323

Da Roza T H[1], Brandão S[2], Duarte S V[3], Mascarenhas T[4], Natal Jorge R[5], Alberto Duarte J[6]

1. *IDMEC, Faculty of Engineering, University of Porto; Faculty of Sport, University of Porto, Research Centre in Physical Activity, Health and Leisure.,* ***2.*** *Department of Radiology, Centro Hospitalar de São João – EPE.,* ***3.*** *Faculty of Medicine, University of Porto - São João Hospital, Porto, Porto, Portugal.,* ***4.*** *Department of Gynecology and Obstetrics, Hospital de S. João, Faculty of Medicine, University of Porto.,* ***5.*** *IDMEC, Faculty of Engineering, University of Porto.,* ***6.*** *Faculty of Sport, University of Porto, Research Centre in Physical Activity, Health and Leisure.*

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 a 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).

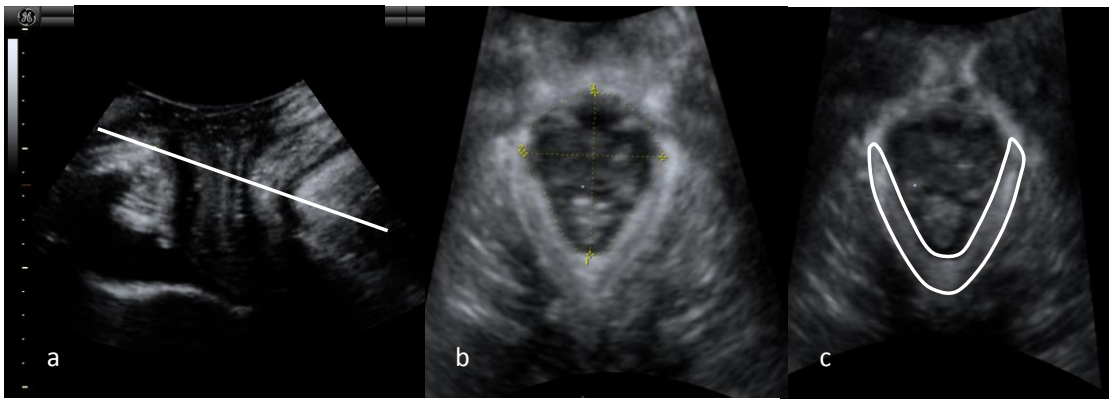

Figure 1: Translabial pelvic floor ultrasound, in the mid-sagittal plane, showing the plane of minimal *hiatal* dimensions (a). In (b), measures of *levator hiatus* area, AP and RL diameters at rest are depicted. In (c), the area of pubovisceral muscle is measured to calculate the MOI.

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).

Variables	*Rest*	*Valsalva Maneuver*
AP diameter (cm)	6.28±0.9	6.96±1.4
RL diameter (cm)	4.42±7.1	5.39±1.0
Area of LH (cm^2)	13.9±2.6	17.9±4.3
Thickness of PV (cm)	0.83±0.3	0.79±0.4
Area of PV (mm^2)	1290.1±657.9	1204.6±451.0
Moment of inertia (mm^4)	554669,4±540516,1	422826,2±265456,9

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

1. El Sayed RF, El Mashed S, Farag A, Morsy MM, Abdel Azim MS. Pelvic floor dysfunction: assessment with combined analysis of static and dynamic MR imaging findings. Radiology 2008;248:518-30.
2. Brandao S, Da Roza T, Mascarenhas T, et al. Moment of inertia as a means to evaluate the biomechanical impact of pelvic organ prolapse. Int J Urol 2013;20:86-92.
3. Dietz HP, Shek KL. Tomographic ultrasound imaging of the pelvic floor: which levels matter most? Ultrasound Obstet Gynecol 2009;33:698-703.

Disclosures

Funding: First author is supported by a a research grant from CNPq, Conselho Nacional de Desenvolvimento Científico e Tecnológico - Brazil **Clinical Trial:** No **Subjects:** HUMAN **Ethics Committee:** Ethics Committee of the Centro Hospitalar São João-EPE, Porto, Portugal. **Helsinki:** Yes **Informed Consent:** Yes