

VOIDINGS WITH HIGH FLOW RATE AND LOW DETRUSOR PRESSURE IN WOMEN. WHAT IS THE CAUSE?

Hypothesis / aims of study

During normal voiding the urethra should open and dilate easily following the detrusor contraction, i.e. an increase in detrusor pressure. In women, an unexpected, but frequently observed, condition is a high flow rate concomitant with a very low detrusor pressure.

That condition has not been investigated and rough hypothesis have been proposed without scientific proof.

If the meatus governs the flow, the active pressure is the vesical pressure and not the detrusor pressure as the meatus is out the abdominal compartment. The real pressure is the sum of the vesical pressure and about 3 cmH₂O due to the altitude component. These considerations do not explain the high flow rates observed. A nomogram allowing evaluation of detrusor force and urethral obstruction from a PFs [1] gave intriguing results such as negative value of U for high flow rate-low detrusor pressure voiding. Our purpose was to search for a contribution of the urethra related to the urethral elasticity to explain that condition.

Study design, materials and methods

In the VBN knowledge mathematical model [2] there was only a difference in the anatomical description of the urethra between genders; urethral elasticity was assumed the same.

A compressive obstruction was described by a prostatic parameter in man (VBN parameter p_{cup}) and by an "equivalent urethral compression" U in woman.

Modelled description of urethral elasticity was then performed in order to explain these negative values.

Respectively urodynamic data of a population of 222 women, without symptom suggestive of obstruction and referred for investigation of various lower urinary tract symptoms were analyzed.

Results

1- A negative value of U was obtained in 27 (12.1%) women who voided with high flow rate-low detrusor pressure ($Q_{\max} = 23 \pm 7$ mL/s; $p_{\det, Q_{\max}} = 7.5 \pm 4.7$ cm H₂O); mean value of U was -11.2 ± 5.3 cm H₂O. Mean age was 66.3 ± 11.4 y [42-88 y]. After urodynamic study, they were categorized as normal (N=4), urodynamic stress incontinence (N=3), intrinsic sphincter deficiency (N=3), detrusor hyperactivity (N=17).

2- The law of urethral elasticity describes the cross-section of the urethra vs. difference between inside and outside pressure (Δp). It is a sigmoid-like function with a bend at Δp equal 12 cm H₂O [2]. Assuming that the law kept the same shape but that bend could vary with age or histological change, the real compression would be zero in unobstructed women, while a urethral resistance to dilatation (URD) = $(\Delta p_{\text{bend}}/12)$ would vary in a large range.

To verify this, a new nomogram (iso-U in the plane [Q_{\max} - $p_{\det, Q_{\max}}$]) was built. Applied to the data of 195 women (mean age 60.4 ± 16.7 y; range [20-90 y]) with positive value of U (19.4 ± 14.2 cm H₂O), it gave the range [17-30 cm H₂O] with the below distribution with age (Table):

Age (y)	< 49	50-59	60-69	70-79	> 80
URD (cm H ₂ O)	2.5	2.2	1.9	1.7	1.4

In this population mean value was 12.3 ± 5.3 mL/s for Q_{\max} and 30.0 ± 12.4 cm H₂O for $p_{\det, Q_{\max}}$.

To explain voidings with high flow rate-low detrusor pressure one had to assume low URD.

3- For the sub-population with high Q_{\max} and low $p_{\det, Q_{\max}}$ the mean URD value was $.36 \pm .67$ when the mean expected value, according with age, was $1.87 \pm .31$ ($p < .0001$).

Interpretation of results

To date, no satisfactory explanation has been proposed for voidings with concomitant high maximum flow rate and low detrusor pressure. The hypothesis that an underactive detrusor would only be the cause is not satisfactory.

Our hypothesis is that changes in urethral elasticity, consequence of ageing and of a change in the histological structure of the urethral wall (urethral epithelium, vasculature and smooth muscle), perhaps the density in elastic fibers, could be the cause of that specific condition.

Mathematical modeling allows to test different laws of urethral elasticity.

In this study, due to the lack of data on the histological structure of the urethral wall, age is the only parameter taken into account for comparisons.

Voidings with high flow rate-low detrusor pressure are associated with a low urethral resistance to dilatation which implies a change in urethral elasticity.

Our findings are consistent with the conclusion of DJ Griffiths [3]: "mechanical properties of the flow governing zone during micturition may be deduced from PFs".

Concluding message

A non-invasive method, mathematical modelling of micturition, allows to improve the description of the elasticity law of the urethra, thus to quantify a urethral resistance to dilation in women and to propose an explanation of some unexpected observations which are voidings with high flow rate-low detrusor pressure. Further studies could be histological consequences on the urethra of ageing and various clinical conditions.

References

1. Valentini F, Nelson P, Zimmern P, Robain G. Towards a new nomogram and an index for female bladder outlet obstruction. 44th Annual Meeting ICS Rio (Brazil) October 20-24th 2014 # 25; NAU 2014; 33(6)
2. Valentini FA, Besson GR, Nelson PP, Zimmern PE. Clinically relevant modelling of urodynamics function: The VBN model. NAU 2014; 33(3): 361-66. doi 10.1002/nau.22409
3. Griffiths DJ. The mechanics of the urethra and of micturition BJU 1973; 45: 497-507

Disclosures

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