Urodynamic study in women with pure stress urinary incontinence

J.P. Valdevenito\textsuperscript{a,b,*}, F. Águila\textsuperscript{a}, M. Naser\textsuperscript{b}, V. Manriquez\textsuperscript{b}, C. Wenzel\textsuperscript{b}, J.P. Díaz\textsuperscript{a}

\textsuperscript{a} Unidad de Urodinámica, Servicio de Urología, Hospital Clínico Universidad de Chile, Santiago, Chile
\textsuperscript{b} Unidad de Piso Pélvico Femenino, Servicio de Ginecología y Obstetricia, Hospital Clínico Universidad de Chile, Santiago, Chile

Received 20 June 2014; accepted 15 July 2014
Available online 3 February 2015

\textbf{KEYWORDS}
Stress urinary incontinence; Diagnostic test; Urodynamics; Reference values

\textbf{Abstract}
\textit{Objective:} To describe the results of urodynamic study in women with pure stress urinary incontinence symptoms, including the characteristics of the overactive detrusor. No other clinical assessments were taken into account.

\textit{Materials and methods:} A retrospective study in women with urinary incontinence consecutively evaluated by urodynamic study. From a total of 710 women, only 108 (15%) with pure stress urinary incontinence symptoms were selected. Women with prior urinary incontinence surgery, pelvic organ prolapse (stage \(\geq III\)), pelvic radiotherapy, using medication active on the lower urinary tract and neurological diseases were excluded. Infusion rate was 70 ml/min. Detrusor overactivity was induced only by cough. A standardized cough stress test with progressive cough intensity was carried out.

\textit{Results:} Reference urodynamic values for stress incontinent women are described. Urodynamic stress incontinence was observed in 79 women (73.1%), detrusor overactivity in 4 (3.7%) and mixed urodynamic diagnosis in 15 (13.8%). Test was inconclusive in 10 patients (9.2%). Two women had detrusor overactivity incontinence (1.9%). One patient had detrusor overactivity induced by cough without urodynamic stress incontinence (0.9%). There was an association between detrusor overactivity and nocturia \(\geq 2\) (\(p=0.002\); odds ratio: 3.74; 95% confidence interval: 1.22–11.39). One woman had a bladder outlet obstruction (0.9%).

\textit{Conclusions:} In women with pure stress urinary incontinence, without knowing the outcome of other clinical assessments, urodynamic study can provide useful information to define the proper therapy.

© 2014 AEU. Published by Elsevier España, S.L.U. All rights reserved.

\textsuperscript{*} Corresponding author.
\textit{E-mail addresses:} jpvaldevenito@yahoo.com, jpvaldevenito@hcuch.cl (J.P. Valdevenito).

Estudio urodinámico en mujeres con síntomas de incontinencia urinaria de esfuerzo pura

Resumen

Objetivo: Describir los resultados del estudio urodinámico en mujeres con síntomas de incontinencia urinaria de esfuerzo pura, incluyendo las características del detrusor hiperactivo, sin conocer otras evaluaciones clínicas.

Material y métodos: Estudio retrospectivo de mujeres con incontinencia urinaria evaluadas con estudio urodinámico de forma consecutiva. De 710 mujeres evaluadas, se seleccionaron 108 con síntomas de incontinencia urinaria de esfuerzo pura (15%), excluyendo aquellas con cirugía de incontinencia urinaria previa, prolapso de órganos pélvicos en estadio ≥ III, radioterapia pelviana, uso de fármacos uroslectivos y enfermedades neurológicas. La velocidad de infusión fue de 70 ml/min. La tos fue el único método utilizado para provocar la hiperactividad del detrusor. La prueba de esfuerzo se hizo estandarizada, con uso de tos de intensidad progresiva.

Resultados: Se describen valores de referencia de las diferentes etapas del estudio urodinámico. Se demostró incontinencia urinaria de esfuerzo urodinámica en 79 mujeres (73,1%), detrusor hiperactivo en 4 (3,7%) y diagnóstico urodinámico mixto en 15 (13,8%). En 10 pacientes el examen no fue concluyente (9,2%). Dos mujeres presentaron incontinencia urinaria por detrusor hiperactivo (1,9%). Una paciente presentó detrusor hiperactivo inducido por tos sin incontinencia urinaria de esfuerzo urodinámica (0,9%). Hubo asociación entre detrusor hiperactivo y nocturia ≥ 2 (p = 0,002; odds ratio: 3,74; intervalo de confianza del 95%: 1,22–11,39). Una mujer presentó obstrucción de la salida de la vejiga (0,9%).

Conclusiones: En mujeres con incontinencia urinaria de esfuerzo pura, sin conocer el resultado de otras evaluaciones clínicas, el estudio urodinámico puede proporcionar información útil para definir el tratamiento.

© 2014 AEU. Publicado por Elsevier España, S.L.U. Todos los derechos reservados.

Introduction

While some professional organizations advise against the routine use of urodynamic studies in the small group of women with a diagnosis of pure stress urinary incontinence (SUI) based on a medical history and a detailed physical examination, others recommend their use before invasive treatments, when the outcome of the examination may change patient management, as well as in cases of complicated urinary incontinence or after treatment failure.

Most recently, a randomized multicenter study on women with uncomplicated, demonstrable SUI showed non-inferiority in 1-year postoperative results, when only a clinical evaluation was made versus when a urodynamic study was additionally used in pre-surgical assessment.

Whereas the importance of this study has been recognized, it has also been criticized for including patients with mixed urinary incontinence, for the disproportion in the different branches studied, for using multiple surgical techniques and for only showing 12-month results. In view of the foregoing, the discussion on the use of urodynamics before SUI surgery is apparently not finalized.

The International Continence Society (ICS) defines urodynamic SUI (urod-SUI) as a phenomenon occurring during filling cystometry, characterized by the involuntary leakage of urine with increased intra-abdominal pressure in the absence of a detrusor contraction. This definition entails the risk of clinically diagnosing SUI in patients who only experience urine leakage secondary to a detrusor contraction caused by increased abdominal pressure (stress or exercise, sneezing or coughing).

The aim of this analysis was to describe the outcomes of the different stages of urodynamic testing in women with clinical signs of pure SUI, including the presence of overactive detrusor (OAD), with a description of the latter as being caused by increased abdominal pressure, without knowing the result of other clinical assessments.

Materials and methods

This is a retrospective study on women with urinary incontinence consecutively evaluated using urodynamic studies between March 2009 and February 2013, at a referral university center, following the definitions and recommendations of the ICS.

All patients were questioned by a single urodynamic urologist, with the following aspects being recorded: (1) SUI symptoms; (2) voiding urgency and urge urinary incontinence symptoms, (3) the use of some form of protection for urinary incontinence; (4) voiding frequency (in waking and sleeping hours); (5) symptoms of the lower urinary tract, including emptying ones (decreased urinary stream, straining when urinating and intermittent voiding); (6) a medical, obstetric and surgical pelvic history, and (7) drugs used 2 weeks before the examination. We decided to disregard the result of other clinical evaluations on grounds of having incomplete information, since a significant proportion
of patients were only referred for the examination to be performed, without having been treated at our center. 108 urodynamic studies were selected out of a total of 710 examinations conducted on women in the indicated period (15%), corresponding to women with SUI symptoms and the following exclusion criteria: (1) voiding urgency or urge urinary incontinence; (2) previous incontinence surgery, (3) pelvic organ prolapse (POP) ≥ stage III; (4) pelvic radiotherapy; (5) use of uroselective drugs, and (6) neurological diseases.

No approval by the Ethics Committee was required since this was a retrospective study describing our standard care. Before the examination, all patients gave informed consent for the use of their clinical data in research studies, ensuring data confidentiality.

Urodynamic studies were done following the recommendations of the ICS. Firstly, a non-invasive uroflowmetry was performed privately and post-void residual was measured by catheterization (it was repeated in patients with an altered voiding test and a volume of urine < 150 ml). Filling cystometry was subsequently performed via a double-light 6F urethrovaginal catheter for bladder filling and bladder pressure measurement, and an 8F rectal catheter with an inflated balloon for abdominal pressure measurement. External pressure transducers were placed on the upper edge of the pubic symphysis and held a “zero” value when in open air. 0.9% saline solution at room temperature was added, at a flow rate of 70 ml/min. Pressure transmission was assessed during cough maneuvers at the beginning and end of each study, at every minute throughout the study and before and after each major event, in order to immediately correct the device, this being the only method used to cause detrusor overactivity. The stress test was performed in a standardized and staggered manner, using coughing episodes of progressive intensity, and following successive stages in case no urod-SUI was demonstrated: (1) with 300 ml infused in the sitting position; (2) with 300 ml infused in the standing position, and (3) at maximum cystometric capacity in the standing position (with the corresponding change in height of transducers). In patients with a maximum cystometric capacity lower than 300 ml, capacity was generally assessed in the sitting and standing positions. We tried to obtain 3 leak-point pressure values with cough (LPP-c), the lowest one being taken into consideration, and were classified into ≥100 cmH₂O, between 66 and 99 cmH₂O and ≤65 cmH₂O. When there was no change in detrusor pressure during the filling phase, accommodation was considered equal to the maximum cystometric capacity. A value lower than 20 ml/cmH₂O was considered as poor bladder accommodation. Voiding cystometry (pressure-flow study) was conducted privately. Finally, post-void residual was measured by urethrovaginal catheterization. The diagnosis of bladder outlet obstruction (BOO) was made with a peak flow ≤ 12 ml/s associated with detrusor pressure at peak flow ≥ 25 cmH₂O, and the diagnosis of impaired detrusor contractility (IDC), with a peak flow ≤ 12 ml/s associated with detrusor pressure at peak flow ≤ 10 cmH₂O when there was a consistent non-invasive uroflowmetry.

LPP-c values were compared in patients who always or occasionally used some form of protection for urinary incontinence versus those who did not use it, and we looked for any association between the presence of OAD and a daytime voiding frequency (in waking hours) ≥ 8 and nocturia ≥ 2.

Data were included in the Stata® 11.2 software package (Stata Corporation, 2009) and statistically analyzed using Student’s t test for average comparison and the Chi-square test or Fisher’s exact test for proportion comparison. Besides, odds ratios were calculated. Statistical significance was defined as a p value < 0.05.

Results

We analyzed the urodynamic studies on 108 women with symptoms of pure SUI with median age of 52 years. Table 1 shows some aspects of their medical records.

Table 2 shows the results of the non-invasive uroflowmetry conducted on 78 patients whose urine volume was equal to or greater than 150 ml (72% of the total). No patient had a post-void residual volume greater than 100 ml. Table 3 shows the results of the filling cystometry. Infusion was stopped at 600 ml (with the first voiding desire and before it) in 2 patients. Twelve women showed no variation on detrusor pressure during the filling phase (11%). Fourteen patients showed a maximum cystometric capacity lower than 350 ml (10%), and 12 patients, greater than 600 ml (11%). There were no women with poor bladder accommodation. Table 4 shows the results from the voiding cystometry of 97 patients (90% of the total); 11 patients were excluded from the analysis: 4 because of their inability to urinate due to inhibition, and 7 due to rectal or bladder catheter removal. Nine patients had a post-void residual volume greater than 100 ml (9%), which differs from non-invasive voiding. Two women showed signs of BOO, one of whom showed a consistent non-invasive uroflowmetry (0.9%). One patient showed signs of IDC which was non-consistent with the non-invasive uroflowmetry. None of these 3 patients showed symptoms of the lower urinary tract in the emptying phase.

Urod-SUI was reported in 79 patients (73.1%), OAD in 4 (3.7%) and mixed urodynamic diagnosis in 15 (13.8%). In 10 patients, the examination was inconclusive (9.2%). Of the 94 women who showed urod-SUI (87%), 77 showed LPP-c ≥ 100 cmH₂O (82%), 9 patients between 66 and 99 cmH₂O (9.5%) and 8 patients ≤ 65 cmH₂O (8.5%). Nineteen patients

Table 1 Medical history of women with symptoms of pure stress urinary incontinence (n = 108).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age in years, average ± SD</td>
<td>53.4 ± 11.7 (18–82) (range)</td>
</tr>
<tr>
<td>Daytime voiding frequency ≥ 8, n (%)</td>
<td>26 (24)</td>
</tr>
<tr>
<td>Nocturia ≥ 2, n (%)</td>
<td>19 (17.5)</td>
</tr>
<tr>
<td>Voiding LUTS, n (%)</td>
<td>30 (27.7)</td>
</tr>
<tr>
<td>Protection for incontinence (n = 106), n (%)</td>
<td></td>
</tr>
<tr>
<td>No use</td>
<td>25 (23.5)</td>
</tr>
<tr>
<td>Occasional use</td>
<td>8 (7.5)</td>
</tr>
<tr>
<td>Use ≥ 1 pad/d</td>
<td>73 (69)</td>
</tr>
<tr>
<td>Vaginal births, median ± SD</td>
<td>1.99 ± 1.43 (0–6) (range)</td>
</tr>
<tr>
<td>Previous hysterectomy, n (%)</td>
<td>9 (8.3)</td>
</tr>
</tbody>
</table>

SD: standard deviation; LUTS: lower urinary tract symptoms.
### Table 2  Results of non-invasive uroflowmetry (n = 78).

<table>
<thead>
<tr>
<th></th>
<th>Mean (SD)</th>
<th>Median</th>
<th>Range</th>
<th>Percentile 2.5</th>
<th>Percentile 5</th>
<th>Percentile 95</th>
<th>Percentile 97.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum flow (ml/s)</td>
<td>31 (13)</td>
<td>28</td>
<td>9–68</td>
<td>9</td>
<td>11</td>
<td>60</td>
<td>67</td>
</tr>
<tr>
<td>Mean flow (ml/s)</td>
<td>16 (8)</td>
<td>14</td>
<td>5–39</td>
<td>5</td>
<td>6</td>
<td>32</td>
<td>36</td>
</tr>
<tr>
<td>Urinated volume (ml)</td>
<td>345 (155)</td>
<td>289</td>
<td>150–803</td>
<td>150</td>
<td>153</td>
<td>623</td>
<td>752</td>
</tr>
<tr>
<td>Post-void residual (ml)</td>
<td>14 (19)</td>
<td>5</td>
<td>0–90</td>
<td>0</td>
<td>0</td>
<td>56</td>
<td>68</td>
</tr>
</tbody>
</table>

SD: standard deviation.

### Table 3  Results of filling cystometry.

<table>
<thead>
<tr>
<th></th>
<th>Mean (SD)</th>
<th>Median</th>
<th>Range</th>
<th>Percentile 2.5</th>
<th>Percentile 5</th>
<th>Percentile 95</th>
<th>Percentile 97.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume at the first fullness (ml)</td>
<td>169 (106)</td>
<td>163</td>
<td>16–549</td>
<td>25</td>
<td>34</td>
<td>321</td>
<td>400</td>
</tr>
<tr>
<td>Volume at first desire to void (ml)</td>
<td>297 (128)</td>
<td>275</td>
<td>107–701</td>
<td>115</td>
<td>125</td>
<td>521</td>
<td>539</td>
</tr>
<tr>
<td>Volume at first intense desire to void (ml)</td>
<td>429 (127)</td>
<td>423</td>
<td>164–984</td>
<td>174</td>
<td>220</td>
<td>622</td>
<td>626</td>
</tr>
<tr>
<td>Maximum cystometric capacity (ml)</td>
<td>453 (115)</td>
<td>442</td>
<td>180–949</td>
<td>201</td>
<td>236</td>
<td>626</td>
<td>642</td>
</tr>
<tr>
<td>Detrusor pressure at the start of filling (cmH\textsubscript{2}O)</td>
<td>1 (2,3)</td>
<td>1</td>
<td>−5–7</td>
<td>−3</td>
<td>−2</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Detrusor pressure at the end of filling (cmH\textsubscript{2}O)</td>
<td>5 (3,6)</td>
<td>5</td>
<td>−1–17</td>
<td>−1</td>
<td>0</td>
<td>12</td>
<td>15</td>
</tr>
<tr>
<td>Accommodation (ml/cmH\textsubscript{2}O)</td>
<td>166 (128)</td>
<td>110</td>
<td>20–626</td>
<td>33</td>
<td>46</td>
<td>466</td>
<td>522</td>
</tr>
</tbody>
</table>

SD: standard deviation.

### Table 4  Results of voiding cystometry (n = 97).

<table>
<thead>
<tr>
<th></th>
<th>Mean (SD)</th>
<th>Median</th>
<th>Range</th>
<th>Percentile 2.5</th>
<th>Percentile 5</th>
<th>Percentile 95</th>
<th>Percentile 97.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum flow (ml/s)</td>
<td>27 (10)</td>
<td>26</td>
<td>7–55</td>
<td>7</td>
<td>10</td>
<td>47</td>
<td>48</td>
</tr>
<tr>
<td>Detrusor pressure at maximum flow (cmH\textsubscript{2}O)</td>
<td>23 (11)</td>
<td>21</td>
<td>6–72</td>
<td>8</td>
<td>10</td>
<td>44</td>
<td>47</td>
</tr>
<tr>
<td>Detrusor pressure at maximum flow (cmH\textsubscript{2}O)</td>
<td>35 (15)</td>
<td>30</td>
<td>7–78</td>
<td>12</td>
<td>14</td>
<td>68</td>
<td>75</td>
</tr>
<tr>
<td>Urinated volume (ml)</td>
<td>467 (134)</td>
<td>466</td>
<td>165–972</td>
<td>187</td>
<td>233</td>
<td>654</td>
<td>735</td>
</tr>
<tr>
<td>Postvoid residual (ml)</td>
<td>25 (68)</td>
<td>0</td>
<td>0–410</td>
<td>0</td>
<td>0</td>
<td>190</td>
<td>220</td>
</tr>
</tbody>
</table>

SD: standard deviation.
showed OAD (17.5%), 2 of them with associated urinary incontinence (1.9% of the total). Table 5 shows the characteristics of OAD. Twelve patients showed only spontaneous OAD during the filling phase (63%), 6 patients showed spontaneous OAD during filling, and induced by coughing (32%; 2 induced by coughing during filling and 4 induced by coughing in the stress test), and one patient showed OAD only induced by coughing during the filling phase (5%); this patient showed no uroS-f (0.9% of the total). The other 3 patients with OAD without uroS-f spontaneously showed it during filling.

Those women who always or occasionally used protection for urinary incontinence showed a significantly lower LPP-c than those patients who did not use it (129 ± 41 versus 146 ± 35 cmH2O; p = 0.035). There was an association between the presence of OAD and nocturia ≥2 (p = 0.002; odds ratio: 3.74; 95% confidence interval: 1.22–11.39), but not with daytime voiding frequency ≥8. The sensitivity, specificity, positive predictive value, negative predictive value and nocturia accuracy ≥2 for the presence of OAD were 0.37, 0.87, 0.37, 0.87 and 0.78, respectively.

Discussion

This is a study on women with a clinical diagnosis of pure SUI, evaluated with urodynamics by a single urodynamics urologist, at a referral university center, following the recommendations of the ICS. Despite being a retrospective study, it has the strength of evaluating a homogeneous group of patients in a standardized manner, with the analyzed data being recorded at the time of examination. On the other hand, it has the limitation of disregarding the result of other clinical evaluations, which may have modified the decision to indicate the study.

(1) We are not aware of previous studies describing the reference values of the different stages of a urodynamic study in women with pure SUI. Nager et al. published reference values of women with pure or predominant SUI who were candidates for surgery. When comparing the results of this study with ours, we found in the latter case: in non-invasive uroflowmetry: higher peak flows exceeding the expected ones due to greater urine volume according to the Liverpool nomogram and similar post-void residuals.

(2) In the filling cystometry: larger volumes in their desire to void and greater maximum cystometric capacity, with similar detrusor pressure at the start and end of the filling phase, and higher accommodation values; it should be noted here that the above-mentioned study included patients with mixed urinary incontinence with filling occurring in the standing position.

(3) In voiding cystometry: greater peak flows, which also exceeded what was expected due to greater urine volumes, associated with slightly greater detrusor pressures at the peak flow; it should be noted here that, in the mentioned study, double-light urethral catheters (8F or smaller), without describing how many patients used 6F catheters, as was the case of our study.

Most of the articles assessing urodynamic studies in patients with urinary incontinence fail to report the results of the voiding study. In women with a clinical diagnosis of pure SUI, with POP up to stage II, with no previous anti-incontinence surgery or BOO surgery and without important symptoms of voiding difficulty, Jeong et al. described 3.8% of BOO or IDC. In our study on women with a clinical diagnosis of pure SUI, with POP up to stage II, with no previous anti-incontinence surgery, which included patients with symptoms of the lower urinary tract when emptying, we described 0.9% of BOO, with no cases of IDC being found.

In their systematic review of the literature, which included 22 studies of women with a clinical diagnosis of pure SUI, van Lijen et al. described uroS-f in 78% of patients, mixed urodynamic diagnosis in 8%, pure OAD in 6%, and inconclusive urodynamic testing in 7%. Our results showed a similar frequency of uroS-f (73.1%) and an increased frequency of mixed urodynamic diagnosis (13.8%) to the detriment of lower OAD only (3.7%), with a consistent frequency of inconclusive tests (9.2%). Our study included the characteristics of OAD in this group of patients and described around 1% of OAD induced by increased abdominal pressure in the absence of uroS-f, information which was not available in the above-mentioned review.

In one of the pioneering studies on the assessment of urethral sphincter function by using leak-point pressure measurements, McGuire et al. evaluated patients in the standing position without making any distinction between the values obtained using the Valsalva maneuver or the cough test. The stress test induced by coughing is more sensitive than that induced by the Valsalva maneuver; however, an abrupt change in pressure makes the establishment of the exact value when urine leakage occurs difficult. Our use of the cough test with a progressive intensity to define the value from which urine leakage occurs, seeks to resolve this problem.

Some studies have found an association between the subjective grade of urinary incontinence and leak-point pressure values, and others have not. Our study showed that those women using some form of protection for urinary incontinence had significantly lower LPP-c than those who did not use it, this being an objective demonstration of the usefulness of this measurement in the assessment of urethral sphincter function.
The unexpected absence of urod-SUI in women with a clinical diagnosis of SUI constitutes a challenge, which at the same time provides important information. In women with clinical signs of pure SUI and an inconclusive conventional urodynamic study, some authors have found that all patients showed OAD in an outpatient urodynamic study.21 Moreover, an important article denying the usefulness of urodynamic testing in the prediction of a result of postoperative continence in women with a clinical diagnosis of predominant SUI, paradoxically demonstrated in an almost statistically significant manner that those women with absence of urod-SUI were 2 times less likely to have a satisfactory surgical outcome than those who did have urod-SUI.24 On the other hand, in women with pure or predominant SUI and a positive standardized stress test and whose urodynamic study showed no urod-SUI, Lemack et al. found significantly lower scores of SUI and a smaller average daily number of urinary incontinence episodes.25

In conclusion, in women with pure SUI without knowing the outcome of other clinical evaluations, urodynamic testing can provide useful information to define the treatment.

Conflict of interest

The authors declare that they have no conflict of interest.

References