidence of thoracotomies in this age group were scant, it is very likely that they were preformed without being visible on the bone. None of the elements of the fully articulated neonate [5140] exhibited any evidence of intervention.

9.6 Pathology

The aim of this section is to qualify the types of diseases observed. Due to the disarticulated nature of the assemblage the identification and quantification is restricted and diseases diagnostic in singular elements are likely to produce a higher prevalence rate than those diagnosed by distribution pattern. Elements exhibiting pathological changes or trauma have been calculated by number of identified specimens (NISP), observations on matching elements or minimum number of individuals has been noted in the text when relevant. A total of 131 aged specimens exhibited pathological changes (6.86%) (131/1908) in bone from all three age categories at a rate of 10.35% (114/1101) for the AA, 1.16% (2/172) for the CH group and 2.36% (15/635) for the INP group. The distribution of identified pathological conditions by age can be seen in Table 38; The INP group was dominated by metabolic conditions whilst the AA group saw a higher prevalence in joint diseases, inflammations, DISH and trauma.

	INP	**CH**	**AA**	**Total**
Inflammatory	5	2	13	20
Joint	0	0	57	57
Metabolic	9	0	2	11
Trauma	0	0	19	19
Congenital	1	0	2	3
DISH	0	0	19	19
Neoplastic	0	0	2	2
Total affected NISP	15	2	114	131
Total NISP	635	172	1101	1908

Table 38 distribution of specimens with pathological changes in order of disease categories

9.6.1 Inflammations

The most frequently occurring condition was non-specific periosteal reactions on the bone. Such generic diagnosis is likely to be higher in comingled remains due the lack of observable distribution patterns. Table 39 shows the number and elements affected by this condition; the causative mechanics for such skeletal changes are likely to differ between adults and juveniles (Singleton, 1966: 84pp). Inflammations were observed in a total of 1.05% (20/1908) of all aged specimens (NISP). The most frequently affected were individuals in the AA group at 1.18% (13/1101) followed by the CH group (1.16% (2/172)) with the least bones affected in the INP group (0.78% (5/635)).

AA	**Element**	**Pathology**	**n=**	**N=**	**%**
	Humerus	Non-specific periositis	1	14	7.14
	Fibula	Non-specific periositis	4	11	36.37
	Tibia	Non-specific periositis	3	20	15.00
	Rib	Rib lesions	3	330	0.90
	Maxilla	Maxillary sinusitis	2	9	22.22
		Total AA group	**13**	**1101**	**1.18**
CH	Femur	Non-specific periositis	1	7	14.28
	Parietal	Ectocranial inflammation	1	5	20.00
		Total CH group	**1**	**172**	**1.16**
INP	Femur	Congenital syphilis/rubella/metabolic??	3	21	14.28
	Tibia	Congenital syphilis/rubella/metabolic??	1	15	6.67
	Fibula	Congenital syphilis/rubella/metabolic??	1	14	7.14
		Total INP group	**5**	**635**	**0.78**

Table 39 Elements showing non-specific and specific inflammations

9.6.1.1 Non-specific inflammation (AA group)

A total of eight long bones displayed mild healed non-specific periosteal reactions, indicating that the infection had healed at the time of death. The most frequently affected were the lower limb bones (87.5% (7/8 predominantly in the tibiae (15% (3/20)) and the fibulae (36.4% (4/11)). Tibiae are often subject to reoccurring trauma due to its close proximity to the skin, but the cause of such lesions may also be attributed to haemorrhage, various veins or chronic skin ulcers (Aufderheide & Rodriguez-Martin, 1998: 179; Roberts & Manchester, 1995: 130). Only one element from the arm, a humerus [30] (7.1% (1/14) had non-specific bony reactions appearing as both healed in the form of smooth plaque like bone on the surface and unhealed in the form of woven pitted bone the disto-mesial and posterior aspects of the shaft. The plaque like bone had the appearance of non-gummatose lesions associated with treponematosis, with the bone remodelled into the cortex. Such lesions are, however, not commonly seen in the humerus and with the relatively mild appearance of the lesions it would be a very tentative diagnosis (Aufderheide and Rodriguez-Martin 1998, 158). The presence of healed and unhealed bone shows this individual had suffered a long standing infection that was still active at the time of death. A total of three ribs from the AA group (0.9% (3/330) had healed periosteal bone inflammation on the visceral surface. These appeared as raised smooth striae running along the shaft of the rib. Such inflammation can be indicative of tuberculosis but far from pathogenomic of this condition (Roberts and Buikstra, 2003: 103).

9.6.1.2 Maxillary sinusitis (AA group)

Maxillary sinusitis is a very common condition in both historic and modern populations. It is a chronic infection of the mucous membrane of the sinuses. The bony reaction appears as bone formations on the floor of the sinuses and is archaeologically usually only observed in individuals with damage to the skull or by x-rays or endoscopic examination. The cause of this condition is multifactorial and has been attributed to dental abscesses, air pollution and infections (Aufderheide & Rodriguez-Martin, 1998: 257). Two individuals showed evidence of chronic sinusitis, appearing as nodular bone in the maxillary sinuses. It was possible to attribute a cause of dental infection in both cases; Maxilla [654] had a large carious lesion in the left upper maxillary with an abscess visible by the root of the same tooth. The other maxilla [921] had a large carious lesion of the right third molar with a deep penetrating abscess into the maxillary sinus. The bone had been cut in a transverse direction above the nasal septum exposing both sinuses, confirming that the condition was bilateral (Figure 67).

9.6.1.3 Non-specific inflammation (CH group)

One individual in the CH group displayed mild healed periosteal reaction to the proximal posterior portion of a femoral shaft (14.28% (1/7)). One case of mild periosteal reaction on the ecto-cranial surface on the posterior aspect of the left parietal bone (20.00% (1/5)) was noted in a rearticulated 6 year old child [561]. The lesion appeared active with grey pitted bone adhering to the periosteum. Such relatively mild periosteal reactions can have a number of causes, usually associated with trauma or soft tissue infections.

9.6.1.4 *Specific infections (INP group)*

It is difficult to differentiate between non-specific infections and specific viral and bacterial infections in comingled remains. It is possible that metabolic conditions may be very similar to, or occur with such infections. Figure 98 shows what is believed to be a matching, femur [376], tibia [367] and fibula [366] with the growth plates undulating or serrated in appearance with the metaphysis exhibiting evidence of poor mineralization. The bone did not have any abnormal periosteal activity leaving the diaphyses unaffected. Similar conditions may also be suggested in another pair of femora [618] and [744] (Figure 99). This dramatic example of a possible specific infection was present as extensive destruction of the proximal and distal methaphyses, the diaphyses atrophied and the metaphyseal margins serrated to proximal and frayed to distal. The integrity of the cortex of the diaphysis remained intact with no periositis. Though ageing of pathological specimens can prove very misleading due to growth disruptions, it was estimated that both individuals were below the age of one year. The first individual was aged from femoral long bone length to 34-36 gestational weeks. The second individual was much more difficult to age due to the atrophied state of the bones and the destruction to both proximal and distal metaphyses. An approximation of length was made comparing the bone to individuals of different ages and an estimated age of 1-6 months was estimated, though it should be stressed that this individual could be much older. At least two inflammatory conditions can generate such features; congenital syphilis and congenital rubella.

Congenital syphilis is transmitted by hematogenous dissemination of the spirochetes through the placenta from the infected mother to the unborn foetus. This occurs in around 80% of all cases where the mother is infected and usually takes place in 16-18 weeks in utero. Severe osteochondritis, periositis and the Hutchinson triad (deafness, notching of incisors and intestinal keratitis) are typical manifestations. Growth plates may, however, be the only affected areas in unborn and premature babies (Aufderheide & Rodriguez-Martin, 1998: 164). Other indicators of congenital syphilis are Wimberger's sign apparent as bilateral mesial focal destruction of the proximal tibiae as well as calcification encircling the metaphyses. Another manifestation may be observed as "sawtooth" metaphyses and deep segments of diminished density of the metaphyses (Rasool & Govender, 1989: 753).

Another possible diagnosis is congenital rubella also known as German measles transmitted from the mother to the foetus. If this occurs in the first trimester of a pregnancy this can lead to serious foetal abnormalities. Foetal abnormalities are seen in around 20-25% of all cases resulting in 40% stillbirths. Around 35% of cases manifest skeletal changes most commonly occurring in the metaphyses of the long bones in particular distal femur and proximal tibia. The changes are poor mineralization of the metaphyses, coarsening of the trabecular and longitudinal streaks of altering sclerosis and lucency (celery stalk appearance). There is no periositis or diaphyseal involvement. Bone changes disappear 2-3 months after birth if the baby survives (Aufderheide & Rodriguez-Martin, 1998: 209). Further observations of irregular metaphyses may be observed and a narrowing of the medulary cavity (Singleton *et al.*, 1966: 84pp).

Figure 98 Abnormal growth plate and destruction of cortical bone around the metaphyses of the femur, tibia and fibula of a neonate [376], [367] and [366]

Figure 99 Two femora showing atrophy of the shaft and complete destruction of the femoral head [618] & [744] (Age: neonate/infant)

9.6.2 Joint disease

A total of 5.18% (57/1101) elements were presented with joint disease, all observed in the AA group (Table 40). Observed joint diseases could be divided into four categories; Smorl's nodes (SN), Osteoarthritis (OA), Degenerative Joint disease (DJD) and Inflammatory Arthritis (IA).

Element	**Pathology**	**n=**	**N=**	**%**
Vertebrae	Smorl's nodes (SN)	22	204	10.75
Rib	Osteoarthritis (OA)	1	330	0.30
Ulna	Osteoarthritis (OA)	1	8	12.50
Temporomandibular joint	Degenerative Joint disease (DJD)	2	12	16.67
Clavicle (both epiphyses)	Degenerative Joint disease (DJD)	1	9	11.11
Vertebrae	Degenerative Joint disease (DJD)	25	204	12.25
Carpal	Degenerative Joint disease (DJD)	1	16	6.25
Manubrium (sterno-clavicular joint)	Degenerative Joint disease (DJD)	1	15	6.67
Phalanges	Degenerative Joint disease (DJD)	2	60	3.33
Carpal	Inflammatory Arthritis? (IA)	1	6	16.67
	Total AA group	**57**	**1101**	**5.18**

Table 40 Prevalence rate of joint diseases (NISP)

9.6.2.1 Smorl's Nodes (SN)

Smorl's nodes are herniations of the intervertebral disc. They are recognised as concavities seen in the intervertebral disc space and are fairly common in post medieval archaeological assemblages (Roberts & Cox, 2003: 311) represented at a rate from 10-70.1% in London post medieval cemeteries (Crude Prevalence rates (CPR) from www.museumoflondon.org.uk 2005) They are commonly seen in elderly individuals as part of degeneration of the spine, but are also noted in adolescents (14-18 years). The indentations have been associated with trauma to the spine (Yochum & Rowe, 2004: 512). Smorl's nodes were the second most dominant condition with 10.78% (22/204) vertebrae displaying the above signs. By matching up the vertebrae it was estimated that at least four individuals would have been affected by this condition, mainly noted in the thoracolumbar region of the spine (T7-L1) One younger individuals with recently fused epiphyseal rings presented smorl's nodes in the 10th to 12th thoracic vertebrae.

9.6.2.2 Degenerative Joint disease (DJD) and Osteoarthritis (OA)

Both Degenerative Joint Diseases (DJD) and Osteoarthritis (OA) are the results of the gradual wear to the skeleton with age caused by the reduction of synovial fluid in the joints. The distinction between the two conditions is the absence of eburnation in DJD. The interpretation of DJD and OA in comingled remains is of limited value as it is the distribution pattern that may reveal any specific causes of the condition (Burgerner *et al*., 2006: 130). DJD was noted in a total of 32 joints, predominantly vertebrae exhibiting marginal lipping and pitting of the joint surfaces. The most commonly affected area in the vertebrae (n=25) was the lower cervical (C4-C7) (17.02% (8/47)), lower thoracic (12.20% (15/123)) and upper lumbar (6.25% (2/32)) areas.

Other areas affected were the clavicular joints (22.22% (2/9)), phalanges of the hand (3.33% (2/60)) and the temporomandibular joint of at least two individuals [1076] and [195]. Eburnation was noted in the head of one rib [1545] and on the styloid process of one ulna [1597].

9.6.2.3 Inflammatory Arthritis (IA)

One possible case of inflammatory arthritis was noted in a single carpal bone [346] exhibiting several scalloped lesions (Figure 100). The term Inflammatory arthritis encompasses a number of diseases such as rheumatoid arthritis and psoriatic arthritis, more specific diagnosis relying on the presence of a distribution pattern (Burgerner *et al.*, 2006, 130)

Figure 100 carpal bone showing multiple scalloped lytic lesions [346].

9.6.2.4 Metabolic diseases

Evidence for metabolic conditions were recorded in the AA and INP age categories as shown in Table 41

	Element	**Pathology**	**n=**	**N**	**%**
AA	Tibia	Osteoporosis? (OP)	1	20	5.00
	Fibula	Osteoporosis? (OP)	1	11	9.09
		Total AA group	**2**	**1101**	**0.18**
INP	Ribs	Vitamin D deficiency (rickets)	9	104	8.65
		Total INP group	**9**	**635**	**1.42**

Table 41 Prevalence rate of metabolic diseases (NISP)

9.6.2.5 Osteoporosis (OP)

Osteoporosis is a disease causing a reduction in bone mineral density. Typically the bone becomes porous due to thinning of the cortical bone and reduction of trabecular bone causing an increased risk of fractures (Agarwal & Glencross, 2010: 197). In the AA group one tibia [361] and one fibula [372] exhibited marked reduction in bone density with the cortical showing dramatic thinning. The general condition of the bone was good suggesting this was not caused by taphonomic processes.

9.6.2.6 *Vitamin D deficiency (Rickets)*

Vitamin D is an essential component in ensuring skeletal health and may be obtained by exposure to sunlight and consumption of certain foods such as oily fish and egg. In sub adults this condition is called rickets whilst in adults the same deficiency is named osteomalacia (Aufdeheide & Rodriguez-Martin, 1998: 305). The manifestation of rickets are typically bending deformities in long bones in children and in neonates and infants the condition may be recognised by significant flaring of the diaphyses and sternal rib ends, cortical porosity and thinning, flattening of the femoral head and tilting of the distal growth plate in the distal tibia (Mays *et al.*, 2006: 364-369). Rickets was not noted in any of the long bones, though it cannot be dismissed that the two cases of suggested congenital syphilis/rubella may be changes associated with rickets. A more certain diagnosis of metabolic disorder was seen in a total of nine ribs in the INP group exhibiting marked flaring and increased porosity of the bone (Figure 101).

Figure 101 ribs of neonate displaying marked porosity and flaring of the sternal rib ends

9.6.3 Trauma

Trauma was noted only in the AA group and was present as both healed and unhealed fractures as well as soft tissue injuries and blunt force trauma. A total of 19 elements were affected including both fractures as well as soft tissue injuries (Table 42). Given the relatively limited amount of fractures a wide array of fracture types were recorded.

	Element	Location	Pathology	n=	N=	%
AA	Fibula	Distal	Healed fracture	1	11	9.09
	Tibia	Mid shaft	Join to form butterfly fracture	3	20	15.00
	Tibia	Distal	Intra articular fracture	1	20	9.09
	Rib	Shaft	Healed fracture	8	330	2.42
	Rib	shaft	Unhealed fracture	3	330	0.91
	Parietal	Left and right	Unhealed blunt force trauma	1	23	0.43
	Tibia	Proximal	Soft tissue injury	1	20	15.00
	Humerus	Distal	Soft tissue injury	1	14	7.14
			Total AA group	19	1101	1.72%

Table 42 prevalence rate of trauma (NISP)

9.6.3.1 *Blunt force trauma*

Skull cap [928] displayed evidence of blunt force trauma on the left portion of the parietal bone, with both the outer and the inner table affected (Figure 102). These types of fractures are most often associated with high velocity impact, with the size and shape of the fracture indicating the nature of the instrument (Aufedeheide & Rodrigues-Martin, 1998: 23). In this case the fracture was circular in nature and measured 35x38mm. Such fractures are most common on the left side, suggesting face to face encounter with a right handed opponent (Aufedeheide & Rodrigues-Martin, 1998: 23). On the right parietal bone there was evidence of radiating fracture lines in the same area this individual had two trepans performed, one along the margin of the skull cap and one slightly further towards the midline and more anterior, this bone had also been severed just posterior of the lower trepan and on either side of the more superior trepan, forming a "keyhole" cut. It appears that at least the lower trepan had been performed prior to removal of the skull cap, but it is unclear whether these trepans were associated with these radiating fractures. These injuries could have been caused both peri-mortem and post-mortem as there was no evidence of healing (Figure 103).

Figure 102 blunt force trauma of parietal bone [928].

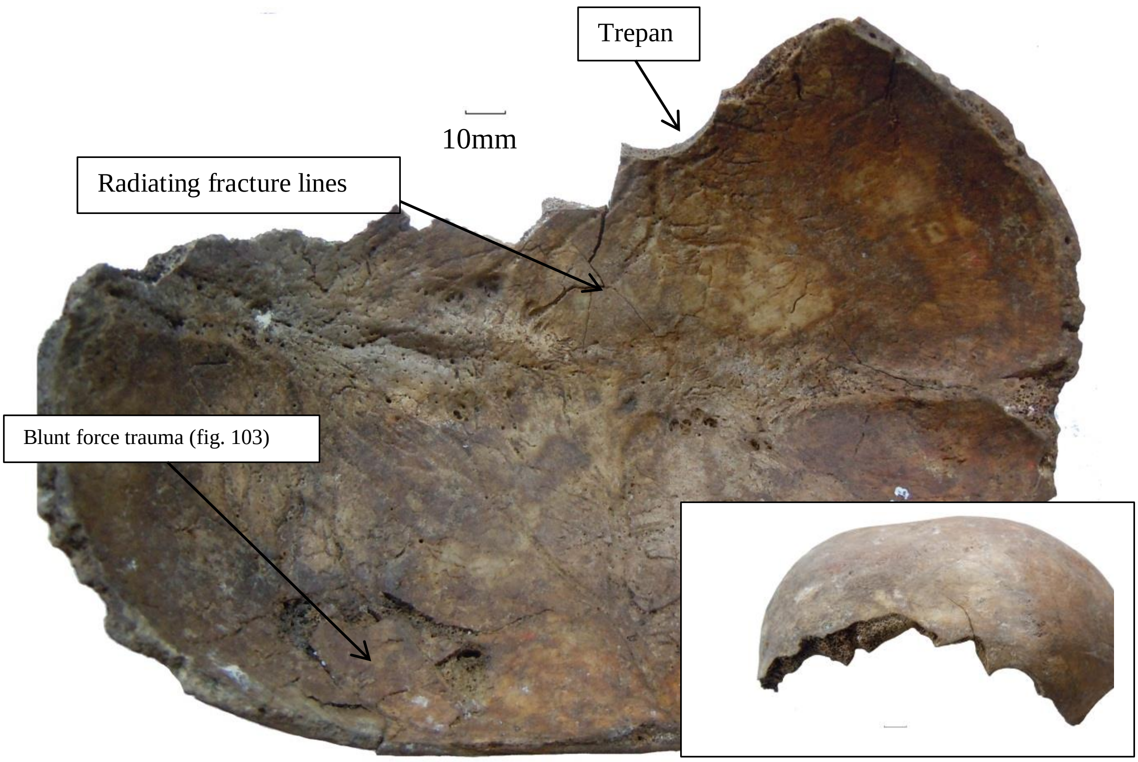

Figure 103 radiating trauma with subsequent trepans and cuts [928] inferior view

9.6.3.2 Butterfly fracture

One right tibia [703/2144/938] exhibited a complex facture on the anterior portion of the mid shaft, usually known as a "butterfly" fracture due to its shape, but basically a comminuted fracture created by two oblique fractures forming a butterfly shaped fragment (Figure 104). These fractures can be complex to heal as the blood supply may have been compromised and a traditional splint would be unable to keep the bones together until healed. There was no evidence of healing on the fracture though this does not mean the individual did not survive some time after the injury as it can take up to two weeks before the bone show any evidence of healing (Aufderheide & Rodrigues-Martin, 1998: 23) and active non-specific periositis around the area of the injury. It is possible that this infection was associated with the injury as one proximal aspect of the bones seemed much less affected than the distal portion but several layers of healed and unhealed bone suggest that the infection may have lasted for some time. The same bone also had a small bony outgrowth (5mm) to lateral of the tibial tuberosity commonly associated with a healed soft tissue injury, but it is uncertain whether this was associated with the fracture. This bone had been severed at the point of the fracture with clear saw marks present on the surface of the loose "butterfly" fragment, which had not been sawn through, with no other part of the bone severed.

Figure 104 mid shaft butterfly fracture on anterior aspect of tibia [703/2144/938]. The area of the fracture displayed clear cutmarks.

9.6.3.3 Tibia Malleolar fracture

One right tibia [1226] displayed a fine incomplete hairline fracture of the posterior malleola extending across the base of the malleola in a medio-lateral direction. Such fractures are most commonly associated with stress fractures, which are not due to a single accident but a series of repeated micro injuries (Bartolozzi & Lavini, 2004: 19). The bone showed no evidence of severing but had been broken during exhumation and it was therefore not possible to ascertain whether the bone had been severed at some point.

9.6.3.4 Healed and un-healed fractures of the ribs

A total of eight ribs exhibited healed fractures and three fragments un-healed rib fractures. A majority of the ribs were small fragments which made the fracture locations difficult to determine. One fracture [1026] was located just anterior of the head. Another fracture [317] was only partially healed and was situated on the mid shaft and had been severed near the location of the injury. Three rib fragments were unhealed, with two fragments joined to form a single rib (Figure 105)

Figure 105 unhealed fracture [380/377] of rib

9.6.3.5 Other trauma

One left distal fibula [1224] exhibited a well healed possible oblique fracture situated above the joint facet, this was matched with a left distal tibia [1227] and it was therefore possible to establish that the injury was confined to the lateral malleolus. Such injuries most commonly occur when the ankle is twisted or rolled. Both the fibula and the tibia had been severed on the distal portion of the shaft.

Humerus [707] had an area of smooth dense bone on the superior lateral aspect of the shaft measuring 9mm medio-laterally and 13mm posterior to inferior. The bone did not exhibit any healing from fracturing and the bone growth was most likely associated with a soft tissue injury such as a muscle rupture of *Pectoralis major*.

One left humerus [956] of a neonate displayed a bony spur on the anterior shaft approximately 15mm from the medial epicondyle (Figure 106), believed to be the result of soft tissue trauma. Another possibility is an anatomical variation found in approximately 1% of the population called a supracondylar spur, thought to be a vestigial formation from a supracondylar foramen, such as seen in felines (Kessel & Rang 1966: 768).

Figure 106 distal left humerus [956] of a neonate with a possible trauma or supracondylar spur

9.6.4 Congenital

One left clavicle [1458] from an adolescent exhibited marked flattening in a superior to inferior direction, possibly associated with spinal deformation such as kyphoscoliosis.

Another possibly congenital condition was seen in the form of two fused ear ossicles (the incus and the malleus) [5343] (Figure 107). Fusion of inner ear bones is rare but can be congenital or due to infection or injury. Fusion impedes vibrations transmitted from the malleus to the incus and incus to stapes resulting in conductive hearing loss. A similar case was discovered in a 19th century male from Saskatchewan, Canada, where a CT-Scan identified fusion of the incus and malleus in association with *Aural artresia* (failure to develop external auditory canal) (Swantson et.al 2013). This condition is congenital and present in 1:10000-20000 and often causes microtia (underdevelopment of the external ear) (Son, 2007: 4).

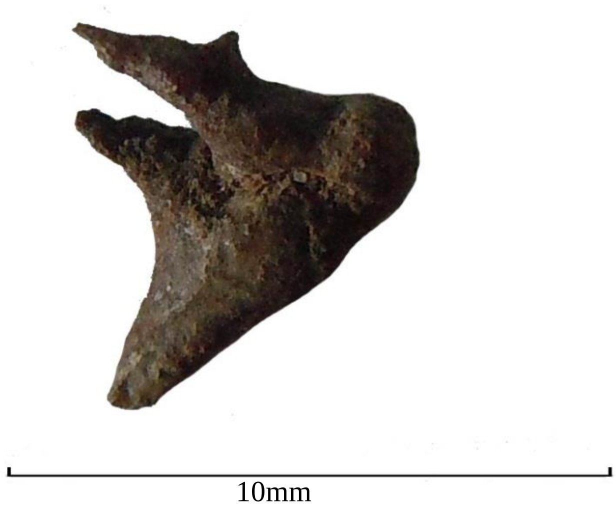

Figure 107 Fused incus and malleus [5343]

9.6.5 Diffuse Idiopathic Skeletal Hyperostosis (DISH)

Diffuse Idiopathic Skeletal Hyperostosis (DISH) could be diagnosed without the presence of complete individuals as it tends to predominantly affect the spine in a very characteristic manner pathognomonic to the disease. DISH is a spinal disease causing ankylosis of the spine by bony fusion along the right anterolateral portion of the vertebrae. This feature is commonly referred to as “candlewax fusion” and do not involve the apophyseal joints and usually commences in the thoracic region of the spine (Aufderheide & Rodriguez-Martin, 1998: 98). The condition is more likely to affect males and is most commonly seen in middle-aged to older individuals (Resnick & Niwayama, 1988: 1563). The cause of this condition has been widely debated and has been linked to obesity in medieval monks (Patrick, 2007), but is not uncommonly seen in post medieval individuals, with a propensity to a higher prevalence rate in “high status” cemeteries such as Chelsea Old Church (Cowie *et al.*, 2008: 48) and Christ church Spitalfields (Molleson & Cox, 1993) at a rate of around 5-6%. At Craven Street a rate of 9.30% (19/181) was recorded, though this rate was recorded by NISP and not by individuals and may therefore be inflated. It was possible to confidently reassemble some of these vertebrae by matching up the “candle wax lesions” as demonstrated in Figure 108, showing at least one individual would have suffered from this condition and two with early signs of the condition, exhibiting ossification of ligaments with early fusion but without involvement of the intervertebral disc space.

Figure 108 Rearticulated vertebra displaying classic changes associated with DISH [bone numbers]

9.6.6 Neoplasms

Two vertebrae from the lumbar region displayed gross bony changes to the right lateral and anterior aspects of the vertebral body. The changes were dominated by osteoblastic activity whilst the integrity of the original vertebrae appears intact. Small rounded lesions in the osteoblastic bone formation were apparent along the left inferior margin suggesting smaller cyst formations (Figure 109).

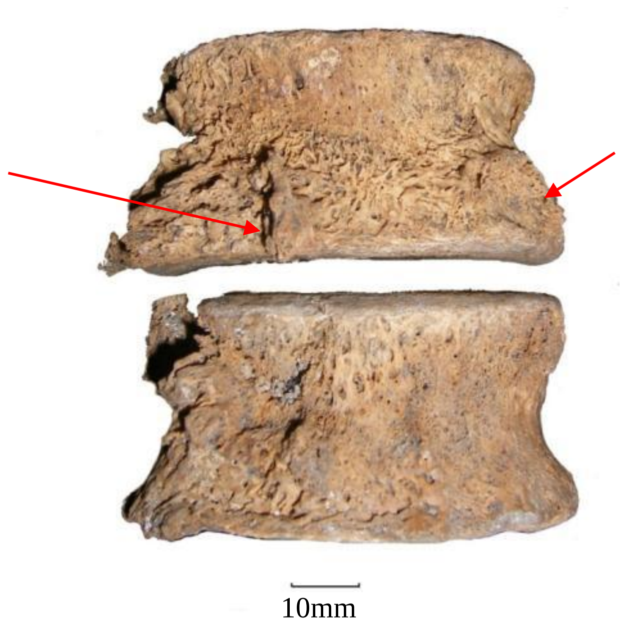

Figure 109 lumbar vertebrae [1371-1372]

A case showing very similar bone changes in the vertebrae has been described in a complete individual at Red Cross Way burial ground in London (Brickley *et al*., 1999). This individual exhibited widespread changes across the skeleton with both osteoblastic and osteoclastic lesions particularly in the vertebrae, pelvis and ribs thought to be bone metastases from prostate cancer. It is not inconceivable that the vertebrae from Craven Street belonged to an individual with similar widespread changes as the extent of the bone formation was very similar. Both vertebrae had been severed through the superior and inferior facets exposing the spinal canal as in a laminectomy.

9.7 Dentition

Dentition may reveal information on the age, health and hygiene of the individuals buried. In a disarticulated context this information is limited to groups of teeth in the maxilla or mandible providing information about an individual without the context of the remaining body. In the context of the anatomy school it was speculated that the teeth may provide different and perhaps more valuable information to the study. From the historical records we know that lectures on dentition were given at Craven Street, albeit in a limited fashion (Falconar, 1777b). It is also known that teeth were frequently traded to dentists to serve as implants for the living. The excavation at IFS (Henderson, 1996: 937) revealed possible evidence of tooth extraction based on four main observations;

- Complete absence of incisors and canines on site
- Breakage of alveoli to buccal, particularly by the deep rooted canines
- Cut marks on anterior portion of alveoli by canine (observed in a single individual)

- Snapped roots (roots left *in situ* whilst crown of tooth missing) constituting failed attempts of tooth removal.

There are inherent problems of detecting evidence of deliberate tooth extraction; As Henderson (1996: 937) quite rightly pointed out, loss of incisors post mortem is commonly seen in an archaeological context and alveolar bone, because it is so thin, is frequently damaged. Henderson argued that a complete absence of incisors and canines was indicative of the tooth extraction process, but culturally there may have been a selection process associated with the extraction of teeth depending on condition of the dentition with a preference for teeth with minimal staining, wear and decay. The only way to detect this was by considering the condition of the remaining teeth.

9.7.1 Dentition (AA group)

It was considered of little value to address the standard questions of social status and health of the population through dentition due to the low number of teeth available and the disarticulated nature of the assemblage rendering ageing and sexing difficult. Conditions such as enamel hypoplasia were not present in the assemblage and no pipe facets were observed. Only the AA group dentition has been included in the analysis below due to the very limited number of teeth in the other age groups.

Table 43 shows the presence of dentition split into incisors, canines, premolar and molars. No distinction was made between left and right as this was not thought to be relevant to this investigation. A total of five maxillae and seven mandibles were counted suggesting dentition from at least seven individuals. Only in one instance was it possible to match the maxillae with the mandibles [1074/1067/1184] a skull of a 15-17 year old individual, the remaining maxillae and mandibles could not be positively matched or confirmed to be from different individuals.

		Incisors	Canines	Premolars	Molars	Total
Maxilla	Present	2	4	6	7	19
	Ante mortem	0	0	4	4	8
	Post mortem	13	3	5	9	30
	Total observable spaces	**15**	**7**	**15**	**20**	**57**
	Not observable spaces	5	3	5	12	25
	Total	35	17	35	52	139
Mandible	Present	3	3	8	12	26
	Ante mortem	3	0	6	12	21
	Post mortem	10	8	7	2	27
	Total observable spaces	**16**	**11**	**21**	**26**	**74**
	Not observable spaces	11	3	6	11	31

	Total	43	25	48	63	179
Loose	Max present	1	2	9	2	14
	Man present	3	0	2	1	6
	Total observable	**4**	**2**	**11**	**3**	**20**

Table 43 AA group dentition

The total number of teeth present was 65 with a relatively even distribution between maxillae (33.33% 19/57) and mandibles (35.14% 26/74). The least represented were the incisors at 13.33% (2/15) in the maxillae and 18.75% (3/16) in the mandibles. The highest prevalence rate of incisor post mortem tooth loss was in the maxillae (86.67% (13/15)) whilst a high post mortem loss in the mandibles was seen in both the incisors (62.50% 10/16) and canines (72.73% 8/11). The overall rate of post mortem tooth loss was 43.51% (57/131) based on number of spaces. Ante mortem tooth loss was predominantly seen in the lower molars (46.15% 12/26) particularly in the first molars (68.75% (11/16) (Figure 110).

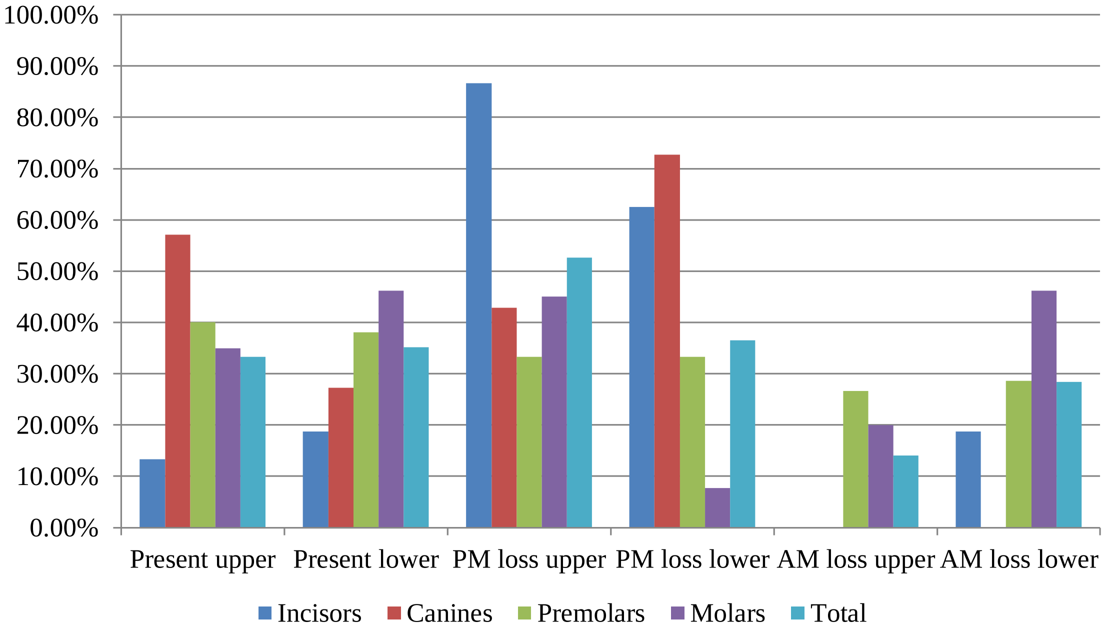

Figure 110 percentage distribution of dentition present lost post mortem and ante mortem.

The significance of this distribution is not immediately apparent, though the high post mortem loss of incisors and canines compared to pre molar and molar dentition may suggest that this was due to pre depositional tooth removal. The low frequency of loose dentition in the assemblage (20) indicates post burial tooth loss may not have been the main cause of dental absence, though the upper layers were disturbed and may have caused some dentition to be removed from site.

It was speculated that the remaining dentition in the maxillae and mandibles may provide some indication of the condition of the teeth that had been lost or removed after death. Table 44 provides a general indication of the condition of the teeth in the mandible and maxillae. The loose dentition exhibited extensive caries in at least five teeth whilst caries were also present in two maxillae and one mandible with a total of eight teeth affected or 11.76% (8/68). At least two maxillae had caries with associated abscesses and the presence of maxillary sinusitis [654] and [921] (Figure 67). Broken roots were only noted in one individual [921] in the area of the left first premolar.

	Bone no.	**Age**	**Sex**	**Present**	**PM loss(no of teeth)**	**AM loss (no of teeth)**	**Caries**	**Alveolar resorption**	**Calculus**	**Wear**	**Alveoli bone loss**	**Root present**
Maxilla	[63/285]	AA	F	6	3	1	2	0	0	0	yes	no
	[654]	AA	n/a	2	6	0	3	0	0	0	no	no
	[921]	AA	n/a	3	8	5	0	1	0	2	yes	p3
	[1100]	AA	n/a	5	3	4	0	0	0	2	yes	no
Max/man	[1067/1074] [1184]	15-17 yrs	F?	10	14	5	0	0	1	0	yes	no
Mandible	[153/1580]	AA	M	4	3	9	0	3	1	2	yes	no
	[1552]	AA	F	2	10	2	0	0	0	0	yes	no
	[1101/1009]	AA	M	6	4	6	0	2	1	3	no	no
	[293]	AA	M	7	0	0	1	0	1	2	no	no
	[1103]	AA	M	0	0	0	n/a	n/a	n/a	n/a	n/a	n/a
	[1097]	AA	M	1	7	3	0	n/a	0	1	n/a	no
Loose	Maxilla	n/a	n/a	14	14	n/a	5	n/a	2	3	n/a	n/a
	Mandible	n/a	n/a	6	6	n/a	0	n/a	1	1	n/a	n/a
	Unknown	n/a	n/a	2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Total				68	78	35	8					

Table 44 condition of dentition in mandibles and maxillae (Resorption/caries/calculus 0= none, 1=mild, 2=medium. 3=extensive (loose teeth were recorded as number of teeth present))

The presence of calculus was noted in four mandibles and three loose teeth, in all but one case these were recorded as mild, one loose premolar had extensive calculus present on the lingual portion. Dental wear was recorded as medium to extensive in two maxillae and three mandibles as well as in four loose teeth, with “medium” constituting dentition with exposure of dentine and “extensive” being exposure of dentine on the whole occlusal surface. The wear appeared dependent on absence of other dentition as extensive ante-mortem tooth loss resulted in heavy wear of the remaining dentition and is therefore less likely to be an indicator of cultural variations.

The high post-mortem tooth loss in [1552] (Figure 111) of a young female was of interest; only the two second molars remained, with the two first molars lost ante mortem. The two sockets of the canine dentition displayed breakage on the buccal aspect of the alveoli bone. The condition of the second molars was excellent, perhaps indicating the dentition lost post mortem may have been in sufficiently good condition to be extracted for selling.

Figure 111 Mandible [1552] (young female) showing complete anterior post-mortem tooth loss.

Maxilla [63] (Figure 112) also had post mortem loss of the anterior dentition, and though caries were present in two remaining teeth the teeth were white and in overall good condition with minimal wear. The anterior margins of the alveoli bone of the incisors lost post mortem had fine chipmarks along the margins and breakage to buccal, perhaps indicating post mortem tooth extraction rather than tooth loss (Figure 112).

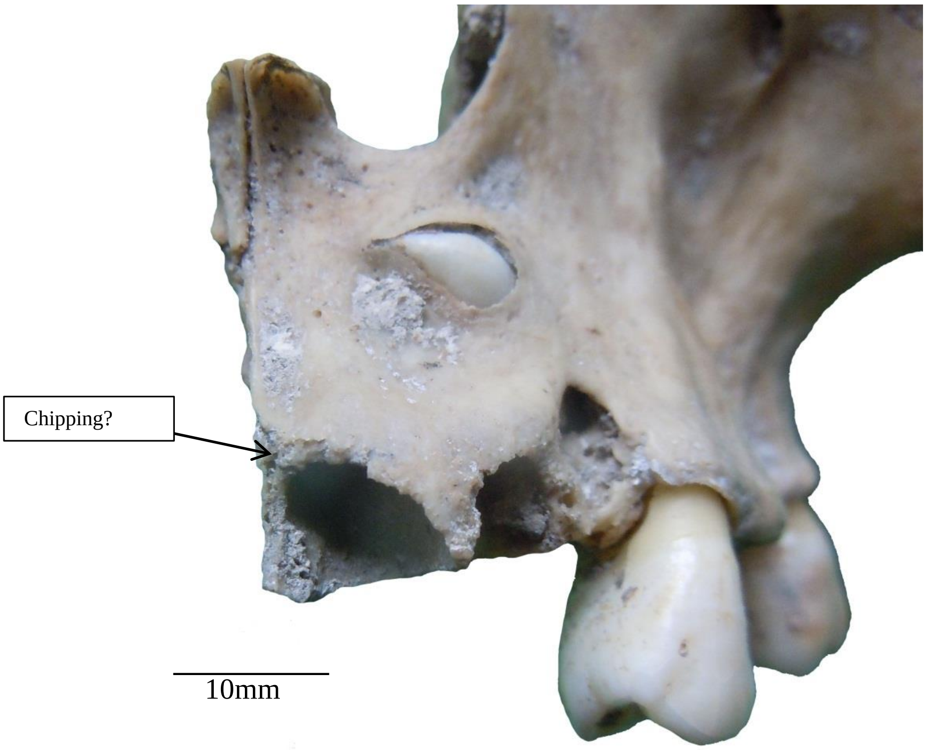

Figure 112 left maxilla [63] with possible deliberate tooth removal of the anterior dentition, displaying possible "chip" marks along the margins. This individual also had an impacted canine.

In cases where anterior dentition was present they exhibited moderate to extensive tooth wear, which would presumably have made them much more difficult to sell. It is a tentative suggestion that tooth extraction may have taken place as this model has not been tested. Taphonomic factors strongly affect the reliability of results, none the less it is an issue rarely addressed in this type of context, perhaps for this reason, but a topic worth considering.

9.8 Comparative sites

A total of eight sites were selected for comparison with the human skeletal remains. These sites offered a varying degree of details and have not been consistently included in all considerations. Three sites were considered to be extramural anatomy schools, in that they were not directly associated with a hospital but were purely teaching establishments; Medical College Georgia (MCG), Trinity College Dublin (TCD) and the Ashmolean Museum (ASM). The other five sites were excavated on hospital grounds; Royal London Hospital (RLH), Newcastle Royal Infirmary (NRI), Bristol Royal Infirmary (BRI), Worcester Royal Infirmary (WRI) and 13 Infirmary Street (IFS). For further overview of the sites see section 8.2.

9.8.1 Body part distribution

The overall specimen number (NISP) was compared in Figure 113 to the specimen numbers from WRI and MCG. The comparative distribution of fragments was broadly similar across the sites, although the fewer long bones but slightly more skulls (15.7%) and vertebrae (18.9%) were present. The higher number of skull and vertebrae fragments may however be explained by the higher presence of very young individuals which would see the NISP count increase dramatically in these body portions; in the skull due to higher fragmentation and in the vertebrae due to lack of fusion of the laminae to the body. Figure 114 shows the same site comparison but exclude the sub adult groups, showing a more equal distribution of skull fragments. Fragmentation of adult skulls was due to activities at the anatomy school, likely accounting for the high rate of skull specimens (8.4%) compared to say long bone specimens (ranging from 0.6% to 1.9%). The relative distribution amongst the anatomical groups was very similar on all three sites, with a high percentage of ribs (CVS: 31.2%, WRI: 27.1% and MCG: 18.7%), vertebrae (CVS: 20.2%, WRI: 9.2% and MCG: 12.3%) and skulls (CVS: 8.4%, WRI: 5.6% and MCG: 7.2%). Interestingly Craven Street and Medial College Georgia had a higher prevalence of hand bones whilst WRI saw a higher proportion of long bones, which may be a reflection of the nature of the sites.

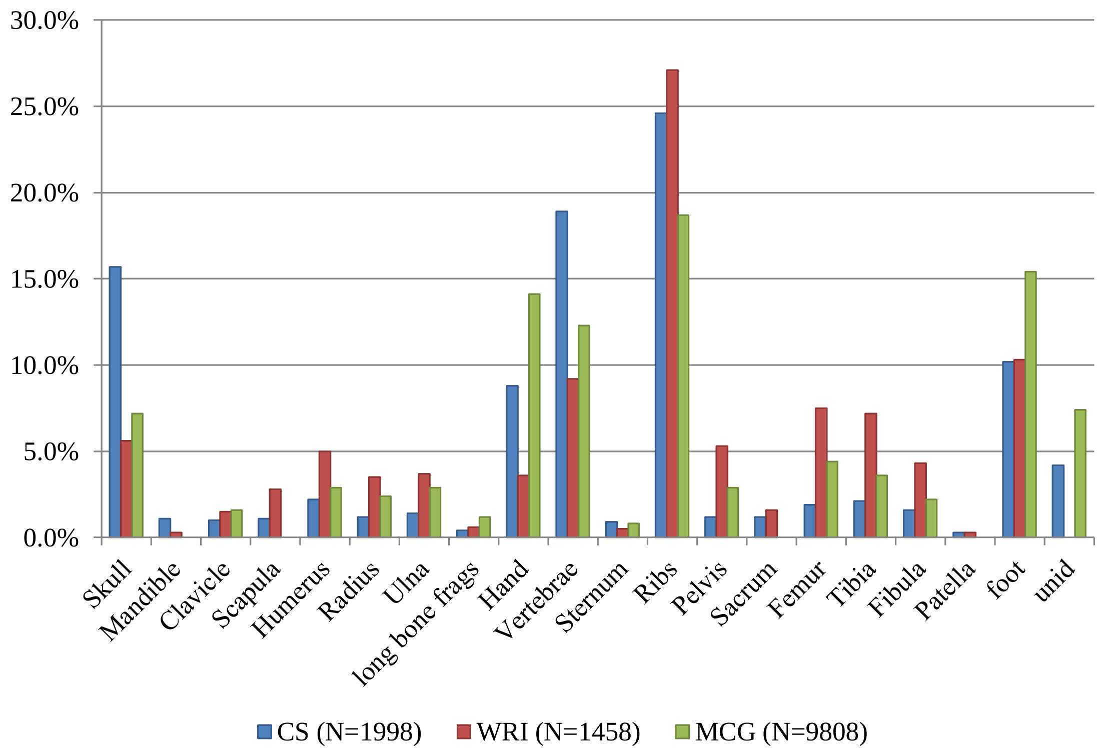

Figure 113 Percentage distribution of number of identified specimens (NISP) from the whole of CVS compared with WRI and MCG. (No information was available from MCG on scapulae, mandibles, sacrum and patellae)

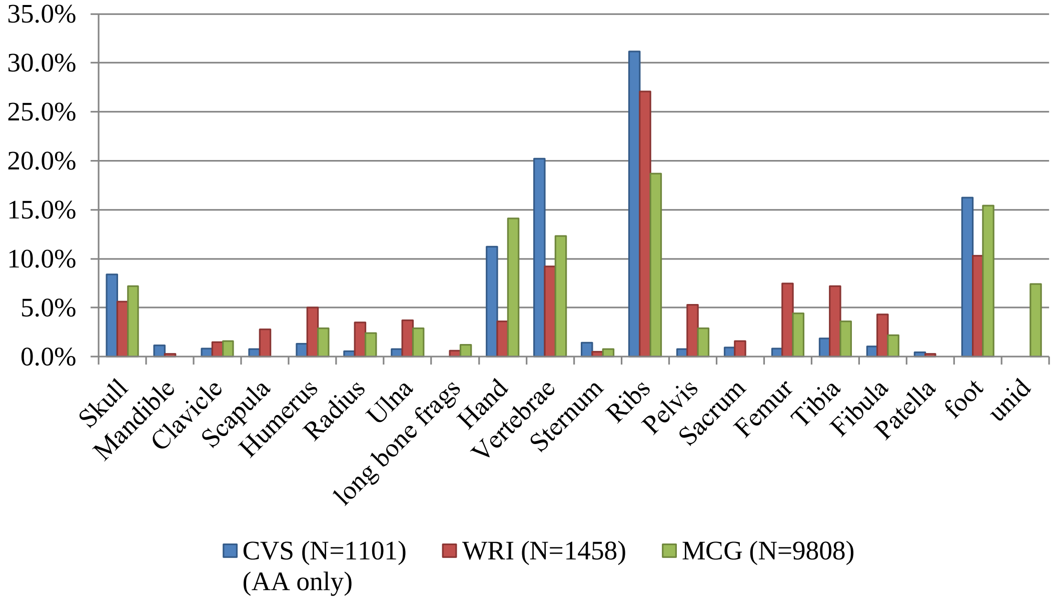

Figure 114 Percentage distribution of number of identified specimens (NISP) from CVS AA group compared with WRI and MCG. (No information was available from MCG on scapulae, mandibles, sacrum and patellae)

9.8.2 Age distribution

Age at death distributions in traditional cemeteries is very different depending on whether the source is historical or archaeological. Historical sources from 1750s-1780s (chapter 3) suggested a very high child death rate (50%), particularly infants (<2 years) (35%). Archaeological excavations tend to reveal substantially less children compared to historical sources much to the bewilderment of the archaeologists. It is commonly acknowledged that child bones are significantly more affected by taphonomic factors than adult bones but this alone does not explain the lack of children (Robertson and Cox 2003, 303).

The eight comparative hospital sites revealed a high proportion of adult remains on all sites (Figure 115). This was in stark contrast to the findings at Craven Street anatomy school, which saw a higher proportion of children (53.62% (15/28)) with 73.3% (11/15) less than one year old.

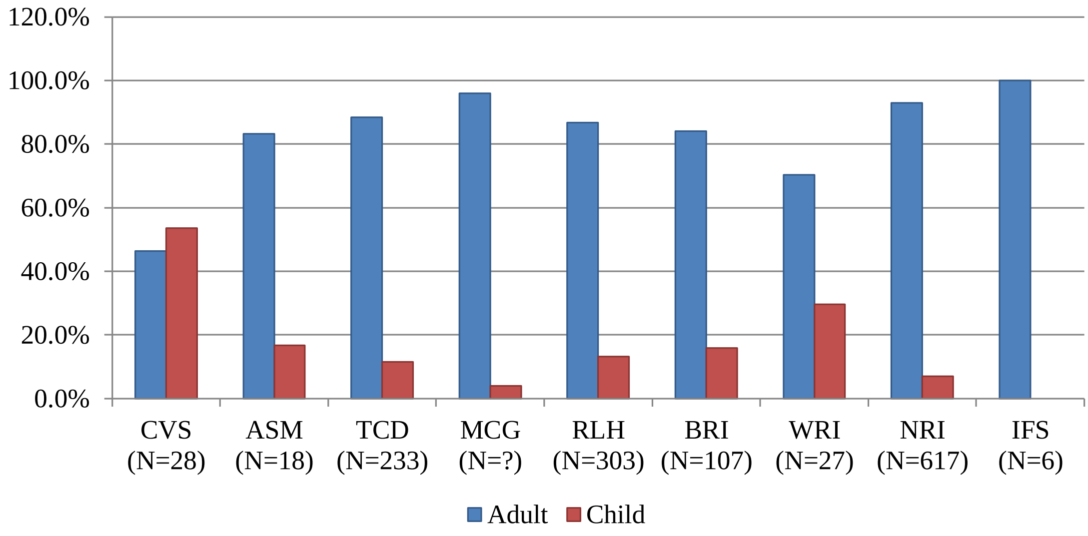

Figure 115 percentage distribution adult and children from excavations associated with anatomy schools

9.8.3 Sex distribution

In an anatomy school context a higher percentage of males would be expected as these were favoured for anatomical demonstration, if assumed that the assemblage is representative of the demographic profile brought to the anatomy school. This assumption is not entirely true as a number of factors could have affected the sex distribution depending on the true nature of the site. Though they were all the remains associated with hospital anatomy schools, the distribution of gender may have been influenced by the type of patients associated with the hospitals or the nature of the subjects taught at the school. TCD suggests a large proportion of the teaching involved midwifery and therefore saw a higher percentage of females than males. At BRI the findings were mainly associated with surgical waste and autopsies and therefore the sex distribution reflected the number of these procedures carried out on males (Figure 116).

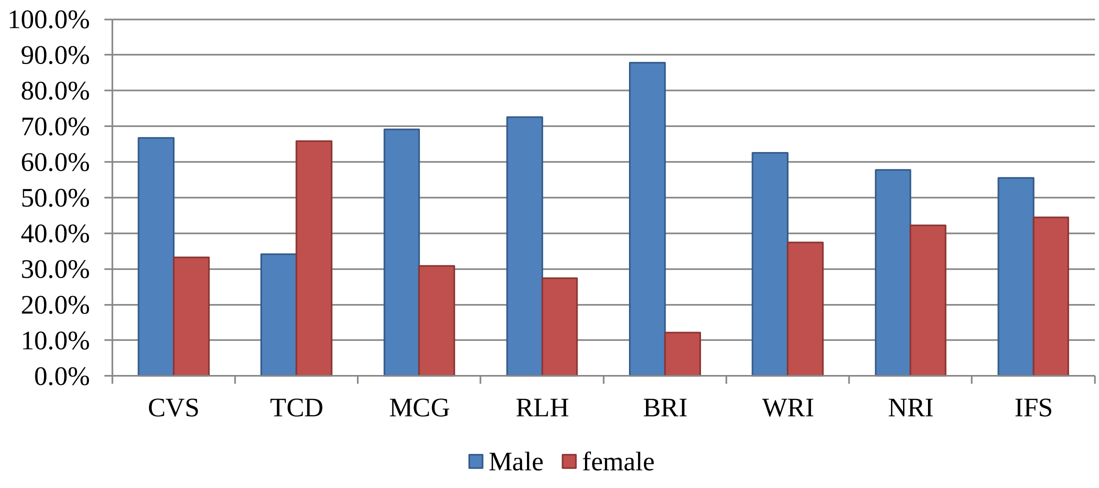

Figure 116 percentage distribution males and females from excavations associated with anatomy schools

9.8.4 Pathologies

Comparatives of pathological data between sites proved very difficult due to the manner in which they were presented. It seemed futile comparing crude prevalence rate of articulated individuals with a disarticulated assemblage as this would have been based on two very different datasets. Even using the true prevalence rate (calculated against specific bones present) the data would have been skewed due to the likelihood of more accurate diagnoses in articulated individuals. This section draws out some main points made on pathological observation amongst the different sites. It is also of note that Craven Street saw a high proportion of the individuals less than one year old, whilst comparative sites saw a much higher frequency of adults and only a small number of children and infants, this in itself would cause a discrepancy in pathological representation.

Inflammations were of interest in the long bones due to the likelihood of being associated with amputations. Non specific inflammations such as periositis and less so osteomyelitis are most commonly seen in tibiae. The rate of periosteal reactions in the tibiae was high in a number of hospital sites (TCD/10.05%, WRI/30.9%, BRI/28.97%, NRI/16.70% and RLH/33.8%).Osteomyelitis and osteoitis was recorded at a much lower rate (BRI/0.93% and NRI/0.53%). Witkin (2011: 180) compared the results with post medieval lay cemeteries and found though that though the rate of infection was high it was still within the range of lay cemeteries. Western (2011: 70) noted that according to surgical literature of the time, amputation was only recommended in the most severe cases, but this was not reflected in the osteological assemblage where several severed bones did not exhibit any significant pathology. It is naturally possible that prior to amputation it was only the soft tissue that was affected. Western and Bekvalac (2011) examined 76 bisected bones and noted the majority were “moth-eaten” or “permeative” indicative of chronic or acute osteomyelitic infections, which would have required amputation. Compared to the other sites Craven Street saw a relatively low prevalence rate of inflammation on the tibiae (15%), but also still within the normal range for lay cemeteries. Unfortunately rates could not be calculated for ASM and MCG due to the data available, but it was noticeable that TCD as the only other extramural anatomy school had a lower rate than the intramural schools.

Specific infection such as tuberculosis and treponematosis were identified on most sites in low numbers. These were mainly identified in the articulated assemblage (RLH/1.7%TB and 4.6% treponemal, NRI/1.0% TB). The disarticulated or both assemblages provided very low figures (MCG/1 bone TB/2 bones treponemal, BRI/6 bones TB and 21 bones treponemal, WRI/2 bones TB and 5 bones treponemal). None were identified at TCD or Craven Street. It is immediately apparent that the prevalence rate decreases in disarticulated assemblages for two reasons; they are harder to identify and they are calculated against a much larger number of bones rather than individuals.

Trauma was another reason for hospitalisation and possible amputation in case of complex fractures. Fracture rates were variable (MCG/0.21% (disarticulated), TCD/5.2% (inhumations), RLH/35.6% (inhumations), BRI/23.33% (articulated), NRI/1.4% (all skeletal remains). Both RLH and BRI had a relatively high fracture rate but only a very small proportion of these were unhealed and likely to be the reason for hospitalisation or amputation. Unhealed fractures at RLH had a prevalence rate of 2.4% and at WRI the rate was as low as 0.32%.

A number of other conditions were recorded across most of the sites such as DISH, rickets and neoplasms in low numbers and a relatively high proportion of joint diseases were also recorded.

9.8.5 Interventions

The crania and the mandibles were the most frequently affected elements in the skeleton. Table 45 shows the presence of cuts performed. The variation in cuts was high at the anatomy schools not directly associated with hospitals; such variation was also noted at RLH and WRI. Some cuts were standard, such as removal of the skull cap, occipital wedge, orbital wedges, mandibular mentum and mandibular ramus cuts; all associated with standard procedures of dissections. Hospital sites such as BRI and NRI with assemblages predominantly associated with autopsies and surgical waste did not produce any occipital wedges, suggesting these were mainly associated with dissection and not with autopsies. Some cuts were specific to Craven Street, such as the diamond cuts oblique cap cut and the maxillary horizontal cut. It is of interest that the two former were only performed on children.

Though trepans were noted in the majority of sites, Craven Street was unique in their frequency with 18 trepans performed on five individuals. Most of the other sites had relatively few (TCD/2, MCG/2, RLH/3, NRI/3, WRI/1, BRI/1).

Alterations of the skull	**CVS**	**MCG**	**TCD**	**RLH**	**BRI**	**WRI**	**NRI**	**IFS**
Calvarium cut	x	x	x	x	x	x	x	x
Occipital wedge	x	x	x	x		x		
Orbital wedge	x	x		x		x	x	
Over nose cut	x			x				
Sagittal plane	x		x	x				
coronal plane			x					
temporal (auditory/mastoid)		x	x				x	

trepan	x	x	x	x	x	x	x	
Trepan w cuts	x					x		
mandibular mentum	x	x	x	x		x		
mandibular ramus	x	x	x	x		x		
Mandibular lateral body			x	x				
Diamond cut	x							
Oblique cap	x							
Maxillary horizontal cut	x							
zygomatic transverse	x	x						
zygomatic longitudinal		x		x				

Table 45 presence of cuts affecting the cranium and mandibles

The location of bisectioning of long bones was recorded in the majority of sites (Table 46). Comparing the sites, the two sites (BRI and NRI) believed to represent predominantly surgical waste exhibited very precise patterns compared to the other sites. At BRI all humerie had been severed to distal and at BRI and NRI the femora had rarely been severed to proximal whilst the tibiae were predominantly severed to proximal. The data from the other sites, including Craven Street provided a much less clear pattern.

Long bone	CVS	MCG	TCD	WRI	BRI	NRI	RLH
Hum P	16.7%	13.3%	34.7%	0.0%	0.0%		22.5%
Hum M	83.3%	33.3%	26.5%	40.0%	0.0%		40.4%
Hum D	0.0%	53.3%	38.8%	60.0%	100.0%		37.1%
Rad P	20.0%	22.2%	24.1%	0.0%	0.0%		42.9%
Rad M	40.0%	55.5%	45.3%	100.0%	0.0%		42.9%
Rad D	40.0%	22.2%	31.0%	0.0%	100.0%		14.2%
Uln P	0.0%	13.3%	12.5%	50.0%	0.0%		33.3%
Uln M	60.0%	66.7%	75.0%	0.0%	0.0%		55.6%
Uln D	40.0%	20.0%	12.5%	50.0%	100.0%		11.1%
Fem P	20.0%	7.1%	23.6%	21.7%	0.0%	9.0%	
Fem M	60.0%	75.0%	22.0%	34.8%	46.2%	42.0%	
Fem D	20.0%	17.9%	54.3%	43.5%	53.8%	49.0%	
Tib P	30.8%	16.7%	45.9%	66.7%	78.9%	81.0%	
Tib M	15.4%	83.3%	12.5%	28.6%	15.8%	15.0%	
Tib D	53.8%	0.0%	41.8%	4.8%	5.3%	4.0%	
Fib P	30.0%	60.0%	27.0%	20.0%	60.0%		
Fib M	0.0%	20.0%	17.0%	60.0%	20.0%		
Fib D	70.0%	20.0%	55.0%	40.0%	20.0%		

Table 46 percentage distribution of cut locations for long bones

Table 47 shows the cuts present in the post cranial skeleton other than the long bones. It was noticeable that Craven Street and BRI were the only sites where the clavicles had not been severed. Transverse cuts across the manubrium was also seen at MCG and TCD and the three cut locations on ribs were also noted at RLH and TCD and most likely also WRI, where cut to sternal were not noted but most likely performed by cutting the cartilage.

Transverse cuts were noted in the cervical and upper thoracic regions of the vertebrae, suggesting removal of the head. The majority of sites also exhibited transverse cuts of the lumbar vertebrae, a feature not seen at Craven Street. Cuts to the laminae for exposure of the spinal cord were noted in thoracic vertebrae from MCG, RLH, WRI and Craven Street, with all cuts performed on either side of the spinous process. The lumbar region had been cut in a similar manner at RLH and WRI, and whilst removal of the laminae was also seen at Craven Street these were performed differently (section 9.5.3.1). Cuts to the pelvis and sacrum were noted on most sites with a sagittal bisection of the sacrum. Most noticeable in the comparative data was the wider variety of cuts at the anatomy school sites.

Post cranial alterations	CVS	TCD	MCG	RLH	BRI	WRI	NRI	IFS
Clavicle (Sagittal)		x	x	x		x	x	x
Scapula (Transverse)		x						
Scapula (sagittal)		x				x		
Sternum			x				x	
Sternum (Transverse)	x	x	x					
Sternum (Sagittal)	x	x	x	x				
Sternum (Oblique)				x				
Ribs						x	x	
Ribs head	x	x		x		x		
Ribs middle	x	x		x		x		
Ribs sternal	x	x	x	x	x			
cervical			x	x				
cervical (transverse)	x		x			x		
Cervical (Sagittal)			x					
Cervical (Lamiae)				x		x		
thoracic			x	x				
Thoracic (transverse)	x	x	x	x		x	x	
Thoracic (sagittal)		x				x		
Thoracic (Coronal)	x					x		
Thoracic (laminae)	x		x	x		x		
Lumbar			x	x				
Lumbar (Transverse)		x	x			x	x	
Lumbar (Sagittal)	x	x						
Lumbar (Coronal)								
Lumbar (Laminae)	x			x		x		
sacrum (sagittal)	x	x		x		x	x	
Sacrum (Transverse)		x						
Pelvis/hand/foot								
Pelvis (Illium and ischium)	x	x	x	x		x	x	
Pelvis (pubis)	x	x	x	x		x		

Hand (Carpals)								
Hand (MC and phalanges)			x	x				
Foot (tarsal)	x		x	x		x		
Foot (MT and Phalanges)	x		x	x				

Table 47 post cranial modification (not including limb bones)

10 Results – faunal skeletal assemblage

This chapter presents the results of the analysis of the faunal skeletal remains. Though the recording was carried out in a similar manner to the human remains the results differed significantly in nature and have therefore been presented in a different format.

Species identified have been summarised in Table 48, each of which have been discussed separately in the subsequent text. A total of 1732 skeletal elements were categorised as being faunal with a calculated MNE of 911 and an MNI of 43. The largest NISP group were mammals (59.70% (1034/1732)) followed by birds (25.92% (449/1732)), fishes (8.49% (147/1732), reptiles (3.87% (67/1732) and amphibians (1.10% (19/1732)). faunal assemblages were analysed at three other medical school with the distribution summarised in Table 48.

Each taxonomic group was discussed individually under sections of classifications; mammals, birds, fish, reptiles and amphibians with a presentation of data from other comparative sites (Table 49).

Class	Order	Family, Genus and species	NISP	%	MNE	%	MNI	%
Mammalia	Carnivore	*Canis familiaris (sp.)*	283	16.34%	222	24.37%	4	9.30%
		Felis domesticus(sp.)	297	17.15%	248	27.22%	5	11.63%
	Artiodactyla	*Bos taurus (sp.)*	8	0.46%	6	0.66%	1	2.33%
		Sus scrofa (sp.)	4	0.23%	3	0.33%	1	2.33%
		Cervus elaphus(sp.)	11	0.64%	11	1.21%	1	2.33%
		Capra/Ovis (sp.)	99	5.72%	50	5.49%	4	9.30%
	Perissodactyla	*Equus (sp.)*	4	0.23%	4	0.44%	1	2.33%
	Lagamorpha	*Leporidae (family)*	3	0.17%	3	0.33%	2	4.65%
	Rodentia	*Sciuridae (family)*	1	0.06%	1	0.11%	1	2.33%
		Acomys (genus)	1	0.06%	1	0.11%	1	2.33%
		Rattus norvegicus(sp.)	8	0.46%	8	0.88%	2	4.65%
	Large mammal		14	0.81%				
	Medium mammal		154	8.89%				
	Small mammal		94	5.43%				
	Unidentified		53	3.06%				
Aves	Ansiformes	*Anas platyrhynchas(sp.)*	264	15.24%	160	17.56%	4	9.30%
		Anatidae(fam)	17	0.98%				
	Galliformes	*Gallus gallus domesticus(sp.)*	7	0.40%	6	0.66%	2	4.65%
		Meleagris (sp.)	3	0.17%	3	0.33%	1	2.33%
	Columbiformes	*Columba palumbus(sp.)*	7	0.40%	7	0.77%	1	2.33%
	Falconiformes	*Haliaeetus albicilla (sp.)*	3	0.17%	3	0.33%	1	2.33%
	Unidentified		148	8.55%				
Pisces	Salmoniformes	*Salmon solar (sp.)*	18	1.04%	17	1.87%	1	2.33%
	Carcharhiniformes	*Galeorhinus galus (sp)*	9	0.52%	9	0.99%	1	2.33%
		Elasmobranchii (subclass)	84	4.85%	84			
	Pleuronectiformes	*Scophthalmus sp.*	8	0.46%	8	0.88%	2	4.65%

	Clupediformes	*Clupedia (fam)*	1	0.06%	1	0.11%	1	2.33%
	Gadiformes	*Gadidae (fam)*	1	0.06%	1	0.11%	1	2.33%
	Osteoichthys	*unidentified bony fish*	8	0.46%		0.00%		0.00%
	Unidentified		18	1.04%		0.00%		0.00%
Reptilia	Testudines	*Chelonia mydas (sp.)*	66	3.81%	55	6.04%	1	2.33%
		Gopherus (Genus)	1	0.06%	1	0.11%	1	2.33%
Amphibia	Anura		19	1.10%	19	2.09%	3	6.98%
unidentified			16	0.92%				
			1732		**911**		**43**	

Table 48 Distribution of faunal remains

Classification	**CVS**		**RLH**		**ASM**		**MCG**	
	NISP	%	NISP	%	NISP	%	NISP	%
Mammals	1034	59.70%	1869	94.68%	843	98.94%	170	57.24%
Birds	449	25.92%	31	1.57%	8	0.94%	80	26.94%
Fish	147	8.49%	54	2.74%	1	0.12%	3	1.01%
Reptiles	67	3.87%	19	0.96%	0	0.00%	3	1.01%
Amphibians	19	1.10%	1	0.05%	0	0.00%	0	0.00%
Other (invertebrates)	0	0.00%	0	0.00%	0	0.00%	5	1.68%
Unidentified	16	0.92%	0	0.00%	0	0.00%	36	12.12%
Total	1732		1974		852		297	

Table 49 overview of the distribution of the faunal assemblage at other medical schools

Overall skeletal completeness was excellent, the highest fragmentation seen in mammals, followed by birds and fishes (Figure 117). Further remarks on skeletal completeness has been discussed in association with the individual animals

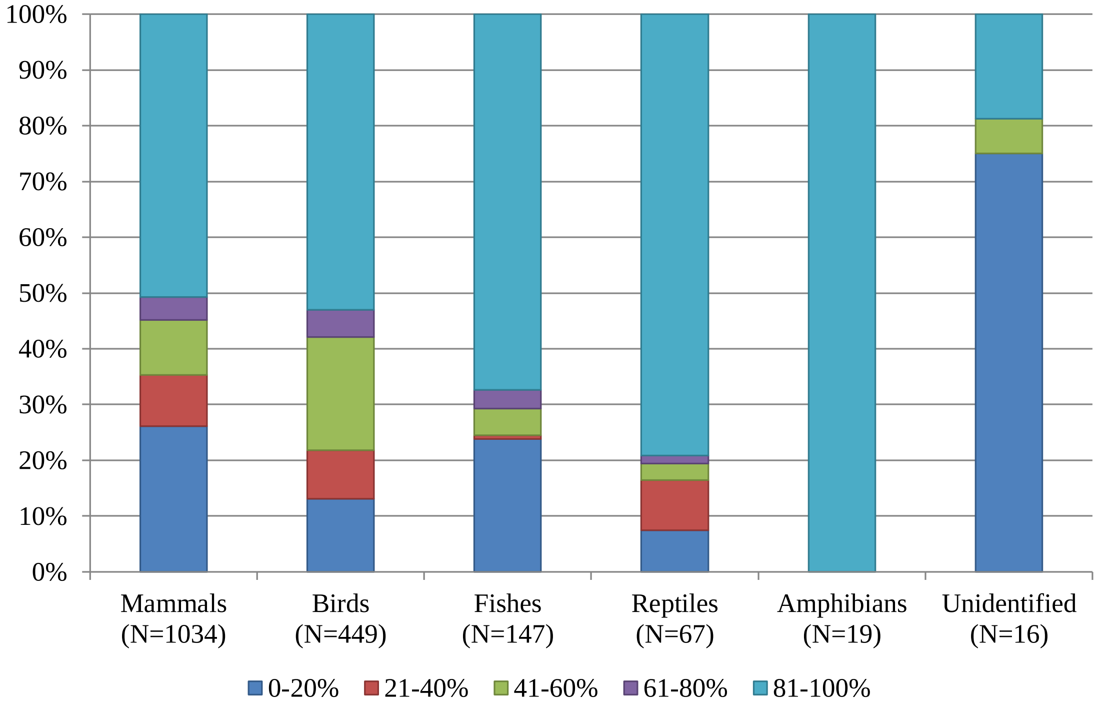

Figure 117 percentage skeletal completeness by class

10.1 Mammals

Mammals were the dominant classification of animals with a total of 1034 fragments placed in this category. The orders represented were all from subclass *eurtheria* and included; *Carnivore* (cat and dog), *Artiodactyla* (sheep/goat, cattle, pig, cow and red deer), *Perissodactyla* (horse/donkey), *Lagamorpha* (rabbit) and *Rodentia* (mouse, squirrel and rat). The representation of these was very varied and heavily dominated by cat and dog. The variation in number of elements was strongly influenced by the partial articulation of the carnivores. Recovery of smaller species may have been hampered by the nature of the excavation and identification of disassociated non-species specific fragments also affected the distribution of elements (Table 50).

Order	*Carnivore*				*Artiodactyla*								*Perissodactyla*		*Lagamorpha*		*Rodentia*					
Genus	*Canis*		*Felis*		*Ovis/Capra*		*Bos*		*Sus*		*Cervus*		*Equus*		*Leporidae*		*Scuridae*		*Acomys*		*Rattus norvegicus*	
	NISP	MNE	NISP	MNE	NISP	MNE	NISP	MNE	NISP	MNE	NISP	MNE	NISP	MNE	NISP	MNE	NISP	MNE	NISP	MNE	NISP	MNE
skull	10	3	27	2	3	2					1	1										
mandible	6	4	8	6							1	1							1	1		
teeth	44	44	13	13			1	1			8	8	1	1								
cervical	9	9	10	10	2	2																
thoracic	25	18	35	31	6	5																
lumbar	12	10	35	34	2	1	1	1							1	1						
caudal	10	10	25	21			3	2					2	2								
ribs	40	24	13	12	46	12																
sternum			1	1																		
pelvis	8	5	5	5	9	3									2	2					1	1
humerus	8	4	7	6	2	2			3	2					1	1					2	2
radius	6	4	5	5	4	2																
ulna	5	4	7	7	2	2															1	1
carpals	8	8	3	3	3	3																
femur	8	4	5	5	3	2	2	1													2	2
Tibia	9	5	5	5	7	5															1	1
fibula	0	0	1	1																		
Phalanges	28	28	49	46			1	1														
calcaneum	2	2	1	1	4	4																
metapodials	18	18	25	25	1	1							1	1								
baccula	1	1																				
patella	2	2																				
premaxilla	1	1									1	1										

sacrum	4	4	2	2																		
scapula	3	3	4	3	2	1			1	1							1	1			1	1
tarsals	1	1			2	2																
talus	2	2			1	1																
vertebrae	13	4	11	4																		
Total	**283**	**222**	**297**	**248**	**99**	**50**	**8**	**6**	**4**	**3**	**11**	**11**	**4**	**4**	**4**	**4**	**1**	**1**	**1**	**1**	**8**	**8**

Table 50 anatomical distribution of mammals

10.1.1 Dog (*Canis familiaris*)

Dog was the second most abundant species of mammals, with a total of 283 fragments were present making up an MNE of 222 elements and a minimum number of four individuals. Dog was predominantly recovered from the primary layers (19) (65.72% (186/283)). One dog was at least partially articulated in layer (19). There was very limited evidence of any pre-depositional modifications and the overall skeletal completeness was excellent with 74.80% of the elements 80-100% complete.

Figure 118 shows the distribution of the minimum number of elements. The MNI was calculated by the presence of four first sacral vertebrae, number of lumbar vertebrae and by visually matching the elements based on size and fusion.

The large number of teeth, feet and vertebrae naturally reflects their higher element representation in the body. The true distribution clearly indicated a relatively even distribution of elements, with the presence of at least one complete dog.

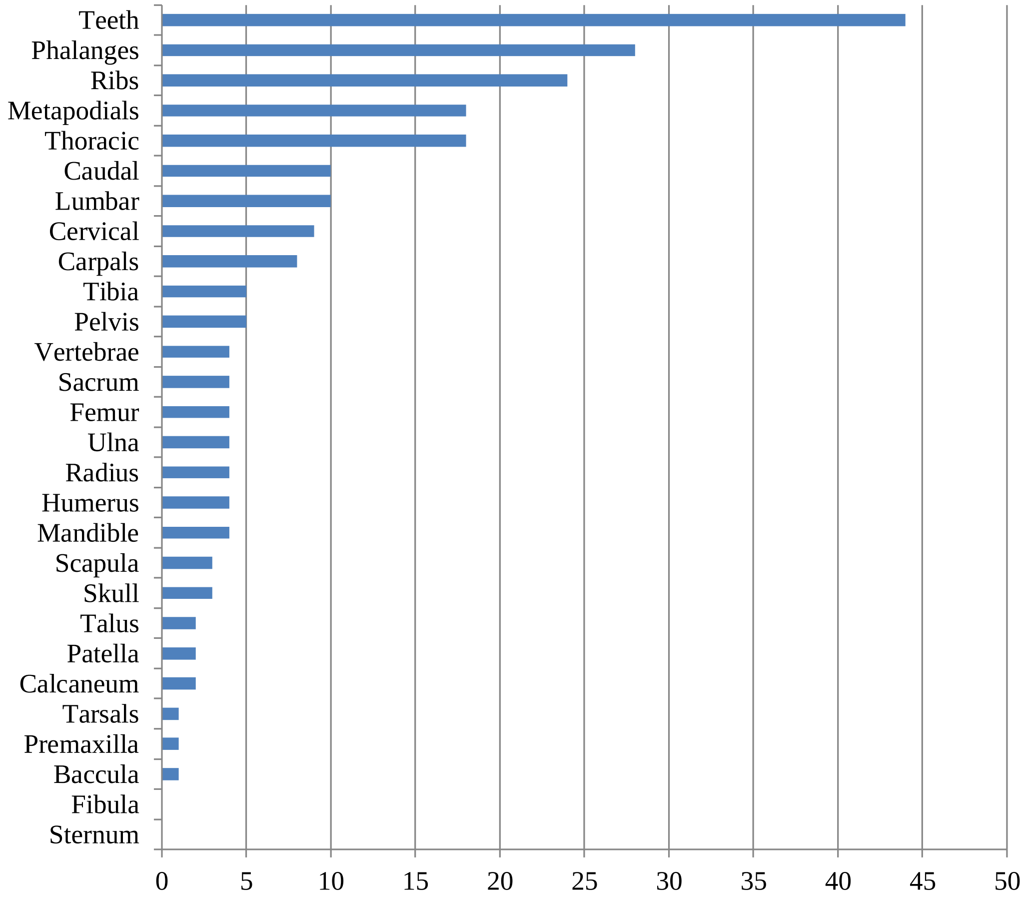

Figure 118 minimum number of elements (MNE) for dog.

The age distribution showed at least three of the four dogs were of immature age, only one fully fused proximal femur confirmed the presence of one individual of more than 18 months. The articulated dog had an estimated age of ~18 months based on partially fused proximal femora and tibiae and two dogs were estimated to be between 10-15 months based on the humerie and ulnae.

	Age of fusion	**FF**	**JF**	**UF**	**MNI**	**% FF**
Pelvis (Main body)	6 mos	2		3	3	
Scapula (bicipital tuberosity)	6-7 mos			1	1	
1st phalanx (D)	7 mos	2				
2nd phalanx (D)	7 mos	4				66.7
Metacarpus (D)	8 mos	15			2	
Humerus (D)	8-9 mos	2			2	
Ulna (Olecraneon)	9-10 mos	4			2	
Metatarsus (D)	10 mos					100
Radius (P)	11-12 mos	1		1	2	
Ulna (D)	11-12 mos					
Radius (D)	11-12 mos			1	1	33.3
Tibia (D)	13-16 mos	2		3	3	
Calcaneum	13-16 mos	2			1	
Fibula (D)	15 mos					
Humerus (P)	15 mos			4	2	
Fibula (P)	15-18 mos					36.4
Femur (P)	18 mos	1	2	2	3	
Femur (D)	18 mos		2	1	2	
Tibia (P)	18 mos		2	3	3	7.8
		35	6	19		

Table 51 age distribution of dog showing the number of fragments aged (NISP) and the percentage fused elements (Age ranges; Silver 1969)

One dog was uncovered at least partially articulated from layer (19), whilst part of the individual was uncovered from the un-stratified assemblage (Figure 119). The hind limbs, caudal, lumbar, thoracic vertebrae, pelvis and ribs were uncovered articulated (21), the fore limbs, scapulae, cervical vertebrae and the skull were uncovered from the un-stratified layers. The presence of a baculum confirmed this was a male dog. Fusion provided an age of ~18 months. Though the dog was not yet fully grown the epiphyses were present and a Wither's height was calculated combining the measurement of the femur and the tibia (312mm) estimated at a height of 47.18cm, equating to a whippet sized dog or slightly smaller than a border collie. As the dog had not yet fully matured prior to death it is likely that the final wither's height would have been slightly higher.

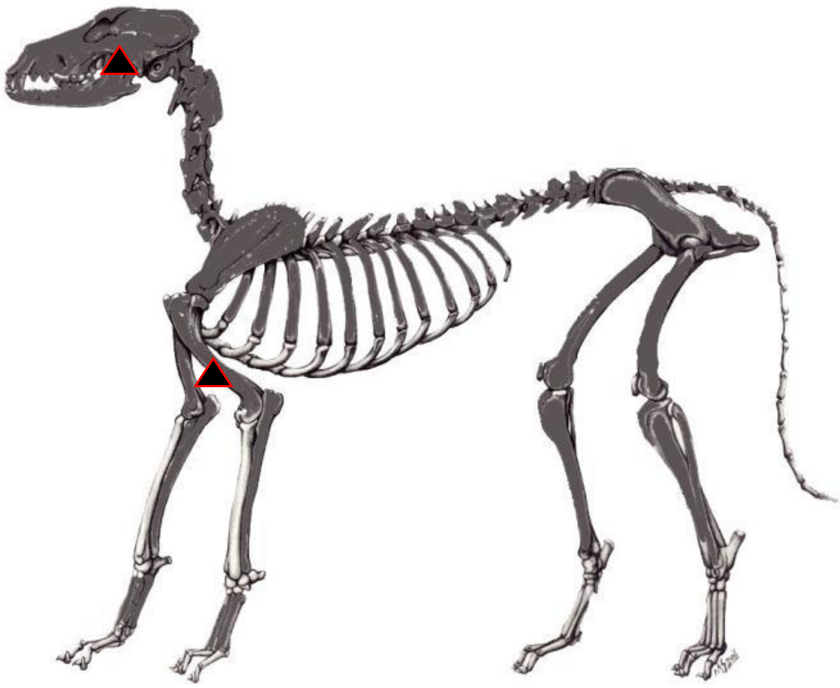

Figure 119 articulated dog (21) partially recovered from layer 19. Triangles show location of cut marks.

This dog was the only one with evidence of pre-depositional modifications, limited to the left humerus [657] exhibiting fine knife marks running in a horizontal direction across the anterior central aspect of the shaft and the right temporo-mandibular joint showing fine cut marks associated with joint dismemberment, none of the skeletal elements had been severed. It was reported that this dog had traces of vermillion present in the soil in a pattern suggesting it had been injected (Dr Louise Martin, *Pers. Comm*.), though this evidence was not apparent in the post excavation analysis of the remains.

Other anatomy schools with dogs present included; RLH (34.56% (758/2193), ASM (74.18% (632/852)) and MCG (6.73% (20/297)). Morris *et al.* (2011) argued the high prevalence rate of dog at RLH were due to a large number of associated body groups (ABG) (partially articulated individual) uncovered from coffins. These must have been placed as partial individuals, though only a few had any evidence of dissection. The body groups revealed the presence of both sub-adults and adults with at least two ABG's being of infant age. The dogs uncovered at ASM represented at least 23 individuals, all disarticulated and all mature dogs, except for one "not very young" puppy (Hull, 2003: 16). Five bones exhibited cut marks at ASM, one of these were similar to that at Craven Street, showing cut marks across the middle of the shaft of a humerus.

At MCG a minimum of two dogs were present with one dog exhibiting a severed occipital bone. Ageing information was not provided.

It was the overall consensus from comparative sites, that dogs formed part of anatomy school "waste", despite the limited evidence of intervention on the skeletal remains. This also appears to be the case at Craven Street where the articulated dog had been injected with vermillion, whilst only the humerus and temporo-mandibular joint of the mandible showed any evidence of intervention. The large number of dog bones at Craven Street is most likely due to the high rate of articulated remains deposited in the primary layer (19).

10.1.2 Cat (*Felis domesticus*)

Cat was the most abundant species of mammal present in the assemblage. A total of 297 fragments of cat (17.15% (297/1732)), provided an MNE of 248 and an MNI of at least five individuals, with some partially articulated. Skeletal completeness was high (78.17% showed 80-100% completeness).

Figure 120 shows the MNE distribution of major elements, dividing these with the actual number of elements in the skeleton showed a high representation of lumbar vertebrae (4.86 (34/7)), as well as humerie and ulnae (3.5 (7/2)). Like dog, the distribution suggested that these were the remains of at least some complete individuals.

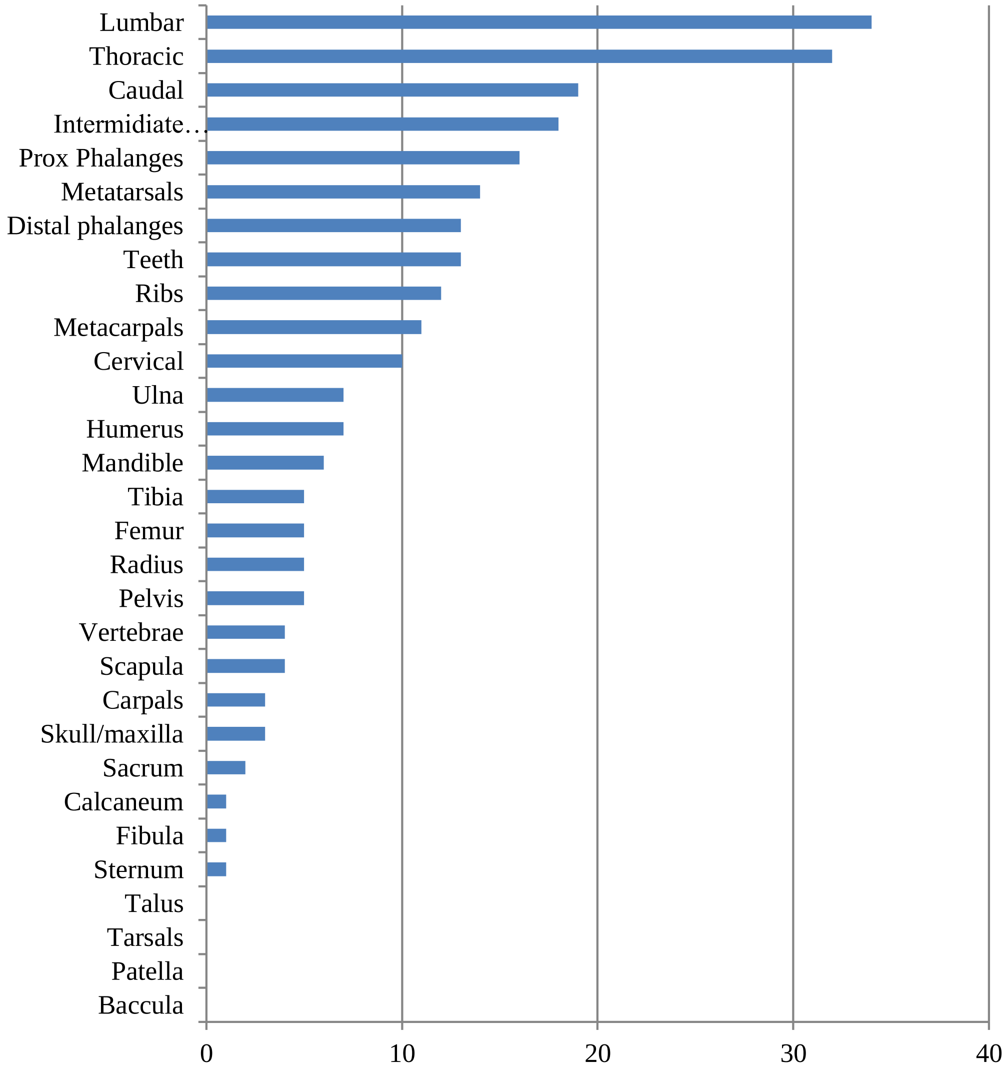

Figure 120 MNE distribution of cat.

The vast majority of cat bones were recovered from layer (19) (62.96% (187/297)), with 32.09% (60/187) of these being partially articulated (Table 52). Some of the body groups recorded may have derived from the same animal.

Layer	Element group	N=
19	Cranium and mandible	28
19	Cranium and mandible of kitten	3
19	Humerus and ulna	2
19	Thoracic vertebrae	6
19	Thoracic and lumbar vertebrae	14
19	Lumbar vertebrae (6th and 7th) and sacrum	3
19	2nd-5th metatarsal	4
	Total	60

Table 52 partially articulated body groups of cat

Table 53 shows the percentage of fully fused bones within each of the age clusters of fusion. Cats were aged by fusion and dentition with a total of five cats provided with an age range. The presence of humerie in all individuals confirmed the number of cats present. Cat (1) had fully fused. The maxilla and mandible suggested a mature cat; the left mandible was almost completely edentulous and one maxillary P4 exhibited a large amount of calculus (Figure 121). Cat (2) was aged 14-18 months based on fusion of the radius and the femur. Cat (3) was of a similar age to cat (2), aged ~14-24 months based on fusion data of the humerus and radius. Cat (4) and cat (5) were both very young individuals, fusion ages of the humerus confirmed they were less than 3-4 months and one mandible had one unerupted first molar where the root had not yet formed. The first molar erupts around the age of 5-7 months. The long bone suggested these were very young animals, most likely perinatal or neonate kittens.

	Age of fusion	**FF**	**JF**	**UF**	**MNI**	**% FF**
Scapula (bicipital tuberosity)	3-4 mos	3			2	
Humerus (D)	3-4 mos			2	2	
1st phalanx (D)	4-6 mos	13				
2nd phalanx (D)	4-6 mos	18				94.40
Metacarpus (D)	6-10 mos	10		1	2	
Radius (P)	6-7 mos	5			3	
Metatarsus (D)	7-10 mos	10			1	
Femur (P)	7-9 mos	2	1	2	3	87.1
Ulna (Olecraneon)	8-12 mos	3		3	4	
Tibia (D)	9-12 mos	2			1	
Fibula (D)	9-13 mos	1			1	
Tibia (P)	11-18 mos	2		2	3	61.5
Fibula (P)	12-17 mos					
Femur (D)	12-18 mos	2		2	2	
Radius (D)	13-20 mos	5			3	
Ulna (D)	13-23 mos	4		2	4	
Humerus (P)	17-24 mos	1	1	1	3	66.7
		81	2	15	98	

Table 53 Fusion age of cat (Age of fusion adapted from Smith, 1969)

Figure 121 Mandible and maxillary P4 of mature cat. Left side of mandible is completely edentulous and the P4 exhibited gross calculus.

Table 54 show the measurements taken from the long bones and mandible, showing slight size variations between the adults.

Mandible	Humerus	Radius	Ulna	Femur	Tibia
52.8	23.0	82.9	21.0	20.5	99
54.7	88.7	83.1	21.2	22.5	103.8
58.8	88.7	83.3	98.1	93.3	
	91.2	85.5	98.2	93.8	
		86	100.7		

Table 54 Mandible and Long bone lengths (=GL) recorded for cat (neonate bone measurements exclude epiphyses)

Cats were uncovered at three other anatomy schools, with low representation in the faunal assemblage; RLH (3.42% (75/2193)), ASM (1.05% (9/852)) and MCG (5.05% (15/297)).

At RLH four partially articulated cats and a number of disarticulated remains were recorded. All the partially articulated were remains of juvenile and neonate individuals. One pelvis and femur of an adult cat had been wired providing evidence of skeletal articulation of cat. No cut marks were noted on any of the animals. At ASM no information was provided on the nine cat bones uncovered, other than t that they had a “similar light appearance” as the dogs, the author perhaps suggesting that dogs and cats were treated in a similar manner. No information was provided on the small number of cat bones at MCG, other than with dog they had a higher representation of skull remains than other mammals, perhaps again suggesting the animals were treated in a similar manner.

No skeletal modifications were noted at Craven Street and skeletal completeness was high. The partially articulated elements in layer (19) were similar to those noted in individual coffins at RLH. Cats almost certainly formed part of the anatomy school; they could have been used for vivisections, demonstrations and research without impacting on the skeleton.

10.1.3 Sheep/goat (*Ovis/Capra*)

A total of 99 specimens were identified as sheep/goat with a number of elements identified as belonging to sheep whilst none were identified as goat. This was the largest group represented in the re-deposited upper layers of the trench with 16.16% (16/99) of the bones deriving from this area. A total of 27.27% (27/99) were uncovered from the stratified layers and over half (55.57% (56/99)) were un-stratified. Sheep/goat was the most dominant of the possible food species within the mammal category (9.60% (99/1031)). The minimum number of elements (MNE) was calculated to 50 representing at least four animals based on the count of the innominate bones. None of the elements were articulated, though the heavy disturbance does not exclude this from being the case. Skeletal completeness was poor with 56.57% (56/99) less than 60% complete.

The body part distribution has been summarised in Figure 122 based on the minimum number of elements present. There was a clear dominance of elements from the main torso and upper extremities and a complete absence of phalanges and caudal bones. Skull elements were present, representing the posterior portion (occipital and parietal bones) from at least one animal.

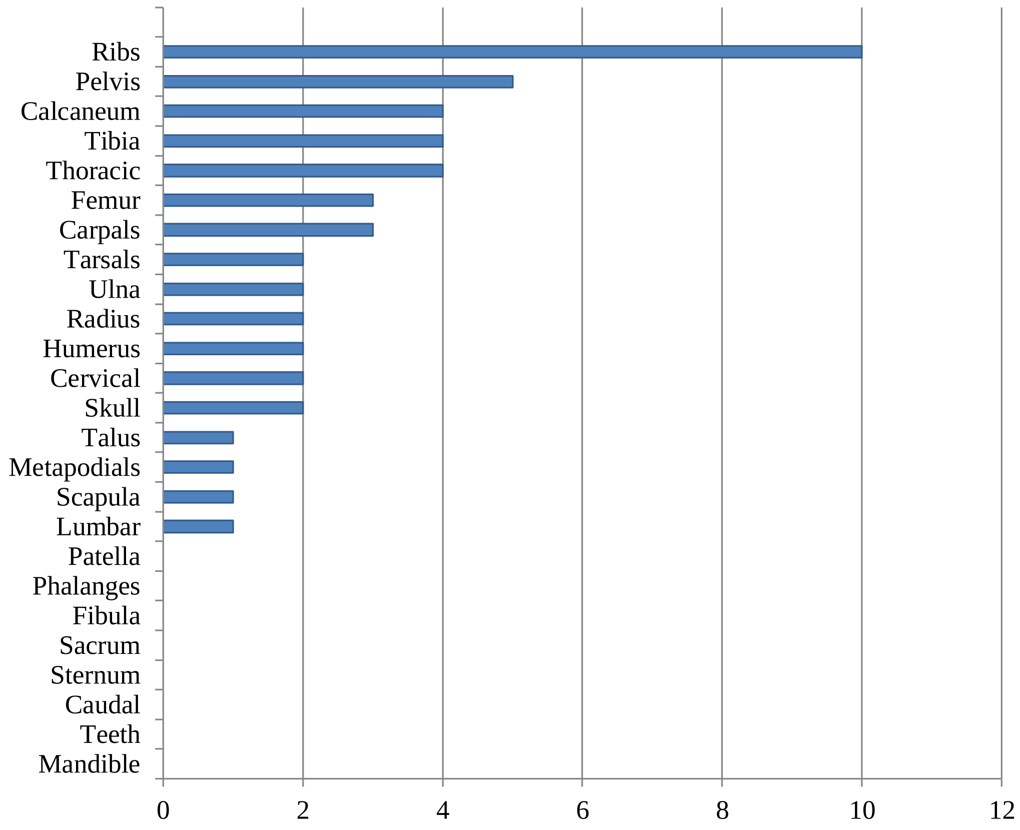

Figure 122 Minimum Number of Elements (MNE) shown in order of abundance for sheep/goat (N=50), deriving from at least four animals.

There was no sheep/goat dentition present in the Craven Street assemblage making epiphyseal fusion to be the only reliable method of ageing. Table 55 shows the number of bones with any fusion information. The cumulative percentage of fused bone suggested that only 20% of the animals survived beyond the age of 30 months. Due to the small size of the assemblage it was possible to estimate that out of the minimum estimate of four animals at least 75% (3/4) were less than 10 months at the time of death based on fusion of the pelvis. This suggests that only one animal was older (at least 30 months).

Bone	**Fusion point**	**Total**	**Fused**	**Unfused**	**% fused**	**Approx. Age of fusion (months)**
Scapula	Glenoid	1		1		6-10
Pelvis	union	5		4		6-10
Humerus	Distal	2	1	1	6.7%	10
Radius	Proximal	2		1		10
Tibia	Distal	4	1	1	13.3%	18-24
Metacarpal	Distal	1		1		18-24
Ulna	Proximal	2	1	1	20.0%	30
Femur	Distal	3		2		36-42
		20	**3**	**12**		

Table 55 Fusion data for sheep/goat shown as a cumulative percentage of bones fused (N=20)

Only one fragment of pelvis [1194] was estimated as being possible male, no other elements could be included in considerations regarding gender.

Sheep/goat species are traditionally uncovered from archaeological sites as food or butchery waste. At Craven Street it cannot automatically be assumed that this is the case. A number of the bones were uncovered from the dense primary layer (19), indicating that at least some of the bones were directly associated with the anatomy school or deposited at the same time. According to Seetah (2006) butchery patterns vary through time but become more consistent with urbanisation.

Indicators of butchery may be; cut marks around joints, cooking/burning marks, helical breaks and chop marks. A total of 40.40% (40/99) specimens exhibited evidence of one or more post mortem modifications in the form of saw marks (9.09% (9/99)), cut/chop marks (24.24% (24/99)), knife marks (11.11% (11/99)) and copper staining (1.01% (1/99)). Helical breaks were present in 5.05% (5/99) of the bones, indicating that they had been broken whilst the bone was still fresh or green. Post deposition breakage was present in 28 fragments; 16.16% (16/99) were noted to have old breaks whilst 12.12% (12/99) had new breaks.

Severed surfaces by sawing were noted in seven ribs (15.91% (7/44)) from both the left and the right side, two by the head, two at the mid axillary line and two towards the sternal end. Three cuts were made from the visceral aspect whilst none were recorded as being severed from the anterior. One right pelvis [3169] (11.11% (1/9)) was sawn posterior of the acetabulum on the shaft of the ilium with knife marks present on both sides of the ilium. Finally one shaft of a left radius [1181] (25.00% (1/4)) had been sawn towards the distal portion of the shaft.

Chop and cut marks but no saw lines were present in 29.54% (13/44) of the ribs from both the left and the right sides, four were cut by the head of shaft, three on the mid axillary line and two towards the sternal end whilst four were indeterminate. At least eight (61.54% (8/13)) of the ribs had been cut from the visceral surface, whilst none of the cuts were recorded to be from anterior. A total of five vertebrae had been chopped; one cervical [2005], three thoracic [693], [2205] and [945] and one lumbar [3492]. Four had been cut down the medial sagittal plane and one thoracic on the right side of the spinous process. Four elements of pelvis [568], [985], [1194] and [2086] had been chopped (44.44% (4/9)) all just posterior of the acetabulum on the shaft of the ilium. Knife marks were noted around the shaft of at least one acetabulum. One right distal portion of a humerus [3165] (50.00% (1/2) had a helical break towards the distal portion of the shaft, which may have been caused by chopping; though no immediate chop marks were present a series of fine knife marks were noted just inferior of the break on the anterior aspect of the shaft. One femur [1739] (25% (1/4)) had been chopped several times on the distal portion of the shaft clear and chop marks were present both to anterior and posterior.

Knife marks were noted on several fragments including the vertebrae [423] and [3300], humerie [3165], scapulae [1460], ribs [442], [1281] and [3478] and pelves [985] and [3169]. On the vertebrae the knife marks were noted on the spinous processes and superior facets in the lumbar region, on the ribs skinning marks in the form of several parallel lines were noted only on the anterior aspect. The scapula exhibited a series of knife marks along the posterior border and on the pelves the knife marks were situated around the acetabulum.

Figure 123 shows the distribution of body parts shown against typical meat cuts of mutton indicating the animals were a product of consumption rather than being part of the animal group used at the anatomy school. It is not to say that animals demonstrating these traits were not used at the school, but they may have served a dual purpose. The higher fragmentation pattern further support the notion that sheep/goat had a different function than the carnivores in the assemblage.

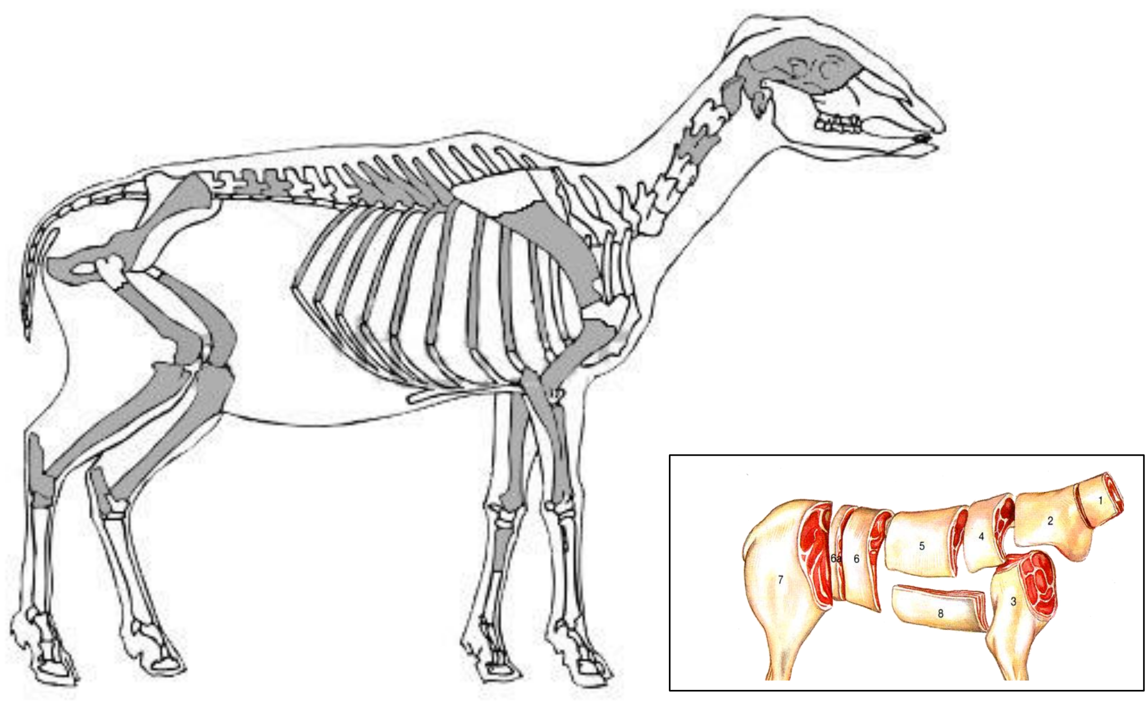

Figure 123 element distribution in sheep/goat. (1. scrag end of neck; 2. middle neck; 3. shoulder; 4. best end of neck; 5. loin; 6. chump; 6a. chump chops; 7. leg; 8. breast (http://occasional.lazyeight.net/archive/2006_10_01_index.html))

Comparing the results with the excavation at the RLH (Morris *et al.*, 2011: 13); 239 fragments were uncovered, some partially articulated. It was assumed that sheep/goat fragments were kitchen waste rather than anatomy school waste. With a high frequency of pelves, femora and lumbar vertebrae it was concluded that these had derived from cuts of “mutton saddle”. Like at Craven Street the vertebrae had also been split along the sagittal plane. The similarities between sheep/goat at Craven Street and RLH were striking, both more consistent with remains of kitchen waste rather than anatomy school waste or butchery. MCG also reported the presence of sheep/goat (2.02% (6/297) whilst ASM provided a slightly higher prevalence rate of 4.46% (38/852))

10.1.4 Cattle (*Bos taurus*)

Identification of cattle was limited to eight specimens (0.46% (8/1732); one tooth, four vertebrae, two femoral fragments, and one proximal phalange. These fragments made at least six elements (MNE) deriving from at least one individual. None of the elements were articulated and derived mainly from primary layers (19) or were un-stratified.

Fusion data suggested cattle aged over 18 months but less than 48 months based on one fully fused proximal phalange and one unfused distal epiphysis of a femur.

None of the elements had been sawn but two had been chopped; one large distal unfused epiphysis of a left femur [579] had been chopped vertically between the condyles and one body of a lumbar vertebra [1204] had been chopped in the sagittal plane to the right of the central portion of the body. One femoral fragment [390] exhibited a helical break.

No larger fragments of cattle had been placed in the trench. Due to the limited number of elements it would be highly speculative to provide any interpretation of their purpose. RLH had a total of 127 fragments (5.79% (127/2193)) of cattle with elements dominated by vertebrae, humerie, radie, pelves and femora suggesting meat consumption (Morris *et al*., 2011, 14). At Craven Street the distribution appeared random and not associated with any particular cuts of beef. Other anatomy schools reporting the presence of cattle were MCG (12.12% (36/297), WRI (13.04% (3/23)) and ASM (3.50% (30/852))

10.1.5 Pig (*Sus scrofa*)

Only four fragments were identified as pig (0.23% (4/1732); three of those fragments made up two humerie a right shaft [591] and a left distal shaft and epiphysis [605/607] whilst the last element was a fragment of a left scapula [1200]. The left humerus and the scapula were both unfused providing an age estimate of less than 12 months, whilst the right shaft could not be aged. This provided an MNE of three elements from at least one pig. No saw marks were noted but the left humerus had chop marks both on the epiphysis along a helical break and had been chopped through on the left distal portion of the shaft (23mm from the metaphysis). The presence of shoulder and humerus and the location of the cut marks suggested kitchen waste being the remains of shoulder of pork. The RLH had a prevalence rate of 1.60% (35/2193), MCG 2.02% (6/297) and ASM (0.35% (3/852)) whilst WRI had none (0/23), suggesting that pigs are not commonly associated with anatomy schools.

10.1.6 Horse/donkey (*Equus (genus)*)

Only four fragments were identified as horse (0.23% (4/1732)); two caudal vertebrae, one right metacarpal and one left central upper incisor, making up an MNE of four from at least one individual. The metacarpal was fully fused indicating an age of more than 15-18 months and the presence of a permanent central incisor provided an age of at least 2.5-3years (Silver, 1969: 291) though moderate wear indicated it was more likely to be older around nine years of age (Loch & Bradley, 1998).

Only the central incisor (Figure 124) had been modified and had been sectioned down the long axis of the tooth to show internal anatomy. Clear saw marks were present in two directions indicating the tooth was sawn two directionally from the occlusal surface anterior to posterior and then posterior to anterior at an oblique angle. Green staining was present at the proximal portion of the tooth

Figure 124 bisected central incisor [4528]

Horse was also recorded at RLH (0.55% (12/2193)) and whilst some elements associated with butchering, the presence of a dissected horse skull and mandible also indicated they may form part of anatomy school waste (Morris, 2010). Horse was also present at ASM (1.29% (11/852)) but neither WRI nor MCG recorded any presence of horse. The elements at Craven Street were very limited but the presence of the bisected incisor provided a clear link to the anatomy school.

10.1.7 Red deer (*Cervus elaphus*)

Remains of red deer were present (0.60% (11/1732)) as skull fragments of maxilla with teeth, pre-maxilla, mandible with teeth and two loose teeth. The MNE was 11 deriving from at least one individual. All dentition situated in the maxilla and mandible had erupted (right maxillary and mandibular dp2, dp3, dp4), re-inserting one loose right M1 into its socket suggested it was erupting, indicating these were the remains of a neonatal individual (Brown & Chapman, 1991: 521). The presence of one loose dp3 from the left side suggested that both sides had been present at some stage. The determination of species was based on the size of the individual. No modifications were recorded.

The remains being those of the skull may suggest that the waste was associated with the anatomy school rather than kitchen waste. It is entirely possible that the unrecovered parts of the animal were used for consumption and that the skull was retained and brought to the anatomy school, but this is speculative as there was no further indication of use. No deer species were present at RLH or WRI but one white tailed deer (*Odocoileus virginianus*) was recorded at MCG with 2 tibia fragments present (0.67% (2/297)).

10.1.8 Rabbit (*Leporidae fam.*)

Only three elements were identified as rabbit, all from the un-stratified assemblage (0.17% (3/1732)). This provided an MNE of three from at least two animals, based on two right pelves, with the last element present being the left proximal portion of a humerus. All elements were fully fused indicating the individuals were older than 9 months, according to age estimations in cottontails(*Lepus sylvaticus floridanus*), bearing a close resemblance to the European rabbit (*Oryctolagus cuniculus*) (Bothma, 1972: 1209). Pre-depositional modifications were noted only on the humerus, showing fine diagonal knife marks on the anterior central portion of the shaft.

Rabbits were found in relatively large quantities at RLH (14.96% (328/2193)) but much less so at ASM (0.12% (1/852)) and MCG (1.34% (4/297)). Morris et.al (2011) noted that some of the rabbits would have been very large, equivalent to a Flemish giant rabbit (a breed of *Oryctolagus cuniculus*), at least six body groups of rabbits were uncovered from the graves and one rabbit premaxilla had been horizontally sawn through the alveolus, leaving the front part of the mandible and the incisors present. The location of the rabbits in human graves and the cut of the pre-maxilla clearly indicated they formed part of the disposal from the anatomy school rather than food waste. No speculation on this was made at ASM and MCG. At Craven Street there is little archaeological evidence to support their use at the anatomy school they may just as well have formed part of kitchen waste. Being un-stratified it was impossible to know whether they formed part of the primary layers or belonged to the Victorian layers, as no stratified remains supported the presence of rabbit.

10.1.9 Rodents

Rodents made up 3.64% (63/1732) of the assemblage. The majority were unidentified rib fragments (84.12% (53/63)), whilst ten elements could be further identified.

10.1.10 Squirrel (*Sciuridae (fam)*)

One right scapula was identified as being a possible squirrel. It was uncovered in pit fill (16) and was almost complete. Only MCG reported the presence of squirrel (*Sciurus sp.*) (2.3% (7/297)), but no speculation offered as to the reason for their presence in the assemblage. At

Craven Street one element was insufficient to make any assumptions with regards to its presence.

10.1.11 Spiny mouse (*Acomys (genus)*)

One left mandible with the incisors and molars present was identified as a spiny mouse. There were no other identified elements. *Acomys sp*. appear to originate from Africa and southern Europe and not a native species of northern Europe. This may suggest that the mouse was acquired rather than being coincidentally integrated into the assemblage even though it was un-stratified. No mouse remains were indentified at any of the comparative sites.

10.1.12 Brown rat (*Rattus norvegicus*)

A total of eight elements were identified as brown rat (0.46% (8/1732)), with an MNE of eight and an MNI of one individual. Brown rat is a common species found all over the British Isles close to human habitats. Again the remains formed part of the un-stratified assemblage making it difficult to argue they formed part of the anatomy assemblage. The bones may simply have become incorporated into the assemblage by accident but it is not impossible that rats were used as part of the anatomy school; they would certainly have been readily available. The presence of rat was reported in small numbers at RLH (0.13% (3/2193)) and MCG (1.01% (3/297)). None appear to have been found in the human graves at RLH, perhaps suggesting they were not commonly used at the school.

10.1.13 Large mammals

A total of 14 fragments were recorded as large mammal (0.81% (14/1732); seven were splinters of long bone, six vertebral fragments and one rib. No age information was present. Five out of the seven long bone fragments had helical breaks. Of the vertebrae skinning marks were present on one spinous process and one vertebral body had been chopped in the medial sagittal plane. Most of the vertebrae (5/6) were fragmented by post depositional breaks.

It is likely that these elements belonged to either cattle or horse as there was no indication of other species present. The large number of helical breaks may be from division of large long bone for consumption. The modifications on the vertebral fragments were also seen in cattle, associated with kitchen waste.

10.1.14 Medium mammals

Medium mammals made up the largest unidentified group including fragments of cat, dog and sheep/goat size, constituting 8.89% (154/1732) of the entire faunal assemblage. The distribution of the fragments have been summarised in Figure 125.

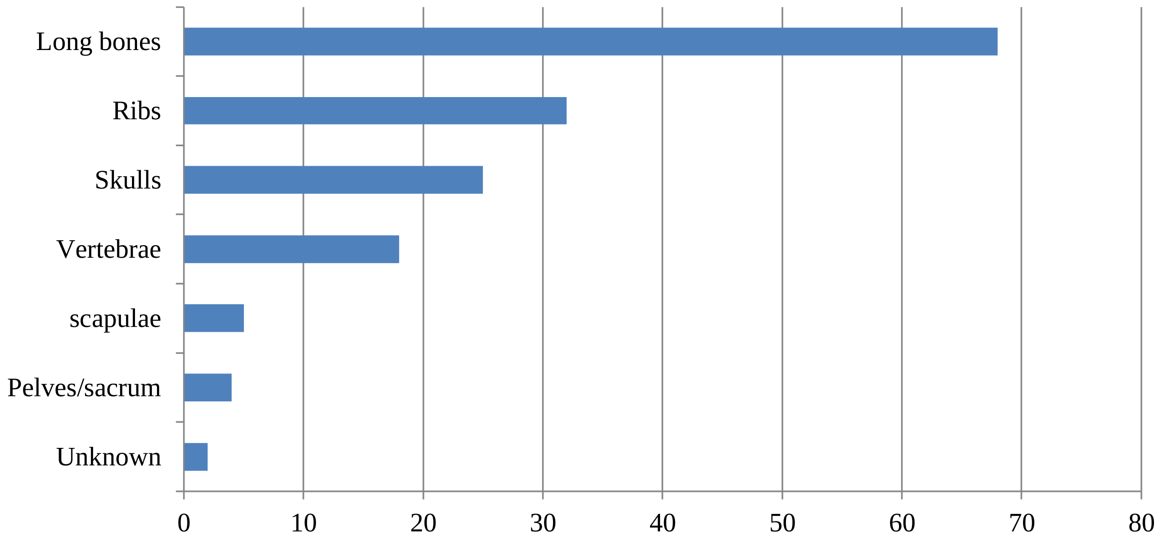

Figure 125 number of fragments from medium mammals by element groups (NISP=154)

The long bones made up the largest category (44.15% (68/154)) predominantly made up by splinters of bone. Only a single helical break was noted with the remaining fragments damaged by old breaks (33) and new breaks (32). Two fragments exhibited cut marks and one bone had been sawn. Out of the 32 ribs present (20.70% (32/154)) only one modification was noted as fine knife marks on the visceral surface. Skull fragments made up 16.23% (25/154), damaged by old breaks. Two fragments displayed fine knife marks on the outer surface. The vertebrae (11.69% (18/154) were affected by old breaks only. Six of the vertebrae could be established as having unfused epiphyseal rings. Three fragments exhibited chop marks; one on the superior facet, one in the medial sagittal plane and one was cut horizontally through the body. One had knife marks on the spinous process. The pelves and sacral fragments (2.59% (4/154)) had one helical break of a pelvis, one chop mark and one knife mark the remainder were damaged by old breaks. The scapulae and unknown fragments exhibited no modifications.

10.1.15 Small mammals

Small mammals were those of small rodent size and made up 5.43% (94/1732) of the assemblage made up predominantly of rib fragments (65.96% (62/94)). None of the elements exhibited any post mortem modification (Figure 126).

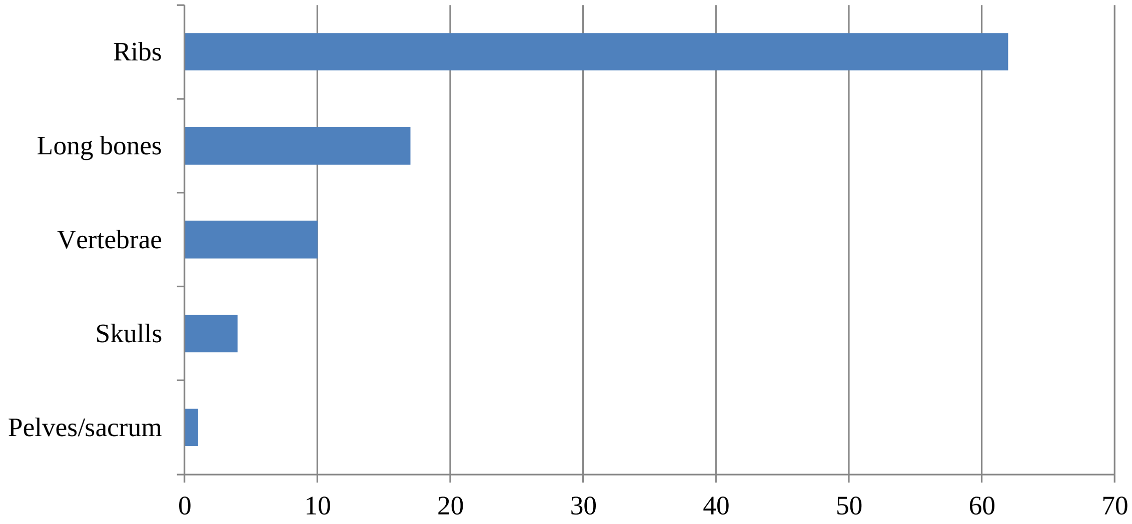

Figure 126 number of fragments from small mammals by element groups (NISP=94)

10.2 Birds

Birds were the second largest class in the assemblage after mammals (25.92% (449/1732)), with an estimated MNE of 180 and an MNI of at least ten birds. Four different genus were identified with the largest being *Ansiformes* (62.81% (282/449)), followed by *Galliformes* (2.22% (10/449), *Columbiformes* (1.78% (8/449)) and *Falconiformes* (0.89% (4/449)), whilst a total of 147 fragments (32.74% (147/449)) could only be identified as fragments of bird. Table 56 show the distribution of Identified elements.

	Anisformes		*Galliformes*				*Columbiformes*		*Falconiformes*	
	Anas platyrhynchas		*Gallus gallus*		*Meleagris*		*Columba palomba*		*Haliaeetus*	
	NISP	MNE	NISP	MNE	NISP	MNE	NISP	MNE	NISP	MNE
Cranium	19	2								
Maxilla	8	4								
Quadratum										
Mandibula	7	4								
Larynx										
Syrinx										
Tongue skeleton										
Tracheal rings										
Atlas										
Axis	2	2								
Cervical vertebrae	6	6								
Thoracic Vertebrae	16	16								
Lumbar vertebrae	7	0								
Caudal vertebrae	17	17								
Notarium										
Synasacrum	3	2								
Pygostyle	2	2								
Ribs (vertebral/sternal)	79	28								
Sternum	8	4								
Furcula	1	1								
Scapula	5	5			1	1				
Coracoid	4	4	1	1						
Humerus	7	6	4	3			1	1		
Ulna	8	6			1	1	1	1		

Radius	8	4					1	1		
Radius carpal										
Ulnar carpal										
Carpometacarpus	5	5							1	1
Wing (alular) digit I/II	2	2							1	1
Major digit (III) prox. Phalanx	2	2							1	1
Major digit (III) Dist. Phalanx	5	5								
Minor digit (IV)	2	2								
Pelvis	4	4								
Illium										
Ischium										
Pubis										
Femur	6	6	1	1			1	1		
Patella										
Tibiotarsus	8	5	1	1	1	1	1	1		
Fibula	1	1								
Tarsometatarsus	8	7					2	2		
Medial digit (I)										
Digit (II)										
Digit (III)										
Lateral digit (IV)										
Proximal phalanx	6	6								
Distal (Terminal/ungula) phalanx										
Long bone splinter	8	2								
Total	264	160	7	6	3	3	7	7	3	3

Table 56 NISP and MNE of identified elements of bird

10.2.1 Mallard (*Anas platyrhynchas*)

Mallard was by far the most abundant bird species 58.80% (264/449), with an MNE of 160 making up at least four individuals. At least two partially articulated body groups of mallard were identified in layer (19) accounting for 56 of the fragments (21.21% (56/264)). The remaining 6.03% (17/282) were only identified as *Ansiformes.* The majority were uncovered in layer (19) (97.16%) and were very well preserved with no signs of weathering.

No unfused bones were uncovered suggesting the presence of fully developed individuals. Dial and Carrier (2012) measured the limb bones of mallard to establish their development. From a graph produced showing the length of the bones by days after hatching it was possible to establish the bones at Craven Street produced very consistent results of 45 days to adult. The age range was wide but the consistent results at least showed that none of the birds were below 45 days of age. Meints and Oates (1987) and Woelfle (1967) produced measurement for sexing in six different bones, but at Craven Street measurements were only available for the coracoids, humerie and carpo-metacarpie. All of these measurements fell within the female range (Table 57).

		GL (mm)	Age range	Sex
Coracoid	L	53.4		Female
	R	53.5		Female
	R	51		Female
Humerus	L	88.7	50 days - adult	Female
	R	88.2	50 days - adult	Female
	R	88.4	50 days - adult	Female
Radius	L	68.3		
Ulna	R	73	45 days-adult	
Carpo-metacarpus	R	56.2	45 days-adult	Female*
	L	55.4	45 days-adult	Female*
Tibio-tarsus	L	80.8	45 days-adult	
	L	86.3	45 days-adult	
	R	81.1	45 days-adult	
Tarso-metatarsus	L	49.2	45 days-adult	

Table 57 long bone lengths of mallard, showing estimated age of the individuals according to Dial and Carrier (2012) and sex according to Meints and Oates (1987) and *Woelfle (1967)

No modifications or helical breaks were noted on any elements of mallard which may have been expected if they formed part of kitchen waste.

One element of mallard was uncovered from RLH (0.05% (1/2193)) and two elements from ASM (0.23% (2/852)), suggesting that duck were not a common occurrence on anatomy school sites.

10.2.2 Galliformes

Domestic fowl were uncovered in small quantities; chicken (*Gallus gallus domesticus*) (1.56% (7/449)), with an MNE of six from at least two individuals and turkey (*Meleagris (genus)*)

(0.67% (3/449)) with an MNE of three from at least one individual. The majority were from the un-stratified layer (70.00% (7/10)) with all turkey elements belonging to this category. One bone was found in Victorian layer three and two in layer (10) and (19).

10.2.2.1 Chicken (Gallus gallus domesticus)

Chicken were present with three humerie, one coracoid, one femur and one tibio-tarsus. All observable bones were fully fused. The humerus measured 73mm and the coracoid measured 47.7mm. The bones of chicken, though well preserved, had a weathered appearance not present in the mallard assemblage, suggesting they may have been left on the surface. One element exhibited clear puncture marks from a carnivore.

The femur was the only element exhibiting any modifications with chop marks noted just inferior of the femoral head, most likely associated with butchery or consumption.

All bones where observable were fully fused. No bones had any trace of medullary bone in the endosteal cavities of the long bones. This would have been expected if they were female individuals as this is almost consistently present in females after egg-laying maturity (Dacke et.al 1993, 64).

Chicken was also recorded at RLH (0.73% (16/2193)), ASM (0.35% (3/852)) and MCG (22.56% (67/297)), they were on all sites recorded as forming part of kitchen waste rather than anatomy school waste. The low number of bones of chicken is most likely due to their use for consumption, at Craven Street the condition of the bones were most consistent with kitchen waste with little to suggest they formed part of the anatomy school assemblage. Though the number of bones was significantly lower than mallard the MNI suggested that chicken was only half as frequent as duck (2/4), the clear suggestion is they had a different function all together.

10.2.2.2 Turkey (Meleagris (genus))

Turkey was present with three elements only, providing an MNE of three from at least one individual. The elements were made up of one scapula, one ulna and one tibio-tarsus. Skeletal completeness was poor with the cortical surface weathered gnawing and puncture marks were present on the ulna. A series of parallel Knife marks were present on the anterior proximal shaft of the tibio-tarsus.

Turkey was present at RLH in the later layers of the site (0.87% (3/345)) and was estimated to be large birds similar in size to modern Norfolk Blacks. Fragmentation at Craven Street was too high and it was therefore not possible to provide any further identification. The appearance of the bones suggested that they too formed part of kitchen waste rather than being from the anatomy school.

10.2.3 Wood pigeon (*Columba palumbus*)

A total of seven long bone elements were from smaller birds, identified as pigeon (1.56% (7/449)) (Table 56), with an MNE of seven from at least one individual. Two of the bones were un-stratified whilst the remainder were uncovered scattered across the primary layers of the trench. All elements were 80-100% complete with measurements taken of the humerus (35.7mm), femur (47.5mm) and tarso-metatarsus (30.1mm). None of the bones had any modifications and were well preserved.

Pigeons were not reported from any other sites, but RLH did report a smaller bird (passerine) as a single element. It is difficult to establish the function of birds such as pigeon, it may well have formed part of the anatomy school, though such birds were also frequently used for consumption or could have become integrated into the assemblage by coincidental integration.

10.2.4 White tailed eagle (*Haliaeetus albicilla*)

Three elements identified as white tailed eagle were uncovered from the un-stratified assemblage, making up the most distal aspect of the wing; the carpo-metacarpus and the second and third digit. The carpo-metacarpus measured (109.9mm). It has been suggested that wings were removed from these birds. Findings of wings only of the same bird were noted by Enghof and Arneborg (2003: 32) who suggested wings were kept for decorative or practical purposes such as making arrows and brooms. It is not unlikely that the wing bones at Craven Street had been purchased as separate items either for decoration or demonstration at the school. No other anatomy school sites reported findings of *Falconiformes*, but they are not unheard of in archaeological assemblages in Britain.

10.2.5 Discussion (birds)

Birds formed an important part of the faunal assemblage making up 25.92% (449/1732). Mallards were found partially articulated in the primary deposits of the pit and were aged >45 days old, all sexed elements indicated they were females. Mallard were the only bird bones that would almost certainly have formed part of the anatomy school waste. Wood pigeon may have formed part of the anatomy school, but were scattered across a number of layers, no modifications were noted on the bird and it is possible it may have become incorporated into the assemblage without having any association to the school or as kitchen waste. Chicken and turkey had the appearance of kitchen waste. White tailed eagle was only present by three extremities of the wing, and may well have been the only part of the bird present, purchased as a decorative or functional item.

10.3 Fish

The fish skeletal remains were analysed by Dr Hannah Russ, University of Sheffield (Table 58). A total of 147 fragments (8.49% (147/1732)) were identified as fish. The overall preservation was excellent with none of the remains exhibiting any cut marks. A small number of fragments of bony fish 95.44% (8/147)) and unidentified (12.24% (18/147)) species were uncovered from layer (19) consisting mainly of small fragments of rib and vertebrae with no further identification possible.

Order	Family or species	NISP	%	MNE	%	MNI	%
Salmoniformes	*Salmon solar*	18	12.24%	17	11.64%	1	16.67%
Carcharhiniformes	*Galeorhinus galus*	9	6.12%	9	6.16%	1	16.67%
Elasmobranchii (subclass)		84	57.14%	84	57.53%		
Pleuronectiformes	*Scophthalmus sp.*	8	5.44%	8	5.48%	2	33.33%
Clupediformes	*Clupedia (fam)*	1	0.68%	1	0.68%	1	16.67%
Gadiformes	*Gadidae (fam)*	1	0.68%	1	0.68%	1	16.67%
Osteoichthys		8	5.44%	8	5.48%		
Unidentified		18	12.24%	18	12.33%		
Total		147		146		6	

Table 58 Indetification and frequency of fish remains

10.3.1 Atlantic salmon (*Salmo salar*)

A total of 17 abdominal vertebrae and one unidentified fragment were identified as Atlantic salmon, with the presence of at least one individual. The majority were uncovered from layer (19) (82.35% (14/17)). The species is native to the British Isles and migratory; predominantly living in a marine environment but migrates to freshwater lakes to spawn.

10.3.2 Tope shark (*Galeorhinus galeus*)

A total of nine teeth (6.12% (9/147) were identified to species level as Tope shark. A further 84 vertebrae were identified as Elasmobranchii (shark/skate/ray) were most likely from the same species. The majority of the remains derived from layer (19) (73.12% (68/93) with the remainder un-stratified. It was estimated that at least one individual was present, measuring a total of 100cm in length. This species is native to British marine waters and can grow up to 200cm in.

10.3.3 Flatfish (*Pleuronectiformes (order*)

A total of eight elements of flatfish were uncovered (5.44% (8/147)) from at least two individuals. One post temporal and one hyomandibular fragment were identified as turbot or brill (*Scophthalmus fam.*) with the remaining fragments being vertebrae. One pre-caudal vertebra had been burnt. Flatfish were mainly uncovered from the upper Victorian layers (4) and (5) with a single element from layer (19).

10.3.4 Herring family (*Clupeidae fam.*)

A single small caudal vertebra uncovered from layer (7), was identified as being from the herring family. Herring are 2-46cm in length and are native to the British Isles.

10.3.5 Cod family (*Gadidae fam*.)

Cod was present with a single pre caudal vertebra, which had been burnt. Cod is native to the British Isles with species like Atlantic cod (*Gadus morhau*) measuring up to 200cm in length.

10.3.6 Discussion

A total of six fish were uncovered from the assemblage, predominantly from layer (19), suggesting they do not form part of the later disturbance, apart maybe from the flatfish uncovered from the Victorian layers. The identified species are all native to the British Isles. There was little indication whether the fish were kitchen waste or anatomy school waste. The cod fragment had been burnt and so had one element of flatfish, suggesting perhaps some of the fish were food waste. The tope shark and the Atlantic salmon may well have formed part of the anatomy school waste with a relatively high number of elements present in layer (19). Fish were present in small numbers at RLH (2.51% (55/2193)) with the presence of plaice (40/55), cod (2/55), mackerel (1/55) and one partially articulated conger eel (12/55). ASM had only one fragment of plaice (0.12% (1/852)) and MCG had one fragment of flatfish and two fragments only identified as bony fish (1.01% (3/297)). Only the conger eel from RLH, uncovered from a human grave provided a clear indication of it being anatomy school waste (Morris, 2010: 9).

10.4 Turtle/tortoise (Testudines)

Turtle/tortoise was present with 67 fragments, with an MNE of 56 elements representing at least two individuals.

10.4.1 Green sea turtle (Chelonia mydas)

A total of 66 fragments were identified as green sea turtle (3.81% (66/1732)) providing an MNE of 55 deriving from at least one individual (Table 59). Skeletal completeness was excellent with 78.79% (52/66) 80-100% complete. A number of elements exhibited flaking on the surface but without any other forms of weathering. The majority of the elements derived from layer (19) (84.85% (56/66)) with the remaining elements from layer (5), (7) and un-stratified context. The elements present were from the plastron and appendicular anterior skeleton (Figure 127)

	NISP	MNE	MNI
After Wyneken (2001)			
SKULL			
Skull/mandible (16)			
AXIAL			
cervical (7)			
thoracic (10)			
Sacral (2-3)			
caudal (12+)			
CARAPACE (dorsal)			

Pleural bone (Ribs) (20)			
Neural bone (Assoc w. vert) (20)			
Nuchal (Anterior bone) (1)			
Peripheral bone (Outer rim) (20)			
Pygal (Posterior bone) (1)			
Suprapygal (Anterior of pygal)(1)			
PLASTRON (9)			
Epiplastron (Anterior) (2)	5	2	1
Entoplastron (1)*	1	1	1
Hypoplastron (2)	3	1	1
Hyoplastron (2)			
Xiphplastron (Posterior) (2)	3	2	1
APPENDICULAR ANTERIOR			
Scapula (Pectoral girdle)(2)			
Acromion process (1)	1	1	1
Coracoid (Pectoral girdle)(2)	5	2	1
FORELIMBS			
Humerus (2)	2	2	1
Radius (2)	1	1	1
Ulna (2)	2	2	1
Radiale (Carpal) (2)			
Intermedium (Carpal) (2)	1	1	1
Ulnare (Carpal) (2)	2	2	0
Pisiform (Carpal) (2)	2	2	1
Centrale (Carpal) (2)			
Distal carpals (10)	13	13	1
Metacarpal (10)	2	2	1
Proximal phalanges (10)	9	9	1
Intermediate phalanges (8)	6	6	1
Claw (Distal phalange) (10)	6	6	1
APPENDICULAR POSTERIOR			
Illium (Pelvis)(2)			
Ischium (Pelvis)(2)			
Pubis (Pelvis)(2)			
HINDLIMBS			
Femur (2)			
Tibia (2)			
Fibula (2)			
Astragalus (Tarsal) (2)			
Calcaneum (Tarsal) (2)			
Tarsals (6)			
Metacarpal (10)			
Proximal phalanges (10)			
Intermediate phalanges (8)			
Claw (Distal phalange) (10)			
unknown	2		
Total	66	55	1

Table 59 Elements present of green sea turtle (numbers in brackets = numbers present in skeleton)

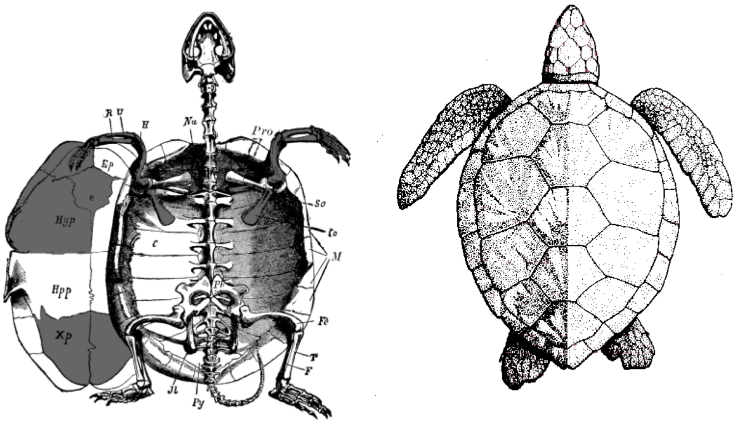

Figure 127 elements present and Ink drawing of a green turtle (template: NOAA, Jack Javech Graphic)

The entoplastron enabled the identification of green sea turtle, being a very destinct shape with its very narrow elongated shaft (Wyneken, 2001: 51). A comparative example of green sea turtle was present in the UCL skeletal collection about twice the size of the turtle uncovered from Craven Street (Figure 128).

Figure 128 Entoplastron is one of the key skeletal elements by which cheloniid species can be identified. The Craven Street bone (right), matched the entoplastron of a green sea turtle in the UCL reference collection (left).

A strong correlation has been found between carapace length and age in Hawaiian green turtle (Zug & Balazas, 1998). It is possible to estimate the length of the carapace based on the diameter of the humerus by using formula (SCL=2.272 (humerus diameter) +2.971) (Goshe *et al.*, 2014). The carapace length of the Craven Street turtle was calculated to be 57.50cm (SCL=2.272(24mm) +2.971), providing an age range of 17-27 years. This age range could be estimated with an accuracy of 89%, this falling dramatically to 18% when the carapace measured >80cm (Zug & Balazas, 1998: 127-128).

It was not possible to provide any sex estimation as this is done by the morphology of the caudal bones which were absent at Craven Street. The differences show females have short tails with the caudal vertebrae decreased distally whilst mature males have long tails with robust lateral and dorsal processes (Wyneken & Witherington, 2001: 45).

One element, the acromion process had been severed to proximal close to the body of the glenoid fossa (Figure 129).

Figure 129 severed acromion process of the scapula [225] of green turtle.

Four of the element exhibited flaking with no other signs of weathering was present. If the tortoise had been dissected this would most likely have been reflected in the elements of plastron as the opening of the animal is generally carried out by cutting along the margin of the plastron (Wyneken & Witherington, 2001). It is unclear why only the acromion process had been severed. The right acromion process was absent so it was not possible to establish whether this was a bilateral cut. It is possible it was a method of removing the proximal appendicular portion of the animal from the carapace. Turtle was also used as a culinary delicacy in the eighteenth century, the method of preparation affected the bone in a similar manner as during dissection except the turtle was generally beheaded. The plastron was removed to gain access to the soft tissue but then the turtle was cooked whole as this was easier to remove the bones after cooking (Schweitzer, 2009: 41). It may be expected that the bones would exhibit a larger number of knife marks from scraping the bones clean or evidence of cooking, such as burning, but none of these procedures were evident.

10.4.2 Tortoise (*Gopherus (genus)*)

One complete scapula of a tortoise was identified using the UCL reference collection. Identification to species was based on Olsen (1968, 82) and Sobolik and steele (1996: 51) and the wide arched boomerang shape was found to be consistent with Gopher tortoise which can measure up to 50cm and is native to North America (Figure 130). The Scapula measured 99.20mm (scapula =76.2mm acromion=38.2mm). Fine parallel cut marks were noted on the neck of the glenoid fossa and on the central portion of the scapula, but the bone had not been severed.

Figure 130 tortoise scapula [1196] (possible gopher tortoise)

10.4.3 Summary

Testudines are very rare archaeologically on the British Isles. One partially articulated hermann's tortoise (*Testudo hermanni*) and one humerus of a non-european tortoise species were recovered from the human graves at the RLH (Morris, 2010: 371). These dated from the early 1800s and formed part of the waste from the anatomy school. Only one other example of tortoise, a single femur, was recovered from Stafford castle, believed to be the remains of a pet as it was uncovered with remains of cats and dogs (Thomas, 2010).

At MCG three elements were uncovered from testudines, all turtles of American origin; Common snapping turtle (*Chelydra serpentine*), aquatic freshwater turtle (*Graptemys sp*.) and another larger freshwater turtle (*Pseudemys sp*.). No modifications were noted on any of the three elements.

The findings of both turtle and tortoise at Craven Street make these the earliest findings of tortoise and possibly the first discovery of turtle in an archaeological context on the British Isles.

10.5 Amphibian

A total of 19 vertebrae including one atlas and one axis, were identified as a small amphibian most likely frog or toad (*Anura* (order)), exhibiting the distinct protruding transverse processes. All were recovered from layer (19) except one un-stratified. Frogs/toads only have nine vertebrae suggesting the presence of at least three individuals.

Only RLH (Morris *et al*., 2011) had one element of frog/toad, which was uncovered from one of the human graves suggesting it was anatomy school waste.

10.5.1 Summary

The faunal assemblage made up almost half of the skeletal assemblage at Craven Street with all classifications of vertebrates represented. The assemblage appears to represent an amalgamation of kitchen waste and anatomy school waste. Kitchen waste was identified by elements present and the presence of chop marks, location of cut marks, helical breaks and evidence of burning. It was concluded that sheep/goat, pig, chicken and turkey were kitchen waste. Analysis of articulated species, like dog, cat and mallard and more unusual species such as tope shark, white tailed eagle, green turtle and gopher tortoise were more consistent with anatomy waste. The pausity of cut, chop and skinning marks on the bone suggested limited exposure to actual dissection. These animals also had a high percentage of completeness and had no helical breaks. Due to the nature of the excavation it was in some cases difficult to estimate whether an animal may have been brought to site in a partial state or even skeletonised state. One example of such a case may be the white tailed eagle wing, which may have been purchased as an object rather than a complete animal. The only evidence of an actual anatomical preparation was the bisected horse tooth the remaining animals were more likely to have been subject to vivisections for demonstrations in class and Hewson's research. There is little to suggest they were treated similarly to human remains.

Comparative data showed some consistency in species though the distribution in terms of frequency differed significantly. Craven Street had a particularly high prevalence of birds, particularly mallard. Turtle and Mona monkey was present at RLH and exotic species such as racoon and manatee were present at ASM, suggesting anatomy schools embraced comparative anatomy of more exotic and unusual species.

Further considerations on the relevance of faunal remains have been presented in the discussion together with the historical sources and the human skeletal remains.

11 Discussion

This thesis set out to investigate the organistation of a private medical school in eighteenth century London through a combination of historical and archaeological evidence. Though the main questions on procurement, use and disposal are predominantly formulated on the basis of the archaeological findings, it would not have been possible to answer these without the presence of historical records. I suggested in the beginning of this thesis that the organisation of the anatomy school has to be placed within the setting of widers social and moral trends manifest in eighteenth century society. The subject of the thesis and the evidence available rendered it well placed within the archaeological framework of human agency. The thesis set out to explore how it is possible to extract a greater sense individuality in the archaeological record. By systematically scrutinising both the historical and archaeological evidence in a similar manner, it was possible identify the more complex aspect of the data and distinguish individual choices from those more universally applied in the medical world.

A series of recent archaeological excavations has drawn together archaeological and historical data to investigate the use of human and animals at anatomy schools in the eighteenth and nineteenth centuries. Craven Street however is the first truly private anatomy school in Britain to be excavated and historically investigated. These private establishments formed an integral part of medical education in London at the time. Together with the teaching hospitals they became the epitome of London medical education and a gateway for less financially privileged young men to carve themselves a niche in the medical profession and thereby an opportunity for upward social mobility. Universities were for the affluent Latin-educated upper classes and the hospitals were expensive to attend. Many students opted for private anatomy schools for their main education and attended occasional lectures and visits to the wards at one of the teaching hospitals (Lawrence 1996: 29).

Historical research on these private anatomy schools has been inclined to focus on the Hunter Brothers and their enterprises, but these were unlikely to represent the average anatomy school. William Hunter in particular had the finances and the business acumen to build an unmatched medical empire and all that came with it, but this is unlikely to be the case for many of the extramural private schools. As Lawrence (1996) pointed out, these schools were first and foremost businesses. Like Hewson, many of the men setting them up were not part of the wealthy upper classes and did so to make a living and gain some advantage over their previous financial and social positions. By the time Hewson entered this highly competitive world, many schools were already well established and competition was fierce. Hewson therefore had to rely on his reputation, skills and associations to draw in students. The evidence for Craven Street anatomy school highlights their true nature: they were not glamorous establishments run by the rich and fortunate but gritty businesses relying on the erratic cadaver trade for the supply of their essential raw material. It clearly required tenaciousness and dedication to keep an anatomy school up and running. The investigation into Hewson as a person has highlighted just how unrelenting the medical scene was and how impervious one had to be to withstand the competition not only in business but also as a researcher.

Practical teaching was consistent with the removal from the concept of life as divine to understanding the world through its biological processes. The Baconian method of research adapted by the Royal Society promoted the accumulation of data to form a strong argument. These changes in attitudes towards scientific research required many repeated experiments and consequently a steady supply of human cadavers and animals for both teaching and research. The adoption of the Parisian method of teaching in London, at the dissecting table, was far from straight forward. Even if the need for dissection was acknowledged, it was not possible to accommodate it under the governing laws in Britain at the time. In this context, Hewson was no different to many other ambitious scientific explorers of his time. His quest for recognition and new discoveries led him on the path of physiological research into the circulatory system, on which he conducted a large number of experiments on both humans and animals. He made his living running a medium sized anatomy school where he taught anatomy, surgery, midwifery and comparative anatomy, using his expanding museum collection to teach students as well as providing hands-on experience of dissection. Hewson's advancement in society was far from smooth and his strive for recognition was dependent not only on his own ambitions and skills but also on his social network. Who he knew and was associated with was as important.

As outlined in chapter one, the aim of this thesis was to investigate the archaeological and historical findings at Craven Street anatomy school to determine the role and function of a smaller private anatomy school in London and how it was run. The archaeological data allow an unprecedented insight into the role of human cadavers and animals and how they were acquired, used and disposed of in comparison with other larger anatomy schools predominantly associated with hospitals. Though historically it may seem like a reversal of events to start with the disposal of remains, from an archaeological viewpoint this is perfectly sensible as disposal is the primary source of evidence and therefore interpreting the site has evolved from this perspective to assess events occurring previously.

11.1 Disposal

There is little historical evidence on disposal of cadavers once they were no longer of any use to an anatomy school. Chaplin (2009, 63) presented evidence of human limbs being dumped on the outskirts of London in 1773, but given the local media interest this must have been the exception rather than the rule. Tarlow (2011) and Crossland (2009) quite rightly drew attention to an almost complete void of dissected cadavers in London's many cemeteries.

Archaeological excavations of local cemeteries have yielded very limited evidence of body disposal after dissection even during the years following the Anatomy Act of 1832, and it begs the question – what happened to all the dissected bodies? In the case of schools associated with hospitals, excavations of hospital sites have revealed that many were buried in the hospital grounds themselves either as coffined inhumation burials or in pits (Western, 2011: 3; Fowler & Powers 2012, 10). In the case of Trinity College Dublin (TCD) they were buried within the adjacent physic garden in pits and trenches (Murphy 2010, 20) whilst at Medical College Georgia (MCG) they were unceremoniously scattered across the earthen floor of the dissection rooms and covered in quicklime in order to lessen the putrid smells (Blakely, 1997: 10). Private anatomy schools, such as Craven Street, would have had very limited opportunity to dispose of remains on the actual premises, situated in a residential area with a small yard to the back of the house and no garden of note. John Hunter buried some remains in pits in his own garden in Earl's Court, where they were discovered in the 1880s by workmen (Chaplin, 2009: 63). The remains at Craven Street were therefore not unique in their method of disposal, suggesting that this may to some extent have been common practice. Like MCG the Craven Street bones had layers interspersed with slacked lime to prevent the smells from emerging and similarly may have been buried within the building in the floor of the actual dissection room. Though the excavation was only partial it is unlikely that Hewson would have been able to dispose of all the remains entering the school in this manner, and that the remains buried at the school were in some fashion "selected" to be buried there.

The sequence of events at Craven Street suggests that they may have been buried in a pit where the more complete remains of a human baby, a dog and a number of mallards were thrown in at the bottom then covered in lime. Following this a number of partially articulated and disarticulated remains were thrown in on top, building up layers of remains and lime. The heavy disturbance of the remains prior to the actual excavation made the sequence of events less transparent, but the matching of fragments of the same bones from different layers suggested that this pit was created as a single event rather than over a longer period of time. This means the selection of remains for disposal may have been dictated by a single event at the school, but it is also of interest to speculate on the particular reasons.

Most noticeable was the disposal of human and animal remains together; the complete dog lying next to the complete neonate and the birds. After this, parts of both human and animals were disposed of, such as the torso of an adult, adult feet and mallards. It is evident that the pit was not intended for any particular species, though it may have been dug in the first place with the intention of disposing of the more complete individuals and then topped up with other unneeded remains which were part of what Blakely (1997: 16) called a "waste stream" of remains, first stored on the surface and then later buried. It appears in this sequence that there was no discrimination between humans and animals. It is also evident that this pit was not dug to dispose of the more sensitive waste, the human remains, to avoid them being transported elsewhere into the public domain. The NISP suggested an almost equal distribution of remains, whilst the MNI showed significantly more animal than humans. Some of the animals had the appearance of kitchen waste, suggesting that the pit may have contained material both from the school and from the household. It can therefore be dismissed that this was a "premium" space reserved for remains that were difficult to dispose of elsewhere.

The second distinctive feature of the pit in terms of disposal was the disproportionally large number of foetal and neonate remains in comparison with other sites of a similar nature. Given the arguments in the paragraph above, they were not buried at the premises for sensitive reasons and not present in the pit *because* they were human but *despite* being human. Looking at the nature of the remains in terms of body part distribution, a distinct pattern is apparent in terms of size. No complete adult humans were buried in the pit. The adult remains were heavily dissected with a dominance of skull, torso hands and feet. The completeness of neonate/foetal remains was less evident due to potential recovery problems but appeared to be dominated by limb bones. It could from these observations be argued that the pit was filled with smaller items – parts of bodies rather than whole bodies. The only larger animal was the complete dog, with an approximate size of a whippet; the remaining animals were smaller, partial or disarticulated. This may simply have been a simple matter of the size of remains which could be accommodated. It may therefore be argued that the remains dumped in the pit were dictated by the burial environment.

From this it is also evident that there had been little effort to re-unite the remains of a single human or animal prior to burial, in the way that was observed at the RLH (Fowler & Powers 2012: 211). It cannot be dismissed that parts of these remains were retained to form part of the museum collection or had once formed part thereof and then discarded, whilst other parts may have been disposed of elsewhere. It is entirely possible that the composition of the remains in the pit was dictated by the events leading up to their burial. As suggested above, the pit appeared to have been generated from a single event. This means that the content symbolises a single or short period of time of the anatomy school, though the remains may have been used at different points in time, either years before or just prior to burial. We know from historical sources that unless the remains were preserved through an expensive and complex process of making museum preparations, there was no way of maintaining a fleshed body on the surface for a long period of time. On the other hand it would have been entirely possible to have maintained skeletonised remains, but the complete skeleton would then naturally have become disarticulated. It is therefore reasonable to suggest that any articulated or partially articulated remains in the pit were fleshed at the time of burial, such as the human trunk, the neonate and the dog, and that they would have been a recent acquisition by the school. It is much harder to ascertain whether the large numbers of disarticulated remains were skeletonised or fleshed at the time of burial but the spreading of lime to prevent smells points towards the remains being predominantly fleshed. It is therefore reasonable to believe that many had relatively recently been acquired by the school.

Blakely (1997: 16) discussed the possibility of a "waste stream" and the high likelihood of this in an anatomy school context. He suggested that there might have been several stages to the disposal of remains after they had served their purpose to the school. Thus, they might first have been collected in vats as dissection progressed and then later buried. This suggestion is entirely consistent with the carnivore and rodent teeth mark evidence at Craven Street which shows that at least some remains were left on the surface prior to burial. Weathering of remains was however minimal and most of the remains of both animals and humans were in excellent condition. This in a traditional faunal assemblage would suggest that the remains had limited surface exposure, but due to the nature of the Craven Street school this may not necessarily have been the case. If the remains were contained indoors exposed to a relatively consistent cold temperature and humidity, the bones would have been much less prone to warping and flaking. It was concluded that the pattern of carnivore activity suggested by the teeth marks was consistent with those recorded in modern forensic contexts, except for the lesser activity in the area of the torso, most likely a consequence of the remains having been dissected prior to consumption. One human juvenile had several areas with evidence of exposure to carnivore gnawing suggesting the child was left exposed at least partially articulated on the surface. We know from historical sources that Hewson was not averse to having rabbits and dogs, used for vivisections, running around the house. It is perhaps therefore not surprising that a number of both humans and faunal remains exhibited teeth marks.

It therefore seems most unlikely that the pit was the sole source of disposal at the anatomy school. The remains buried there were not selected because they were too sensitive to bury elsewhere, but more likely because they were suitable in size to be disposed of in a confined space. The incomplete nature of the remains suggests that others would have been retained by the school or buried elsewhere. It is pure conjecture to suggest what might have happened to the remainder of the material that was originally used by the school for teaching and research. Archaeologically there is no evidence of this from Craven Street or other sites such as parish cemeteries. Historically, it is equally an enigma. It seems plausible that the remains were loaded up into a cart and driven off to selected discreet places to be buried, but to date this has not been confirmed. If this occurred it must have been a complicated and risky business, whether carried out by the resurrection men or by the anatomy schools themselves. It seems very unlikely that a residential area in the centre of London would not have been in some way aware of the undertakings at 27 Craven Street and the neighbouring school of Dr Leake.

11.2 Utilisation

The idea of a single event for the disposal of the archaeological remains leads on to the question of utilisation– what purpose did the remains in the pit serve and how had they been used before disposal? To answer these questions, historical sources formed an integral part of the evidence as interpretation of the pattern of cuts and distribution of species can only truly be understood in light of our knowledge of Hewson and the application of different techniques known to have been used at the time. The historical chapters of this thesis have provided a comprehensive review of anatomical and surgical techniques available at the time (chapter 4) and a detailed review of Hewson's own research interests and experimental techniques (section 5.5). Evidence of other excavations of anatomy school/hospital waste further help to shed light on the significance of the remains at Craven Street and the activities that went on in the school.

The waste in the pit is likely to have been the result of a number of different activities at the school taking place over an unknown period of time. Historical evidence shows that some events took place in the lecture theatre -making of prosections and use of living and dead animals for demonstrations. Some took place in the museum – particularly the making of preparations for display. Many of these activities would have been in the dissection room - student dissection (including surgical practice and comparative anatomy) and Hewson's own research on humans and animals relating to the circulatory system. It must also be considered whether or not some of the remains might have had an entirely different purpose independent of the anatomy school, such as kitchen waste. In the following sections, each of these possible uses for the remains is examined in turn, in order to establish the most plausible scenario.

11.2.1 Student dissection and demonstration

The historical evidence presented in this thesis has suggested that Hewson taught predominantly anatomy (66.11% of his classes), surgery (22.31%), obstetrics/midwifery (5.79%) and comparative anatomy (5.79%). These subjects included lessons in pathology, dentistry, embalming and the making of museum preparations (section 6.1.6). Similar techniques would have been applied in student dissections and making prosections for student demonstrations in the lecture theatre and have therefore all been treated together.

11.2.1.1 Methods of dissection

Drawing on evidence from dissection manuals from the eighteenth, nineteenth and twenty-first centuries it has been possible to focus on three particular regions of the skeleton and to compare the cut patterns of Craven Street with those suggested by the methods described (section 9.8).

Cuts to the cranium and mandible

From the manuals (Lyser & Thomson, 1740; Hooper & Ruysch, 1809; Holden, 1894;Tank & Grant, 2009) (section 4.1.5) it was apparent that the vast majority of dissection cuts affecting the skeleton would have been made to the skull; such as removal of the skull cap, occipital wedge, orbital wedge and bi-sectioning of the mandible. All these can be seen in the Craven Street material. A number of the Craven Street cuts seem to be absent from the earlier manuals: removal of the occipital wedge was not clearly described until the nineteenth century; bi-sectioning of the skull was not described in the eighteenth century manual or the early nineteenth but was recommended by both Holden (1894: 257) and Tank and Grant (2009: 239). Craven Street had three examples of bi-sectioned skulls, performed in the manner described by Holden (1894: 257). In at least two cases (Appendix 4: 4:7 and 4:9) the occipital wedge had been removed prior to the skull bisection, making it more likely to be student dissection rather than a museum preparation where the cranium would have been dissected in its entirety (Pole 1790, 35 and Parsons 1831, 167). Other cuts recommended in the manuals were not seen at Craven Street such as removal of the zygomatic arch and the coronoid process. Only one example was noted of a transverse cut across the mandibular ramus. The cutting of the petrous bone to gain access to the inner ear was not observed.

Thoracotomies

The thorax was another focus of cuts described in contemporary dissection manuals. Thoracotomy – the opening of the chest cavity – is represented by many cut marks in the Craven Street material. It is, however, noticeable that none of the clavicles had been bisected and this being consistent with Lyser and Thomson (1740: 89), who removed the clavicle by separating the cartilage between its sternal end and the manubrium. The manuals instructed that the ribs too were to be cut along the cartilage with Hooper and Ruysch (1809: 188) also recommending they be sawn off near the spine to view the intercostal nerve. This also appears to have been the case at Craven Street, where a number of ribs appeared to have been pulled back and sawn from the visceral surface, which must have involved removing some of the internal organs in order to perform the cut. Cuts to the sternum were not recommended until the later manuals – both Lyser and Thomson (1740:89) and Hooper and Ruysch (1809: 172) kept the sternum complete. At Craven Street two sternums were cut in a transverse direction across the manubrium and one in a sagittal direction. It is possible they were cut with their upper parts still attached to the clavicles. Both transverse and sagittal cuts were noted at other sites like TCD, MCG and RLH.

Laminectomies

Dissection for exposure of the spinal cord was done by cutting on the arches (laminae) of the vertebrae with Tank and Grant (2009: 15) recommending cuts on either side of the spinous process from the sixth thoracic to the 12th thoracic vertebra. At Craven Street cuts of this type were seen in three thoracic vertebrae. Lumbar vertebrae at Craven Street were cut in a very different manner, through the inferior and superior articular processes. The transverse processes were likewise removed in a manner that would have been very difficult to perform in an articulated individual and not very practical in a standard dissection. It appears these cuts may have been performed for a different but somewhat obscure reason. These cuts had been made on at least three different individuals and are therefore unlikely to have been made by a misguided student. One lumbar vertebra had a partial cut through the body from posterior to anterior which may have been a failed attempt at removing the posterior portion. Two of these specimens exhibited evidence of a neoplasm but the other did not display any pathology. Cuts to the pelvis were consistent with those described by Holden (1894, 483). There was no instruction in the four manuals reviewed for the severing of long bones or transverse cuts to the vertebrae other than for convenience of dissecting.

Thus the great majority of dissection cuts see at Craven Street can be matched with manuals and with other archaeological excavations of similar sites. It is, however, evident that they did not resemble those described by earlier manuals as might have been expected, but rather those of the later manuals. It may well be that the variations in the manuals was not chronological but dictated by preference.

11.2.1.2 Body sharing

The survey of historical evidence has shown that body sharing was an economical way of using the available material and ensured dissection of all parts before the onset of putrefaction. The body would have been divided into set portions: head; arms; hands; thorax; abdomen; legs and feet were obvious portions of division (Fowler & Powers, 2012: 179). At Craven Street there was clear evidence for removal of the head with transverse cuts of the third and seventh cervical, or first thoracic vertebrae. The division of the thorax from the abdomen was less evident, with no transverse cuts to the lower thoracic and lumbar vertebrae. One articulated torso had cuts to the fifth cervical and sixth thoracic vertebrae, suggesting they were severed significantly higher up than at other anatomy school sites which have been excavated. This is supported by a cut to one fourth thoracic vertebra. All these cuts would have been located in the area between the shoulder blades and, even though it was not possible to determine the direction of cut, it seems more likely they were associated with Hewson's research (see below) than with body sharing.

The discussions above are inconclusive on the interpretation of the large number of long bones with severed shafts. It is equally possible that they resulted from body sharing or of surgical practice in form of amputations. The locations of the cuts did not provide sufficient evidence for this as both body sharing and amputations would have avoided any joint involvement. At Craven Street it was noticed that many of the long bone cuts had several transverse knife marks just below the severed surface and it is unlikely that this would have occurred had it been an actual amputation that would have had to be performed swiftly and accurately. At Craven Street a number of lower limb bones had been severed more than once and could be matched post-excavation to form one complete bone. These are therefore unlikely to have formed part of surgical waste. In summary, it seems reasonable to assume that the majority of the severed long bones at Craven Street were associated with division of bodies rather than amputations. A number of long bones had not been severed and were complete, including two femora, two ulnae, one radius and one fibula. Given dissection did not involve cutting of long bones *per se* this suggests that body sharing was not consistently applied. It is possible that the un-severed long bones formed part of discarded cadavers used in demonstrations rather than student dissections.

It is much more difficult to ascertain if body sharing was applied to infants as well as adults as division of the torso is unlikely to have been perceptible in the skeletal remains as for children it would have been easier to cut the body between the unfused vertebrae. The long bone cuts varied between the adults and those seen in the INP group, in which none of the tibiae and fibulae had been severed, despite being present in relatively large numbers. The humeri in the INP group like the adults had been bisected at the middle only. It is uncertain what these discrepancies mean but it is plausible that the INP group were divided into fewer body portions so that the legs and feet were examined together and the arms and hands together. One child in the INP group had a sagittal cut along the sacrum similar to that of the adults, supporting the notion that body sharing may have been practiced on children as well as adults. This would imply that the children had been used for student dissections on equal terms as the adults, a conclusion supported by the number of skull cap removals seen in the INP group.

11.2.1.3 Animal vs *human*

The large number and variety of cuts present on the human remains was almost completely absent on the faunal remains. This was not unique to Craven Street but also noted at Royal London Hospital (RLH), MCG and The Ashmolean museum (ASM). It was evident that animals did not serve as substitutes for human anatomy as they had done in the early days of anatomical study. It was not possible to suggest that any of the animals had been used as a replacement or otherwise for student dissection. The coffins at RLH with mixed partially articulated human and animal remains (Fowler & Powers 2012: 160) perhaps suggested that the animals were not uniquely used for comparative anatomy at the end of a course, but featured throughout the sessions, perhaps used for live demonstrations in the lecture theatres as historical evidence suggests, and then disposed of alongside the humans.

11.2.1.4 Surgery/surgical practice

11.2.1.4.1 Amputation/amputation practice

It seems reasonable to assume that the likelihood of amputations in living patients and routine autopsies would be much less likely to be present in the Craven Street assemblage than in the remains recovered from hospital sites. It is, however, entirely possible that amputation as part of teaching for surgical practice was carried out on the bodies. The cuts on the long bones at Craven Street were consistent in location with those seen at the other archaeological excavations in being located in the upper third of the shaft, lower third or centrally. This was also consistent with the advice of Le Dran (1768) and Sansom (1858) for practical locations of amputation (section 4.2.1). It was notable that the remains from hospital grounds – Worcester Royal Infirmary (WRI), Bristol Royal Infirmary (BRI) and Newcastle Royal Infirmary (NRI) – had a consistently higher rate of cuts to the proximal shaft of the tibiae than Craven Street, MCG and TCD. BRI and NRI also had a very low rate of cuts to the proximal femur, which was noted in the literature to be an operation location with very low survival rate (Sansom 1858).

Witkin (2011: 263) argued that the presence of large break-away spurs and notches were less likely to be amputations (section 9.5.2). For Craven Street, measurements of the break-away spurs and notches did not reveal any significantly large examples as seen in Witkin (2011: 264) and it may be concluded that spur size is of limited value in determining the purpose of the cut. Witkin (2011: 264) also noted this, commenting that large spurs may have been produced during amputations if the patient moved during the operation. It could equally be argued that smaller spurs were easier to produce in cadavers as there was no movement to contend with and the cut could be performed at a leisurely pace. The presence of multiple knife cuts and slip marks from the saw appeared to be a better indicator of activity with regards to possible amputations. Only one specimen from Craven Street showed a cut consistent to some extent with the expected method of limb amputation. This was a distal portion of femur (Figure 79), in which a circumferential knife cut 63 mm below the sawn surface would allow sufficient soft tissue to cover the bone stump. The rest of the bone showed no evidence of a pathological condition that would require amputation, so this seems most likely to have been a practice amputation. Naturally, if only the proximal portion of an amputation was present a knife cut would not be viewable and it would have been difficult to determine whether the limb had been an amputation or body sharing. It may be equally argued that the manner in which the "flap method" of amputation is performed would leave less clear knife marks on the bone. It is therefore entirely plausible that a larger number of bones were "amputated" than visible in the archaeological record.

The direction of the cuts for amputations was discussed by Sharp (1740: 217) and Le Dran (1768: 427). Both agreed that in amputating the lower leg and lower arm it was important to saw through both bones at the same time, with Sharp suggesting that this was best done by cutting the bone lateral to mesial (standing inside the limb) (section 4.2.1.1). The cuts on the Craven Street bones did not reflect these directions, assuming the lower arm was in the correct anatomical position and not cut whilst the bones were crossing with the hand rotated.

There were examples of tibiae and fibulae severed twice, on the proximal third and the distal third of the shaft. It cannot be dismissed that these were amputations acquired by the students and the cut again to remove the foot. In one case the proximal portion of the tibia was present, so this cannot have been a discarded hospital amputation, but in two cases the proximal portion was absent. In one case the bone was fragile with possible osteoporosis (section 9.6.2.5), though this is unlikely to have caused the leg to be amputated. In the other case (section 9.6.1.1) healed periositis was present on the shaft. The proximal cut was neat with no slipmarks present, whilst the distal cut exhibited several slipmarks along the shaft. These cases may possibly be examples of surgical waste from amputations acquired for student dissection.

It is known from historical sources that the Craven Street museum collection did contain examples of amputation; one particular case a wet preparation of a femur from a woman with a note stating "15 days after amputation" (Paterson, 1778: 13/10/1778 lot 88). The leg may have been acquired from one of the hospitals after the patient died and was most likely used to demonstrate the healing process of an amputation, or perhaps lack of healing.

11.2.1.4.2 Trepanning

Historical evidence suggests the survival rate from trepanning was very low and strict procedures were recommended in terms of best practice regarding location and method of application (section 4.2.2). At Craven Street, historical evidence clearly indicates that trepanation was an integral part of surgical practice because the school boasted over 12 trepanning instruments in its collection (Paterson, 1778: 38). In the archaeological remains, a total of 18 trepanation holes were recorded in four adults and one infant. The majority of trepanations were located on the frontal and parietal bones away from the sutures, as recommended in contemporary manuals. Two trepanations were located on the frontal sinus area and did not fully perforate the cranial vault, whilst another trepanation on the squamous part of the frontal bone was equally incomplete. The trepanations seem to have been performed in close succession and in some cases overlapped. In one case the skull had been sawn between the trepanation apertures joining them together and in another case two oblique cuts had been made from the trepanation itself, forming a “keyhole shaped” cut, similar to one noted at WRI (Western 2011: 50). A number of trepanations were incomplete, whilst some had been cut almost through, leaving a thin bevelled margin on the endocranial aspect of the bone. Still others had been cut all the way though. The sheer haphazard nature of the trepanations at Craven Street suggest these were not in-vivo surgical operations, but practice as part of the teaching. The different levels of perforations may be testament to the difficulties of keeping the instrument perpendicular to the surface of a curved cranial bone, and it may have been necessary to lever the disc of bone away with the chisel rather than cutting all the way through and risking damage to the soft tissue inside. Only one skull specimen showed evidence of blunt force trauma of the type that would normally be treated by trepanation (Figure 103) but showed no evidence on the operation on the same side as the trauma lesion. There were, however two trepanations on the opposite side of the same skull, where several radiating fractures were present. Though they could not be directly associated with the wound they did appear to have been cut prior to the removal of the skull cap.

11.2.1.5 Dentition and dentistry

Dentistry was a new but by the mid eighteenth century a relatively well established profession in Britain. In 1770 Thomas Beardmore published “*A treatise on the deformation and disorders of Teeth and Gums*” and in 1771 John Hunter published “*The Natural History of Human Teeth*”, both addressing the diseases and transplantation of teeth. Hewson and Falconar did address the topic of teeth as a part of the curriculum in a single lecture “X*XIV On the structure of the teeth with remarks on some of their diseases*” (Falconar, 1777b: 7), but this appears to be the only time the subject was approached. Nonetheless the sale catalogue shows that the museum collection boasted a total of 29 preparations on human dentition including two sections through the jaws exposing secondary dentition and jars with diseased teeth. Intriguingly it also included three examples of burnt teeth. In twelve of the specimens the teeth had remained *in situ* in the jaw, and in five cases teeth (most likely loose) were placed in jars (Paterson, 1778). This means some of the jaws would have been retained either complete or in half and some would have been extracted to make preparations of healthy and diseased teeth. The archaeological record from Craven Street did reveal a series of bisected mandibles although these were most likely associated with general dissection techniques than for the particular purpose of making preparations, being roughly cut to the lateral of the first incisors rather than through the middle. One mandible [1103] had clearly been broken whilst the bone was still fresh with the likelihood that this was done in order to remove the teeth from the jaw. In one case only the right half of one mandible was recovered [293], revealing a series of very healthy teeth, being cut lateral to the first incisor and the aspect missing would have had both the first incisors present. It is not unlikely that this half of the mandible was retained as a demonstration of perfect healthy dentition. The relatively low rate of diseased teeth preserved amongst the remains may also serve as an example of possible retention of the more interesting specimens for demonstration in the museum.

Dentition would also have had a secondary role at the anatomy school as teeth were highly sought after by dentists as implants to replace decaying and missing dentition. John Hunter (1771) promoted the implantation of both fresh and dead teeth making a clear distinction between the two. He was a firm believer that fresh and dead teeth could be fixed in the jaw by natural adaptation and growth, but only the incisors, canines and premolars. Molars were dismissed as it would be impossible to find a tooth that could fit into the pre-existing sockets of the patient (Hunter, 1771: 217). Calling the tooth for transplantation the "scion tooth", he strongly recommended the tooth to be small, so that it could easily fit into the socket and to that purpose recommended female teeth. He also stated that the tooth of a younger person was best and it had to be in perfect condition and not taken out of a diseased mouth, though he added that he did not believe any transfer of diseases could occur (Hunter, 1771: 221). Finally he noted that teeth with straight roots were the easiest to fit, though if absolutely necessary the "fangs" could be filed to fit the socket (Hunter, 1771: 217). Though Hunter believed in "fresh" tooth transplantation, he acknowledged the inherent problems of this process as several people willing to sell their teeth had to be ready during transplant in case the first tooth did not fit. He recognised that transplantation of dead teeth was much more convenient as the dentist could have a large supply of different teeth to find the "best fit", though he did find that dead teeth were susceptible to staining (Hunter, 1771: 226). From Hunter's instructions it is possible to surmise that the teeth most sought after were the incisors, canines and premolars of young people with healthy teeth, no diseases and straight roots. These teeth were therefore highly sought after and would have been a good method of generating cash for the anatomists and students alike.

From the historical evidence it is apparent that teeth would have commonly been extracted, either to add to museum collections or to sell for transplantation. The seemingly high rate of postmortem tooth loss, particularly the upper incisors and lower canines may thus be a consequence of tooth extraction (section 9.7). The high rate of postmortem tooth loss is however in itself not sufficient evidence that teeth extraction was practiced as it is relatively common in archaeological assemblages to find post mortem absence of anterior dentition due to taphonomic processes. One left maxilla of a young female with the first premolar and the first and second molar present showed evidence of having a very good set of teeth, ivory in colour and with minimal wear. The anterior teeth were missing with the thin maxillary bone absent to anterior and fine chip mark present. It seems entirely possible that this may have been caused by removal of dentition.

11.2.1.6 Comparative anatomy

Historical evidence suggested that animals were frequently used for demonstrations during lectures and it was suggested during periods of shortage that animals be used. There was however little to suggest at Craven Street that animals were used in a similar manner and therefore as a substitute to humans. No removal of the cranial vault had taken place and cutting of the bone was minimal. It is much more likely the animals were used in cases where demonstrations required a live subject.

11.2.2 Hewson's research

The archaeological assemblage from Craven Street can be closely linked with Hewson and his research. It included the remains of microscope glass sheets and tubes consistent with those seen at the Hunterian Museum in London (section 7.7). The faunal remains revealed a wide variety of species including turtle and tortoise and a number of birds, which formed part of Hewson's interest in the lymphatic system in oviparous animals. Use of human bodies in his experiments was suggested from publications (Falconar, 1777c), but this was less transparent in the human assemblage at Craven Street.

11.2.2.1 Hewson's research on the thymus gland

Hewson's research revealed a specific interest in the thymus gland and its function and development, particularly the fact that it atrophied during life and was largest in the newborn (section 5.5.8). The human skeletal assemblage revealed a comparatively large number of foetal and neonate dissected individuals. Given this demographic profile was unique to Craven Street compared with other similar archaeological excavations (Figure 115) it seemed highly probable they served a specific purpose and were not simply part of standard student dissection. Lymph nodes are also generally seen to be larger in children than adults due to their constant exposure to new infection and antigens, so it is quite likely that Hewson had noted they were larger and found this advantageous in tracing the lymphatic system.

It was not possible to associate any cuts in the children with research into the thymus and the lymphatic system, but in the adult assemblage transverse cuts were noted to the manubrium and on the fourth and sixth thoracic vertebrae. As noted above, these cuts were unlikely to have been associated with body sharing. The cut to the fourth thoracic vertebra is consistent with exposure of the inferior portion of the superior mediastinum, extending from the inferior portion of the manubrium to the inferior portion of the fourth thoracic vertebra. It is similarly not unlikely that the articulated thorax with cuts to the fifth cervical and sixth thoracic was prepared to show the superior mediastinum but at a wider angle. This area is where it is possible to gain access to the glandular plane and thereby the location of the thymus gland.

11.2.2.2 Hewson's research into the lymphatic system

Animals formed an important part of Hewson's research, not simply in support of his human physiological work but in terms of comparative anatomy and the function and appearance of the circulatory system in different species of animals. He particularly gained recognition for his research into the lymphatic system in oviparous animals.

11.2.2.2.1 Birds

The large number of bird remains was unique to Craven Street amongst all the excavations of remains from anatomy schools and though the others did contain some birds, these appeared to be predominantly associated with kitchen waste and present in much smaller quantities. This alone suggests that birds were of some significance to Craven Street. Thomson (1835: 522) noted aquatic birds were the most favourable when investigating the lymphatic system because the posterior extremities are larger and more easily found than those of other birds. The goose in the auction catalogue for the Craven Street museum is testament to Hewson's knowledge about this (Parsons, 1778: 14/10/1778 – lot 68). The archaeological skeletal assemblage further supported this with the partially articulated remains of at least four mallards that formed part of the anatomy school waste rather than kitchen waste. It would certainly explain why the bird assemblage was so dominated by mallards rather than for instance domestic fowl, which appeared to have entered the pit as kitchen waste. This does not explain why all the mallards were female and it is uncertain whether this was a deliberate choice or simply a question of availability. Birds did feature in the auction catalogue with a total of 13 lots. These included the bones of a "bird of prey" and four cases of "common fowl". No mallards were identified in the catalogue and goose was the only aquatic bird represented with an egg, a whole individual and a lymphatic injection of the trunk. It is interesting that the goose trunk, most likely the one depicted in his publication on the lymphatic system on birds, only sold for 7 shilling 6 pence; a relatively modest price compared to lymphatic injections of turtle.

11.2.2.2.2 Fish

Fish formed an integral part of Hewson's research on the lymphatic system. He used a wide variety of fish in his experiments and travelled to Brighton to acquire larger fresh fish for his studies (section 5.5.6). Table 60 shows the fish identified from the excavated remains compared with those mentioned in Hewson's publications and in the museum catalogue. A large number of species were available straight from the river Thames, which could yield over 125 different species including cod, ray, sole, sprats, herring and eel, whilst other fish would have been available from the market.

Excavation	Publications	Catalogue
Cod	Cod	Cod
Flat fish	Haddock	Eel
Herring	Kingston fish	Flying fish
Salmon	Monk fish	Monk fish
Tope shark	Skate	Remora
		Torpedo

Table 60 fish identified from excavation, Hewson's experiments and the museum catalogue (Experiments: Hewson 1769b and Paterson 1778)

Fish such as plaice, cod, mackerel and conger eel and other flat fish were uncovered from RLH and MCG in limited numbers. Only the conger eel at RLH was clearly associated with the anatomy school (Morris *et al*., 2011). Hewson's experiments on fish led him to seek out a wide variety of fish from Brighton and London. Whilst his museum catalogue contained more exotic species such as flying fish and remora, which are non-native to British waters, both the archaeological remains and published experiments involve species which were all native to Britain. This is perfectly understandable as Hewson would have required live specimens for his research.

11.2.2.2.3 Amphibians and reptiles

Hewson carried out extensive research on turtles and frogs in relation to the circulatory system. Hewson classified turtles as amphibious animals whereas today these are classified as reptiles. In his publication on the lymphatic system in amphibious animals he mentioned using a turtle 82.30 cm across the carapace. This turtle was acquired whilst he was still in partnership with William Hunter and appears to have been significantly larger than the green sea turtle uncovered at Craven Street which would have had an estimated carapace size of 57.50 cm and can therefore not have been the same animal. Hewson most likely acquired these animals and the tortoise to carry out further research on the lymphatic system and for making of preparations for museum specimens (see below).

11.2.2.2.4 Cats, dogs and rabbits

Cats, dogs and rabbits were readily available and with easier access to these animals they may have been used for student dissections, demonstrations and preparations. None of the bones had been severed, but this did not necessarily mean dissection did not take place. They were however treated differently from the human remains. Both comparative sites and historical records suggest that, of common domestic species, dog was the most popular for anatomical research. Hewson did use dogs and rabbits in his experiments on the blood and the lymphatic system but there were no mentions of cats in any of his publications, which is curious in view of the cats present in the excavated pit and in the museum catalogue. In the auction catalogue cats featured in 14 lots. Five of these were associated with the uterus and foetus; five were kidneys;

there were two complete injected cats and two skeletons. Dogs had a lower representation of seven lots, the majority skeletal. Though cats and dogs may be considered animals used for similar purposes there was little to suggest that this was the case at Craven Street. Dogs were mainly used in relation to Hewson's studies on the blood. Experiments involving a total of 16 dogs were counted in his publications on the blood and lymphatic system. Rabbits likewise featured strongly in Hewson's research with at least nine rabbits described in his published experiments. It should be kept in mind that a number of the published experiments were made during his partnership with William Hunter and specimens may have been more readily available than at Craven Street.

Two kittens were present amongst the cats in the Craven Street pit and dog was represented by at least four individuals, three younger than 18 months. The rabbits were estimated at nine months or older. It is noticeable that a large proportion of the animals were young and this in particular stood out when Craven Street was compared with ASM where the vast majority of the 24 dogs present were older individuals (Hull, 2003: 16). It may well be that Hewson had a particular interest in younger individuals for the purpose of investigating the lymphatic system, similar to the findings of the human remains (see above).

11.2.3 Museum preparations

The survival of the sale catalogue with its descriptions of the entire contents of the museum and the school (Paterson, 1778) provided an unprecedented insight into the retention of human and faunal individuals. The pit may have contained discarded preparations or specimens perceived as unfit for the making of museum preparations.

11.2.3.1 Human preparations

Comparing the age distribution of the estimated MNI from the catalogue and the pit suggested a very similar pattern, with only slightly more individuals in the INP group in the pit (Figure 131). In comparison, the other archaeological anatomy school sites all had markedly higher proportions of adult remains. It is possible that the Craven Street assemblage was representative of the type of cadavers used at the school, despite appearing to result from a single event. Historical sources suggested that children and young persons were better when making preparations (Pole 1790), which may explain the high percentage of child remains in the auction catalogue, and this may in turn suggest that Hewson may have targeted this age group in order to make preparations for his museum.

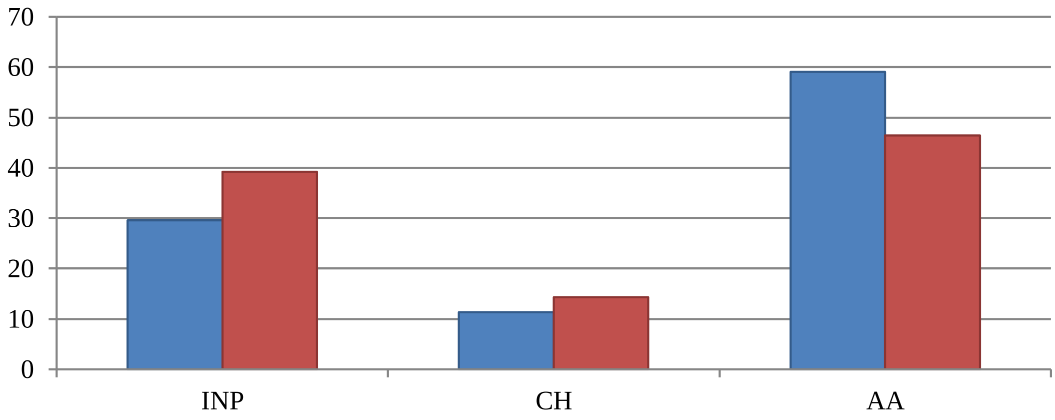

Figure 131 Percentage distribution of humans by age based on MNI (Blue = auction catalogue (N=44), Red = Skeletal assemblage (N=28)

11.2.3.1.1 Preparations from children

From the distribution of cuts on the bones, it is apparent that the remains of children were consistently treated in a different way to those of adults at Craven Street. In comparison, the remains from other excavations showed a consistency between children and adults in the majority of cuts, with the exception of two cut types performed on children: the "diamond cut" and the "oblique skull cap". These are believed to result from museum preparation, rather than student dissections.

The **"Diamond cut"** (Figure 86) was present on two skulls from Craven Street. In one of these, a 6-7 year old child, the whole skull survived, suggesting this may have been a failed or discarded attempt at a museum preparation of the brain contained in the cranium. This would have provided a birds-eye view of the brain in its original position. It was not possible to find any examples of this cut type at any comparative, museum or modern anatomical archives or texts, so the procedure seems to be unique to Craven Street. The saw marks on the pieces of skull indicated the cut had been difficult to perform and must have served a particular purpose, perhaps in demonstration of the *Dura mater* of the brain and its association with the cranial vault. In the auction catalogue (Paterson 1778) a total of 12 wet preparations (17/10/1778 – 42-53) were of the brain, either demonstrating the *Dura mater* or the *Pia mater* with three injected and one of the *Dura mater* with the brain imitated in plaster. Two demonstrated pathological conditions. It was however not possible to link any of these preparations directly with the "diamond cut" procedure.

The **"oblique skull cap" (**Figure 87) might have been a method of removing the skull cap without the need to cut an occipital wedge. No other example was found in the historical or archaeological literature and it is possible that this was an experimental method devised at the Craven Street School, for use with younger individuals with thinner and more fragile skulls. Sett *et al.* (2007:1) presented a method of removing the skull cap and exposing the spinal cord at the same time, involving a cut 2 cm above the orbit, extending over the auricle and to posterior 1 cm above the occiput (the posterior portion of the foramen magnum). This cut differed from Craven Street by including the frontal bone and cutting the occipital bone lower. The oblique cuts at Craven Street were sawn from just behind *bregma* to the external occipital protuberance. Sett *et al.* (2007) argued that their oblique method was superior to the traditional procedure of removing first the skull cap and then cutting an occipital wedge, which tended to cause damage to the brain stem and not expose the posterior fossa. They also argued that their method allowed for the preparation of superior museum specimens. Sett *et al.* (2007) however performed this method on adult skeletons whilst at Craven Street this was only evident on the skulls of very young children. It is possible that it was necessary to perform the cuts in a more superior position due to the unfused state of the cranial bones (the basilar and lateral parts of the occipital were not fused to the squamous portion of this bone and this cut would have allowed him to remove these portions with more ease and thereby expose the spinal canal. If the purpose was to make a museum specimen, it is possible that the frontal bone was left intact in order to preserve the face whilst demonstrating the connection between the brain and the spinal cord. It may well be very young individuals were selected as being a more convenient size for preparations. In the Surgicat catalogue of the Hunterian Museum at the Royal College of Surgeons, there are seven specimens showing injections of the human *Medulla spinalis* (the spinal cord), but none were seen connected to the brain. One example (RCSHC/800) showed a human foetal *medulla spinalis* with injected arteries. The Craven Street auction catalogue (Paterson, 1778) listed at least six lots of wet preparations of the spine and *Medulla spinalis*: two children and four foetuses (15/10/1778 lots 82-87). Three were purchased by William Hunter. These were, a child with a defect of the spine opened before death, one very young individual and a nine month old foetus.

The postcranial skeleton would have left very limited direct evidence from the making of preparations, though it could be argued that the severed long bones may have been associated with this activity. For example, in cutting the limbs to size once they had been injected and dried or prepared as a wet specimen. Only one element, a distal unfused epiphysis of a radius (Figure 89) exhibited a small circular perforation on the central portion, consistent with the opening made for the purpose of extracting the marrow and cleaning the bone.

11.2.3.1.2 Preparations from adults

Several cuts seen in the Craven Street assemblage do suggest the preparation of museum specimens. In one, the maxilla was severed transversely to expose the maxillary sinus inside which there was evidence of inflammation resulting from the penetration of the pulp chamber in the third molar by a carious lesion (Figure 67). This was not in any way consistent with the cuts normally made in student dissections. It is possible this preparation was made as a demonstration of a relatively common infection in the eighteenth century (Roberts & Cox, 2003: 299). Pole (1790: 35) described a preparation involving the exposure of the frontal sinuses, recommending using the trepan to drill into the sinuses. It is possible one specimen from Craven Street with a double trepanation on the frontal sinus (Figure 69) was a failed attempt at the same.

One head of a humerus (Figure 76) had been bisected in the sagittal plane, appearing to have been cut too close to the medial side and then snapped. This might have been either a failed attempt at sectioning the bone to demonstrate its structure or perhaps an attempt to cut a slot on the head in order to assemble the shoulder joint for an articulated skeleton (section 4.3.4). Unfortunately no other specimens from the Craven Street pit provided any evidence for preparation of articulated skeletons, so there is nothing with which the humerus can be compared.

A number of cuts recorded on the Craven Street adult remains are known from historical research to have been used in both dissection and the making of preparations. For instance, Parsons (1831, 40) recommended cutting the ribs in the mid axillary line to display the heart *in situ*, a cut location seen at Craven Street. Bisections of complete individuals in the median sagittal plane would have been performed by cutting upwards from the coccyx through the spine and sternum and then cutting down through the head from its superior side. Bisections in the sagittal plane of vertebrae were not seen at Craven Street but there were examples of both adult and infant bisections of the sacrum. In order to display the lower arm, Parsons (1831: 35) suggested cutting the arm a little above the elbow. At Craven Street cuts to the humerus were only made on the central portion of the shaft, but it is not impossible that at least some of them were associated with preparations and not solely associated with body sharing or practice amputations.

11.2.3.1.3 Collecting pathological specimens

A limited quantity of pathological specimens were identified in the pit. They exhibited conditions such as mild inflammation, cancer and unhealed fractures. The auction catalogue included a great number of specimens demonstrating pathological conditions. From their wording, the descriptions in the catalogue seem to have been made by lay people at the auction house and many had no identification other than “diseased”. In a total of 346 preparations, however, the condition was listed: venereal disease; ulcers; trauma; amputations; worms; hernias; fractures; infections; ankyloses; congenital and stones. Of these, 111 were presentations in bone including: fractures; dental disease; inflammations; cancer, amputations; joint diseases and congenital malformations. Carious bones (most likely osteomyelitis) were particularly frequent, with 28 preparations. Pathological specimens in general appear to have fetched good money. William Hunter bought a "distorted trunk" for 3 pounds 7 shillings (19/10/1778 – lot 3) and a carious leg for 1 pound 2 shillings (19/10/1778 – lot 7). John Sheldon also purchased an inflamed spine for three pounds 3 shillings (19/10/1778 – lot 14), whilst Cruikshank bought a cancerous jaw for the very large sum of 20 pounds, 9 shillings and 6 pence (21/10/1778 – lot 21).

Specimens demonstrating pathological conditions must have formed an important part of any anatomy school collection and those seen in the bone would have been relatively easy to preserve. It is perhaps therefore puzzling why Hewson did not retain a number of the diseased bones uncovered from the trench. It is of course possible that they were retained and then disposed at a later date or that other parts of the same individual were a better representation of the condition. Of particular interest were the infant bones with possible rubella/syphilis, the complete spine with DISH, the blunt force trauma on the skull and the butterfly fracture of the tibia. These could have been used to prepare specimens which provided excellent demonstrations of these conditions. It is possible that specimens were not required for those conditions, or that they were considered not to be in sufficiently good condition to prepare for museum display. It is possible that the individual with the fused ear ossicles (Figure 107) indicative of *aural artresia* had formed part of the collection. The absence of an external auditory meatus would have been very obvious and this would have been a relatively rare specimen. It was not, however, listed in the catalogue.

The cuts of the lumbar vertebrae discussed above (Figure 83) may have been a failed attempt at a museum preparation. They appear too complex to be a variant of standard dissection procedure but would have allowed a wider view of the spinal cord. Parsons (1831: 173) described a preparation technique which is not completely dissimilar. It is also possible, at least in the case of the two cancerous vertebrae, that the cuts provided a view needed to demonstrate the pathological effect of conditions such as metastatic spinal cord compression in prostate cancer (Lubdha & Salzman, 2011: 3).

11.2.3.2 Faunal remains

If the remains from Craven Street and from the auction catalogue are divided into animal classes (Figure 132) it appears that the excavations yielded a larger proportion of birds and fewer reptiles and amphibians. Mammals and fish were in slightly higher proportions in the excavated assemblage. It is quite possible that more exotic species were retained and the more common species of bird discarded.

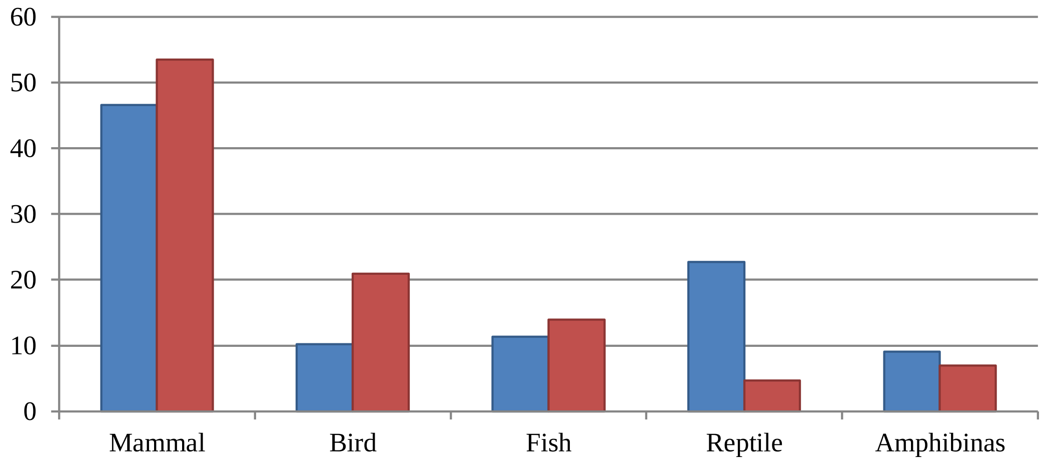

Figure 132 percentage distribution of faunals remains based on the estimated MNI (Blue = auction catalogue (N=88), Red = skeletal assemblage (N=43)) (Catalogue: Paterson, 1778)

11.2.3.2.1 Exotic animals

Exotic species were present at all the other anatomy school sites in the form of monkeys, turtles, and manatees, suggesting it was commonplace for the schools to seek out more unusual specimens to experiment on and add to their museum collections. In this aspect Craven Street was far from unique. The turtle and tortoise in the pit were closely linked to Hewson's research and the catalogue revealed that he also valued exotic species in his museum collection. The lists include monkey, camel, lion, African antelope, porpoise and sea cow, mainly in the form of skeletal remains. The antelope was represented by horns only, the sea cow as head, tooth and tusks, and the porpoise as kidneys. It is apparent that Hewson was unlikely to have acquired these as complete animals for dissection, as more parts of these relatively rare species would have been made into preparations for the museum. Instead, it is much more likely that he received them skeletonised or already made into preparations. The wing of the white tailed eagle (section 10.2.4) uncovered from the pit would easily have fitted into the museum as a specimen alongside the horns of the antelope. Skeletal specimens of birds of prey did figure in the auction catalogue (21/10/1778 lot 93, sold for 16 shillings), but there was no information on the actual species of the birds. The auction prices are testament to the rarity of some of these specimens. The horns of the antelope (21/10/1778 – lot 100) and the monkey skeleton (21/10/1778 – lot 91) sold for 3 pounds and 3 shillings each. The sea cow (21/10/1778 lot 101-102) fetched 21 shillings for the head and 1 pound 16 shillings for the tusks, whilst the remains of the camel (22/10/1778 – lot 8) sold for a mere 18 shillings. John Hunter bought two of the five porpoise kidneys for the price of 9 shillings 6 pence.

The remains of a relatively large green turtle and a possible gopher tortoise in the trench were most likely associated with Hewson's research into the lymphatic system. Only the plastron and the anterior limbs of the green sea turtle were recovered and only part of the scapula of the gopher tortoise. It may be that the remaining parts of these reptiles were buried elsewhere in Craven Street but a more feasible explanation may be the manner in which the animals were dissected and parts retained. Dissection would have started with the removal of the plastron and there was no direct evidence of this on the parts of the plastron which were preserved. Instead, it may have been removed by cutting along the margins and was perhaps regarded as less valuable in an anatomy context and not considered worth retaining for the museum collection. From images of dissection of turtles, the frontal limbs would normally have remained in place, but in this case might have been removed to preserve the carapace. The acromion process of the green turtle had been severed suggesting that there was no intention of retaining this for the collection. This might therefore have been the case for all parts of the front limbs. Turtles were not an easily accessible commodity and the relatively large size of the green sea turtle (57.50 cm) in the pit suggests an expensive purchase for Hewson, or a very generous donation from a friend. Though there is no mention of a carapace in the auction catalogue it is not unlikely that Hewson either kept it for his private collection or sold it to fund further work. It is also possible that it became incorporated into a mixed lot. Lot number 96 (21/10/1778) are dry bones of tortoise described as “skeletons of various animals” suggesting Hewson had access to several turtles or tortoises. These were sold to Henry Cline at the relatively modest price of 3 shillings and 6 pence, suggesting that the bones even of exotic species were not a particularly valuable commodity. Perhaps because they were singular random bones. Sold at a higher price were the injected intestines of turtle as well as the spleen of a calf, both difficult preparations of the lymphatic system, in areas that could be minutely injected with the right skills (Thomson, 1835: 516). Such preparations were of much higher value and sold for over 2 pounds to buyers such as Cruikshank, Alcorn and Blizzard.

11.2.3.2.2 Common species

More common species such as cat, dog, horse, cattle and sheep uncovered from the trench were also listed in the auction catalogue. The most noticeably prepared specimen was the sectioned tooth of a horse (Figure 124). Several sectioned polished teeth were sold in the auction catalogue (17/10/1778 –lot 95-101). They are listed as quadrupeds, which may have included horse teeth, fetching a price of between 6 pounds and 6 shillings to 4 shilling and 6 pence for a lot of two teeth. Unlike the more exotic species the specimens of ass/horse, cow/calf/ox/buffalo and sheep included a variety of preparations, particularly of the cattle, suggesting these species were acquired in a more complete state. The relatively large number of sheep remains uncovered from the pit were considered more likely to be kitchen waste. These common food species must have been available at Hungerford Market just behind Craven Street, brought into the capital alive and then slaughtered at the market to maintain the freshness of the meat.

It was noted that pigs were not abundant at Craven Street or on any of the other anatomy school sites (section 10.1.5). The few remains present were treated in a manner most consistent with kitchen waste. In the auction catalogue there was a conspicuous absence of pigs, despite an abundance of other common species. It therefore seems that pigs were not considered to be a suitable comparative species. This is particularly striking, because Galen (AD 162) frequently used pigs as a comparative to human anatomy and today it is common knowledge that pigs are the domestic species which is anatomically closest to humans (Gross 1998 and Swindle *et al*. 2012). Pig was a common food species and must have been available on the same terms as sheep and cattle at the market and it suggests that pigs might have been excluded for a particular reason. There is ample historical evidence from the sixteenth and seventeenth century of pigs being used for dissection (Schultz, 2002:177; Knoeff, 2012). John Hunter had several hundred examples of pig in his museum collection (they are listed in the Surgicat catalogue of the Royal College of Surgeons), which suggest that it was not because pigs could not be easily managed during dissections and vivisections. Hewson must have been aware of Harvey's use of pigs when experimenting on the circulatory system and it would have been a logical extension of his research to look at the same species. It is therefore not easily explained why pigs appear to be lacking from the archaeological sites and the auction catalogue.

11.2.3.2.3 Animals as pathological specimens

The auction catalogue lists only a few animal specimens showing pathological conditions. There were a total of 21 preparations including 13 of the intestines of an ass, two of diseased lymph in an ox, two "monsterous kittens", bladderstones of ox and horse and one broken leg of a dog. The latter was a dog where the bone had been broken and the dog kept alive for a week and then killed in order to demonstrate the callus formation. This particular specimen was purchased by John Hunter for 7 shillings and 6 pence (Paterson 1778, 13/10/1778 – lot 37). The archaeological assemblage yielded no evidence of pathology in any of the faunal remains but it should be noted that, in general, archaeological faunal assemblages showing pathological conditions are relatively rarely. Perhaps due to their conditions being acute rather than cronic and therefore not manifested in the bone. The dog did none the less demonstrate that animals were in some cases deliberately harmed or at the very least not treated in order to gain interesting specimens for the museum collection.

11.2.3.3 Preparations of the lymphatic system

The lymphatic system was one of Hewson's main areas of research and it was notoriously difficult to inject (Hildebrand, 1968: 70). Some of the areas which could be most minutely injected at the time included genitals, liver, spleen and intestines of humans and in animals the uterus of cows and rabbits, the spleen of cow and intestines of turtle. The injection of both human and animals could be carried out in living and dead individuals. Later accounts show that animals were mainly injected alive (Muller, 1835; Rusconi, 1842; Hildebrand, 1968). Mr Rusconi also kept reptiles alive during injection (including tortoise) and then killing them with prussic acid (Rusconi, 1842: 161). Muller (1835: 256) injected green sea turtle and kept it alive for several hours to observe the flow of the lymphatic heart and then killed it by removing the head. Hildebrand (1968, 70) described a method of injecting the lymphatic vessels in cat "*Anesthetize a cat. Inject subcutaneously ¼ to ½ ml of India ink in each of 6-10 places. Inject under the pads of the feet and any place else except on the back. Wait 20-30 minutes and then kill the animal. Skin carefully and superficially over each injection site. About ¾ of the injections will be successful: Lymph channels will be revealed in black running from the injection site to nearby lymph nodes, which may also have taken the ink. The specimen can be preserved and demonstrated another time"*. This suggests cats were suitable subject for injection and this may be the reason for the high proportion of cats in the Craven Street assemblage. In the 1770s neither prussic acid nor anaesthetics were available but the accounts demonstrate how animals were freely used not as a substitute for humans but as a demonstration of comparative anatomy and because they allowed the lymphatic system to be viewed whilst the subject was still alive. In Hewson's catalogue there were 35 entries under preparations of the lymphatic system; 20 humans and 15 animals. The human specimens were mercury injections of the intestines, arms, legs and trunk. John Hunter purchased two of the more expensive preparations at 2 pounds 14 shillings and 2 pounds 10 shillings, though it was not clear what part of the human had been injected. Other buyers included Sheldon, Chafey and Hawkins.

11.3 Acquisition

Having considered the methods of disposal and usage of remains it is of equal importance to consider the origin of the human and animal material. Humans would have formed part of a trade in cadavers and it is unlikely Hewson acquired dead bodies without having to pay for them. Some human bodies may have been purchased as parts and others complete, because there is evidence that resurrection men did sell bodies in parts as well as whole (Bailey 1896: 62-63). The acquisition of animals would have been a very different matter. They may have been acquired dead or alive, partial or complete and perhaps already prepared, such as the skeletons of exotic animals in the auction catalogue. Animals, such as cats and dogs must have been available on the street and it may have been a simple matter of paying a nominal price for someone to round them up and deliver them to the anatomy school.

11.3.1 Humans

One of the most striking features of the assemblage was the large number of neonate and foetal remains compared to adults. It has been suggested above that this distribution may have been a deliberate choice to accommodate Hewson's research or the making of museum preparations.

In some cases, however, it has also been suggested that these young individuals may have been used in student dissections. In terms of procurement it is therefore worth considering the advantages of acquiring young individuals rather than adults, despite adults being easier to dissect. It is of course entirely possible they were purchased for the specific purpose of demonstrating the anatomy of foetal and neonates in connection with classes in midwifery. Whatever the reasons, it is necessary to consider where these young cadavers might have come from.

Infant mortality was extremely high during the eighteenth century and a large proportion of the burials at the local cemeteries must have been children. They would have been easier to transport and according to Bailey (1896) they were cheaper than adults. Bodies in general were in short supply due to the clandestine nature of the cadaver trade and competition between schools must have been fierce in acquiring the most appropriate and freshest bodies. It is not unlikely Hewson found this competition difficult with his limited finances and therefore might frequently have opted for the lower priced infants. It also cannot be dismissed that Hewson might have been in trade with Dr Leake who taught midwifery in the adjacent property, as he was first physician (from 1767) of the Westminster New Lying-in Hospital (Wilson, 1995: 146). There was no evidence in the historical records of any connection between the two men, but this may simply be a result of their close proximity, rendering written communication unnecessary.

It is also possible that amputated limbs might have been purchased for dissection. This could not be dismissed or confirmed through the archaeological assemblage, though it seems likely that such limbs would have been purchased to demonstrate pathology as the very same would have rendered the limb useless in general anatomical study.

11.3.2 Animals

Animals would have been much more readily available from a number of different sources and though competition may have been present in terms of acquiring exotic species it would have been much less difficult to get hold of common species such as cats and dogs and food species from the local Hungerford Market. The more exotic species were ever present in London in increasing numbers, with menageries all over the capital exhibiting an array of peculiar creatures (Plumb, 2010). Ships from all over the world would have docked in London to bring passengers and merchandise to the capital. Benjamin Franklin himself travelled to America on several occasions and might well have brought back animals for Hewson's collection, such as the gopher tortoise, which is native to the Americas. Dogs and cats were available on the streets with the increasing trend of keeping animals as pets, or for work such as guarding premises or pest control. In one instance Hewson mentioned going to the market to observe the bleeding of a sheep. Other domesticated food species would have been equally available at these markets for

Hewson to purchase dead or alive, whilst the River Thames would have attracted the fish and aquatic birds important in Hewson's research. It is difficult to ascertain what drove the procurement of different species and ages. In Hewson's case it may have been a question of finances or preferences in terms of his research.

12 Conclusion and future research

The aim of this thesis was to investigate the Craven Street anatomy school not only as a unique example of an archaeologically excavated private medical establishment from the eighteenth century, but also a school for which there is historical evidence for the inventory of its museum, notes for its classes and copious correspondence about the anatomists who established and ran it. This exploration has resulted in an unparalleled insight into the workings of one of these private schools and into its founder William Hewson and the fortitude required to maintain a school and become a recognised member of the scientific community. One focus of this thesis was the presentation of the human and animal remains uncovered at Craven Street and a discussion of what they may reveal about the availability of bodies, dissection techniques, the making of museum preparations and Hewson's research and ultimately the attitude towards these individuals in death. The other focus was historical. Hewson appears from the surviving correspondence as a man who was out of necessity forced to open his own school with very limited financial means and managed to do so despite his apparent lack of business acumen and skills in lecturing. Fitting into the backyard of what was primarily a residential property with limited space to the rear, the school was well attended but most likely much smaller and more modest than the school of William Hunter. The school would have been necessary for his income, but his research was clearly his foremost passion. He carved a path into the Royal Society through his work on the lymphatic system, a subject he arrived at through his connections with the Hunter brothers. He experienced both recognition and opposition in his research, testament to the unrelenting competition which drove the scientific community.

Much was found out about what went on in the Craven Street School from more general sources, as well as the museum catalogue, the specimens still preserved both in London and Glasgow and Falconar's lecture notes. The analysis of the human and faunal remains from the site itself has provided a different insight into the work that went on there. It was not possible to determine a single purpose for the remains in the pit but it was possible to identify a number of different techniques and uses, both in general teaching and research and also those which might have been particular to Hewson. It was clear that humans and animals had very different functions as working material at the school. The animal bones displayed much fewer cuts than the human bones and showed no indication of traditional dissection techniques such as removal of the skull cap. The intensity of cuts on the human remains suggested they were used in the most cost-effective fashion possible, leaving very little waste. A large number of young children were identified and it is speculated above that these represented a cheaper way of gaining bodies for dissection. It was evident that at least some of these infants had been dissected in a similar manner to the adults and some even exhibited evidence of body sharing. Infants were, however, also preferred in making complete preparations and Hewson's research would have focused on the young individuals in his research on the thymus gland.

The identification of dissection techniques in the Craven Street material revealed the use of methods described across the four manuals used for comparison. Even though the methods advised in the manuals seem to have changed over the eighteenth and nineteenth centuries, the short period of activity at Craven Street does not reflect its position in the sequence. The cuts also revealed evidence of students practicing surgical procedures such as amputations and trepanning presumably with a view to performing similar procedures on living patients.

The assemblage also strongly reflected Hewson's published research in all its aspects from the microscope slides and tubes, evidence of staining material, mercury, the faunal species present and the demographic profile and cuts on the human remains. It thus appears that the remains in the trench could not solely be attributed to student dissection but also reflected research undertaken at the school. Some cuts also represented more complex procedures more consistent with the making of preparations. A number of these cuts have never been found on sites other than Craven Street and are not described in published manuals. They include the "diamond cut" and the "oblique skull cap" in the children and presumably demonstrate Hewson's unique and experimental approach to museum preparations.

The Craven Street assemblage revealed a very different age and species profile to that seen at other anatomy school sites, with a disproportionately large number of children and animals present. The discussion above concludes that the contents of the pit were dictated by the size of the remains rather than by species or the use to which they had been put. In addition, many aspects of the pit assemblage seem to reflect Hewson's research, so it is therefore unlikely to be a representative sample of an average private anatomy school. The disposal processes suggest a clear disassociation with the individuals in the pit, to the point of objectification, with several having been left on the surface subject to the consumption of carnivores and rodents. The pit was clearly a practical arrangement of disposal and did not reflect any ceremony.

The possibilities of further research on Craven Street are far from exhausted and there are several avenues of research which may lead to further insights into life at Craven Street and the career of William Hewson. Historically, further investigation of letters to and from Hewson's peers may shed further light on his professional and social relationships. Letters by John Hunter were only addressed briefly in this thesis and the American Philosophical Society of Philadelphia has a large archive of Hewson's family letters. Many have been transcribed but there is bound to be further information contained in the archive (American Philopsophical Society; MSS.B.H492). The auction catalogue from Craven Street provided a much broader insight into the school than simply what was contained in the museum. There are other such catalogues which can be analysed further to generate a better understanding of use and selection process of animals and humans in private anatomy schools, reflecting the research trends and teaching practices of the period. One such auction catalogue is for John Sheldon's collection (Wellcome library; MST.260.), a close associate of Hewson and an eighteenth century collector and teacher. The catalogues may be compared and contrasted with existing collections by John Hunter at the Royal College of Surgeons, William Hunter's collection in Glasgow Hunterian Museum and nineteenth century pathology collections such as the Gordon Museum at Guy's Hospital museums of the Royal London and St Bartholomew's Hospitals. From an archaeological standpoint, more detailed work may be carried out on the remains. In the event it was not possible to carry out a microscopic analysis of the cut marks, but it is likely that this could provide better insight into the use of equipment and techniques at the school. It might well be possible to identify individual tools used in the work. This could help suggest a sequence of events in preparing specimens, or shed light on whether or not some bones may have been amputated and then brought to the school for dissection.

Further analysis of pathological conditions may be carried out using x-ray techniques. For example, at WRI (Western & Bekvalac, 2011) this approach was used to suggest the likelihood that specimens resulted from amputations performed on living patients during surgery. The faunal remains from a number of other sites are still awaiting analysis, such as University College London (UCL), TCD and BRI. It is central to recognise that these remains were potentially used at the schools alongside the humans and therefore form an important part of the understanding of topics taught. In addition, the material remains at Craven Street, particularly the microscopic glass slides warrant a specialist investigation into glass manufacturing for scientific research. By examining the physical properties of the glass it may be possible to shed light on some of the obstacles to eighteenth century microscopic research and show how the development of glass may have been crucial to the acceptance of the microscope as a research tool.

Finally it is evident from this research that the study of dissection and medical education lack consistency and clear goals. With the surge in publications in recent years, the next obvious step would be to address the methods of recording, the use of historical data and presentation. It is immediately evident that taphonomy and site formation must be addressed to allow a more coherent comparison between sites. The complexity of anatomy school sites with mixed articulated, partially articulated and disarticulated remains render most of the analysis at best confusing and at its worst useless for inter-site comparison. It is prudent to consider some overarching questions that may be addressed in the recording and analysis of these sites so that these can become integrated into any future publications.

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14 Appendices

14.1 Appendix 1: Significant events in medical education

Chronological presentation of events influencing medical education and dissection in London and the UK (Peachey, 1924; Warren, 1951; Dobson, 1968; Lawrence, 1996; Guerrini 2003; Kean, 2003; Guerrini, 2004; McLachlan & Patten, 2006)

Year	**Category**	**Event**
1368	Surgeons	Fellowship of Surgeons, London founded
1376	Barbers	Company of Barbers founded
1423	Physicans & surgeons	Gilber Kyme r (c.1385-1463) partion for better control of physicians and surgeons in the City
1462	Barbers	Barbers incoorporated by a charter of Edward IV
1476	Printing	Caxton the first English Printer , demand from scholars that books were to be printed in their own language
1518	Physicans	Founding of the College of Physicians in London
1530	Medical education	Act under Henry VIII making attendance of lectures at the Surgeons Hall compulsory
1540	Barber-surgeon	Barbers and Surgeons of London were incoorporated by an Act 32 Henry VIII
1540	Dissection	Barber-Surgeon granted annual permission to dissect four executed fellons.
1552	Physicans	Under Edward VI: Nicolas Encolius Medicus recieve an annuity of £10 in reward of his services in the dissection of Human bodies and permission to take bodies of executed men and women from Middlesex, Sussex and Essex to dissect and instruct students of Surgery. Nicolas Encolius was a Fellow of the College of Physicians.
1558	Medical education	Founding of Caius and Gonville College of Cambridge with fellowship for medical study
1564	Dissection	Cambridge recieve permission from Elizabeth I to dissect two bodies annually who have been condemmed to death for theft or homicide.
1565	Dissection	College of physicians are granted permission to carry out anatomical demonstrations of executed bodies (theft, homicide or other felony)
1566	Dissection	Two masters and two Stewards were to be chosen annually and all anatomies whether public or private should be made at the hall
1617	Apothecaries	Apothecaries company is formed with the apothcaries separating from the grocers' company

1624-1689	Medical education	Thomas Sydenham (Originator of Clinical Medicine in Europe) promotes practical rather than philosophical medical education, through bedside observation. His sytems were adopted by Herman Boerhaave (1668-1738) in Leiden, Holland
1662	Science	Foundation of Royal Society (Charles II)
1663	Dissection	Fellow of the Royal Society acquired the right to recieve bodies of executed criminals and to dissect them, like the college of Physicians and Surgeons
1666	Physicans	College of physicians destroyed during the Great Fire of London
1695	Printing	Laps of the Printing Act opening up the printing trade
1701	Medical education	The start of the Private anatomy school (Rolfe, George and Douglas, James)
1703	Apothecaries	The physicians prosecute the apothecaries for setting up independent practices and treating patients without the presence of a physician, but the apothecaries retained the right to treat following the decision by the House of Lords.
1704	Physicans	College of physicians loose the monopoly of prescribing medicines, apothecaries were also allowed to prescribe
1711	Medical education	Cheselden commenced private surgical lectures at Hospitals
1726	Edinburgh	Edinburgh becomes the British version of Leiden (see 1624-1689)
1745	Surgeons	the Barber-Surgeons company dissolve to give way for a Company of Surgeons (1745-1800)
1746	Medical education	Foundation of William Hunter's Private School of Anatomy
1752	Dissection	Murder act of 1752: Request for Act to allow all persons executed for murder in Middlesex and City of London to be given to the Surgeon's hall and in other places in GB to be given to surgeons as directed by law.
1764	Medical education	Hunter opened Great Windmill Street
1773	Dissection	Committee formed to request an increase of bodies for dissection, to allow all executed felons within City of London, Middlesex and Surrey to be dissected. This also included a request from Cambridge and Oxford - All these requests were rejected.
1778	Edinburgh	Edinburgh Royal College of Surgeons founded
1796	Dissection	Bill requested to allow dissections of bodies of executed felons of highway robbery and burglary were to be handed to College of Surgeons - The Bill was rejected
	Apothecaries	Society of Apothecaries (regulating pharmacy in London)
1800	Surgeons	Company of Surgeons by charter become Royal College of Surgeons, London.

1815	Apothecaries	Apothecaries act giving the society legal control over all general practitioners in England. To become a member the society had to be satisfied with the level of education of the applicant and knowledge of natural sciences and Latin was essential.
1822	Surgeons	Royal College of Surgeons no longer accept summer courses as a qualification for entry to the college diploma
1832	General medicine	Anatomy act regulating anatomy schools and dissection of unclaimed bodies.
1858	General medicine	The Medical Act 1858 was a British Act of Parliament which stated that under the Poor Law system Boards of Guardians could only employ those qualified in medicine and surgery as "Poor Law Doctors"
1876	Animals	Cruelty to Animals Act introduced. Promoted by Charles Darwin in 1871, protecting vertebrates only
1961	General medicine	Human tissue Act 1961 (including legislaitons of parts of bodies)
1984	General medicine	Anatomy Act 1832 repealed by Anatomy Act 1984
1986	Animals	Animals (Scientific procedures) Act introduced protecting all vertebrates, cephalopods
2004	General medicine	Anatomy act 1984 repealed by Human Tissue Act 2004

14.2 Appendix 2: Hewson's Associations

Individuals named in association with Hewson in literature used for this thesis.

Name	Title	Date	Position	Connection	Date of contact	Source of information
Armiger, Thomas	n/a	n/a	n/a	Attended a Patient together a young woman	03 dec 1770	n/a
Bancroft	Mr.	n/a	n/a	Signed up to be a student at Craven Street. A friend of Benjamin Franklin	1772	M. Hewson Oct 22 1772/franklinpapers.org 1988
Bostock, John	Dr	1740-1774	Medical Doctor, Edinburgh, went to Liverpool 1770	Attended readings at society Former student at GWS (1769)	1769	Brock, 2008: 85 &444
Bromfield, William	Mr	1713-1792	Surgeon to her Majesty and to St George's Hospital Esq	Falconar dedicated his paper to him	1777	Gulliver, 1846
Brooks, Joshua	Mr	1761-1833	Anatomist	Studied w Hunter and Hewson	?	Brock, 2008
Cooper, William	Dr	1752-1808?	n/a	wrote letter to Hunter on foetus which Hewson Dissected October 1773	06 Jun 1774	Brock, 2008:142-148
Credence, H.,	n/a	n/a	Unknown: but he resided at Grace Church Street, no 12 the corner of Ball Yard.	Appears to be the supplier of the different coloured powders Hewson used for his injections	27. Nov 17??	Private letter/ Hewson family dated 27 Nov.
Cruikshank, William Cumberland		1745-1800	Assistant to William Hunter	Replaced Hewson as anatomy assistant at GWS in 1772	1770	Wilford, 1993
Cullen, William	Dr	1710-1790	Scottish physician and chemist, University of Edinburgh.	Hewson taught by Cullen in Edinburgh Spent time w him after lectures with Mr Stark	26 feb 1765	Brock, 2008:210

Da Costa, Emanuel Mendes	n/a	1717-1791	Wrote "Concology or Natural History of Shells" 1770	Sends Hewson's his regards in letter to Hunter (7 Jan 1771)	1771	Brock, 2008
Denman, Thomas	Dr	1733-1808	Medical Doctor, Aberdeen	Attended readings at society	n/a	Brock, 2008: 85
Eustace, ?	Mr	n/a	Apothecary in Jermyn Street	Sent Hewson a Phial from his patient	n/a	Gulliver, 1846: 84
Falconar, Magnus	Mr.	1752-1778	Anatomist at Craven Street Anatomy School	Friend, colleague and Brother-in-law.	n/a	Gulliver, 1846
Ferguson, James	Dr	1710-1776	Gave public lectures on experimental philosophy. Member of the Royal Society	Recommended Hewson to the royal Society	1770	Gulliver, 1846: xvi
Field, ?	Mr	n/a	Student? Lived at middlesex hospital	Assisted Hewson in his experiments 32 of blood 1774	07 march 1770	Gulliver, 1846: 67

Fothergill, A	Dr.	n/a	Physician at Northampton	Students together in Edinburgh? Wrote extensively to each other in a very private and friendly manner 1770-1774undated c.1769/1770: Fothergill praise Hewson on his treatise on the lymphatic system and remarks that he as a country physician would never get nominated for the medal (copley medal?)14 jan 1770: obtaining bodies on conjoined twins.1771: On the coagulable lymph.June 25 1773: Case study of a woman named Mary Calland, aged 26 exhibiting symptons of locked jaw.April 30, 1774: Remarks on Hewson's latest publication on the blood.	1768?-1774	Hewson family private letters. Undated letter c. 1769/1770, 14 Jan 1770, 1771, June 25 1773 and April 30 1774.
Franklin, Benjamin	Mr	1706-1790	American Statesman and Philosopher.	Friend and tenant at 36 Craven Street	1770-1774	Gulliver, 1846
French,?	Mr		Apothecary in St Alban street	Talked to Hewson on his illness	n/a	Gulliver, 1846: 83

George, Old "Old George"	n/a	n/a	Model for William Hunter	Model at GWS when Hewson was there. He stayed at Hunter's house for some time and when they parted Hunter made sure he was set up for old age.	n/a	Brock, 2008: 18
Gregory, James	Prof.	1753-1821	Professor of Medicine Edinburgh	Hewson's teacher in Edinburgh	1761	Wilford, 1993
Halle	Dr	n/a	Professor of Physics at the University of Leiden	Personal friend of Hewson	n/a	Wilford, 1993
Harvey, Robert	Dr	n/a	Physician in Exeter	Responded to Hewson's publicaiton on the coagulation of the blood	n/a	Private letter of the Hewson family/ dated 7 Jan. 1772
Hawkeworth, John	Dr	1715?-1773	Lambeth, Author who published "An account of the voyages Taken....for making discoveries of the Southern Hemisphere 1773	Visited Mr Hewson in his house at Craven Street	n/a	Brock, 2008: 86
Haygarth, John	Dr	1740-1827	Physician in Chester	Letter from Hewson on red blood particles	19 July 1773	Gulliver, 1846:287
Hendy, James	Mr	n/a	Student? Lived at middlesex hospital	Assisted Hewson in his experiments 32 of blood 1774 and later remarked on this is a private letter to Hewson	07 march 1770-1774	Private letter of the Hewson family/ dated March 1774. Gulliver, 1846: 67
Hertford	Lady	1755-?	unknown	Provided Dr H with sick turtle which Hewson injected	before 1772	Brock, 2008: 79 & 86
Hey, William	n/a	1736-1819	Surgeon at Leeds General Infirmary	Discussed medical matters with Hewson, mentioning a case of Hernia	07 Nov 1770	Brock, 2008: 362

Hunter, John	Mr	1728-1793	Surgeon at St. George's Hospital	Brother of William Hunter. Hewson took over his poistion in 1761. Later had disputes over plagiarism of discoveries of the lymphatic system.	1759-1774	Wilford, 1993
Hunter, William	Dr	1718-1783	Owner of Great Windmill Street anatomy school.	Hewson's partner 1762-1772	1759-1774	Brock, 2008
Lambert, Richard	Mr	-1778	Surgeon, Newcastle-upon-Tyne	Hewson was an apprentice of Mr. Lambert	1753-1759	Gulliver,1846: 84
Leake, John	Dr	1729-1792	Man midwife at no 35 Craven Street	Do not know of any direct link, but ran their schools during same period	1772?-1774?	BFH, *pers. Comm.*
Lettsom, John Coakly	Dr	n/a	President of the Medical Society (1775)	Wrote memoir of William Hunter and knew him personally	n/a	Lettsom, 1810: 53
Mackenzie	Dr	n/a	Taught midwifery at Guy's and st Thomas	Taught Hewson	1760	Lettsom, 1810: 53
Manning, Henry?	Dr	n/a	Doctor trained at Edinburgh	Announced that he was sorry that Hewson supported Dr Hunter in his disputes with Monro	1771	Brock, 2008:18
Maty, Matthew	Dr	1718-1776	n/a	Hewson wrote to Dr Maty regarding his dispute with Mr Monro. Recommended Hewson as a member for the Royal Society	10 jan 1769	Brock, 2008:294

Monro, Alexander secundus	Dr	1733-1817	Lecturer at Edinburgh	Taught Hewson 1761-1762 Had several disputes on plagarism with Hewson	n/a	Gulliver, 1846
Monro, Donald	Dr	1727-1802	Monro's brother	Attended Hewson's reading on the discovery of lacteals in birds, fish and amphibious animals on 8th dec 1768. Hewson met him at St Geroge's Hospital where Donald told him that his brother had already made that discovery	08 dec 1768	appendix to monro Gulliver, 1846: 109
Moore, John		1729-1802	Scottish physician and writer	Student at Great Windmill Street during Hewson's time there		Brock, 2008: 88
Morgan, John	Prof.	1735-1789	Preofessor of Medicine Philidelphia	Attened Monro's course in Edinburgh at the same time as Hewson. With recommendations to Cullen from William Hunter lived with Hewson in Covent Garden (Brock 2008,183)	n/a	appendix to monro Gulliver, 1846:109
Parsons, John	Prof.	1742-1785	professor of Anatomy christchruch oxford	Attended reading on emphysema	n/a	Hewson, 1774: 166
Pepys, Lucas	Dr	1742-1830	Physician at Middlesex Hospital (MD, F.R.S)	Attended reading on emphysema	n/a	appendix to monro Gulliver, 1846; Brock, 2008: 85

Pringle, John	Sir	1707-1782	1774 he was appointed Physician to His Majesty King George III.	Falconar dedicated his paper to him Good friend of Hewson (Mary Hewson left an inheritance from William Hewson, which was a gift from Pringle)	n/a	Mary Hewson's will, National Archive. Prob 11/1273
Robertson, ?	Mr	n/a	Apothecary in Earl Street	talked to Hewson on Mr Herbert a patient	n/a	Gulliver, 1846: 83
Ruston	Dr	n/a	Physician at Middlesex Hospital (MD, F.R.S)	Attended reading on emphysema		Hewson, 1774: 166
Rymsdyk, Jan Van	Mr	1750-1788	Anatomical artist	Produced drawings of the lymphatic system of the turtle	before 1772	Brock, 2008: 79 & 86
Saunders, William	Dr	1743-1817	Physician at Guy's Hospital	Attended reading on emphysema		Hewson, 1774: 166
Sheldon, John	Dr	1752-1808	Anatomist at Great-Queen-Street Anatomy school	Trained with Hunter and Hewson in Windmill Street, Possibly assistant or colleague to Hewson/Falconar Bought Preparations when Falconar died Took over course from Craven Street (copied it?)		Sheldon, 1780
Hugh, Smith	Dr	n/a	Lecturer of medicine at Guy's and St Thomas Hospital and former student of William Hunter	Taught hewson		Lettsom, 1810: 53

Sėnac, Jean Baptiste	Dr	1693-1770	French Physician in Paris	Hewson attended some of his lectures in Paris where he observed Sėnac's technique on viewing the RBC	1765	Private letter to Hewson dated Nov.24 1773 from unknown author.(Letter from Hewson family private colleciton) Kleinzeller, 1996: C2
Simmons, Samuel Foart	Dr	1750-1813	Physician and Writer	Personal friend of Hewson Mary Hewson wrote him a letter of with a description of Hewson's life in 1782		Wilford, 1993
Stark, William	Dr	1741-1770	physician and medical pioneer	Friend of Hewson, who attended his deathbed and dissected him.Gets mentioned several times in paper on emphysema 1767		Hewson, 1774: 166
Turton, J	Dr	1735-1806	physician to George III and royal family	recommended Hewson to the royal Society		Gulliver, 1846: xvi
Walsh	Mr.		n/a	Signed up to be a student at Craven Street. A friend of Benjamin Franklin	1772	M. Hewson Oct 22 1772/franklinpapers.org 1988
Williams, John	n/a	n/a	n/a	Wrote a letter to Hewson when in Edinburgh, regarding the dispute on the lymphatic system and his promise to send him the pamphlet Monro had produced on the subject	Feb. 3 1771	Private letter/ Hewson family

14.3 Appendix 3: Hewson's publications

Hewson's published work according to Gulliver (1846: xlviv)

Year	Title and reference
1767	Hewson, W. 1767. The Operation of the Paracentesis Thoracis Proposed for Air in the Chest: With Some Remarks on the Emphysema, and on Wounds of the Lungs in general. By William Hewson, Reader in Anatomy: Communicated by Dr. Hunter; read June 5, 1767. - Medical Observations and Inquiries, by a Society of Physicians in London, art xxxv, vol.iii, pp.372-96, 8vo, London 1767.
1768	An Account of the Lymphatic System in birds. By William Hewson, Reader in Anatomy: In a Letter to William Hunter, M.D., F.R.S, and by him communicated to the Society. Received October 3, 1768; Read December 8, 1768. - Philisophical Transactions for the year 1768, vol. lviii, pp.217-26
1769	An Account of the Lymphatic System in Amphibious Animals. By Mr. William Hewson, Lecturer in Anatomy: in a Letter to William Hunter, M.D and F.R.S and by him communicated to the Society. Received June 19, 1769, vol. lix, pp. 198-203.
1769	An Account of the Lymphatic System in Fish. By the same. Received June 19, 1769 ; read November 16, 1769.- Philosophical Transactions for the year 1769, vol. lix, pp.204-15.
1770	Experiments on the Blood, with some Remarks on its Morbid Apperances. By William Hewson, F.R.S. Received May, 1770; read November 15, 1770. - Philosophical Transactions for the year 1770, vol. lx, pp. 398-413.
1770	On the Degree of Heat which Coagulates the Lymph, and the Serum of the Blood; With an Inquiry into the Causes of the inflammatory Crust, or Size, as it is called. By the same. Received May 7, 1770; Read November 15, 1770. - Philosophical Transactions for the year 1770, vol. lx. pp.384-97.
1770	Further remarks on the Properties of the Coagulable Lymph, on the stopping of Haemorrhages, and the Effects of the Cold upon the Blood. By the same. Received July 7, 1770; read November 15, 1770. - Philosophical Transactions for the year 1770, vol. lx, pp.398-413.
1773	On the Figure and Composition of the Red Particles of the Blood, commonly called red Globules. By William Hewson, F.R.S, and Teacher of Anatomy. Read June 17 and 24, 1773. - Philosophical Transactions 1773, vol. lxiii, pp. 303-23.
1771	An Experimental inquiry into the Properties of the Blood, with some Remarks on its Morbid Apperances; an Appendix, relating ti the Discovery of the Lymphatic System in Birds, Fish, and the animals called Amphibious. By William Hewson, F.R.S, and teacher of Anatomy. 12mo. Printed for T. Cadell, in the Strand, London, 1771. A second edition, the above title being preceded with "Experimental Inquiries, Part the First," was printed 8vo., for T. Cadell, in the Strand London, 1772; and a third merelt and exact repreint of the second, for J. Johnson, St. Paul's Chruchyard, London, 1780.
1774	Experimetal inquiries, Part the Second, containing a Description of the Lymphatic System in the Human Subject, and in other Animals. Illustrated with Plates. Together with Observations on the Lymph, and the Changes which it undergoes in some Diseases. By William Hewson, F.R.S, and Teacher of Anatomy. Printed for J.Johnson, No.72, St. Paul's Churchyard, 8vo. London 1774.
1777	Experimental inquiries, part the Third, containing a Description of the Red Particles of the Blood in the Human Subject and in other Animals; with an Account of the Structure of the Offices of the Lymphatic Glands, and of the Spleen; being the remaining part of the Observaitons and Experiments of the late Mr. William Hewson, F.R.S, and Teacher of Anatomy. By Magnus Falconar, Surgeon and Teacher of Anatomy. London, Printed for T. Longman, No.39, Paternoster Row. 8vo, 1777.

1775	A Letter from the late Mr. William Hewson, F.R.S, and Teacher of Anatomy in London, to Dr. John Haygarth, Physician in Chester. - Medical and Philosophical Commentaries, by a society in Edinburgh, vol. iii, pp.87-93, 8vo., London, 1775.

14.4 Appendix 4: Matched human skeletal elements