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INFLUENCE OF INTRA-ABDOMINAL PRESSURE ON THE VALIDITY OF PELVIC FLOOR DYNAMOMETRIC MEASUREMENTS

Hypothesis/aims of study

Pelvic floor dynamometry has been shown to yield reliable measurements of the pelvic floor muscle (PFM) strength [1] and yet its validity has never been studied. It is hypothesized that, because of its design, a pelvic floor dynamometer is not significantly influenced by an increase in intra-abdominal pressure (IAP) such as in Valsalva and coughing. The objective of this study, therefore, was to validate the dynamometric PFM strength measurements during 1) voluntary PFM contractions and 2) standardized Valsalva manoeuvres. The validation process comprised two parts. First, IAP evaluated with an intra-rectal balloon was used to estimate to what extent IAP influences the dynamometric PFM strength measurements. Second, the point of application of the resultant force was compared to the location of the highest EMG activity recorded by a series of electrodes placed on the dynamometer. Agreement between the force and the EMG locations lends support to the validity of strength measurements.

Study design, materials and methods

Ten continent women specialized in PFM physiotherapy participated in the study. This group was targeted as being more aware of how to specifically contract and isolate their PFM. The dynamometric speculum comprises an upper and a lower branch. The latter has two blades (L-IAP and L-PFM). Inspired by earlier work [2], the L-IAP blade is configured to be positioned deep in the vagina (6 cm) in order to assess the forces coming from the IAP. As it is situated between the upper branch and the blade L-PFM, it is not affected by the PFM contractions. The L-PFM blade covers the vaginal hiatus to a depth of 4.5 cm. Since the muscle is reported to be located approximately 3.5 cm from the vaginal opening, the L-PFM blade is intended to evaluate the PFM although it may be influenced by IAP located at the PFM level. The strain gauges allow measurements to be made of the resultant force amplitude and location. In addition, four pairs of Medtronic electrodes separated by a distance of 4 mm were attached to the L-PFM blade. The EMG amplitude was computed as the root mean square value for a time window of 100 ms. An intra-rectal balloon was used to monitor the changes in IAP. The participants adopted a supine lying position, knees bent, in order to be evaluated by an experienced physiotherapist. They were instructed to perform a 10-s maximal PFM contraction while breathing out. To standardize the Valsalva manoeuvres, they were asked to blow in a tube connected to a pressure transducer and had to reach and hold pressures of 50 and 100 cm H_2O for 10 s. To determine the contribution of forces resulting from IAP to the PFM strength measurements during PFM voluntary contractions and Valsalva, we first compared the forces directly recorded with the blade L-IAP to those predicted by the pressure recorded by the intra-rectal balloon. For these predictions, the pressures recorded with the intra-rectal balloon were converted into force units (newtons) by considering the cross-sectional area of the blade (predicted forces on L-IAP= intra-rectal pressure x conversion factor (0.0098 N/cm^2) x cross-sectional area of L-IAP (2.6 cm^2)). These calculations have been reported elsewhere [3]. Pearson's correlation coefficient for the direct and estimated forces on L-IAP was calculated.

Results

For Valsalva at 50 cm H_2O, the mean direct force recorded on L-IAP was 0.60 N ± 0.41 (standard deviation (SD)) while the mean predicted forces from IAP was 0.57 N ± 0.29 SD. Regarding Valsalva at 100 cm H_2O, the mean direct forces on L-IAP was 1.03 N ± 0.65 and the mean predicted forces were 0.99 N ± 0.55. The correlation between the direct forces measured on L-IAP and predicted forces were very good with a coefficient of $r=0.712$ ($p=0.001$).
The good relation between the deep vaginal blade (L-IAP) and the predicted forces with the intra-rectal balloon suggests that these calculation techniques are appropriate. We can therefore use the intra-rectal balloon and apply the same calculations to estimate the degree to which the IAP influences the PFM strength measurements (forces acting on L-PFM blade).

Table 1. Forces measured on the L-PFM blade and estimated contribution of IAP on PFM measurements

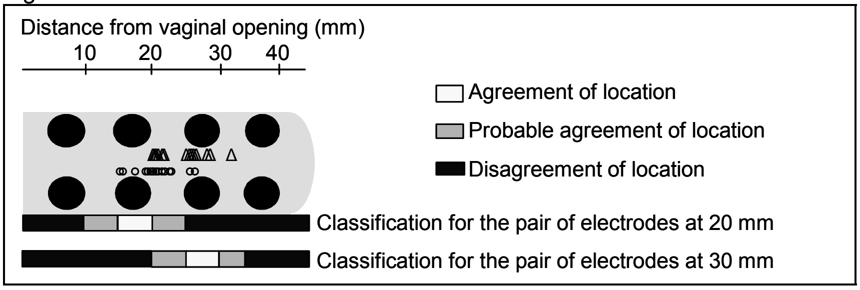
	Mean direct forces recorded on L-PFM (N) ± 1 SD	Mean estimated force due to IAP (N) ± 1 SD	% of the contribution of IAP*
Valsalva at 50 cm H_2O	5.80 ± 2.92	0.66 ± 0.34	11.9
Valsalva at 100 cm H_2O	8.84 ± 4.81	1.14 ± 0.64	14.2
Maximal voluntary contraction	11.35 ± 6.99	0.54 ± 0.26	6.8

*Contribution of IAP= (estimated contribution of IAP/direct forces recorded on L-PFM)*100

As shown in Table 1, for a mean maximal PFM contraction of 11.35 N, there is 0.54 N that is attributed to IAP. Percentages ranging from 6.8 to 14.2% of the forces recorded on L-PFM are caused by IAP during voluntary maximal PFM contraction.

The arbitrary classification validating the correspondence between the location of the resultant forces recorded on the L-PFM blade and the maximal EMG activity is illustrated in Figure 1. Agreement of location is obtained when the location of the resultant force corresponds to the electrodes with the highest EMG amplitude while probable agreement of location is when the location of the resultant force is just beside the electrodes with the highest EMG amplitude and disagreement of location is when the location of the resultant force corresponds to the area of another pair of electrodes. During maximal voluntary contraction and Valsalva, agreement was found in 15 trials, probable agreement in 13 and disagreement in two. In the latter case, the EMG amplitude of the adjacent pairs of electrodes was near equal.

Figure 1. Location of the resultant forces exerted on L-PFM



Circles indicate the location of the resultant force when maximal EMG was recorded by the electrodes situated at 20 mm while triangles designate the electrodes at 30 mm. The proportion of the blade and the electrodes is respected in Figure 1.

Interpretation of results

The influence of the IAP on PFM strength measurements is small during PFM voluntary contraction and Valsalva. The location of the resultant force of the PFM generally corresponds to the highest EMG amplitude recorded by a closely located pair of electrodes, suggesting that the forces recorded by the lower branch of the dynamometer originate from the PFM.

Concluding message

Our results support the validity of PFM strength measurements during voluntary contraction and Valsalva in continent women. The validation process should be pursued in other population subgroups.

References

[1] Neurourol Urodyn. 2004. 23: 134-42.
[2] US 6468 232 B1.
[3] Am J Obstet Gynecol. 2005. 192: 1722-1728.

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