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THE URETHRAL RESISTANCE TO DILATION (URD) IN WOMEN.

Hypothesis / aims of study

Bladder outlet obstruction (BOO) is one of the main diagnoses in man. Abrams-Griffiths number (A-G) and OCO number are the most common indices and have been demonstrated linked to BOO. Equivalent indices do not exist for woman and evaluation of BOO in woman remains a great challenge.
In the VBN knowledge mathematical model [1] the urethral compression is described by the parameter pucp in man (compression exerted by the enlarged gland) and an "equivalent urethral compression" U in woman.
The aims of this study were to discuss the physiological meaning of U.

Study design, materials and methods

The VBN model was first built for man and it has been shown that the parameter pucp was strongly correlated with A-G and OCO [2].
First this model was brutally transposed to study female micturition by only changing the anatomical description of urethra; it allowed carrying out a nomogram for urethral obstruction [2]. Applied to analyze pressure-flow (PFs) recordings of large populations of women referred for evaluation of lower urinary tract dysfunction (LUTD), the nomogram led to intriguing results such as negative value of U for high flow rate-low pressure voiding or high value of U for women without proven BOO.
Second, taking into account these results, we search for a physiological explanation.
Studied populations were non-neurological women: 202 women without symptom suggestive of obstruction and referred for evaluation of LUTD, and 126 women with anatomical BOO (site of urethral obstruction confirmed by lateral view voiding cystourethrogram).

Results

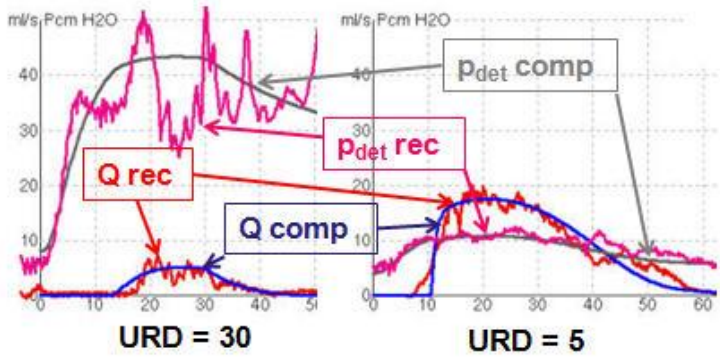
1- The value of U was obtained from each PFs. The mean value of U was significantly lower in the non-obstructed group (15.6±14.0 vs. 28.5±22.0 cm H_2O, $p < .0001$). In this group, two unexpected results were observed: first U was found high and constant until menopause age (29.80 ± 22.10 cm H_2O) and then decreased regularly with ageing (table),

Age (y)	< 30	30-39	40-49	50-59	60-69	70-79	> 80
Number	8	16	26	40	37	46	29
U(cm H_2O)	25.9±20.4	24.9±18.3	23.3±19.8	17.1±13.8	16.0±13.8	12.0±12.5	11.5±10.6

second a negative value of U was obtained in 17 (8.4%) women who voided with high flow rate – low detrusor pressure.
2- An explanation was searched by looking at the curve describing the cross-section of the urethra vs. the difference between the hydrodynamic pressure (inside the urethra) and the outside (□p). In the initial model [1] this elasticity law was a sigmoid-like function with a bend at URD (urethral resistance to dilation) equal 12 cm H_2O for all patients. We assumed that the function kept the same shape but that URD could vary with age or histological change. Thus, in unobstructed women, the real compression was zero while URD was in the range [17-30 cm H_2O] with the below distribution with age (Table):

Age (y)	< 49	50-59	60-69	70-79	> 80
URD (cm H_2O)	30.0	26.3	23.0	20.0	17.0

To explain voidings high flow rate – low detrusor pressure we had to assume low URD.
Two examples of VBN analysis of PFs recordings are given. Left PFs of a 32 y old woman, without symptom suggestive of obstruction but voiding with low flow-rate high detrusor pressure; right PFs of a 66 y old woman, voiding with high flow-rate-low detrusor pressure.



Interpretation of results

As for detrusor contractility, quantifying urethral obstruction remains very difficult. Use of a mathematical model of micturition allows this quantification. Unexpected value is sometimes obtained when one assumes the same law of urethral elasticity for men and women.

With the hypothesis of a non standard urethral resistance to dilation one can explain these findings. Abnormal value of urethral obstruction could be the 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.
In addition, 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".
Further studies could be histological analysis of the urethra with ageing and during some clinical conditions such as bladder outlet obstruction.

Concluding message

For the first time, a non-invasive method, mathematical modelling of micturition, allows to improve the description of the elasticity law of the urethra, thus to quantify the urethral resistance to dilation in women and to propose an explanation of some unexpected observations such as voidings with high flow rate-low detrusor pressure.

References

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Disclosures

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