Indian Institute of Science
Centre for BioSystems Science and Engineering
BSSE Seminar

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Novel Ligament / Tendon Repair Strategies

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ABOUT THE SPEAKER

Sarah was appointed Professor of Bioengineering at The University of Manchester in 2014 in the School of Materials after joining Manchester in 2010. She received a B.Eng. in Materials Science with Clinical Engineering and a Ph.D. degree in Clinical Engineering from The University of Liverpool in 1996 and 2000, respectively and then furthered her studies at Georgia Tech, Atlanta for two years as a postdoctoral research fellow. She joined Keele University in 2002 where she continued her postdoctoral studies until obtaining a Lecturership and then a Senior Lecturer position in orthopaedic tissue engineering in 2008. She is currently the Head of the Materials Department. She is also the UK Biomedical Materials champion for The Royce Institute of a £235 million UK government investment for advanced materials. Sarah has been awarded 51 grants, >£12.7million of grants as lead PI and >£22million as both PI and CI from 22 different competitive sources ranging from government, charity and industry. She has over 70 publications with over 3400 citations, 180 published abstracts and has given over 40 invited keynotes in the field of tissue engineering and regenerative medicine. She is currently the associate editor for 'Science and Technology of Advanced Materials (STAM)' and an editorial board member for 'World Journal of Orthopaedics'.

ABSTRACT

The UK incidence of flexor tendon injuries necessitate >18,000 repairs per annum (30-42 per 100,000 worldwide) (de Jong et al 2014), many of whom have multiple tendon injuries, and their repair remains an unmet clinical need as only 75% achieve a satisfactory functional result (Su et al, 2005). Currently, inadequate tendon repair surgery results in the formation of scar tissue which is structurally and biomechanically inferior to natural tendon tissue. Our approach utilizes a novel PCL electrospun device in augmentation with current suturing to enable improved healing and restore natural tissue architecture and biomechanical properties. This device is used to augment current tendon suturing techniques allowing topographical guidance for successful bridging of tendon repair (which currently is not met as 5% of tendon repairs re-rupture) - thus eliminating the need for secondary surgery. Data gathered from our research indicates that its presence in the tendon significantly increases the production of important extracellular matrix proteins and reduces the production of inflammatory cells in comparison to current suturing techniques alone. This demonstrates that patients have the potential to receive much faster and stronger tendon healing with this product in place which could reduce physiotherapy session need by 50%. In addition, a novel staining and tensioning method for micro X-ray CT scanning of sutured tendons will be presented. Suturing has been recommended to re-join tendons and permit tissue regeneration for over a century. However, 25% of flexor tendon patients achieve unsatisfactory postoperative mobility. Traditional in vivo, ex vivo and clinical studies have failed to determine an ideal suture arrangement for tendon repair. We aim to employ in silico analysis in approaching a conclusion. Tissue acellularity and impaired remodelling may be preceded by stress concentrations and stress shielding respectively. We therefore employed Micro X-ray CT and finite element analysis (FEA) to observe the stress patterns in tendon following suture withdrawal. To ensure characteristic deformation during suture withdrawal, the contrast agents must assert minimal change to tendon and suture mechanical behaviour. Tendon Constitutive behaviour was described using the anisotropic, hyperelastic Holzapfel model in Abaqus. There was no significant difference in failure load between unstained and surface-stained tendons during suture pull-out, and the surface staining enabled reliable data reconstruction. FEA results and reconstructed volumes showed good agreement, thus validating the method.