3D printed PLA/collagen hybrid scaffolds for bone-cartilage interface tissue engineering

M Tamaddon[1], G Blunn[1], C Liu[1*]

[1] *Institute of Orthopaedic & Musculoskeletal Science, Division of Surgery & Interventional Science, University College London, Royal National Orthopaedic Hospital, Stanmore HA7 4LP*

INTRODUCTION: The bone–cartilage interface in an articulating joint is a biomechanically important region where calcified cartilage forms an intersection between the hyaline cartilage and subchondral bone. It is prone to fracture and may undergo abnormal thickening, which can lead to progression of osteoarthritis[1]. A biologically and mechanically stable bone-cartilage interface as part of an osteochondral scaffold can thus have considerable clinical relevance. In this study, we have reported on a porous 3D printed polylactic acid (PLA)/collagen hybrid scaffold as a junction between bone-cartilage and preliminary *in vitro* evaluation results such as biocompatibility and mechanical properties are presented.

METHODS: The PLA biopolymer scaffold was fabricated by a 3D printing technique that runs on fused deposition modelling (FDM) technology by heating and extruding thermoplastic filament. The scaffold has a unit cell size of 0.5 mm. The PLA scaffold was subjected to 10 minutes UV processing in a UV/ozone reactor to improve its surface wettability. Then, collagen was filtered into the porous structure to obtain PLA/collagen hybrid scaffold. Sheep bone marrow mesenchymal stem cells (BMMSCs) were used to assess the cell morphology, viability, proliferation and differentiation on these PLA/collagen scaffolds. Live/Dead and Alamar Blue assays were used to examine viability and proliferation. Scanning electron microscopy (SEM) and immunostaining were used to look at cell morphology. Osteogenic and chondrogenic differentiation of BMMSCs were also investigated. The mechanical stability of scaffolds was evaluated using compression testing.

RESULTS: It was shown that the 3D printed PLA scaffolds support cell viability (Fig.1) and proliferation throughout 28 days. The design of the scaffold affected cell attachment and proliferation. Well-developed actin cytoskeleton was shown by immunostaining, and cell spreading was confirmed by SEM (Fig.1). It was also confirmed that the scaffolds supported osteogenic and chondrogenic differentiation of BMMSCs. Compressive modulus and strengths of these scaffolds were 11MPa and 3.4MPa, respectively.

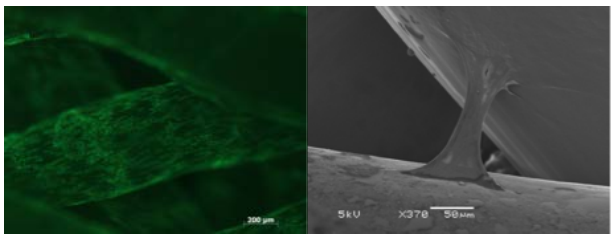

Fig. 1: Biocompatibility of the developed PLA hybrid scaffolds: Live/Dead assay - green shows viability of cells on day 14 (left); SEM micrograph shows cell bridging between two layers of the 3D printed scaffold (right)

DISCUSSION & CONCLUSIONS: It has been shown that the developed 3D printed PLA hybrid scaffolds have the potential to be used for bone-cartilage interface tissue engineering. They are biocompatible, with the potential to provide substrate for chondro- and osteogenic differentiation of stem cells. These scaffolds can be produced inexpensively and be tailored specifically to patients.

REFERENCES: [1] H.S. Gupta, S. Schratter, W. Tesch, et al (2005) *J Struct Biol* 1**49**:138-48

ACKNOWLEDGEMENTS: This work was supported by The ARUK Proof of Concept Award (grant no: 21160), and EPSRC MeDe Innovation (grant No: 103516).