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IS EVALUATION OF URETHRAL OBSTRUCTION AND DETRUSOR FORCE POSSIBLE FROM COUPLING OF DATA FROM ONE FREE UROFLOW AND ONE PENILE CUFF TEST IN PATIENTS WITH BENIGN PROSTATIC ENLARGEMENT (BPE)? PRELIMINARY STUDY.

Hypothesis / aims of study

A technique for noninvasive measurement of isovolumetric bladder pressure has been developed in Newcastle [1]. Our purpose was to show that, by using the VBN mathematical micturition model [2], data from one free flow and one cuff test are sufficient to evaluate the detrusor pressure at maximum flow rate ($p_{det.Qmax}$) and thereby usual obstruction indices such as the Abrams-Griffiths (AG) number.

Study design, materials and methods

We studied 42 male patients attending with lower urinary tract symptoms. Each underwent one pressure-flow study (PF), one pressure-flow study with cuff test (PFC) and one free cuff test without vesical pressure measurement (FC).

Applying the VBN mathematical micturition model [2] to urodynamic recordings, one can determine two parameters that characterize the obstructive status of a patient:

(i) the prostatic urethra counter-pressure (pucp) is the pressure exerted on the urethra by the enlarged prostate (equivalent to prostatic opening pressure);

(ii) the detrusor force coefficient (k) quantifies the detrusor function and so the effect of the urethral obstruction on the muscle function.

To analyze cuff recordings, we used a slightly improved version of the VBN model which makes a distinction between intra- and extra-abdominal compartments. This is necessary since the flow controlling zone moves from the prostate to the penile urethra as the cuff is inflated.

We applied the VBN model according to the following procedure:

1) Since the cuff test is non-invasive, we used the PF study simply to obtain a free flow trace FF. VBN analysis of this trace does not give absolute values of k or pucp, just a relationship between them. In addition we used the PFC to obtain one free cuff test FC2.

2) Using the standard cuff test analysis, we determined the cuff pressure required to arrest flow for each inflation cycle. These cuff pressures give one or more point estimates of isovolumetric bladder contraction pressure $p_{ves,isv}$. Since bladder contractility varies with time, we also recorded the time or times at which flow interruption occurred (t_{stop}).

3) Using these point estimates of $p_{ves.isv}$, we used the VBN model to determine from the P-F study the best fit for k and pucp.

4) Finally, we used to VBN model with these parameters to predict Q_{max}, the detrusor pressure at maximum flow ($p_{det,Qmax}$), and thereby the AG number ($p_{det,Qmax} – 2\ Q_{max}$).

Results

1) A simple graphical use of the recorded flow and pressure curves of PFC led to evaluate the transmission coefficient T: T = 0.85 +/- 0.15.

2) 30 from the 42 files (70%) were usable. The FC computed flow curves were very alike the recorded ones except during a short time (about 3 seconds) after deflation of the cuff. Then, a spike of flow rate was observed. VBN calculations using unsteady hydrodynamics found spikes shorter than observed.

3) Because of the good fitting of the curves, evaluation of the detrusor pressure was possible for 27 of the 30 files. The main result was that the accuracy of the evaluation was better with the VBN-cuff coupling than with the only cuff. As an example, in a case with Q_{max}=13 mL/s, the measured and evaluated values of $p_{det.Qmax}$ in cm H_2O were:

measured from PFstudy : 110

cuff test FC: 40 to 93; **cuff test** FC2 (2 cuff inflations): 65 to 119 and 53 to 118

VBN method from FC: 91 to 127; **VBN method** from FC2: 80 to 114.

Interpretation of results

The main problem is the accuracy of the evaluations. The causes of inaccuracy seem to be
a) the dispersion of the values of the transmission coefficient T, the presence of the catheter can affect it.
b) a delay of roughly 3 seconds which can be due to an instrumental artifact or a change in the compliance of the distal urethra, widens the spikes duration and replaces the brisk interruption of the flow by a smooth curve; thus, t_{stop} is badly defined.
c) anxiety of the subjects may cause a delayed opening of the urethra and involuntary contractions of perineal muscles and sphincter. Our method seems able to eliminate the effect of the third cause, to reduce the effect of the second, but cannot reduce the effect of T dispersion.
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Concluding message

Coupling of theoretical analysis and recorded data of penile cuff test allows to discuss the accuracy and the reliability of the method. Theoretical analysis of the recorded data improves the quantitative evaluation of the obstruction due to BPE.

References

[1] Noninvasive measurement of bladder pressure by controlled inflation of a penile cuff. J Urol 2002. 167: 1344-47.
[2] Modelized analysis of pressure-flow studies of patients with lower urinary tract symptoms due to benign prostatic enlargement. Neurourol Urodyn 2003. 22: 45-53.