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INTRAVAGINAL PRESSURE MEASUREMENTS PROVIDE A VALID REPRESENTATION OF THE CHANGES IN URETHRAL PRESSURE THAT OCCUR DURING MAXIMUM VOLUNTARY CONTRACTIONS AND DURING COUGHING

Hypothesis / aims of study

Vaginal pressure is frequently used as a measure of pelvic floor muscle (PFM) function and as a surrogate measure for urethral closure pressure in physiotherapy research and practice [1]. Efforts have been made to determine where in the vagina pressure measurements should be taken [2, 3], however vaginal pressure measurements have not been correlated with urethral pressure measurements to determine if they are an appropriate surrogate. We hypothesized that pressure increases recorded in the vagina reflect the functional outcome of PFM contraction as it pertains to increases in urethral closure pressure and that, due to its closer proximity to the urethra, pressure recorded adjacent to the anterior vaginal wall is more highly correlated with urethral pressure than is pressure recorded adjacent to the posterior vaginal wall.

Study design, materials and methods

This was an observational study that received institutional ethics approval. Women without neurological or rheumatological diagnoses, diabetes, prolapse ≥ POP-Q stage II or previous pelvic surgery were recruited. All participants provided informed, written consent. Demographic data were recorded and volunteers completed the Urogenital Distress Inventory (UDI). The women were taught how to correctly perform a PFM contraction, confirmed by vaginal palpation and observation. Urethral pressure was measured with a saline-filled, 8 French triple lumen catheter interfaced with a Becton Dickinson DTX™ Plus DT-12 pressure transducer. The catheter opening was positioned in the urethra at the point where the transducer recorded the highest pressure values during both a PFM contraction and a cough. Vaginal pressure data were recorded adjacent to the anterior and posterior vaginal walls using two air-filled, 10 French rectal balloons mounted on the anterior and posterior surfaces of a vaginal probe, which were interfaced with Motorola MPX5010 Integrated Silicon pressure transducers. Data were recorded using Delsys EMG Works™ Acquisition software at a sampling rate of 1000 Hz. In supine the volunteers performed three maximum voluntary PFM contractions (PFM MVCs) and in standing they performed three PFM MVCs and three maximum effort coughs. There was a 5 ms transmission delay in the vaginal pressure data. This delay was removed from the vaginal pressure data prior to processing. All data were then dual filtered with a third order, 5Hz low pass Butterworth filter. The filtered mean of the first 100 data points was subtracted from all values. The highest smoothed value for each pressure recording site during each repetition of each task: supine PFM MVC, standing PFM MVC and cough, was determined to be the peak pressure. The peak pressures were compared among the pressure recording sites and tasks using a repeated measures analysis of variance (ANOVA) and post hoc tests were completed using the Bonferroni method (∝=0.05). For each task, the peak pressures were also compared between pressure recording sites by calculating the regression (∝=0.05) of the peak urethral versus peak vaginal pressure curves. Lastly, to study the relationship between rises in urethral and rises in vaginal pressure during each task, the data recorded during the rise in urethral pressure were normalized to the maximum smoothed amplitudes achieved during each task and ensemble averaged urethral pressure versus vaginal pressure curves were created.

Results

Eleven women participated. The median age was 42 (range 29 to 68) years. The participants had a median body mass index of 26.7 (range 18.9 to 29.7) kg/m^2, a median UDI score of 3/19 (range 0 to 8), and had had a median of 2 (range 0 to 4) children and 2 (range 0 to 2) vaginal deliveries. The peak urethral pressure was higher during coughing than during either the supine or the standing PFM MVCs ($p<0.001$ for both), there was no difference between the peak urethral pressure generated during the supine and standing PFM MVCs ($p=1.00$). There was no difference in peak intravaginal pressure among the three tasks for either the anterior or the posterior pressure recording site ($p=1.00$ for both). Women who generated higher urethral pressures also generated higher intravaginal pressures ($p<0.001$ for all tasks). The relationship between the generation of urethral pressure and the generation of intravaginal pressure is presented in Figure 1. The intravaginal pressure was much higher at the onset of urethral pressure during the MVCs as compared to during the cough, where anterior and posterior vaginal pressure had an intercept close to zero. Urethral pressure was highly correlated with the anterior (slope= 0.768 ±0.030) and posterior (slope= 0.772 ±0.092) vaginal pressure recorded during coughing. The relationship between urethral and vaginal pressure was still linear during the standing PFM MVCs, but the slope was much lower (anterior slope=0.252 ± 0.049, posterior slope=0.321 ±0.043) and more variable. The relationship between urethral pressure and vaginal pressure was curvilinear during the supine PFM MVCs.

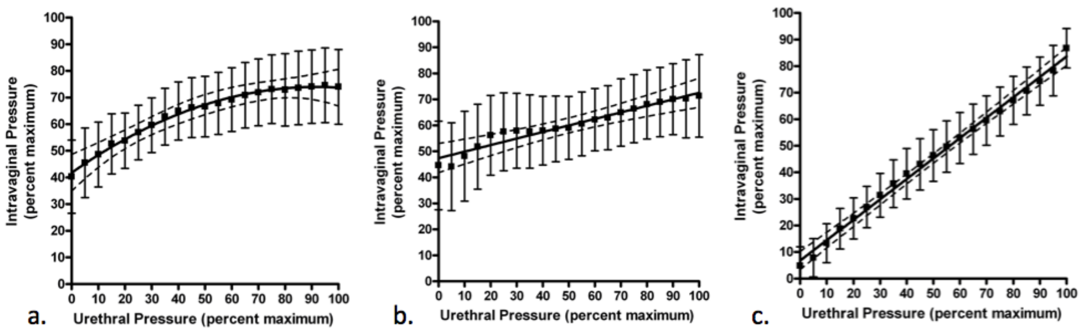

Figure 1. Ensemble average curves for urethral pressure versus anterior vaginal pressure: a. supine MVC, b. standing MVC, c. cough. The filled squares indicate the mean and the whiskers indicate the 95% confidence interval of the mean. The solid lines indicate the best fit regression, and the dashed lines indicate the 95% confidence interval for the regression line.

Interpretation of results

As expected higher urethral pressure was generated during coughing than during the PFM MVCs. It appears that women do not generate true maximum PFM activation, nor urethral or vaginal closure pressure when performing a PFM MVC. Although we expected a difference, peak pressure recorded using the anterior vaginal transducer was not different from that recorded using the posterior vaginal transducer, and there was no difference in the ensemble averaged urethral pressure versus anterior and posterior vaginal pressure curves for any of the three tasks. The location of the pressure transducers within the vagina (anteriorly or posteriorly) appears to be of no consequence on experimental results when peak pressures are recorded. The urethral pressure versus vaginal pressure ensemble average curves all have y-intercepts that are greater than zero because vaginal pressure generation began before urethral pressure generation. This delay may be related to the electromechanical delay between muscle activation and force output and/or due to time required to take up slack in the pelvic tissues before pressure can be transmitted to the urethra. The curves do not reach 100% on the y-axis because of dispersion: the individual volunteers' curves reached 100% at different points on the percentage of maximum urethral pressure axis.

Concluding message

While it must be recognized that urethral pressure includes components generated by the urethral sphincters and passive tissue stiffness that do not contribute to intravaginal pressure, this study has demonstrated that intravaginal pressure recorded adjacent to both the anterior and posterior vaginal walls is representative of urethral pressure and can be used as a surrogate for urethral pressure measures in biomechanical studies of the continence system and as a functional outcome measure in physiotherapy.

References

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Was informed consent obtained from the patients?	**Yes**