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COMPARISON OF BLADDER CONTRACTILITY VALUES ESTIMATED WITH THE NON-INVASIVE CONDOM CATHETER METHOD AND PRESSURE-FLOW STUDIES

Hypothesis / aims of study

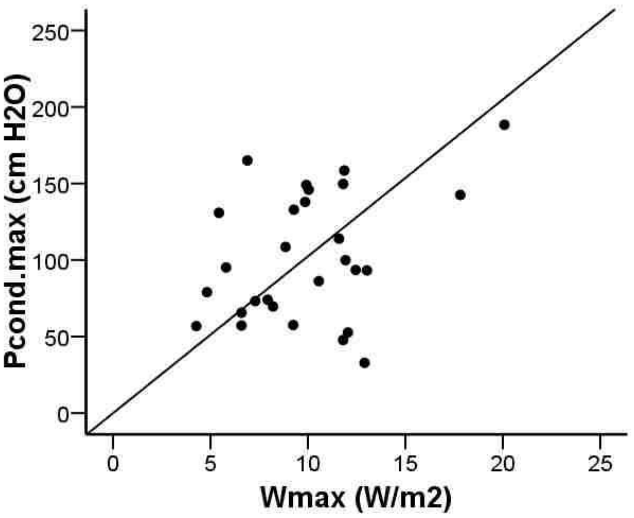
Bladder contractility is an important parameter in the diagnosis of lower urinary tract dysfunction. Currently, pressure-flow studies are used to assess bladder contractility by combining flow rate and detrusor pressure into one parameter, e.g. W_{max} or W_{Qmax}. The determination of W_{max} and W_{Qmax} is based on a theoretical model (1). Using the non-invasive condom catheter method bladder contractility is assessed by measuring the maximum condom pressure, which represents the isovolumetric intravesical pressure.
In a recent study, measurements with the non-invasive penile cuff method were used to assess among other things the theoretical model used to calculate W_{max}. It was found that there are marked similarities between the experimental model and the theoretical model at high flow rates (2). However, at low flow rates, the experimental data showed lower bladder contractility compared to the theoretical models.
Our aim was to compare the bladder contractility estimated with the non-invasive condom catheter method directly to the bladder contractility derived from the invasive pressure-flow studies. In addition, the quality of both methods was assessed by calculating the normalized repeatability (3).

Study design, materials and methods

Twenty-eight male patients underwent both filling/voiding cystometry and non-invasive condom catheter measurements. Inclusion criteria were: age ≥ 18 years, maximum free flow rate ≥ 5 ml/sec, mentally and physically able to visit the outpatient clinic, considered candidate for TURP and signed informed consent. If the patient was unable to urinate in the standing position, had had previous surgery or congenital disease of the lower urinary tract or heart failure, he was excluded. The cystometry was done using water filled catheters (7F), transducers that were referenced to atmosphere and set at the level of the symphisis pubic, and a Dantec® rotating disc flowmeter. The detrusor contractility (both W_{max} and W_{Qmax}, (W/m^2)) was calculated automatically by Andromeda Medical Systems® software. For the non-invasive measurement of bladder contractility, the condom catheter method was used. During voiding through the condom, the urine flow was repeatedly interrupted to measure the maximum pressure in the condom ($P_{cond.max}$, cmH_2O), which represents the maximum isovolumetric intravesical pressure. W_{max}, W_{Qmax} and $P_{cond.max}$ were measured twice in each patient, in two different voidings (n=28 for W_{max} and W_{Qmax}, n=25 for $P_{cond.max}$).
For data analysis, the non-invasively measured $P_{cond.max}$ was plotted against the invasively measured W_{max} and W_{Qmax}. Linear regression was used to test the relation between both parameters. To compare the repeatability of the non-invasive and invasive parameters, the standard deviation of the difference in parameter values of paired measurements was calculated, as well as the mean of both paired measurements. The standard deviation of the difference was then normalized by dividing it by the difference between the 97.5th percentile and the 2.5th percentile of the mean (3). To compare the paired measurements of all three parameters, the paired t-test was used. Data are presented as mean±SD.

Results

The figure shows the relation between the non-invasive contractility parameter $P_{cond.max}$ and the invasive contractility parameter W_{max}. Regression analysis through the origin showed a relation with a slope of 9.56 ± 0.79 cmH_2O / (W/m^2) ($r^2 = 0.85$, $p<0.05$).
Using W_{Qmax} instead of W_{max}, a very similar relation with $P_{cond.max}$ was found, with a slope of 10.05 ± 0.83 cmH_2O / (W/m^2) ($r^2 = 0.84$, $p<0.05$).
Bladder contractility values derived from the first and the subsequent second invasive measurement were significantly different. W_{max} was 10.8±3.5 W/m^2 and 9.4±2.9 W/m^2, respectively ($p<0.05$, paired t-test) and W_{Qmax} was 10.1±3.4 W/m^2 and 8.9±2.9 W/m^2, respectively ($p<0.05$, paired t-test).



Paired non-invasive bladder contractiltity values were not significantly different, 82±40 cmH_2O for the first measurement and 87±46cmH_2O for the subsequent second measurement (p=0.49, paired t-test).
The table shows that the repeatability estimate of the non-invasively measured bladder contractility is almost twice the repeatability estimate of the invasively measured bladder contractility.

Parameter	Unit	N	% 2.5	% 97.5	SD of difference	Repeatability SD / (% 97.5-2.5)
W_{max}	W/m^2	28	4.6	17.7	1.6	0.12
W_{Qmax}	W/m^2	28	4.4	17.0	1.6	0.13
$P_{cond.max}$	cmH_2O	25	29.9	184.3	34.0	0.22

Interpretation of results

The data show that the non-invasively derived bladder contractility in terms of the isovolumetric intravesical pressure (in cmH_2O) is approximately 10 times the invasively derived W_{max} or W_{Qmax} (in W/m^2), which is in accordance with the equation of the contraction strength variable WF (1). Both parameters give a comparable assessment of the bladder contractility.

The repeatability estimate of the non-invasively measured bladder contractility is higher than that of the invasively measured bladder contractility, which means that the random variation of the non-invasive parameter is greater than that of the invasive parameter. The better repeatability in the invasive parameter could explain the significant difference between the means of the 2 subsequent measurements, as a systematic difference could more easily be detected when the repeatability is better.

The repeatability of the non-invasive parameter is not as good as that determined in an earlier study, in which the same non-invasive method was used in a large group of volunteers (3). The difference is probably caused by differences in the population of participants (volunteers vs patients). Earlier, we have shown that the quality of condom measurements depends on the flow rate. For a reliable condom measurement, the maximum free flow rate should be at least 5 ml/s. In the present study, the study population comprised only patients with voiding problems, like low flow rate. Mean flow rate in the present study was 9 ml/s, whereas mean flow rate in the earlier study with volunteers was 16 ml/s.

Also, the number of patients in this study was 28, whereas the number of volunteers was over 350, which most likely gives a more reliable repeatability estimate.

Remarkable is the inverse result of the repeatability of the invasive measurements between both studies. In the present study the repeatability of the invasive parameter was much better than in the earlier study (3).

Inclusion of patients in the present study population continues, to improve our understanding of these phenomena.

Concluding message

Bladder contractility values non-invasively measured with the condom catheter method are comparable to invasively measured bladder contractility values, although in a small population of patients indicated for TURP the repeatability of non-invasively measured contractility was less than the repeatability of invasively measured contractility.

References

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