**IS THE MOMENT OF INERTIA OF PELVIC FLOOR A USEFUL CLINICAL PARAMETER TO DETECT ABNORMALITIES IN PELVIC FLOOR MUSCLES?**

**Hypothesis / aims of study**

Evidence of muscle and nerve damage has been reported in women with pelvic floor dysfunction (PFD), and progress is being made to assess what specific role the levator ani (LA) muscle injury plays in PFD. Anatomical features and functional performance of PFD were previously described using ultrasound (US) and magnetic resonance imaging (MRI), with great success [1]. A recent study focused on the biomechanical impact of certain morphological features on static MRI found a relation between the moment of inertia (MOI) and the pelvic organ prolapse stage in women. The studied women had a decreased thickness of the pubovisceral muscle (part of LA muscle) and of the cross sectional area with an increased levator hiatus (LH) [2]. Briefly, MOI is a geometrical property of a structure cross-sectional area which defines its bending or deflection characteristics.

With this concept in mind, the purpose of the present work was to assess if morphological data acquired on Translabial 3D/4D US, at rest and during Valsalva Maneuver, could be related to MOI.

**Study design, materials and methods**

Eleven women with stress urinary incontinence were clinically evaluated and imaged by Translabial 3D/4D US at rest and during Valsalva maneuver. Measures of pubovisceral (PV) muscle thickness and area were obtained in the plane of minimal dimensions (Figure 1a) [3]. In the same plane, the anterior-to-posterior (AP) and the right-to-left (RL) diameters, and the area of the LH were taken (Figure 1b). The software Inventor® was used to draw a contour spline and to calculate MOI (Figure 1c).

**Results**

Table 1 lists the mean values ± standard deviation of PV characteristics (thickness, area, and moment of inertia), as well as the LH measures (area, AP, and RL diameters).

<table>
<thead>
<tr>
<th>Variables</th>
<th>Rest</th>
<th>Valsalva Maneuver</th>
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<tr>
<td>AP diameter (cm)</td>
<td>6.28±0.9</td>
<td>6.96±1.4</td>
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<tr>
<td>RL diameter (cm)</td>
<td>4.42±7.1</td>
<td>5.39±1.0</td>
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<tr>
<td>Area of LH (cm²)</td>
<td>13.9±2.6</td>
<td>17.9±4.3</td>
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<tr>
<td>Thickness of PV (cm)</td>
<td>0.83±0.3</td>
<td>0.79±0.4</td>
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<tr>
<td>Area of PV (mm²)</td>
<td>1290.1±657.9</td>
<td>1204.6±451.0</td>
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<tr>
<td>Moment of inertia (mm⁴)</td>
<td>554669.4±540516.1</td>
<td>422826.2±265456.9</td>
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AP (anteroposterior); LR (lateral diameter); LH (levator hiatus); PV (pubovisceral muscle).

It was found an association between the frequency of urine loss with the variation of the moment of inertia (MOI in Valsalva Maneuver– MOI in rest), p=0.001 and r=0.854.
Interpretation of results
This study demonstrated that it is possible to measure MOI by 3D/4D US. Although none of the woman showed prolapse symptoms, higher hiatal dimensions were shown by the volunteers when compared with the previous study [2]. As so, these participants that already suffer from urinary incontinence should be careful with their pelvic floor muscles. PFD have been already related to changes in pelvic floor anatomy, especially with wider LH and also a more circular morphology. Since MOI is associated with several morphological properties, such as dimensions of the LH and muscle cross-sectional area and thickness, it was expected to find a decreased in MOI during Valsalva Maneuver. Interestingly, we did not find a significant decrease in the PM thickness during Valsalva Maneuver, meaning that the LH diameters and area are more relevant to MOI than muscle thickness.
Furthermore, the results demonstrated that the frequency of leakage is directly related with the difference between the MOI in Valsalva Maneuver and the MOI during rest, i.e higher frequencies of leakage were associated higher MOI decreases during the Valsalva maneuver.

Concluding message
MOI can also be calculated through translabial 3D/4D US. Its decrease during Valsalva Maneuver reflects a higher probability for deformation, with superior force necessary to counteract pressure under the pelvic floor muscles. It appears that the large variations of the MOI during Valsalva Maneuver may be related to the frequency of urine leakage. This is an indirect measure of the biomechanical muscle performance.

References

Disclosures
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