STRUCTURAL PROPERTIES OF PORCINE RECTUS SHEATH

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Introduction

The non-linear, viscoelastic nature of biological tissues makes their structural properties inherently difficult to classify, and thus to select or develop surrogate materials to represent the tissues in physical models.

As part of a larger effort to address the problem of hernia development at wound sites after laparoscopic surgery (prevalence 1-3% [Comajuncosas, 2011]), a physical surrogate abdomen rig is under development. Accurate simulation of the hernia development process is essential, thus materials used in the rig must accurately represent biological tissues. The small intestines have already been evaluated [Lyons, 2013], however data on the abdominal wall is lacking.

The rectus sheath, a fibrous layer encompassing the rectus abdominis muscle is often implicated in hernia formation. There is limited data on the structural properties of this tissue, however, with most of the data contradictory and inadequately reported for the development of surrogate materials [Martins, 2012, Rath, 1997].

This study aims to characterise the structural properties of the rectus sheath with a view to selecting a suitable surrogate material to represent the tissue in the abdominal rig.

Methods

Three 3 year old pigs were slaughtered in a local abattoir and the abdominal walls were removed and frozen for transport to our lab. Tissue was kept frozen until required. It was then defrosted in a fridge and samples of rectus sheath were harvested by dissection. Samples were taken in a longitudinal and a transvese direction to investigate directionality. Samples were elongated to failure in a Zwick/Roell Z005. A pre-stress of 0.1MPa was applied prior to elongation at a constant strain rate of 10%/min. Strain was analysed by videographically tracking dots applied to the tissue.

Results

Preliminary results show within sample strain variation up to 8% and a substantial effect of clamp slippage - reported stretch from Zwick data was 9% greater than from dot tracking. A preliminary Poisson's ratio of 0.4 was found and corroborated by a higher Young's modulus in the fibre direction. These results are shown graphically in Figure 1 below.

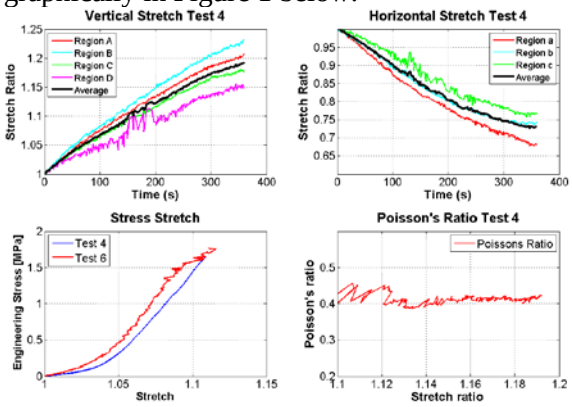

Figure 1: Within sample strain variation, sample stress stretch profiles and Poison's ratio preliminary results

Discussion

These results are the first to report Poisson's ratio and to consider the effect of within specimen strain variation and clamp slippage in rectus sheath. Both factors had a large effect on reported stretch of up to 8% and 9% respectively. Previously, authors have reported stress strain characteristics of this tissue ignoring these effects. While fibre orientation within the tissue has been investigated [Axer, 2001], the effects on strength have not. These preliminary results show that the material is stiffer in the fibre direction. Further testing is underway to refine these results with an expected total sample size of 30 specimens.

References

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