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BLADDER VOLUME SENSITIVITY OF NON-INVASIVELY OR INVASIVELY MEASURED ISOVOLUMETRIC INTRAVESICAL PRESSURE

Hypothesis / aims of study

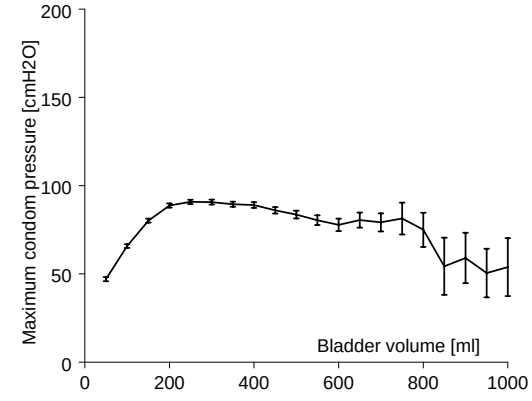
Repeatedly it has been asked if the bladder volume influences the accuracy of non-invasive bladder pressure measurements. Basically these methods proceed by (repeated) interruption of voiding. Earlier we reported the bladder volume dependency of the isovolumetric pressure in 9 volunteers each voiding approximately 20 times using the condom catheter method [1]. We concluded that the bladder volume must be considered to obtain a reliable estimate of the isovolumetric bladder pressure. Presently we conduct a longitudinal study on more than 1000 subjects using this non-invasive method [2], which enables us to analyse the volume sensitivity of this and other non-invasive or invasive methods of measuring isovolumetric intravesical pressure, and recommend cut off values for the bladder volume.

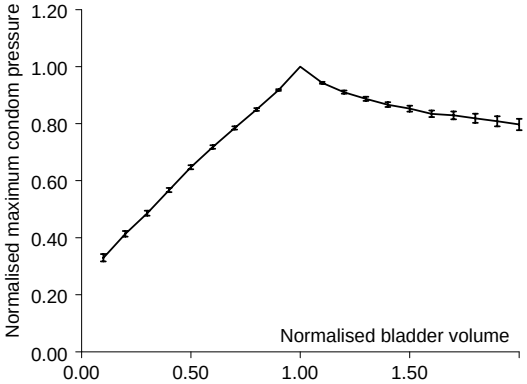
Study design, materials and methods

11914 males of age 38-77 were invited to participate in the study, mainly by 25 general practitioners. A complete flowchart of the recruitment is available, a preliminary version was published earlier [2]. Although certain conditions were excluded, LUTS was not an exclusion criterion [2]. In 1021 subjects at least one succesful condom catheter measurement was done. From 986 of these also a correct 3 day voiding diary was available. A bug corrupted the volume dependence of 9 measurements, leaving 977 measurements in 977 subjects to be analysed. On average voiding was interrupted 5 times.

Results

The maximum condom pressure was linearly interpolated to derive values at evenly spaced bladder volume values, and mean ± standard error were plotted in the top panel. The high standard errors at high bladder volumes reflect that most subjects did not void such large volumes. In the lower panel maximum condom pressure was normalised by dividing the values measured in each subject by the maximum value in that subject. The bladder volume was normalised by dividing the volume readings in each subject by the volume reading at his maximum pressure. In 381 / 977 = 39% of the subjects the highest pressure was measured at the first interruption of voiding. I.e. there was no true maximum as shown in the lower panel, the maximum pressure steadily declined from the first interruption onwards. In the other 61% of subjects the maximum pressure was read at a later interruption, so that with decreasing bladder volume the maximum condom pressure first increased and then decreased as shown in the lower panel. The table compares descriptives of the volume at which the maximum pressure was found with the voided volume (of the interrupted voiding) and the median and maximum volume registered in the voiding diaries. It also shows the





Variable [ml]	Mean	Median	Standard error of the mean	Correlation with Volume at max press
Median diary volume	240	220	3	0.20
Volume at max pressure	252	236	4	-
Voided volume	364	346	5	0.81
Maximum diary volume	505	475	6	0.21

Pearson) correlations of those volumes. Due to the large number of subjects, all these correlations were significant.

Interpretation of results

The majority of the 977 pressure-volume relations measured in the subjects show a distinct maximum. All of these were found at different bladder volumes. By averaging the data, as in the top panel, the maxima therefore disappear. The graph does show however, that below a bladder volume of approximately 200 ml the average pressure dramatically declined. The median of the volume at which the maximum condom pressure was found is 236 ml, indicating that for half of the subjects, the pressure started to decline at that volume. By normalising volumes to the volume at maximum pressure, as in the lower panel, the shape of the curves is exaggerated, i.e. even if there is no true maximum, which was the case in 39% of subjects, the decline with lower volumes still contributed to the shape of the maximum in the graph. The decline in the graph is reliable though, roughly linear with the bladder volume, and amounting to approximately 8% for each 10% of volume decrease. A pressure reading at 50% of the volume at the highest reading, is thus reduced to approximately 60%. The volume at maximum pressure was strongly related to the voided volume, which is artefactual, as it cannot exceed that volume. It was significantly, but very weakly, correlated to the median and maximum of the voided volumes registered in a 3 day voiding diary. It thus seems that the volume at maximum pressure represents a different mechanism. It is suggested that the functional (=maximum) and sensory (=median) capacity derived from a voiding diary [3] represent neurological properties of the bladder, whereas the volume at maximum isovolumetric pressure represents mechanical properties.

Concluding message

Isovolumetric pressure readings of the bladder, either non-invasively or invasively measured, should be taken at or above the optimum bladder volume for such measurements. At volumes lower than the optimum volume the pressure decreases by approximately 8 % for each 10% of volume decrease. At bladder volumes smaller than 236 ml pressure readings in 50% of subjects are suboptimal. The bladder volume at maximum isovolumetric pressure probably represents mechanical properties of the bladder, whereas voiding diary parameters more likely represent neurological properties.

References

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