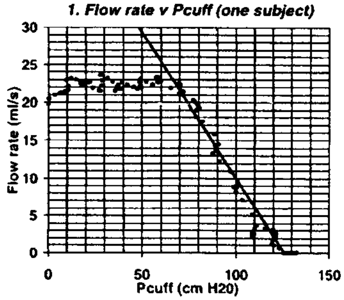
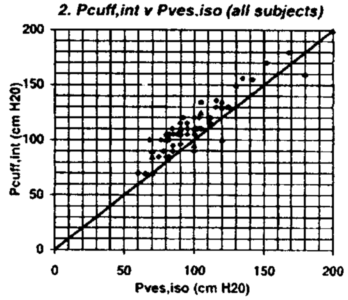




The pressure difference *Pves,isv - Pves,Qmax* is 21 ± 14 cm H_2O for the volunteers and 6 ± 6 cm H_2O for the patients (significant difference: $p < 0.05$). The mean abdominal pressure during voiding is 38 ± 8 cm H_2O.

Conclusions

1. The rise in bladder pressure between maximum flow and interruption is expected from theory. The significantly lower rise in bladder pressure for the patients could indicate that, in the presence of outflow obstruction, the bladder is already operating closer to the isovolumetric limit. This merits further investigation.

2. This study provides good evidence that this new method of controlled interruption of voiding using a penile cuff gives a reliable estimate of isovolumetric bladder contraction pressure. This method non-invasively provides additional objective data which could help the management of male patients with voiding symptoms without recourse to full urodynamics. The method is well tolerated and is quick and easy to apply.

1. Neurourol. Urodyn. 14: 101-114 (1995)
2. J. Urol. 151: 323A (1994)
3. Neurourol. Urodyn. 17: 302-304 (1998)

5

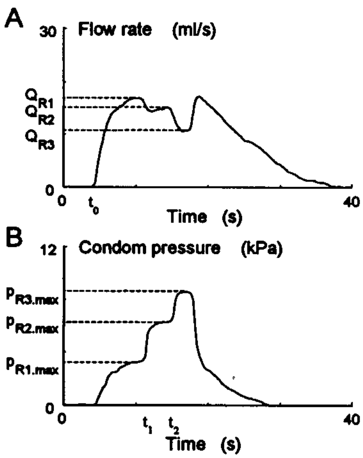
J.J.M. Pel, R. van Mastrigt

Dept. of Urology-Urodynamics, Room Ee1630
Erasmus University, Rotterdam, The Netherlands

A VARIABLE RESISTANCE CATHETER FOR NON-INVASIVE MEASUREMENT OF THE BLADDER PRESSURE

AIMS OF STUDY

In a previous study it was shown, that on the basis of a non-invasively measured isovolumetric bladder pressure and a separately measured maximum flow rate, an accurate non-invasive diagnosis of infravesical obstruction seems possible in male patients [1]. For measuring the isovolumetric pressure, an external condom catheter was used to mechanically interrupt the flow rate. In obstructed patients, the pressure rise in the condom sometimes caused a sphincter contraction, which made the bladder pressure measurement unreliable. As an alternative to this measurement, we developed a variable resistance catheter (patent pending) for non-invasively measuring bladder pressures at different outflow resistances, i.e. without completely interrupting the flow rate. The aim of this study was to investigate if, using this new catheter, the isovolumetric bladder pressure can be estimated.



METHODS

In 7 healthy male volunteers, an incontinence condom (Laprolan®) was attached to the penis. To the outflow opening we connected two parallel tubes with different diameters, to guide the urine into a flow meter (Dantec®). A pneumatic valve was fitted over each tube to interrupt the flow rate through it. A pressure transducer, installed at the level of the variable resistance catheter, recorded the pressure in the condom. At the onset of voiding, the volunteers voided through both tubes, thus through the lowest outflow resistance (R1).

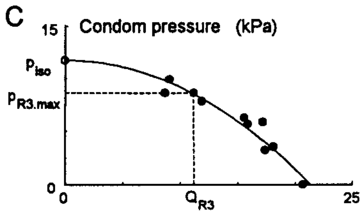


Fig. 1 Example of one measurement of the flow rate and condom pressure measured in a healthy male volunteer using the variable resistance catheter (panel A and B). Summary of all measured pressures values in the same volunteer (panel C).

Then the outflow resistance was increased (R2) by closing the tube with the smallest diameter. Finally, by closing the other tube, the volunteers voided through the tube with the smallest diameter (R3). By using three different sets of tubes, we measured pressure and flow rate at nine different outflow resistances. These pressures were plotted as a function of the associated flow rates. A second order polynomial, based on a mathematical model, was fitted through the data points using non-linear regression (SPSS®) to estimate the isovolumetric bladder pressure, p_{iso}.

RESULTS

None of the 7 volunteers suffered any discomfort and no leakage occurred during the measurements. Figure 1 shows a typical registration of the recorded signals. At time t_0, the volunteer started voiding through both tubes (panel A) until a maximum pressure $p_{R1.max}$ was measured (panel B). At time t_1, the tube with the highest resistance was closed, until a new maximum pressure $p_{R2.max}$ was found. Finally, from time t_2, the volunteer voided through the highest outflow resistance, until $p_{R3.max}$ was measured. In panel C, the second order polynomial was fitted through all data points measured in this volunteer (closed circles) to estimate p_{iso} (open circle). Table 1 shows for all volunteers p_{iso} measured in a previous study, during which the flow was completely interrupted [2], and p_{iso} estimated using the variable resistance catheter. The difference between both pressures was 1.0 ± 1.0 kPa.

***Table 1** Results of isovolumetric pressure measurements with complete interruption of the flow rate and with variable outflow resistances in 7 healthy male volunteers.*

volunteer	Isovolumetric pressure (kPa) interrupted flow	Isovolumetric pressure (kPa) variable resistance
1	12.2	11.2
2	14.2	11.4
3	11.7	11.7
4	13.9	12.4
5	9.0	8.3
6	11.9	11.9
7	11.8	10.8
mean	12.1	11.1
SD	1.7	1.3

CONCLUSIONS

A diagnosis of infravesical obstruction may be based on the isovolumetric bladder pressure combined with a separately measured maximum flow rate [1]. This pressure can be measured non-invasively during a complete interruption of the flow rate. As this condition sometimes causes a sphincter contraction, the isovolumetric pressure may sometimes be unreliable. In the present study, we measured bladder pressures and associated flow rates using a variable resistance catheter. The advantage of this new measurement technique is that the flow rate is not completely interrupted, so that it is certain that the sphincter is open during the pressure measurement. Furthermore, the pressure rise in the condom is lower than during an isovolumetric pressure measurement, which reduces the risk of leakage. In the present data set, a reliable estimation of the isovolumetric pressure was demonstrated using the variable resistance catheter in male volunteers.

[1] Neurourol.Urodyn. 17: 394-395, 1998

[2] Repeated non-invasive bladder pressure measurements with an external catheter. In press.