MATERIAL PROPERTIES IDENTIFICATION OF PORCINE PERINEAL TISSUES

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1. Introduction

The female perineum is a multilayer structure located under the pelvic floor. It contributes to the mechanical integrity of the pelvis and deforms largely during childbirth, deformation that often causes more or less severe tears. The objective of the present work is to investigate the mechanical properties of the perineal tissues.

2. Materials and Methods

Because of the difficulty in acquiring human tissues, we selected the sow as it presents anatomical similarities with humans. Two samples were taken from each layer of the perineum: skin, vaginal mucosa, anal mucosa, external anal sphincter (only one sample) and internal anal sphincter.

The samples (10 for the external anal sphincter and 20 for the remaining tissues) were tested in quasi-static uniaxial tension using the testing machine Mach-1 (Biomomentum Inc, Canada). The tests were done in the general fiber direction until failure at 0.1 $mm.s^{-1}$ and 1 $mm.s^{-1}$ at a constant temperature of 21°C.

Soft biological tissues exhibit non-linear hyperelastic behaviour [1]. Many hyperelastic models were proposed in the literature. Because of a lack of studies on porcine perineal tissues, we will try to identify their material properties with different behaviour laws similarly as in [1]: Yeoh, Mooney-Rivlin, Ogden, Humphrey, Veronda-Westmann, Martins.

The material parameters were identified by inverse method. For each sample, we obtained the Pearson correlation coefficient and the p-value with the null hypothesis that there was no correlation between the experimental and numerical stresses.

3. Results

The results show high correlation coefficients between the numerical and experimental curves confirmed by p-values less than 0.05. The mean correlation coefficient for all models is greater than 0.99 for each tissue. As shown in Fig. 1, the mechanical behaviour is different from one tissue to another which is normal due to the structural differences between the different tissues (some more fibrous than others).

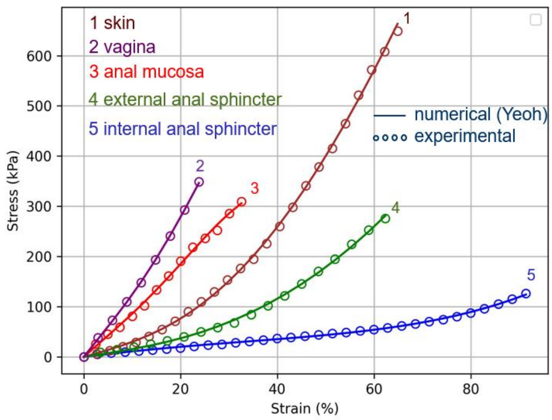

Figure 1: Stress-strain curves for different soft tissues from one sow perineum at 0.1 $mm.s^{-1}$

4. Discussion and Conclusions

In this work, we managed to implement a dissection methodology for perineal tissues and characterize their material properties. Amongst the chosen constitutive laws, the best fit was obtained with Yeoh model except for the external anal sphincter for which Martins model fits better. We also observe a high variability in the response of the tissues depending on the sow.

5. References

1. Martins PALS, Natal Jorge RM, Ferreira AJM, Strain; 42(3):135-147 (2006).