Mechanical Properties of Transversalis Fascia and Hernia formation

A. Kureshi[1], P. Vaiude[1], S. Nazhat[2], S. Barker[3] & R. Brown[1]

[1]*University College London, Tissue Repair & Engineering Centre, Stanmore Campus, HA7 4LP London*
[2]*Dept of Biomaterials & Tissue Engineering, Eastman Dental Institute, UCL, London.*
[3]*St Luke's Hospital, 14 Fitzroy Square, London, W1T 6AH.*

INTRODUCTION: The transversalis fascia (TF) has long been the focus of hernia patho-physiology and management. Of particular interest there appears to be, in many hernias, a dramatic 'stretching' or 'growth' of the TF. This has significant bio-mechanical implications and applications being a natural model of adult tissue expansion. Mechanical properties of connective tissues, including the TF matrix are primarily dependent on collagen architecture particularly orientation and fibril diameter. The mechanical properties of TF were studied using a Dynamic Mechanical Analyser (DMA, Perkin Elmer) and correlated with Transmission Electron Microscopy (TEM) imaging.

METHODS: TF specimens were harvested from 20 patients undergoing inguinal hernia repair surgery and 4 control specimens were obtained from organ transplant donors. The specimens were orientated in transverse and longitudinal anatomical planes. The tissue was then cut into 2mm wide strips and using a metal mesh clamped into a Perkin Elmer Dynamic Mechanical Analysis Instrument (DMA). Detailed mechanical parameters were analysed by putting the tissue under a uniaxial tensile load of 200mN/min to failure or until 6000mN was reached. Stress, strain, modulus and break stress/strain values were calculated for each specimen. These were statistically analysed comparing the two tissue strips in perpendicular planes. The results were correlated to Transmission Electron Micrographs of the same tissue.

RESULTS: The results of the mechanical testing revealed distinct differences between the properties of the TF cut in transverse and longitudinal anatomical planes. Tissue cut and tested in the transverse plane produced higher break stress values than tissue tested in the longitudinal plane for all patient samples. Similar strain values were observed in both planes.

DISCUSSION & CONCLUSIONS: The TF displays anisotropy when comparing longitudinal to transverse orientations in the body.

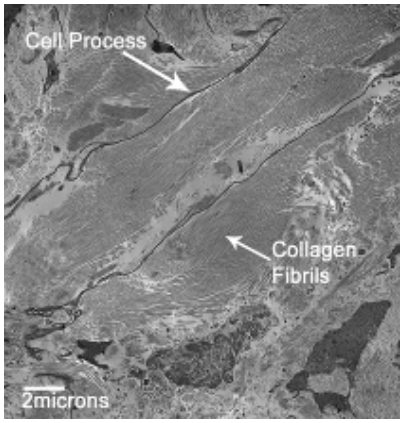
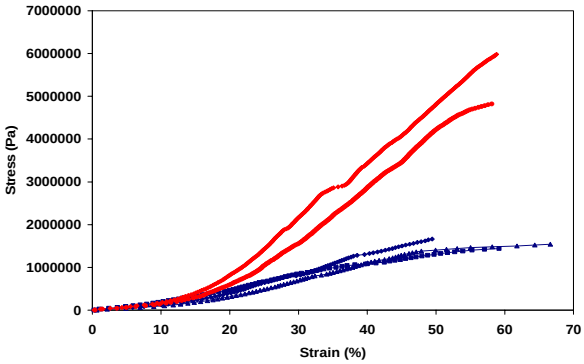
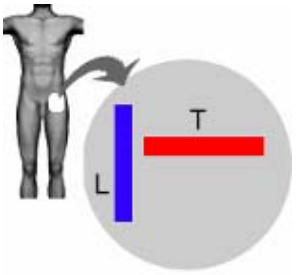


Fig. 1: Micrograph of TF from a direct inguinal hernia showing predominant unilateral fibril direction. Mag: 4400x.



Graph 1: Representative stress-strain curves obtained from Mechanical Analysis of TF showing transverse (red) vs. longitudinal (blue) planes.



This suggests that the collagen fibrils are predominantly orientated in the transverse plane, making the tissue weaker and less stiff in the longitudinal plane. This explanation sheds some light on the pattern of tissue expansion in TF 'stretching' in the hernia.

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