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Research paper

Mechanical and histological characterization of the abdominal muscle. A previous step to modelling hernia surgery

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ABSTRACT

The aims of this study are to experimentally characterize the passive elastic behaviour of the rabbit abdominal wall and to develop a mechanical constitutive law which accurately reproduces the obtained experimental results. For this purpose, tissue samples from New Zealand White rabbits 2150 ± 50 (g) were mechanically tested *in vitro*.

Mechanical tests, consisting of uniaxial loading on tissue samples oriented along the crano-caudal and the perpendicular directions, respectively, revealed the anisotropic non-linear mechanical behaviour of the abdominal tissues. Experiments were performed considering the composite muscle (including external oblique-EO, internal oblique-IO and transverse abdominis-TA muscle layers), as well as separated muscle layers (i.e., external oblique, and the bilayer formed by internal oblique and transverse abdominis). Both the EO muscle layer and the IO-TA bilayer demonstrated a stiffer behaviour along the transversal direction to muscle fibres than along the longitudinal one. The fibre arrangement was measured by means of a histological study which confirmed that collagen fibres are mainly responsible for the passive mechanical strength and stiffness. Furthermore, the degree of anisotropy of the abdominal composite muscle turned out to be less pronounced than those obtained while studying the EO and IO-TA separately.

Moreover, a phenomenological constitutive law was used to capture the measured experimental curves. A Levenberg–Marquardt optimization algorithm was used to fit the model constants to reproduce the experimental curves.

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