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MECHANICAL CHARACTERISATION AND MODELLING OF THE LAYER-DEPENDENT, ANISOTROPIC BEHAVIOUR OF THE HUMAN OESOPHAGUS

Ciara Durcan[1,2*], Mokarram Hossain[1], Grégory Chagnon[2], Djordje Perić[1] and Édouard Girard[2,3]

[1] Zienkiewicz Centre for Computational Engineering, College of Engineering, Swansea University, SA1 8EN, United Kingdom; 998131@swansea.ac.uk (Ciara Durcan), mokarram.hossain@swansea.ac.uk (Mokarram Hossain), d.peric@swansea.ac.uk (Djordje Perić)
[2] Université Grenoble Alpes, CNRS, UMR 5525, VetAgro Sup, Grenoble INP, TIMC, 38000 Grenoble, France; gregory.chagnon@univ-grenoble-alpes.fr (Grégory Chagnon), egirard1@chu-grenoble.fr (Édouard Girard)
[3] Laboratoire d'Anatomie des Alpes Françaises, Université Grenoble Alpes, France

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The oesophagus is a primarily mechanical organ whose material properties are inherent to its function. The characterisation of these properties can be used to enhance the understanding of oesophageal pathophysiology, to aid in medical device design, to improve surgical simulations and within tissue engineering. The oesophagus is the only visceral organ which can be separated into two main layers after explantation: the mucosa-submucosa and the muscularis propria [1]. Overall, there has been very little *ex vivo* experimentation conducted on the human oesophagus, and, to the best of the authors' knowledge, none previously regarding its layer-dependent and viscoelastic properties [2,3]. Therefore, the layer-specific mechanical behaviour of the human oesophagus was investigated through *ex vivo* cyclic tests of the mucosa-submucosa layer [1]. Due to restrictions placed on the laboratory as a result of COVID-19, only oesophagi from cadavers fixed in formalin were allowed for testing. The mucosa of three cadavers were investigated in total. Uniaxial tensile tests were conducted in the form of increasing stretch level cyclic tests at two different strain rates: 1%s^{-1} and 10%s^{-1}. Rectangular samples in both the longitudinal and circumferential directions were tested to observe any anisotropy. Histological analysis was also performed through a variety of staining methods. Overall, the longitudinal direction was found to be much stiffer than the circumferential direction. Stress-softening was observed in both directions, as well as residual strains, and hysteresis. Strain rate-dependent behaviour was apparent in both directions, with an increase in strain rate resulting in an increase in stiffness. Finally, the results were modelled and validated using a visco-hyperelastic matrix-fibre model, whose fibre orientation was derived from the histological results. The model simulated well the anisotropy, visco-hyperelasticity and damage of the experimental data.

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