Hypothesis / aims of study

Potential irritant and/or obstructive effect of a transurethral catheter on the voiding phase has not been widely studied in women. It is frequent to observe a dramatic decrease of the maximum flow rate \(Q_{\text{max}}\) during intubated flow (IF) compared with that during free uroflowmetry (FF) while the initial bladder volume \(V_{\text{ini}}\) and/or the voided volume \(V_{\text{rec}}\) are non significantly different [1].

Our objective was to search for the causes of such unexplained differences between the observed \(Q_{\text{max}}\) using the VBN mathematical model of micturition [2].

Study design, materials and methods

The studied population consisted of 42 women with lower urinary tract symptoms (LUTS) due to frequency or incontinence (all kinds) who underwent an urodynamic testing using the Dorado unit from Laborie. All were free of neurological condition or/and previous pelvic surgery. The urodynamic session included a FF at arrival, an IF after filling cystometry at 50 mL/min filling rate (urethral catheter 7F in seated position) and a urethral pressure profilometry (lying position, bladder empty before cystometry and bladder filled at functional bladder capacity after IF). All women had \(Q_{\text{max}}^{\text{FF}} \geq 1.5Q_{\text{max}}^{\text{IF}}\); among these, 28 had similar \(V_{\text{ini}}\).

Thirty one women, who had same LUTS and for whom similar \(Q_{\text{max}}\) and \(V_{\text{ini}}\) during FF and IF had been recorded, were a control group. VBN analysis [2] was conducted using the usual protocol. Criteria for acceptable conclusions were 1) a good fitting between recorded and computed curves (quadratic error less than 5%) and 2) same value of the mechanical parameters (detrusor contractility \(k\) and urethral parameter in case of compression or constriction) for FF and IF in a given file.

Results

1) Among the 28 files with similar \(V_{\text{ini}}\), analysis could be achieved for 22 files; in the remaining 6 files, a high frequency non rhythmic rectal activity during IF prevented reliable analysis. Mean age was 53 ± 17 y [18-91].

Analyzed flow parameters were \(V_{\text{ave}}\), average Q (\(Q_{\text{ave}}\)), voiding time (\(t_{\text{void}}\)) and time to \(Q_{\text{max}}\) (\(t_{\text{max}}\)).

<table>
<thead>
<tr>
<th>(V_{\text{ave}}) mL</th>
<th>(Q_{\text{ave}}) mL/s</th>
<th>(t_{\text{void}}) s</th>
<th>(t_{\text{max}}) s</th>
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<tbody>
<tr>
<td>FF 321 ± 100</td>
<td>18 ± 7</td>
<td>21.2 ± 8.4</td>
<td>7.9 ± 3.6</td>
</tr>
<tr>
<td>IF 267 ± 36</td>
<td>6 ± 3</td>
<td>60.2 ± 30.1</td>
<td>18.2 ± 10.8</td>
</tr>
<tr>
<td>p n.s.</td>
<td>&lt;.0001</td>
<td>&lt;.0001</td>
<td>&lt;.0001</td>
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</table>

The detrusor contractility \(k\) was 0.57 ± 0.23 [0.20-1.0].

Urethral compression was found in 4 women [3-14 cm H\(_2\)O] and urethral constriction only in 1 (0.8 *standard cross-section area).

2) Among the 28 files with similar \(V_{\text{ini}}\), analysis could be achieved for 12 files. VBN analysis was consistent with an incomplete sphincter relaxation during IF with a remaining sphincter pressure of 20.7 ± 12.2 cm H\(_2\)O (\(k= 0.63 ± 0.27 [0.35-1.0]\)).

Control group: analysis of all files showed a complete sphincter relaxation during FF and IF.

Theoretical analysis: The obstructive mechanical effect of a 7F urethral catheter was theoretically analyzed for \(V_{\text{ini}} = 370\) mL: the computed decrease of \(Q_{\text{max}}\) (standard mechanical parameters for detrusor and urethra) was 4 mL/s, i.e. very lower than the decrease observed.

Interpretation of results

Transurethral catheterization is known to adversely affect the flow curves, inducing polyphasic flow, low Qmax and longer flow time. Possible explanations such as dysfunctional voiding due to anxiety or urethral obstruction can be proposed but none can be verified. Applying VBN mathematical micturition model allows testing the hypotheses of an obstruction induced by the catheter and of a remaining sphincter contraction. Theoretical computation allows excluding the mechanical effect of the catheter. The decrease of \(Q_{\text{max}}\) during IF is clearly related to an incomplete sphincter relaxation. Thus, it is possible to evoke a urethral reflex induced by the catheter in situ.

A consequence of the decreased \(Q_{\text{max}}\) is an increased flow time leading to an inhibition of the voiding process and a large post void residual volume [3].

Concluding message

The decrease in \(Q_{\text{max}}\) observed during IF when compared with that during FF at arrival (same urodynamic session) does not result from the mechanical effect of the catheter. It must be related to an incomplete sphincter relaxation during voiding and could involve, in addition to the anxiety of the patient, a urethral reflex. Other flow parameters (\(Q_{\text{ave}}, t_{\text{void}}\) and \(t_{\text{max}}\)) are also modified. These findings underline the necessity to combine a FF with an IF during an urodynamic session in order to increase the reliability of the conclusions of the urodynamic investigation.