

VARIATION OF INVASIVE AND NON-INVASIVE MEASUREMENTS OF ISOVOLUMETRIC BLADDER PRESSURE ACCORDING TO BLADDER VOLUME

Hypothesis / aims of study

Isovolumetric bladder pressure is an accepted measure of bladder contractility and can now be estimated non-invasively by measurement of the inflation pressure required within a pneumatic penile cuff to interrupt voiding (1). Previous studies have suggested that both invasively (2) and non-invasively (3) measured isovolumetric bladder pressure varies with bladder volume, the highest readings being found close to maximum bladder capacity.

The use of an automated penile cuff test allows repeated measurements of cuff interruption pressure ($p_{\text{cuff.int}}$) during the course of a single void but the varied values obtained give uncertainty of interpretation. The aim of the present prospective study was to investigate the relationship of simultaneous invasive ($p_{\text{det.isv}}$) and non-invasive ($p_{\text{cuff.int}}$) measurement of isovolumetric pressure to bladder volume in men with lower urinary tract symptoms (LUTS).

Study design, materials and methods

Ethical approval and written informed consent were obtained. Men with LUTS attending for conventional pressure-flow studies (PFS) were recruited. Each subject initially underwent PFS according to ICS guidelines for clinical diagnostic purposes. This was then followed by a combined PFS and penile cuff test to give simultaneous invasive and non-invasive pressure measurement. Following a third bladder fill all lines were removed and the penile cuff test was repeated without invasive recording. The voided volume (V_{void}) was recorded at each interruption and normalised as percentage of total voided volume for each subject. Estimation of residual bladder volume was performed at the end of the study using ultrasonography.

At each interruption the volume remaining in the bladder was calculated from individual measurements of V_{void} and expressed as a percentage of total voided volume. Values for $p_{\text{det.isv}}$ and $p_{\text{cuff.int}}$ were measured from the traces obtained during simultaneous recording at each interruption and grouped according to 20% increments of total voided volume. Values for $p_{\text{cuff.int}}$ obtained without invasive recording were analysed separately. Mean [s.d.] values of $p_{\text{det.isv}}$ and $p_{\text{cuff.int}}$ were then calculated for each % increment of V_{void} and tested for statistical significance using analysis of variance (ANOVA).

Results

A total of 30 (83%) patients provided full data acceptable for analysis. The mean (range) number of interruptions was 3.1 (1-6) and the mean [s.d.] total voided volume was 290 [131] mls. The results for mean $p_{\text{det.isv}}$ and $p_{\text{cuff.int}}$ for each volume increment showed a gradual rise to 50% voided volume and then fell as bladder emptying continued (Table 1, Figure 1).

Table 1

% Volume voided	0-20	20-40	40-60	60-80	80-100	ANOVA (p value)
Mean [s.d.] $p_{\text{det.isv}}$ (cmH ₂ O)	62 [29] n=13	67 [24] n=17	73 [25] n=13	64 [25] n=19	48 [15] n=32	0.008
Mean [s.d.] $p_{\text{cuff.int}}$ (with lines) (cmH ₂ O)	102 [38] n=13	111 [24] n=17	120 [28] n=13	115 [41] n=19	86 [26] n=32	0.003
Mean [s.d.] $p_{\text{cuff.int}}$ (without lines) (cmH ₂ O)	80 [30] n=14	108 [25] n=16	116 [31] n=12	109 [37] n=21	88 [28] n=30	0.001

Values of $p_{\text{cuff.int}}$ for each volume increment were similar for cuff tests performed with and without the presence of invasive monitoring (Table 1). At the end of the study no significant residual volume was detected in all but 5 subjects.

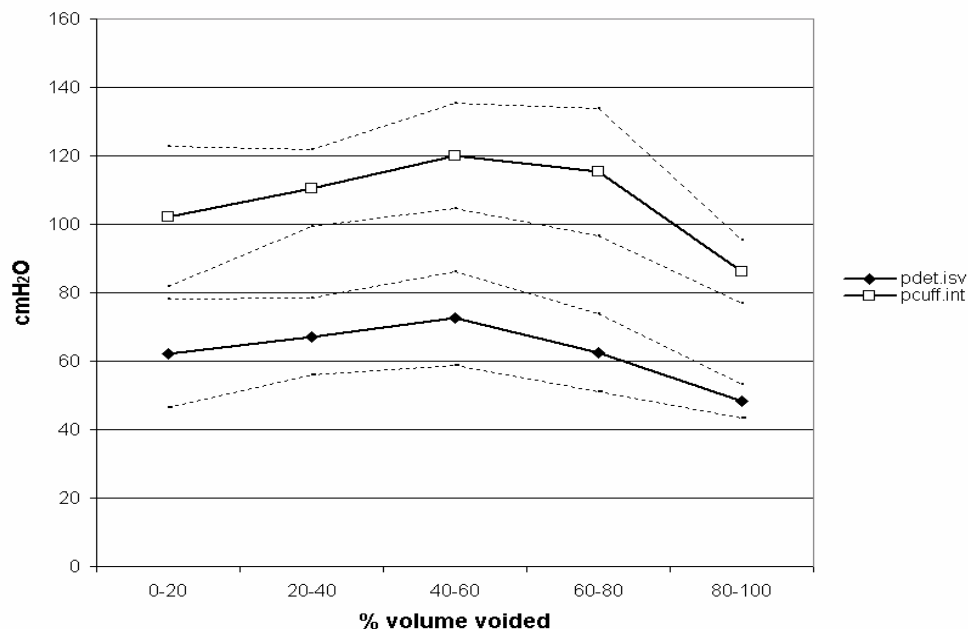
Interpretation of results

These results suggest that the magnitude of isovolumetric bladder pressure measured both invasively ($p_{\text{det.isv}}$) and non-invasively ($p_{\text{cuff.int}}$) is dependent upon bladder volume in men with LUTS. Highest readings representing maximum contractility occur at approximately 50% of bladder capacity with a slight decrease at higher volumes and a more significant decrease as the bladder empties. The concordance between $p_{\text{cuff.int}}$ and $p_{\text{det.isv}}$ throughout the void gives further evidence for the validity of non-invasive measurement of bladder pressure. Interestingly mean values of $p_{\text{cuff.int}}$ at each volume increment were similar throughout the void irrespective of the presence of invasive monitoring lines within the urethra. Our data imply that bladder contractility may be underestimated with low V_{void} and support the requirement for a minimum acceptable voided volume for a valid penile cuff test.

Concluding message

These data from a prospective study of simultaneous invasive and non-invasive measurement of isovolumetric bladder pressure in symptomatic men confirms the variation with bladder volume seen in previous studies using isolated measurements in uncomplicated volunteers and gives further validation of the penile cuff test as a non-invasive urodynamic investigation.

Figure 1 Variation in $p_{\text{det.isv}}$ and $p_{\text{cuff.int}}$ according to bladder volume when measured simultaneously (dotted lines represent 95% confidence intervals)



References

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