

## **The Orthodontic-Oral Surgery interface: Part Two: Diagnosis and management of anomalies in eruption and transpositions**

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# The Orthodontic-Oral surgery interface. Part Two: Diagnosis and management of anomalies in eruption and transpositions.

## Abstract

The Orthodontic-Oral Surgery interface is important for the multidisciplinary management of patients presenting with complex dental anomalies. This article provides an overview of anomalies of eruption and transpositions, their diagnosis, aetiology, presenting features and the different management options. It also highlights the role of the General Dental Practitioner in identifying such anomalies and the importance of timely referral to specialist care.

## Introduction

Part Two of this two part series details anomalies of eruption and transposition. The aetiology, prevalence, classification, diagnosis, features and management of the following conditions are discussed:

- Impacted teeth, including incisors, canines, second premolars and second permanent molars
- Generalised delayed eruption
- Primary failure of eruption
- Ankylosed incisors
- Infra-occluded deciduous molars

## Unerupted Maxillary Central Incisors

**Definition:** A tooth is considered to be impacted when it has an infraosseous position after the expected time of eruption.<sup>1</sup>

**Aetiology:** Possible causes include supernumerary teeth, gingival fibromatosis, generalised delayed eruption, trauma or early extraction of the deciduous predecessor, retention of the deciduous predecessor, cystic formation, and dilaceration of the central incisor root. Very rarely there is congenital absence of a maxillary central incisor.

**Prevalence:** 0.13%.<sup>2</sup>

**Classification:** By aetiological factors.

**Diagnosis:** Dental examination with consideration of patient age and generalised stage of eruption. A maxillary central incisor that has not erupted more than 6 months after the contralateral tooth, or 12 months after eruption of the mandibular central incisors, or an abnormal sequence of eruption may indicate an impaction.<sup>3</sup> Radiographic examination can be used to confirm that an incisor is impacted (Figure 1). The parallax technique or a CBCT scan can be used to help locate the position of the unerupted incisor or any anatomical abnormalities (for example associated supernumerary teeth or dilacerated roots).

**Features:** Retained primary incisors, risk loss of space for the impacted tooth or of cystic formation associated with the impacted tooth.

**Management:** Possible management options include:<sup>3</sup>

- Maintenance of space to allow for spontaneous eruption
- Removal of any physical obstruction (supernumeraries, retained deciduous primary teeth)
- Surgical exposure of the tooth (with or without orthodontic alignment)
- Surgical removal of the tooth (if severely ectopic, anklyosed or dilacerated) followed by prosthetic replacement or orthodontic space closure
- Surgical repositioning of the ectopic incisor into the correct arch position
- Extraction of the impacted incisor and autotransplantation of an alternative tooth into the space. The tooth of choice for autotransplantation is usually, but not always, a developing lower second premolar. This option is only usually carried out when the patient requires the extraction of a tooth, for example due to crowding.

**Role of the GDP:** The GDP can identify and diagnose impacted central incisors and refer patients to secondary care for further assessment and management. The GDP has a unique role in the identification of impacted upper incisors because these usually present prior to patients being referred for a routine orthodontic assessment. Due to the GDP seeing the patient regularly throughout their dental development, they are the best placed clinician to identify any abnormalities in the eruption of the incisors.



**Figure 1.** Intra-oral photographs showing a removable orthodontic appliance being used to align an impacted upper right central incisor and a partially erupted upper right lateral incisor.

### Impacted Canines

**Definition:** A canine is considered to be impacted when it has an infraosseous position after the expected time of eruption.<sup>1</sup> (Figure 2).

**Aetiology:** Buccally impacted canines are usually due to crowding.<sup>4</sup> Whereas palatally impacted canines in the maxilla, have a different aetiology of which there are two main theories, the guidance theory and the genetic theory.<sup>5,6</sup> The guidance theory proposes that the root of the upper lateral incisor guides the position of the canine into eruption<sup>5</sup>. Therefore, impacted upper canines are often associated with the long path of eruption of the canines, hypodontia or microdontia of upper lateral incisors<sup>7</sup>. The genetic theory, however, proposes that impacted canines have a genetic basis.<sup>6</sup> Other possible causes of impacted canines include an ectopic tooth germ, ankylosis of the canine, cystic formation, dilaceration of the root, retention of deciduous teeth, the presence of supernumerary teeth, as well as systemic conditions such as endocrine deficiencies, irradiation, cleft lip and palate, cleidocranial dysostosis, and gingival fibromatosis.

**Prevalence:** 2% for maxillary canines, 0.05-0.4% for mandibular canines.<sup>8</sup>

**Classification:** Usually classified according to their location in relation to the dental arch (buccal, palatal or lingual, in line of the arch).

**Diagnosis:** Clinically, practitioners may suspect an impacted canine if:

- A canine is unerupted
- Upper canines are not palpable buccally by the age 10-11 years old<sup>9</sup>
- There is a palatal bulge

- The deciduous canine is retained
- There is asymmetrical canine eruption
- The position of the adjacent teeth are tipped

Most commonly, radiographic examination using a parallax technique is used to determine the position of an impacted canine and to assess any associated damage to the adjacent teeth. CBCT imaging can also be used if more detail is required than provided on a plain film radiographs. The parallax technique involves comparing two radiographs taken with the beam at different angulations, either with a vertical shift (for example, a DPT and an upper standard occlusal) or a horizontal shift (for example two periapical films). A buccally placed tooth will appear to move in the opposite direction of the beam shift, whereas a palatally placed tooth will appear to move in the same direction (Figure 2).

**Features:** Family history of impacted teeth, retained deciduous canines, absent or diminutive lateral incisors, presence of supernumerary teeth. There is a risk of root resorption of adjacent teeth (commonly lateral and central incisors) and cystic change associated with the impacted canine.<sup>10</sup>

**Management:** Depending on the location of the impacted canine, the presence of any pathology, patient age and patient preference, there are generally five overall treatment options:<sup>9</sup>

- No active treatment and regular clinical/radiographic monitoring for cystic change or damage to adjacent teeth
- Removal of any physical obstruction (deciduous tooth, supernumerary etc.) and monitoring for spontaneous eruption of the impacted canine
- Surgical exposure of the impacted canine and orthodontic alignment. Surgical exposure can either be an open exposure or a closed expose and bond technique. For an open exposure, the mucosa is relieved from the crown of the tooth and orthodontic traction can then be applied directly to the tooth. In a closed procedure, the tooth is exposed, a gold chain attachment is attached to the crown of the tooth, the gingiva is replaced and orthodontic traction is applied indirectly via the gold chain. Orthodontic treatment may also be required to recreate space to allow alignment of the impacted canine if space loss has occurred.
- Surgical removal of the impacted canine and either prosthetic replacement or orthodontic space closure

- Surgical repositioning of the impacted canine into a favourable position

**Role of the GDP:** The GDP has an important role in monitoring the eruption of the permanent canines at the correct age. Due to the GDP seeing the patient regularly throughout their dental development, they are often the best placed clinician to identify any abnormalities in the canine eruption. If the canines have not erupted and cannot be palpated buccally by approximately 10-11 years of age; further investigation is indicated.<sup>9</sup> In this situation, the GDP may take radiographs to assess the position of the canines. It is advisable for these patients to be referred to a specialist Orthodontist for an Orthodontic opinion. Following a detailed assessment, further monitoring may be sufficient, or intervention may be required. If the canine is to be extracted and the space closed the Orthodontist may ask the GDP to mask the first premolar as a canine following completion of the orthodontic treatment. This may involve a composite build-up of the incisal edge and possible grinding of the palatal cusps to avoid an occlusal interference.



**Figure 2.** A DPT and an Upper Standard Occlusal radiograph showing impacted upper right and left canines and hypodontia of the upper right and left lateral incisors. Using the Parallax technique, the right canine can be located as being in a palatal position and the left canine as being in a buccal position.

### **Impacted Second Premolars**

**Definition:** A premolar is considered to be impacted when it has an infraosseous position after the expected time of eruption.<sup>1</sup>

**Aetiology:** Most commonly premature loss or retention of the deciduous molars, or early loss of the first permanent molar.<sup>11</sup> Early loss of the second deciduous molar may lead to mesial drift of the first permanent molar, with a loss of space for the second premolar to erupt. Loss of the first permanent molar may lead to distal tipping of the unerupted premolar, and therefore impaction. Other causes of impaction include; an ectopic tooth bud, pathology (for example a dentigerous cysts), obstruction from a supernumerary tooth (most commonly odontomes), malformation of the permanent tooth, or as part of a syndrome, such as cleidocranial dysostosis or hereditary gingival fibromatosis.

**Prevalence:** 0.1-0.2% in the maxilla, 0.2-0.3% in the mandible.<sup>12</sup>

**Classification:** As with impacted canines, these teeth are classified by the affected jaw and the location of the impacted tooth in different planes; relative to the line of the arch (buccal/ in the line of the arch/ palatal/ lingual, vertical distance from the occlusal plane, mesio-distal placement, and angulation.)

**Diagnosis:** Through dental charting and radiographs (Figure 3). A CBCT may also be required to accurately locate the tooth and surrounding structures. A palatal or lingual bulge may be palpable.

**Features:** Retained or infraoccluded deciduous molars, loss of space due to mesial drift of the first permanent molar, lower midline shift towards the side of impaction, spacing, a palatal or lingual bulge.<sup>13</sup>

**Management:** Treatment options are similar to impacted canines, and include surgical removal of the impacted premolar, removal of an obstructing factor (for example a primary molar or a supernumerary), surgical exposure and orthodontic alignment, and transplantation. Where there has been space loss due to mesial drift of the first permanent molar, space creation will be required if the premolar is to be accommodated.

**Role of the GDP:** The GDP has a role in identifying impacted premolars and referring these patients for a specialist Orthodontic opinion to assess if further intervention is required. Due to the GDP seeing the patient regularly throughout their dental development, they are often the best placed clinician to identify any abnormalities in eruption of the premolars.



**Figure 3.** A DPT radiograph demonstrating several impacted teeth including the lower left second premolar and three second permanent molars.

### **Impacted Second Permanent Molars**

**Definition:** A molar is considered to be impacted when it has an infraosseous position after the expected time of eruption.<sup>1</sup>

**Aetiology:** Causes can be split into systemic (syndromes such as cleidocranial dysostosis), disturbance in eruption path (due to crowding, supernumerary teeth), or ectopic position of the tooth bud.

**Prevalence:** 0 - 2.3%.<sup>14</sup>

**Classification:** Described by location and angulation of the tooth, as well as any clear aetiological factor (for example the presence of an obstructing supernumerary).

**Diagnosis:** Through dental charting and radiographs (Figure 3). Eruption of second molars would be expected at approximately 11 to 13 years old.

**Features:** Impacted second permanent molars may partially erupted or unerupted. They may be associated with partially erupted or unerupted third molars, impacted third molars, dental pathology (for example caries, cysts), pericoronitis and caries associated with the distal aspect of the first permanent molar.<sup>15</sup>

**Management:** Indications for treatment depend on patient age, risk of resorption of adjacent teeth, pathology, and the overall malocclusion.<sup>16</sup> The treatment options are similar to those for impacted canines, and include no active treatment and radiographic monitoring, surgical removal of the impacted molar, removal of an obstructing factor (for example a supernumerary tooth or an impacted third molar), or surgical exposure and orthodontic alignment. Orthodontics alone can sometimes be



used to disimpact a second molar is sufficient space can be created to facilitate alignment of the tooth.

**Role of the GDP:** Patients who present with impacted molars should be referred to a specialist Orthodontist for an assessment and to allow a decision to be made as to if any interventive treatment is required. Due to the GDP seeing the patient regularly throughout their dental development, they are often the best placed clinician to identify any abnormalities in molar eruption.

### **Generalised Delayed Eruption**

**Definition:** Significant delay in eruption of the deciduous or permanent dentition from the normal time or pattern. This may be referred to as retarded eruption, embedded teeth, primary retention or arrested eruption.

**Aetiology:** Delayed eruption can be a variation of the norm based on gender or ethnicity. A number of local factors and systemic conditions are associated with pathological delayed eruption, as outlined in Table 1.<sup>17</sup>

**Prevalence:** Unconfirmed.

**Classification:** By aetiology, as shown in Table 1.

**Diagnosis:** Diagnosis is made through a combination of a thorough medical history, family history, dental examination and supporting radiographs.

**Features:** Delayed tooth or root development, supernumerary teeth, hypodontia, retained deciduous teeth, and abnormalities in tooth shape, size, structure and colour can all be associated with delayed eruption.

**Management:** Often these patients are managed by observation and monitoring of the developing dentition.<sup>18</sup> Interventions may be required to remove any obstruction (for example supernumerary teeth, retained deciduous primary teeth) to encourage eruption. If teeth remain unerupted surgical exposure and orthodontic alignment may be required. In extreme cases extraction of the unerupted teeth may be considered and prosthodontic replacement.

**Role of the GDP:** Patients with generalised delayed eruption may require simple monitoring but it is advisable to refer patients for an orthodontic assessment to assess if any intervention is required.

Feature	Aetiology of delayed eruption	
Teeth have defects in size, shape, structure, or colour.	Amelogenesis Imperfecta, Dentinogenesis Imperfecta, dilacerated teeth, regional odontodysplasia, dentine dysplasia	
Root length underdeveloped for age (<2/3 expected length)	Pre-term birth, Low birth weight, nutritional deficiency, Down's syndrome, hypopituitarism	
Root length close to normal development for age (>2/3 expected length)	Physical obstruction	Supernumery teeth/ odontome, Cysts or tumours of the jaw, ankylosis of deciduous teeth, premature loss of deciduous teeth, gingival fibromatosis, thick mucosal tissue/ scar tissue
	No physical obstruction	Nutritional deficiency, radiation damage, Cleidocranial dysplasia, HIV infection, Gardener's syndrome, Cherubism, Gorlin syndrome, genetic predisposition, traumatic displacement of tooth bud

**Table 1.** Aetiological factors for delayed tooth eruption (adapted from Suri L. *et al.*, 2004).

### Primary Failure of Eruption

**Definition:** A complete failure of eruption, or cessation of further eruption, of a tooth or teeth with no physical obstruction or systemic condition that is commonly associated with eruptive disturbances. Permanent molars are most commonly affected (Figure 4).

**Aetiology:** Poorly understood, with a suggested genetic link and an association made with a mutation of PTH1R gene.<sup>19</sup>

**Prevalence:** 0.01% for first permanent molars and 0.06% for second permanent molars.<sup>20</sup>

**Classification:** Primary failure of eruption (PFE) is commonly classified into three types according to how much eruption there is of the teeth distal to the most anterior affected tooth (Table 2).<sup>21</sup>

**Diagnosis:** A diagnosis of exclusion, which can be challenging due to the lack of clear genetic, pathological or environmental factors. Often a retrospective diagnosis is

made by clinical and radiographic examination with relation to patient's age and dental development.

**Features:** Involved teeth can erupt into initial occlusion and fail to erupt further as the occlusal plane changes and therefore appear relatively submerged; or teeth can fail to erupt entirely. There may be ankylosis of the involved teeth, hypodontia, open bite in affected region. There is no physical obstruction or mechanical failure of eruption.<sup>22</sup>

**Management:** By definition, orthodontic extrusion of these teeth is unsuccessful. Partially erupted teeth may be built up into occlusion. For patients with single or very few involved teeth, management may involve extraction, followed by orthodontic alignment or prosthetic replacement. For cases with multiple involved teeth, segmental osteotomy and repositioning may be the only method to bring these teeth into alignment or at least into a more favourable position for restorative management.

**Role of the GDP:** If teeth have not erupted at the expected age; patients should be referred to a specialist Orthodontist for an orthodontic assessment.



**Figure 4.** An intra-oral photograph showing primary failure of eruption of the upper and lower right permanent molars.

Type of PFE	Description
<b>Type I</b>	All teeth distal to the first tooth affected demonstrate a similar lack of eruption
<b>Type II</b>	Teeth distal to the first tooth affected have erupted further, but still show some lack of eruption
<b>Type III</b>	Patients who have a mixture of Type I and Type II in different quadrants

**Table 2.** Classification of Primary Failure of Eruption (PFE).

## Ankylosed Permanent Incisors

**Definition:** A tooth or teeth whose root cementum has fused or partly fused with the surrounding bone.

**Aetiology:** Necrosis of the periodontal ligament by mechanical trauma or inflammation can lead to osteogenesis within the periodontal ligament space. This is often associated with trauma (for example from severely intruded or replanted avulsed incisors), impaction, dental pathology, or there may be no clear predisposing factor (idiopathic).<sup>23</sup>

**Prevalence:** 31-80% of intruded teeth and 76-100% of replanted avulsed teeth undergo ankylosis.<sup>24, 25</sup>

**Classification:** Ankylosed teeth may refer to:

1. Permanent teeth with a history of trauma (most commonly upper incisors)
2. Infraocclusion of deciduous molar teeth
3. Unerupted or impacted teeth that are found to be fused to bone

**Diagnosis:** Clinical findings (including assessment of mobility and percussion) and radiographs can support the diagnosis. A high-pitched sound on percussion compared to adjacent teeth is an indicator of ankylosis. Failure of a tooth to move when orthodontic traction is applied (or intrusion of adjacent teeth) is also diagnostic of ankylosis.

**Features:** Progressive infraocclusion and distortion of gingivae in the growing patient, tipping of adjacent teeth and crowding. Root canal therapy does not prevent or cease ankylosis of these teeth.

**Management:** In adult patients, where there is a slower rate of replacement resorption, management may include monitoring with minor cosmetic adjustment or build up to bring the tooth into occlusion. For growing patients, depending on the rate, severity of infraocclusion, and distortion of the alveolus, treatment options include:

- Severely intruded teeth may be orthodontically or surgically repositioned immediately following the trauma (this is done before the tooth begins the ankylosis process)
- Cosmetic adjustment of the crown or build up into occlusion, accepting that the tooth has a poor long-term prognosis due to the continued ankylosis
- Extraction followed by prosthetic replacement or orthodontic alignment
- De-coronation of the tooth followed by prosthetic replacement

- Extraction of the ankylosed tooth and autotransplantation of an alternative tooth (commonly a premolar) into the incisor position. This option is only usually applicable if a patient has crowding that requires extractions.

**Role of the GDP:** The GDP can identify incisors that are ankylosing and refer the patient to secondary care for a management plan to be established. As part of the patient management the GDP may be requested to carry out some aspect of the treatment, within their clinical competence.

### **Infraoccluded Deciduous Molars**

**Definition:** A deciduous molar that is below the occlusal plane of the adjacent teeth (sometimes referred to as submergence) (Figure 5).

**Aetiology:** Ankylosis is considered to be the primary aetiological factor for infraoccluded deciduous molars. The affected teeth remain in a static position because the associated alveolar bone does not continue to develop as the patient grows. Therefore, the affected teeth appear to ‘sink’ below the occlusal plane as the adjacent teeth and alveolus continue to erupt and develop vertically.

**Prevalence:** Between 1.3-8.9%.<sup>26</sup>

**Classification:** Can be classified as mild, moderate or severe. Mild: the occlusal surface of tooth is below the occlusal plane but above the interproximal contact point with adjacent non-ankylosed tooth. Moderate: the tooth is below the contact point but above the cement-enamel junction (CEJ) of the adjacent tooth. Severe: the infra-occluded tooth is below the CEJ of the adjacent tooth.

**Diagnosis:** Diagnosis is based on the clinical assessment and the intra-oral examination.

**Features:** Retained deciduous molar or a delay in exfoliation, impaction or absence of the permanent successor, tipping of adjacent teeth and loss of space, lateral open bite, and overeruption of opposing teeth.

**Management:** Management depends on the severity of the infraocclusion, presence of a permanent successor, other dental pathology, and the age and therefore the remaining growth of the patient. Management may include observation of the developing dentition, restorative build up of the tooth to the occlusal plane (when there is an absent permanent successor), or extraction of the infraoccluded teeth.<sup>27</sup>

Space may need to be maintained, opened or created for orthodontic alignment or prosthodontic replacement.

**Role of the GDP:** It is advisable to refer patients with infraoccluded deciduous molars for an Orthodontic opinion because they can affect the overall occlusion. If restorative build ups of the occlusal surfaces are required the GDP may be requested to carry these out. If extractions are indicated the GDP may be requested to do this, however, extractions may be surgical due to the associated ankylosis and position of the tooth. Therefore, patients may be referred to a Paediatric or Oral Surgery specialists for these to be carried out.



**Figure 5A.** Intra-oral photograph showing infraocclusion of the upper and lower second deciduous molars.



**Figure 5B.** A DPT radiograph showing infraocclusion of the upper and lower deciduous molars in a patient with hypodontia of multiple premolars.

## Transpositions

**Definition:** Positional interchange of two teeth, or development of a tooth in a site of a non-adjacent tooth, in the dental arch (Figure 6).<sup>28</sup>

**Aetiology:** Theories include; ectopic eruption of canine due to high pre-eruptive position, displacement of tooth crypts due to trauma or bone pathology, genetic factors and cleft lip and palate.<sup>28</sup>

**Prevalence:** 0.4% in the maxilla and 0.003% in the mandible.<sup>29, 30</sup>

**Classification:** Transposition can be true/complete (both crown and root transposed) or pseudo/incomplete (crowns transposed and root apex in relatively normal position). Transpositions can occur unilaterally or bilaterally. Classification is by the jaw affected and the teeth involved. For example transposition of the maxillary canine to maxillary premolar position would be Mx.C.P1.

**Diagnosis:** Thorough dental examination. Radiographs can aid assessment of whether the transposition is complete or incomplete.

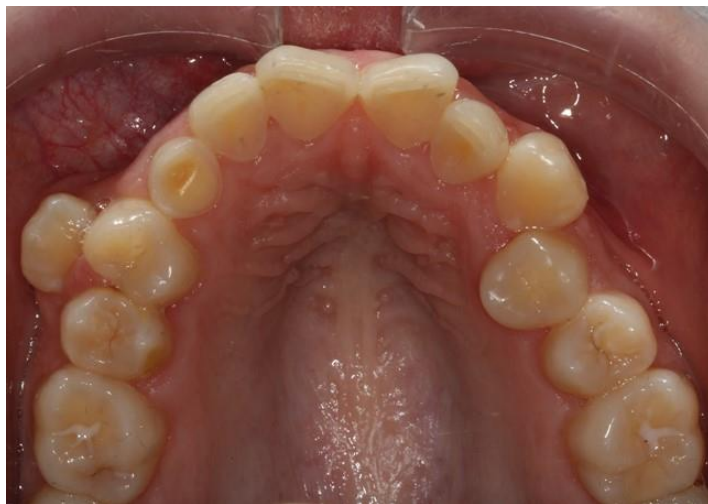
**Features:** Associated tooth anomalies include dilacerations, hypodontia, absent or peg shaped lateral incisors, ankylosed and rotated teeth.

**Management:** Treatment options include accepting the transposed position of the teeth, correcting the transposition using orthodontic appliances, or extracting one of the transposed teeth and aligning the remaining teeth. When deciding on the best treatment option the following factors should be considered: if the transposition is complete or incomplete, the overall malocclusion, any spacing or crowding present, and the patient preference.

**Role of the GDP:** The GDP can identify and diagnose transpositions. There patients should then be referred for a specialist Orthodontic opinion. If a transposition is accepted the specialists may request the GDP to carry out recontouring of the incisal edge or composite build ups of the transposed teeth to improve their aesthetics.



**Figure 6A.** A DPT and long cone periapical radiograph showing a true transposition of the upper right canine and the upper right first premolar.



**Figure 6B.** An intra-oral photograph of the same patient showing the transposition of the upper right canine and premolar.

### **Conclusion**

In Part One of this series, a service evaluation of the Croydon University Hospital Joint Dentoalveolar clinic was detailed, and an overview of the common soft tissue anomalies, dentigerous cysts, and supernumerary teeth provided. Part Two then focused on anomalies in eruption. Together these two papers provide an overview of the aetiology, prevalence, classification, diagnosis, features and management of these



anomalies which often require multidisciplinary management. The invaluable role the GDP has been emphasised in both parts of the article, especially in being able to correctly identify these complex anomalies and understand the need for timely referral to specialist care.

### **Declaration of Interest**

The authors do not have any conflicts of interest.

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