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BIOMECHANICAL PROPERTIES OF THE PUBOVISCERALIS MUSCLE OF ASYMPTOMATIC, INCONTINENT AND PROLAPSED WOMEN USING AN INVERSE FINITE ELEMENT ANALYSIS

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Summary: Pelvic floor dysfunction (PFD), such as stress urinary incontinence (SUI) and pelvic organ prolapse (POP), can be associated with changes in the biomechanical properties of the supportive structures such as pelvic floor muscles (PFM), ligaments or pelvic fascia. Normally, the PFD are related to the weakness or direct injuries of the PFM associated with different risk factors, such as genetic predisposition, age, menopause, obesity - increased body-mass index (BMI), among others [1]–[3]. In this sense, the biomechanical assessment of the pelvic floor tissues is important to understand the PFD, allowing to understand their structure and function, which may contribute to improve clinical outcomes.

The aim of this study was to establish the biomechanical properties of the puboviseralis muscle (PVM) of asymptomatic, incontinent and prolapsed women, using an inverse finite element analysis (FEA). The numerical models, including the puboviseralis muscle and pelvic bones were built from magnetic resonance (MR) images acquired at rest. The numerical simulation of Valsalva maneuver was based on the finite element method and the material constants were determined for different constitutive models (Neo-Hookean, Mooney-Rivlin and Yeoh) using an iterative process.

The values of the material constants were significantly higher for the asymptomatic than for the incontinent women. The variation for asymptomatic vs. incontinent group was approximately 38.46% for the c1 for the Neo-Hookean, 38.46 and 64.29% for c1 and c2 of the Mooney-Rivlin, and 48.39, 84.00 and 95.65% for c1, c2 and c3 of the Yeoh. When comparing asymptomatic vs. prolapsed women, the ratio between the values of the material constants for women without and with prolapse was approximately 43%for the c1 parameter of the Neo-Hookean constitutive model, 57% and 24% for c1 and c2 of the Mooney-Rivlin constitutive model, and 35%, 21% and 14% for c1, c2 and c3 of the Yeoh constitutive model, meaning that women with prolapse presented a higher stiffness.

Using an inverse FEA coupled with MR images allowed to obtain the in vivo biomechanical properties of the pelvic floor muscles, leading to a relationship between them for the continent and incontinent women in a non-invasive manner.