

BIOMECHANICAL RELATIONSHIPS BETWEEN URODYNAMIC PRESSURES DURING COUGH AND VALSALVA IN NORMAL AND STRESS INCONTINENT WOMEN

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INTRODUCTION & OBJECTIVES

Stress urinary incontinence (SUI) is a common health problem among American women (Norton 2006). Symptoms include the complaint of involuntary leakage of urine on effort or exertion, or on sneezing or coughing. When these symptoms are confirmed with the urodynamic finding of urodynamic stress incontinence (transurethral leakage in the absence of a bladder contraction), the condition of SUI is diagnosed (Abrams 2002). Improved understanding of the relationship between abdominal, vesical and urethral pressures may help us better evaluate and treat SUI. Therefore the primary objective of this study was to quantify the biomechanical relationships between these pressures. In addition, we sought to determine how demographics such as age and SUI continence status affect these relationships.

METHODS

Using an IRB-approved, NIH funded protocol, standardized urodynamic data, including vesical, abdominal, and urethral pressures, were acquired from 2 groups of women: (1) *continent women* had no incontinence symptoms or urodynamic findings; (2) *stress incontinent women* had SUI symptoms and confirmatory urodynamic stress incontinence. Urodynamic pressure

data including abdominal, vesical and urethral pressure were obtained during cough and valsalva manoeuvres at 0.2 second intervals at maximum cystometric capacity. Phase plots were generated for each event by plotting abdominal pressure (pabd) versus vesical pressure (pves), vesical pressure versus urethral pressure (pura) and pabd versus pura. A least squares method of linear regression was used to fit a trend line to the phase plots. The coefficients of correlation and determination were calculated for each phase plot in order to establish if the compared variables were mathematically associated and to what extent the variables were dependent. The repeat measures mixed models method was then used to determine the statistical significance of age, continence status, type of event (cough/valsalva) and the volume of urine contained in the bladder at the time of event on the pabd/pura ratio (APUP) and the pves/pura ratio (VPUP) during a cough or valsalva. $P < 0.05$ indicated a significant difference. A VPUP greater than 1 indicates that pves exceeded pura at least once during the event. Predictive models were developed for each of the two ratios, relating both the APUP and VPUP ratio to the variables listed above.

RESULTS

The urodynamic data of 11 continent and 8 stress incontinent women were analyzed. The

results obtained from the linear regression analysis of the pressure phase plots is summarized in Table 1.

	Slope	R	R ²
Pabd vs. Pves	0.93 (0.13)	0.99 (0.06)	0.98 (0.09)
Pves vs. Pura	1.22 (0.32)	0.93 (0.07)	0.87 (0.12)
Pabd vs. Pura	1.13 (0.35)	0.92 (0.09)	0.85 (0.15)

Table 1: Summary of linear regression results: Data is listed in the form of mean (standard deviation). (R = Coefficient of Correlation; R²=Coefficient of Determination; Pabd = abdominal pressure; Pves = vesical pressure; Pura = urethral pressure)

The linear regression results show a strong mathematical association and dependence between abdominal, vesical and urethral pressure as evidenced by R and R² values not significantly different from unity.

The following predictive equations were generated for APUP and VPUP.

Equation 1:

$$APUP = 0.75 - 0.08E - 0.28C - 0.00035V + 0.017A - 0.0068t$$

Equation 2:

$$VPUP = 0.95 + 0.001E - 0.346C - 0.00024V + 0.11A - 0.0082t$$

E = type of event (Cough =1; Valsalva = 0); C = continence status (Continent = 1; Stress Incontinent = 0); V = volume of urine contained in bladder during event; A = age; t = time in tenths of a second from start of event

Statistical results indicated that SUI subjects were significantly older (47±2.6 years) than continent subjects (39± 2.6 years; P<0.05).

The APUP ratio was found to be significantly dependent on age and continence status (P<0.05) while the VPUP ratio was only significantly dependent on continence status (P<0.05) but did contain a trend toward significance with age (P=0.09).

DISCUSSION

Abdominal, vesical and urethral pressures are all strongly and mathematically related to one another. The fact that the slope of the trend lines for all pressure relationships was not significantly different from 1 indicates that abdominal pressure is completely transmitted to both the bladder and the urethra.

APUP and VPUP ratios are biomechanical variables that are predictive of continence status. The decrease in the APUP ratio with increasing age suggests that the urethral pressure that women generate in response to increased abdominal pressure decreases with age in both continent and incontinent women. This finding is consistent with the findings of other studies that have reported the link between the reduction of striated muscle fibres in the external urethral sphincter and age (Perucchini 2002 & DeLancey 2007).

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