A textile platform using mechanically reinforced hydrogel fibres towards engineering tendon niche

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INTRODUCTION: Tendon injuries can result from tendon overuse or trauma, resulting in substantial pain and disability. Given that natural or surgical repair of tendons lead to a poor outcome in terms of mechanical properties and functionality, there is a great need for tissue engineering strategies. Textile platforms enable the generation of biomimetic constructs [1]. Therefore, the main goal of this study is the development of cell-laden hybrid hydrogel fibers reinforced with a mechanically robust core fiber and their assembly into braided constructs towards replicating tendon mechanical properties and architecture.

METHODS: To fabricate mechanically reinforced hydrogel fibres, a commercially available suture was coated using a cell-hydrogel mixture of methacryloyl gelatine (GelMA) and alginate. Composite fibres (CFs) were obtained by ionic crosslinking of alginate followed by photo-crosslinking of GelMA. CFs were assembled using braiding technique and the mechanical properties of single fibres and braided constructs were evaluated. Different cells were encapsulated in the hydrogel layer, including MC-3T3, mesenchymal stem cells (MSCs) and human tendon-derived cells (TDCs). Cell viability and metabolic activity were evaluated by LIVE/DEAD staining and presto blue assay of metabolic activity. The expression of tendon-related markers and matrix deposition were also investigated.

RESULTS: CFs were fabricated with a GelMA:alginate hydrogel layer and using multifilament twisted cotton or biodegradable suturing threads. The biocompatibility of this system was evaluated on encapsulated cells (Fig.1a). Cells (MC-3T3, MSCs and TDCs) were homogeneously distributed along the hydrogel layer, being viable up to 14 days in culture. In addition, TDCs were spreading inside the hydrogel after less than 48 h. Moreover, to further improve the mechanical properties of CFs, braided constructs were generated (Fig. 1b). Braiding CFs together enhanced their tensile strength and the process did not affect the viability of encapsulated cells.

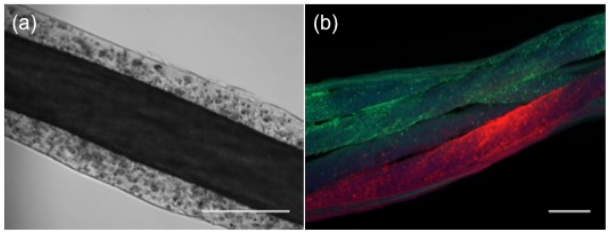

Fig. 1: Composite fibres. (a) Optical microscope images of CFs with MSCs encapsulated after 14 days. (b) Braided CFs with fluorescent beads.

DISCUSSION & CONCLUSIONS:

CFs were generated with a load bearing core and a hydrogel layer towards mimicking both mechanical properties and the matrix-rich microenvironment of tendon tissue. Accordingly, cell behaviour can be further modulated by modifying the hydrogel composition or, ultimately, through the addition of bioactive cues. Finally, braiding CFs together allows tuning the mechanical properties of developed constructs to match those of native tendon tissues.

REFERENCES: [1]M. Akbari, A. Tamayol, V. Laforte et al (2014) *Adv Funct Mater* **24**: 4060-67.

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