Testing and FEA modelling of a modified suture technique to accommodate a tissue engineered tendon *in vivo*

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INTRODUCTION: Tendon repair is surgically challenging as the tendon often retracts resulting in a gap between the torn end and its bony insertion. Tendon auto- or allografts are currently used to fill this deficit, but both are associated with potential complications. We have developed a highly reproducible, rapid process technique to manufacture compressed cell seeded type I collagen constructs to replace tendon grafts (1). However, the material properties of the engineered constructs are currently unsuitable to complete load bearing *in vivo*. A modified suture technique has been developed to withstand physiological loading and off load the artificial construct whilst integration occurs.

METHODS: Lapine tendons were used to test the strength of different suture techniques with different sizes of prolene sutures and tissue engineered collagen constructs in situ.

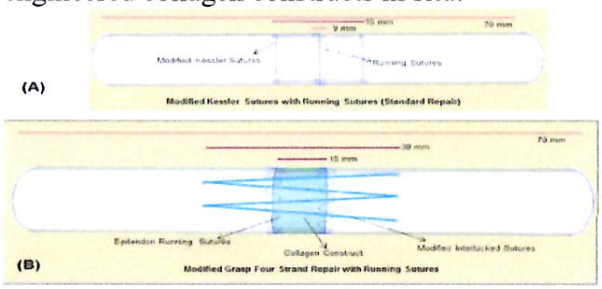

Fig1 *(A) Standard repair for tendon with modified Kessler sutures,* ***(B)*** *Modified repair Grasp four strand sutures with tissue engineered collagen construct*

The data was compared to standard modified Kessler suture using a standard tendon graft. Mechanical testing was carried out and a FEA stress distribution model constructed using COMSOL 3.5 software.

RESULTS: The break point for modified suture technique with tissue engineered collagen construct was significantly higher (50.62 ± 1.62 N) compared to standard modified Kessler suture [12.49±8.17N ($p<0.05$)]. In FEA modelling Van Mises stress in the middle of the geometry, i.e. in the middle of the collagen

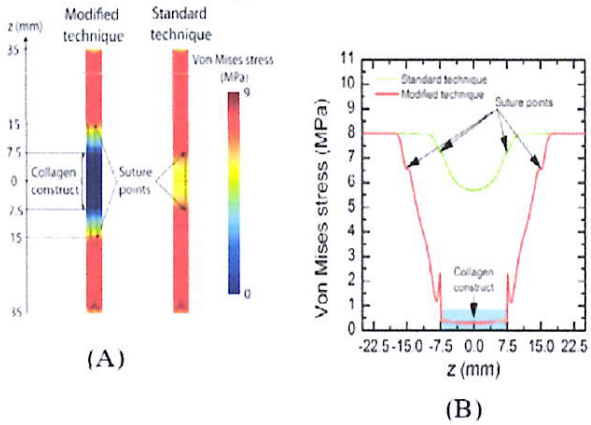

Fig2 *Stress distribution finite element analysis model for modified suture technique and standard technique(A), Von Mises stress across suture points and collagen construct (B).*

construct (for the modified technique) or at the point of the running sutures (for the standard technique) are as follows (at a load of 8 10^6 Pa): standard technique - 56 10^5 Pa; modified technique - 2.8 10^5 Pa. Hence, it is evident that, stress is 20 times less if the modified technique is applied.

DISCUSSION &CONCLUSIONS: Distributing suture tension further proximally and distally from the tendon ends increased the mechanical strength of the repairs. Using this proof of concept data, we will now test this modified suture technique in vivo to test integration and function in a lapine model.

REFERENCE: 1.Mudera V, Morgan M, Cheema U, Nazhat S, Brown R. Ultra-rapid engineered collagen constructs tested in an in vivo nursery site. *J Tissue Eng Regen M.* 2007;1(3):192-8.

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