

COMPARATIVE STUDY OF PELVIC FLOOR DISPLACEMENT IN A WOMAN WITH STRESS URINARY INCONTINENCE USING FINITE ELEMENT METHOD AND MAGNETIC RESONANCE IMAGING

Hypothesis / aims of study

MRI has been used in the diagnostic evaluation of the pelvic floor dysfunctions. Static images show their morphology while dynamic images show the functional changes that occur on straining and contraction of the levator ani. With dynamic images, displacement of organs and pelvic floor muscles can be computed in three planes (axial, sagittal and coronal) [1]. The purpose of this study is to compare pelvic floor muscle (PFM) displacement of a woman with stress urinary incontinence, produced during a voluntary PFM contraction, using magnetic resonance imaging (MRI) and the contraction activation methodology using Finite Element Analysis (FEA).

Study design, materials and methods

Twenty consecutive images obtained in the axial plane were used to construct a 3D model from a pubovisceral muscle of a 33 year old woman with stress urinary incontinence (See Figure 1). The images were acquired from the subject supine position, using a 3.0 T system. Field view of the exam was 25x25 cm, 2 mm thick with a 2-mm gap. The patient during the exam was instructed to contract her PFM as hard as possible, and 10 sequential images were acquired in the sagittal plane. Finite element meshes were generated to the pubovisceral muscle. In the present study the model was meshed with tetrahedral elements. The analyses were made using the finite element tool ABAQUS. The methodology of the numerical model created in [2] and [3] was followed, which uses muscle fiber direction and incompressibility material to simulate the biomechanical behavior of muscle under active contraction. A muscle activation of 1.0 (100%) was set to the pubovisceral model.

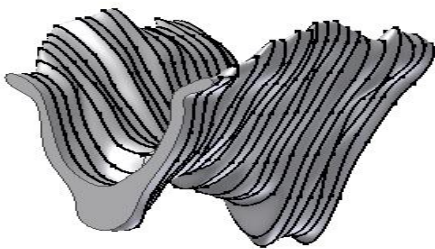


Figure 1: Final 3D generated model from the 20 MRI images.

Results

The results obtained overlapping the Magnetic Resonance Image at rest and at a contraction of the pelvic floor can be better visualized at Fig.2. In this figure lines in the sagittal plane were measured in MRI image at the rest position, and MRI image at the contracted position. The displacement found between the two positions was 5.75mm.

The magnitude of displacements obtained from the numerical simulation in the sagittal plane to the stress incontinent women is 5.58 mm at a 100% contraction.

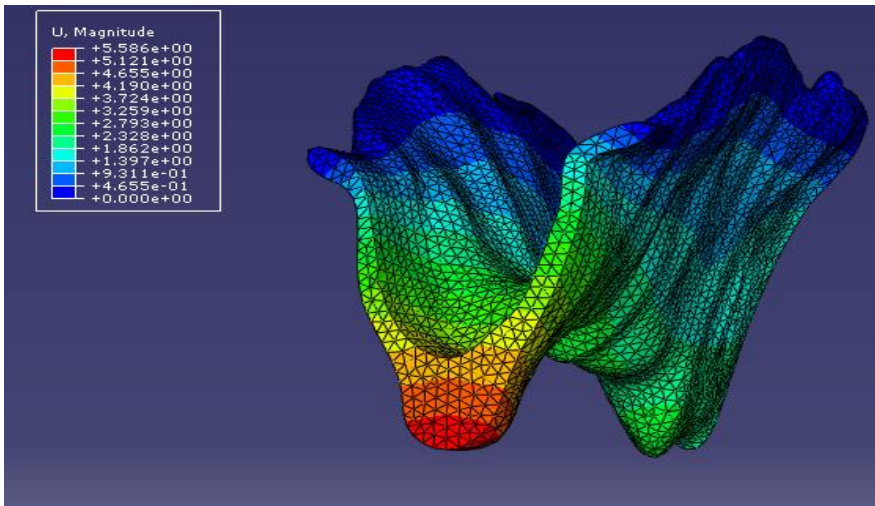


Figure 2: Pubovisceral muscle of the incontinent woman under finite element method analyses.

Interpretation of results

Comparing the displacement from 100% contraction to the real value obtained by overlapping the MRI images, an error of 2.8% is obtained and is not a significant error to this study, supporting through the methodology created with FEA to understand pelvic floor muscle behaviour. With this methodology developed to make pelvic floor muscle activation, future numerical simulation researches, in pelvic floor muscle biomechanics, would be benefited to better understand the pathology of pelvic floor disorders.

Concluding message

The finite elements methodology of the active contraction behaviour proposed in this study is adequate to simulate pelvic floor muscle contraction. In this case, in particular, the 100% contraction was able to displace the pubovisceral muscle in a range of values very similar to the displacement found in the MRI data.

References

1. Obstet Gynecol 2002; 99:433-438
2. Comp Met Biomech and Biom Eng 2005; 8:339–347
3. Int Urogynecol Journal 2008; 19:65–71

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<i>Is this a clinical trial?</i>	No
<i>What were the subjects in the study?</i>	NONE