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DISTRIBUTION OF POST-VOID RESIDUAL URINE VOLUME IN MALE VOLUNTEERS AND THE EFFECTS OF MAXIMUM FLOW RATE, BLADDER PRESSURE AND INTERRUPTION OF VOIDING

Hypothesis / aims of study

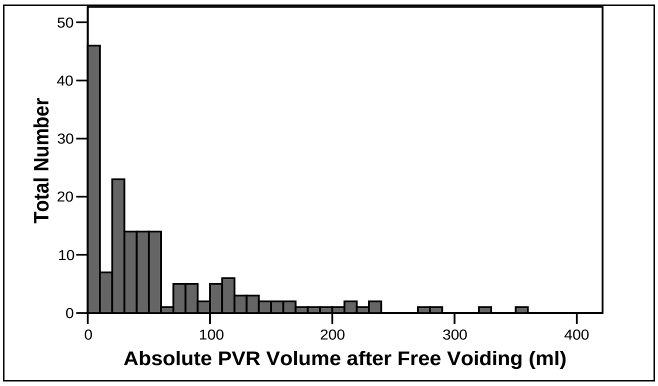
Post-void residual (PVR) urine volume is a well known urodynamic parameter. Its reliability and usefulness have been questioned in view of the high degree of variability found. In a longitudinal study, male volunteers underwent a non-invasive urodynamic examination to determine bladder pressure using the condom catheter method and study its relation to prostate enlargement. We investigated the distribution of PVR urine volume in this population of male volunteers, the possible correlation with urodynamic parameters, e.g. maximum flow rate and bladder pressure, and the influence of the non-invasive bladder pressure measurements on the PVR volume.

Study design, materials and methods

Between July 2004 and February 2005, 167 healthy male volunteers (40-79 years), all taking part in a non-invasive longitudinal study, underwent urodynamic examination consisting of 3 voidings: 1 in a flowmeter and 2 bladder pressure measurements using the condom catheter method [1]. Exclusion criteria were flow rate of less than 5 ml/s, history of any heart condition and treatment or surgery of the lower urinary tract (LUT). The volunteers had an IPSS score of 6 ± 5. LUTS were not an exclusion criterium. During the non-invasive measurements, urinary flow was interrupted repeatedly to measure the pressure in the condom, representing the isovolumetric bladder pressure. Transabdominal ultrasound was used to determine prostate size and PVR urine volume after each voiding. Volume was calculated using both axes in the transverse scan and assuming the prostate and bladder are ellipsoids. From the absolute PVR volume and the voided volume, relative PVR volume was calculated as: $V_{PVR\ rel} = V_{PVR\ abs} / (V_{PVR\ abs} + V_{voided})* 100\%$. A significant absolute PVR urine volume was defined as 50 ml or more, while a significant relative PVR urine volume was defined as 20% of total bladder volume or more [2]. Differences in PVR volumes after normal voiding and the condom catheter measurement were tested using the Wilcoxon Signed Ranks Test. Correlation between PVR volumes and maximum flow rate, age, prostate volume and maximum bladder pressure were tested using Spearman's rho. As the PVR volumes are not normally distributed, the interquartile range (IQR) was used rather than the standard deviation to specify its variability.To test for a dependence of PVR on the number of interruptions of the voiding, measurements were stratified in those with more than 3 interruptions and those with 3 or less.

Results

After free voiding with a voided volume of 361±183 ml (mean±SD), absolute PVR volume was 58 ml (IQR 0-85 ml). Mean relative PVR volume in this population was 13% (IQR 0-21). A significant absolute PVR volume of 50 ml or more was found in 38% of this population (see figure). In the 62% of volunteers in which absolute PVR volume was less than 50ml, 42% had no detectable PVR at all.



A significant relative PVR volume of 20% of bladder volume or more was found in 28% of the population. Absolute PVR in the whole population was not age related (Table 1). Also, in the volunteers with an absolute significant PVR volume there was no relation with age (p=0.159). Absolute PVR volume was also not related to bladder pressure or prostate size, but had a weak correlation with maximum flow rate.
After the first and second bladder pressure measurement with the condom catheter method the PVR volume was significantly higher: 105 (IQR 40-143, P<0.01) and 117 (IQR 51-163, P<0.01), respectively.

Table 1 Correlation to absolute PVR volume (n=167)		
	Correlation coeficient	Significance
Age	0.13	0.086
Bladder pressure	-0.14	0.076
Prostate size	0.03	0.675
Maximum flow rate	-0.22	0.005

Table 2 shows that when the number of interruptions during the first bladder pressure measurement was more than 3, PVR volume was higher then when it was 3 or less (P=0.049). However relative PVR volumes were not different (P=0.673), which can be explained by the difference in voided volume. An increased number of interruptions required a significantly larger voided volume (p<0.01) so that there was an inherent association between these two variables. A similar result was found after the second bladder pressure measurement with an even more significant difference in PVR volumes after more than 3 interruptions, compared to 3 or less (P=0.013).

Table 2 Influence of voiding interruption on PVR volume and voided volume				
	Pressure measurement 1		Pressure measurement 2	
	# interruptions <=3	# interruptions >3	# interruptions <=3	# interruptions >3
N	92	75	88	79
$V_{PVR\ abs}$ (ml)	95 (IQR 32-128)	117 (IQR 48-179)	103 (IQR 43-141)	131 (IQR 62-179)
$V_{PVR\ rel}$ (%)	21 (IQR 9-31)	19 (IQR 8-28)	22 (IQR 10-32)	21 (IQR 11-30)
V_{Voided} (ml)	328±139	491±141	350±138	490±162

<u>Interpretation of results</u>
Although other studies have shown a relation between PVR volume and other urodynamic parameters e.g. prostate size, such a relation was not found in this study. Only maximum flow rate showed a weak negative correlation with PVR. The study shows (among others) that after a non-invasive measurement using the condom-catheter method there is more residual urine than after a free flow rate measurement (in the same subject). That is a factor to take into account when interpreting some results obtained with this method. However it does not affect the value of the method when used to assess urinary bladder contractility or bladder outlet resistance as that assessment is based on pressure readings early in the voiding. The increased residual is most likely caused by fatigue, or incomplete activation of the detrusor muscle, towards the end of voiding, and may be related to the repeated interruption and/or the prolongation of voiding, which are both inherent to the method. For this reason it may be expected that alternative methods for non-invasive urodynamics which are also based on interruption of voiding, such as the cuff method [3] also cause an increased residual urine volume. Also invasive urodynamic procedures as the pressure flow study probably show this effect [unpublished data].

Concluding message

In this population of healthy men between 42 and 79 years PVR volume was equally distributed over all age groups. A significant absolute PVR volume of more than 50 ml was found in 38% of the participants, and it was negatively correlated with the maximum flow rate but not with other urodynamic parameters. The condom catheter method increased PVR volume.

References

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FUNDING: Dutch Kidney Foundation