

IS THE VALSALVA/REST RATIO FOR AREA THE "LEVATOR ELASTICITY INDEX"?

Hypothesis / aims of study

Pubovisceral muscle elasticity is difficult to assess with accuracy due to the non-Euclidean structure of the levator ani muscle. Several authors have described measures to evaluate levator tissue strain (1) or strain/stretch requirements in relation to childbirth (2). Excessive distensibility of the levator ani muscle, also termed ballooning (3), has been shown to be associated with pelvic organ prolapse, and normality measurements for levator area at Valsalva have been established. We undertook this study to evaluate whether other biometric indexes, which have not yet been described, may be valuable in determining levator ani muscle tissue elasticity.

Study design, materials and methods

We retrospectively analyzed the datasets of 272 women referred to our tertiary urogynecological unit for symptoms of pelvic floor prolapse, urinary tract dysfunction or both.

The patients underwent an urogynecological evaluation which included the completion of a standardized pelvic floor questionnaire, physical examination (prolapse grading according to Baden-Walker classification), and multi-channel urodynamic testing (MMS, Holland) when indicated. 4D transperineal ultrasound was performed in supine position after bladder emptying, using a 4-8 MHz probe (GE Kretz Voluson 730) and volumes were obtained at rest, maximal Valsalva and maximal pelvic floor contraction (PFMC). Volume datasets were analyzed offline with 4Dview software (GE Kretz). Hiatal dimensions were assessed at rest, Valsalva and PFMC. Levator avulsion trauma was assessed qualitatively and quantified using tomographic ultrasound imaging (TUI). We attempted to estimate tissue elasticity by calculating the ratio of the various biometric indices of the levator ani at the genital hiatus between maximal Valsalva and rest and maximal contraction and rest. This was performed for the antero-posterior diameter (AP), left-right diameter (LR), circumference, and area (3). Statistical analysis was performed with SPSS software. A p-value<0.05 was considered statistically significant.

Results

There were 272 complete datasets for analysis. The mean age was 54 (range 21-88). The median parity was 3 (range 0-12). Women presented with symptoms of prolapse (60.7%), stress urinary incontinence (24%), urge urinary incontinence (13.5%) and other varied complaints (12.5%). On pelvic examination significant (grade 2 and above) cystocele was observed in 44.6%, uterine prolapse in 20%, vault prolapse in 11.6%, rectocele in 27.5%, and enterocele in 23.1%. In total 61.7% of women had any significant compartment (grade 2 and above) prolapse. On ultrasound, significant (grade 2 and above) cystocele was observed in 36.2%, central descent in 17.6%, rectocele in 19.6%, and enterocele in 8.7%, for a total of 58.8% with any significant compartment prolapse.

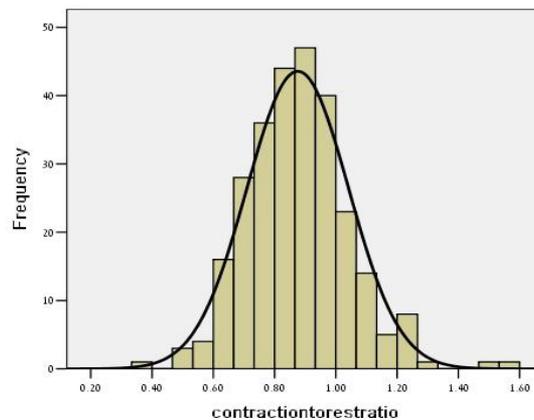
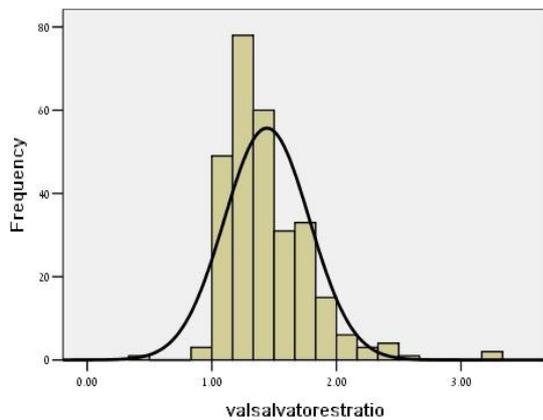
The incidence of levator avulsion injury was 60.1%, with a median TUI score of 6. Ballooning at rest was observed in 23.8% (Mild – 16.6%, Moderate – 5.5%, Marked - 1.4%, Severe – 0.3%). Ballooning on Valsalva was observed in 68.2% (Mild – 24%, Moderate – 19.5%, Marked – 10.6%, Severe – 14.1%). Levator biometric indices are given in table 1.

Table 1: Levator ani biometric indices expressed in means and standard deviations (in cm, area in cm².) AP - antero-posterior, LR - left-right, PFMC – pelvic floor muscle contraction

Measure	AP diameter	LR diameter	Circumference	Area
Rest	6.1±0.86	4.65±0.8	17.96±9.6	21.1±5.97
Valsalva	6.98±1.08	5.4±0.94	20.3±3.1	30±9.3
PFMC	5.41±0.94	4.45±0.81	15.98±2.42	18.18±5.5
Valsalva/Rest ratio	1.15±0.14	1.17±0.15	1.17±0.14	1.44±0.34
Contraction/Rest ratio	0.89±0.11	0.97±0.11	0.92±0.10	0.88±0.17

In women with levator avulsion the Valsalva/Rest ratio for area, and for circumference were both larger (1.48 vs. 1.4, p=0.062 for area, and 1.18 vs. 1.14, p<0.05 for circumference). Spearman's correlation for the Valsalva/Rest ratio for area with the TUI score for avulsion defects and ballooning on Valsalva were both statistically significant (p=0.014 and p=0.001, respectively). When analyzing the contraction indices, the contraction/rest ratio for area was similar in women with and without avulsion (0.8832 vs. 0.8837, p=0.99), however the contraction/rest ratio for circumference tended to be larger in women with avulsion (0.93 vs. 0.90, p=0.073), suggesting poorer contractility. Histograms for both ratios for areas are given in Figure 1.

Figure 1: Histogram and normality distribution for the Valsalva/Rest and contraction/rest ratios for areas.



There were statistically significant relationships between reported symptoms of prolapse and any significant (grade 2 and above) pelvic organ prolapse, both on examination and on ultrasound (all $p < 0.001$). There was a significant relationship between the Valsalva/Rest ratio for area and reported symptoms of prolapse ($p < 0.05$). Receiver–operating characteristics curve (ROC) analysis revealed a similar relationship with an area under the curve (AUC) of 0.598 (95% CI, 0.5-0.696). A cut-off of 1.4 gave a sensitivity of 51% and a specificity of 67%. There was also a significant relationship between the Valsalva/Rest ratio for area and significant prolapse on ultrasound ($p = 0.01$) but not on pelvic examination ($p = 0.22$). Interestingly, a strong relationship was found for the Valsalva/Rest ratio for area and significant rectocele on ultrasound (AUC 0.641, 95% CI, 0.558-0.723), with a cut-off of 1.4 giving a sensitivity of 61% and a specificity of 60%.

Interpretation of results

In this retrospective study we attempted to find a "levator elasticity index". The Valsalva/Rest ratio seems to perform well in correlation with both reported pelvic organ symptoms and objective findings on examination and on ultrasound. Based on the ROC analysis we suggest that a cut-off of 1.4 for the Valsalva/Rest ratio for area be considered normal levator elasticity. Values above this cut-off were related to increased rates of avulsion and ballooning which have been described as risk factors for pelvic organ prolapse.

Concluding message

We suggest that the Valsalva/Rest ratio for area be considered as the "levator elasticity index" with 1.4 as the cut-off for normality.

References

1. Ultrasound Obstet Gynecol 2008; 31:201-205
2. BJOG 2009; 116:1657-1662
3. Ultrasound Obstet Gynecol 2008; 31:676-680

Specify source of funding or grant	None
Is this a clinical trial?	No
What were the subjects in the study?	HUMAN
Was this study approved by an ethics committee?	Yes
Specify Name of Ethics Committee	Sheba Medical Center Institutional Review Board
Was the Declaration of Helsinki followed?	Yes
Was informed consent obtained from the patients?	Yes