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DECREASED MAXIMUM FLOW RATE DURING INTUBATED FLOW IN WOMEN: WHICH IS GUILTY? URETHRAL CATHETER OR LOWER URINARY TRACT MECHANICAL PARAMETERS?

Hypothesis / aims of study

The main cause of the decrease of maximum flow rate (Q_{max}) during intubated flow (IF) in women remains controversial. That decrease could be due to the presence and size of the urethral catheter [1] but other parameters could be put forward: initial bladder volume, detrusor contractility and urethral obstruction (constrictive or compressive). We used the VBN mathematical micturition model [2] to analyze the parameters most likely to influence the voiding phase of an intubated flow in women.

Study design, materials and methods

The VBN model was used to investigate the geometric effect of catheter size during voiding and to tease out its role against other influential parameters of voiding in women, such as initial bladder volume, degree of detrusor contractility (VBN parameter k) or of urethral obstruction (VBN parameters □ for constriction and □ for compression). For a standard subject the values of the VBN parameters are k=1, □=1 and □□=0). Simulations were made for a range of catheter sizes frequently utilized during UDS: 3.5, 5, 6, 7 and 8 Fr. Other studied parameters included initial bladder volumes (V_{ini} range 100-600 mL), detrusor contractility (k range 0.3-1), a compressive urethral obstruction (range 0-30 cm H_2O). Comparisons were made between the computed maximum flow (Q_{max}) in these various conditions.

Results

1- The geometric obstruction due to a catheter was almost negligible compared with the volume effect (Fig 1: k=1 with normal urethra).
For V_{ini} = 300 mL □Q_{max} due to the geometric effect of the catheter was in the range [- 0.8 to -3.9] (3.5F -8F).
2- A highest decrease in Q_{max} resulted from a decrease of detrusor contractility (Fig 2) or a urethral compression. Results are given for a mean V_{ini} = 300 mL..
Detrusor contractility (Fig 4 left) : □Q_{max} was in the range [-7.7 to -7.2] for k=0.6 and in the range [-7.5 to -6.2] for k=0.3.
Urethral compression (with normal detrusor) (Fig 4 right): □Q_{max} was in the range [-5.8 to -4.3] for □□=10 cm H_2O and in the range [-11.7 to -9.5] for □□=20 cm H_2O.
3- Concomitant changes (Fig 3) such as a decrease of detrusor contractility associated to a urethral compression increased the apparent obstructive effect and decreased the volume effect (Fig3: k= 0.3, urethral compression = 15 cm H_2O).

Interpretation of results

Hydrodynamic equations giving the flow rate vs. time are coupled with the law of urethral elasticity: without catheter, the cross-section of the urethra S(x), area of the fluid, is a function of the local hydrodynamic pressure p(x). A urethral catheter (cross-section s) in situ does not modify the elasticity law S(p), but the area of the fluid becomes (S-s). An intra-urethral catheter reduces the cross-section of the urethra, this mechanical effect is taken into account by the VBN model as a constrictive effect.
From computations it appears that the decrease of Q_{max} during IF is more dependent of the mechanical parameters of the lower urinary tract than on the geometric effect of the catheter (catheter size). A decreased Q_{max} can be the consequence of decreased detrusor contractility or of urethral compression.
Thus, a remaining question is: how is it possible to distinguish between these two mechanical parameters? The answer could be given by the study of detrusor pressure at maximum flow rate ($p_{det.Qmax}$). Decreased detrusor contractility is associated with decreased $p_{det.Qmax}$ while urethral compression is associated with increased $p_{det.Qmax}$ (cf. Hill-Griffiths' law).

Concluding message

Based on the VBN model, the main reason for a decrease in Q_{max} during an intubated flow is related to a decrease in detrusor contractility or to a urethral compression effect whereas the geometric obstructive effect of the catheter is less contributive.

$Q_{max} = f(V_{ini})$ for the studied catheter sizes

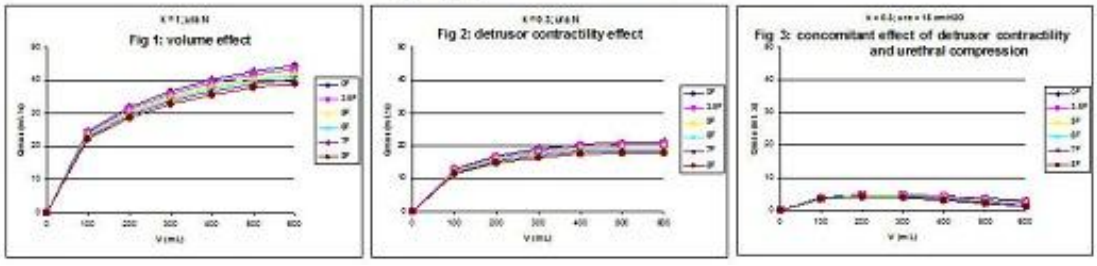
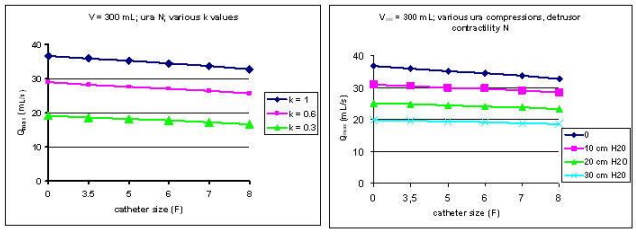


Fig 4: Q_{max} = f(catheter size); left contractility effect; right urethral compression effect



References

1. Urol Int 2005; 75: 21-5
2. NAU 2000; 19: 153-76

Disclosures

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