182

Pel J J[1], van der Boon D C[2], van der Vegt A M[2], Pool-Goudzwaard A L[2]
1. dept. of Urology, dept. of Biomedical Physics and Technology, Erasmus MC, 2. dept. of Biomedical Physics and Technology, Erasmus MC

RELATION BETWEEN DETRUSOR WALL THICKNESS AND BLADDER VOLUME MEASURED AT NATURAL BLADDER FILLING RATES IN HEALTHY MALES USING ULTRASOUND.

Hypothesis / aims of study

It has been proposed that increased bladder or detrusor wall thickness may indicate bladder outlet obstruction (BOO) [1, 2, 3]. The thickness of this muscle layer can be non-invasively measured using ultrasound. The detrusor wall thickness was found to be independent of bladder volume between 50% and 100% of its capacity [2, 3], suggesting that this parameter is correctly measured at a full bladder. Most data, however, was based on (unnaturally) high bladder filling rates applied during invasive (video)cystometry (~ 35-50 ml/s). Others found, at low bladder filling rate, that detrusor wall thickness was depended on bladder volume [4], which suggests the opposite i.e. that it should be corrected for bladder volume. The aim of the present study was to measure the detrusor wall thickness at natural bladder filling rates in a group of healthy male volunteers.

Study design, materials and methods

The study was done in 8 healthy volunteers, aged 29 ± 13 years (mean ± SD). All were asked to appear with a full bladder. First, each volunteer voided in a flowmeter to measure maximum flow rate (Q_{max}) and maximum bladder volume (V_{max}). The presence of residual urine was checked using ultrasound (US). Next, the volunteers were asked to drink ¾ l of water. After 15 minutes, two US images on two different devices were made to estimate detrusor wall thickness (DWT) and bladder volume (BV). At low magnification, the anterior bladder wall was identified using a Toshiba SSA-340A (7,5 MHz linear array). At high magnification, the distance between the serosal and the mucosal layer, which appeared hyperechogenic, was measured at three locations; the average value was used as an estimate of DWT. The BV was estimated on the basis of a two-dimensional image made with an Aloka-SSD 900 (3.5 MHz linear array). BV was calculated as the product of p/6 x height x width x width. All images were made with the volunteer in supine position and both transducers suprapubically positioned in the sagital plane. The US measurements were repeated every 15 minutes until the volunteer felt again a sensation of a full bladder. Finally, measurement of Q_{max}, V_{max} and residual urine was repeated as described. We aimed at measuring DWT and BV at least 5 times in each volunteer. The bladder volumes of each volunteer were normalised by dividing them by the maximum bladder volume. The normalised values were plotted against the DWT. To each data set, a straight line was fitted and the accuracy of each fit was characterised by an R^2 value (R^2 is 1 if all points are matched). The (natural) bladder filling rate (BFR) in each volunteer was calculated as the quotient of the maximum bladder volume and the time between both free voidings.

Results

Residual urine was measured (~75 ml) in 2 volunteers; the associated maximum BV was corrected for this. Figure 1 shows DWT as a function of normalised bladder volume. Each dotted line represents one volunteer. On average, DTW reduced from 1.4 ± 0.2 mm (mean ± SD) to 0.5 ± 0.2 mm. The average slope of all fitted lines was – 0.013 ± 0.006. This slope was significantly different from zero (Wilcoxon Signed rank test; $p<0.05$). The accuracy of all fits, expressed by an R^2 value was on average 0.94 ± 0.04. Table 1 presents a summary of both free voiding parameters (measured at start and end of the investigation), the DWT at V_{max} and the BFR. No significant differences were found between Q_{max} and V_{max} values (paired t-test). The average bladder-filling rate (BFR) was 7 ± 5 ml/s.

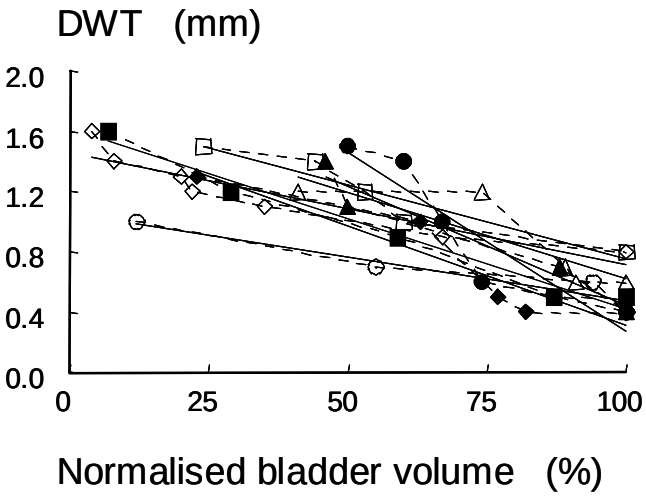

Figure 1 The detrusor wall thickness (DWT) was plotted against the normalised bladder volume measured in 8 healthy male volunteers. The negative slope of each fitted line revealed a decrease in DWT with increasing BV.

Interpretation of results

In contrast to earlier findings in a small group of 5 male volunteers [3], we found that the detrusor wall thickness continuously decreased with increasing bladder volume. Decrease of DWT is in line with the assumption that bladder weight remains constant during bladder filling. It was shown that tension is not equally distributed between the lamina propria and the detrusor when the bladder wall is stretched [4]. It might be that at high filling rates, as previously applied during (video)cystometry, most tension is transferred to the lamina propria, resulting in a less pronounced thinning of the detrusor layer, especially at large bladder volumes. In the present study, BFR was about 8 times lower than that normally applied during invasive (video)cystometry. Presumably, at this low filling rate, tension may be more equally distributed between (both) layers, resulting in pronounced decrease of DWT.

Table I Summary of free voiding parameters, the detrusor wall thickness measured at maximum bladder volume and the (natural) bladder filling rate of each volunteer.

	Start		End			
#	Q_{max} (ml/s)	V_{max} (ml)	Q_{max} (ml/s)	V_{max} (ml)	DWT (mm)	BFR (ml/min)
1	22	490	23	405	0.4	3.2
2	20	252	15	720	0.4	9.0
3	18	333	19	333	0.4	3.7
4	31	418	36	297	0.7	2.8
5	28	724	27	374	0.8	2.9
6	23	549	25	578	0.4	8.9
7	22	1100	30	591	0.8	7.9
8	14	1138	16	1176	0.5	16.8

Concluding message

Measurement of the detrusor wall thickness may be a promising, non-invasive screening test to detect BOO. Our finding suggests that detrusor wall thickness should be adjusted for bladder volume, if this thickness is ultrasonically assessed under physiological conditions. Further investigations need to be done to test if a similar detrusor wall thickness dependence on bladder volume exists in patients with LUTS.

References

[1] J Urol 159: 761-765, 1998.
[2] Neurourol Urodyn 19: 583-593, 2000.
[3] World J Urol 19: 443-452, 2002.
[4] Scand J Urol Nephrol Suppl 201: 38-45, 1999.