Exploring the potential of multifilament electrospun sutures for soft tissue repair

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Statement of Purpose:

Soft tissue injuries, such as torn tendons, represent a substantial and growing medical and economic burden. Sutures are commonly used to repair these injuries during surgery. Patient's outcomes are, however, not promising with around 40% surgical repairs failing within the first few months after surgery due to poor tissue regeneration [1]. To improve these outcomes, there is a need to develop biologically active sutures which enhance healing. An encouraging approach is the use of submicron electrospun filaments, which have the ability to mimic the architecture of natural human tissues and stimulate cell adhesion, proliferation and differentation [2,3]. Here, we present a method for the manufacture of electrospun sutures and investigate their potential for the repair of tendon tears.

Methods:

Continuous polydioxanone (PDO) electrospun filaments were produced with a single nozzle electrospinning set-up using an original collection method [2]. Briefly, PDO submicron fibres were collected on a thin wire (100µm in diameter) as a dense, narrow mesh, which was then detached as a long and continuous thread. The thread was subsequently stretched and twisted into multifilament yarns. For the *in vitro* work, human tendon cells were extracted from rotator cuff tendon tissue obtained during surgical repair, with appropriate ethical approval. *In vivo* experiments were performed in rat models to assess the safety of the material. PDO monofilaments, produced by plastic extrusion and commonly used as sutures in surgeries, were used as a comparator.

Results and discussions:

The morphologies of extruded monofilaments and electrospun sutures are shown in Fig. 1A and 1B, respectively. Monofilaments are very smooth while electrospun sutures show a highly textured surface. As shown in Fig. 1C, electrospun sutures showed improved cellular adhesion and proliferation when compared to monofilament sutures *in vitro*. This suggests that the highly textured surface of the yarn better supports cell adhesion and growth compared to monofilaments. *In vivo*, the yarns showed a good safety profile with mild foreign body reaction and complete degradation within 5 months after implantation. Moreover, tissue infiltration was encouraged in electrospun yarns (Fig. 1E) compared to the conventional sutures (see tissue gaps in Fig. 1D). The multifilament yarns are indeed highly porous, allowing cell infiltration, while the monofilaments are non-porous fibres.

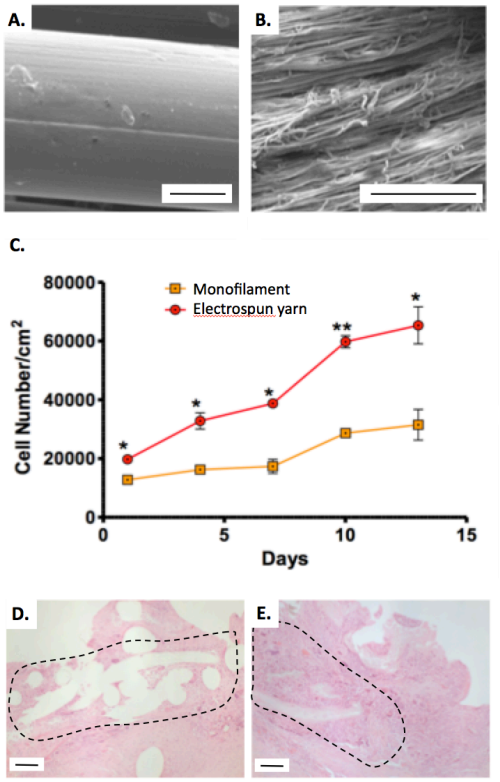

Figure 1. Comparison between PDO monofilament sutures used in clinics (left-side images) and PDO electrospun sutures (right-side images). A-B. SEM pictures showing the surface of each material. C. Cell adhesion and proliferation on the fibres, D-E. Tissue infiltration in a rat model. Scale bars represent 100µm.

Conclusions:

Electrospun yarns show improved biological properties compared to existing surgical sutures, suggesting that they could lead to a new generation of biologically active sutures. Potential benefits to patients include reduction of current failure rate of tissue repair, faster recovery and better tissue healing. We are currently scaling up our manufacturing setup and investigating efficacy in larger animal models in preparation for human trials.

References:

[1] Carr et al., 2014. Bone Joint Res, 3, 155-60.
[2] Mouthuy et al., 2015. Biofabrication 3:025006. doi: 10.1088/1758-5090/7/2/025006.
[3] Hakimi et al., 2015 Acta Biomateriala 26, 124-135.