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Urodynamic and clinical features in women with overactive bladder: When to suspect concomitant voiding dysfunction?

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Abstract

Aim: The aim of this study is to describe the prevalence and type of female voiding dysfunction (FVD) in patients with overactive bladder (OAB) who were studied by urodynamics and its relationship with voiding symptoms.

Methods: This is a cross-sectional study of female adult patients with OAB syndrome who underwent UDS in a University Hospital in Chile between January 2015 and April 2020. FVD was defined either as bladder outlet obstruction (BOO) or detrusor underactivity (DU). BOO was established if the Solomon-Greenwell BOO index was higher than 18. DU was diagnosed when the invasive maximum flow rate (Qmax) was ≤15 ml/sec, detrusor pressure at Qmax (Pdet@Qmax) was ≤20 cmH_2O and postvoid residual (PVR) was greater than 10%. Urodynamic data and clinical features were compared between groups.

Results: Two hundred and ninety-nine UDS were selected and analyzed. Bladder outlet obstruction was diagnosed in 59 patients (19.7%), whereas DU was found in 10 patients (3.3%). In the multivariate analysis, the logistic regression to predict BOO demonstrated that night-time frequency, the presence of detrusor overactivity and a higher PVR were independent predictors of BOO. Instead, for DU, the only independent predictor was a smaller voided volume in the pressure-flow study.

Conclusion: Female voiding dysfunction was found in 23% of patients with overactive bladder. BOO is more frequent than DU, and should be suspected in patients with higher night-time frequency, presence of detrusor overactivity and a high PVR. Instead, DU should be suspected in patients with a smaller voided volume.

KEYWORDS

bladder outlet obstruction, detrusor underactivity, overactive bladder syndrome, urodynamics, voiding dysfunction

1 | INTRODUCTION

Female voiding dysfunction (FVD) is a poorly understood phenomenon, and even though there has been abundant research on the field during the last decade, the definition, study and management of this condition are still elusive. The International Continence Society (ICS) defines it as "an abnormally slow and/or incomplete micturition, based on abnormally slow urine flow rates and or abnormally high post-void residuals."[1] Traditionally, voiding symptoms have been associated to male population but there is plenty of evidence that women suffer also from them. In the EpiLUTS study, intermittency was reported by 15.9%, a sensation of incomplete bladder emptying by 27.4% and a weak flow by 20% of women aged greater than 40 years.[2] This high frequency of voiding complaints has been corroborated world-wide[3,4] and could be as high as 60% on selected populations attending pelvic floor centers.[5]

The coexistence of FVD in patients with overactive bladder (OAB) has been previously described and could affect up to half of these patients.[6] Urodynamics (UDS) aim to elucidate the pathophysiological correlate of FVD such as bladder outlet obstruction (BOO), described in 3%–30%[7] and detrusor underactivity (DU) reported in 8.6%–23.1% [6,8,9] depending on the definition.

The aim of this study is to describe the prevalence and type of FVD (BOO or DU) in patients with OAB who were studied by UDS and its relationship with voiding symptoms. We hypothesize that FVD is a frequent finding in this group of patients and that certain clinical features might help suspect it and prompt its ruling out.

2 | METHODS

This is a cross-sectional study of female adult patients with OAB syndrome who underwent UDS in our University Hospital in Chile between January 2015 and April 2020. Urodynamics were conducted following the ICS good practices.[10] This study was approved by the Ethics Committee of Pontificia Universidad Católica de Chile.

Patients who were referred with OAB syndrome for UDS were included. OAB was diagnosed following the ICS definition: "urinary urgency, usually accompanied by increased daytime frequency and/or nocturia, with or without urinary incontinence, in the absence of urinary tract infection or other detectable disease." Patients with mixed urinary incontinence were also included.

The clinical evaluation included a full medical history and physical examination to rule out high grade pelvic organ prolapse. Before UDS, patients were asked about their lower urinary tract symptoms (LUTS) in a directed manner, including voiding symptoms (feeling of incomplete emptying, slow urinary stream, intermittency, hesitancy, straining to void and terminal dribble). Daytime and nighttime urinary frequency, as well as pads per day were patient-reported (not standardized).

Patients with previous incontinence or radical pelvic surgery, current use of anticholinergics, high-grade pelvic organ prolapse (higher than stage II), bladder cancer, urinary tract calculi, neurogenic bladder and painful bladder syndrome were excluded. Patients without results of flow-pressure study were also kept out.

UDS are executed as follows: First, a noninvasive uroflowmetry is performed followed by measurement of post void residual volume (PVR) by catheterization. Then, the cystometry is conducted using a 6 Fr double lumen catheter for bladder filling and measurement of intravesical pressure, and a rectal balloon catheter is installed to measure abdominal pressure. Warm saline solution is infused at a rate between 10 and 50 ml/min. During filling, patients are instructed to report first sensation of filling, first desire to void and strong desire to void. Fear to leak, urge, pain and presence of detrusor contractions are also reported. Detrusor overactivity (DO) was diagnosed with any increase in the detrusor pressure during the filling phase, with or without concomitant urgency. The stress test is performed with 200 and 300 ml in a sitting and standing position during cough and Valsalva maneuver. Abdominal leak point pressures (ALPP) values are observed and reported. Finally, pressure-flow study is carried out evaluating maximum flow (Qmax), maximum detrusor pressure (PdetQmax), detrusor pressure at maximum flow (Pdet@Qmax), abdominal straining and PVR volume measured by catheterization. Patients who are not able to void with the catheters in, have them removed, and void with a second noninvasive uroflowmetry; these patients were excluded from the analysis. Bladder capacity was retrospectively calculated adding the voided volume and the PVR (measured with the same catheter).

FVD was defined either as BOO or DU. BOO was established if the Solomon-Greenwell BOO index was higher than 18.[11] This index is calculated using the formula BOOIf = Pdet@Qmax−2.2*Qmax, according to the authors, with an index over 18, obstruction is almost certain (over 90%), it is important to note that this nomogram utilizes the Qmax of the pressure-flow study and not the one from the free flow as used in other nomograms. DU was diagnosed when all of the following three features were reached: (1) the invasive maximum flow rate (Qmax) was ≤15 ml/sec, (2) detrusor pressure at Qmax (Pdet@Qmax) was ≤20 cmH_2O and (3) PVR was greater than 10%.[12] Following these definitions patients were allocated into three different groups: Group I

(BOO), Group II (DU), and Group III (without BOO or DU).

Urodynamic data and clinical features were compared between groups. Numerical variables were analyzed with nonparametric tests, and χ^2 was used to compare categorical variables. A logistic regression was conducted including all the variables that were associated in the bivariate analysis and the clinically relevant that could be associated. Data was processed using IBM SPSS version 23.0 and two tailed p values less than 0.05 was considered as statistically significant.

3 | RESULTS

A total of 1556 urodynamic studies were reviewed, after applying inclusion and exclusion criteria, 299 were selected and analyzed. The mean age of the patients was 55.9 ± 12.8 years, they had a median of 2 (IQR 0–2) vaginal deliveries, 14% had diabetes mellitus (DM) and 17% had previous hysterectomy. Most patients had mixed urinary incontinence (87%). Demographic and symptomatic characteristics are listed in Table 1 (All numeric variables are represented with medians and interquartile ranges (IQR), except for age which is shown with its mean and standard deviation).

Following the mentioned definitions, BOO was diagnosed in 59 patients (Group I: 19.7%), whereas DU was found in 10 patients (Group II: 3.3%), the remaining subjects formed Group III. Urodynamic characteristics are listed in Table 2. DO during filling cystometry was found in 49.5%. Positive urodynamic stress incontinence was seen in 79.3%, with a median ALPP of 100 cmH_20 (IQR 73–135), and 23.7% had Valsalva-induced detrusor overactivity.

In the bivariate comparison, BOO was associated with higher night-time frequency, reduced cystometric capacity,

TABLE 1 Symptomatic characteristics comparing patients with OAB and concomitant BOO or DU

Variable	Total ($n = 299$)	Group I BOO ($n = 59$)	Group II DU ($n = 10$)	Group III No BOO/DU ($n = 230$)
Age in years (±*SD*)	55.9 ± 12.8	56.1 ± 13.3	61.3 ± 12.9	55.6 ± 12.7
Arterial hypertension (%)	92 (30.8)	20 (33.9)	**6 (60)***	66 (28.7)
DM (%)	44 (14.7)	8 (13.6)	2 (20)	34 (14.8)
Vaginal deliveries (IQR)	2 (0–2)	2 (0–2)	1.5 (0.75–3)	2 (0–2.25)
Previous hysterectomy (%)	51 (17.1)	7 (11.9)	3 (30)	41 (17.8)
Vaginal bulge (%)	24 (8)	5 (8.5)	0	19 (8.3)
Recurrent UTI (%)	28 (9.4)	9 (15.3)	0	19 (8.3)
Mixed UI (%)	262 (87)	51 (86.4)	9 (90)	202 (87.8)
Pads/day (IQR)	3 (2–4)	3 (2–5)	3 (2–4.5)	3 (2–4)
Daytime frequency (IQR)	8 (6–10)	8 (6–10.5)	**11 (6.8–15)***	8 (6–10)
Night-time frequency (IQR)	2 (1–3)	**2 (1–4)***	1.5 (1–3)	2 (1–3)
Any voiding symptom (%)	123 (41)	24 (40.7)	5 (50)	94 (40.9)
Incomplete bladder emptying (%)	95 (31.8)	19 (32.2)	5 (50)	71 (30.9)
Slow urine stream (%)	35 (11.7)	9 (15.3)	1 (10)	25 (10.9)
Intermittent flow (%)	37 (12.4)	10 (16.9)	2 (20)	25 (10.9)
Latency (%)	14 (4.7)	1 (1.7)	0	13 (5.7)
Straining (%)	41 (13.7)	8 (13.6)	1 (10)	32 (13.9)
Post-void dribbling (%)	38 (12.7)	8 (13.6)	2 (20)	28 (12.2)

Note: Asterisks indicate statistically significant differences between BOO or DU and controls.

Abbreviations: OAB, overactive bladder; BOO, bladder outlet obstruction; DM, diabetes mellitus; DU, detrusor underactivity; UI, urinary incontinence; UTI, urinary tract infection.

*$p < 0.05$.

TABLE 2 Urodynamic characteristics comparing patients with OAB and concomitant BOO or DU

Variable	Total (*n* = 299)	Group I BOO (*n* = 59)	Group II DU (*n* = 10)	Group III No BOO/DU (*n* = 230)
First desire in ml (IQR)	157 (107–200)	169 (119–215)	160 (110–200)	155 (100–200)
Urgent desire in ml (IQR)	252 (179–341)	243 (160–334)	282 (169–392)	250 (180–349)
Bladder capacity in ml (IQR)	352 (290–-403)	**313 (224–400)***	383 (300–400)	359 (300–412)
Detrusor overactivity (%)	148 (49.5)	**44 (74.6)***	5 (50)	99 (43)
SUI (%)	237 (79.3)	42 (71.2)	9 (90)	186 (80.9)
ALPP in cm H_2O (IQR)	100 (73–135)	100 (77–151)	91 (60–110)	100 (73–135)
Valsalva induced–DO (%)	70 (23.7)	**20 (35.1)***	3 (30)	47 (20.6)
Voided volume in ml (IQR)	409 (280–522)	**322 (151–427)***	**266 (134–389)***	429 (319–550)
Qmax in ml/seg (IQR)	16 (10–24)	**7 (4–11)***	**10.5 (5.8–13.3)***	19 (13–26)
PdetqMax in cm H_2O (IQR)	30 (20–40)	**48 (40–60)***	**14.5 (8.3–18)***	27 (19–34.5)
PVR in ml (IQR)	47.5 (10–122)	**120 (34–328)***	**125 (69–217)***	30 (10–100)

Note: Asterisks indicate statistically significant differences between BOO or DU and controls. Numbers represent medians and interquartile ranges (IQR).

Abbreviations: ALPP, abdominal leak point pressure; BOO, bladder outlet obstruction; DU, detrusor underactivity; OAB, overactive bladder; PVR, postvoid residual; Qmax, maximum flow rate; SUI, stress urinary incontinence.

*$p < 0.05$.

higher presence of DO, as well as Valsalva-induced DO and greater PVR. Instead, DU was associated with higher day-time frequency, arterial hypertension and reduced voided volume in the pressure-flow study. DM was found in a higher proportion of patients with DU but this was not statistically significant. None of the voiding symptoms were associated with a particular group. Qmax and Pdet@Qmax, were naturally different between BOO/DU and Group III, since they were part of the definition of the groups. Accordingly, they were excluded from the multivariate analysis.

In the multivariate analysis every variable that was significant in the bivariate analysis was included. The logistic regression to predict BOO demonstrated that a higher night-time frequency (odds ratio [OR], 1.21; [95% confidence interval {CI}, 1.02–1.43], $p = 0.03$), the presence of detrusor overactivity (OR, 4.16 [95% CI, 1.84–9.42], $p = 0.0001$) and a higher PVR (OR, 1.008 [95% CI, 1.005–1.01), $p = 0.001$) were independent predictors of BOO. Instead, for DU, the only independent predictor was a smaller voided volume in the pressure-flow study (OR, 0.994; [95% CI, 0.98–0.99], $p = 0.012$).

4 | DISCUSSION

FVD is a complex condition that lacks clear and objective definition.[13] For many years, there have been reports about the association between this entity and overactive bladder symptoms.[14] Even though the relationship between obstruction-related voiding dysfunction in men has long been related to OAB, this link is not well understood for women.

There is some agreement in the literature, regarding the poor predicting performance of LUTS to identify the underlying disorder, that is why women with complex symptoms are prompted to undergo invasive urodynamic studies. In our study we found that voiding dysfunction symptoms were not associated with urodynamic BOO or DU. Similarly, Kuo et al.[15] submitted more than 1600 women complaining of LUTS to video urodynamics and classified them as either normal, sensory, motor or bladder outlet disordered and concluded that the LUT disorder cannot be based on LUTS alone. Female BOO manifests with non-specific symptoms, and the classic voiding symptoms described by men are less frequent, in fact urgency seems to be the most common complaint.[16] Another study of 636 women concluded voiding symptoms have poor sensitivity and specificity for elevated post-void residuals.[17]

Most individuals with non-neurogenic OAB are initially treated with behavioral and pharmacological management, reserving UDS only for the time these treatments fail. The early suspicion or diagnosis of obstruction could be an important factor in the management of these patients and being able to suspect it based on clinical features would be of most importance. As an example, revision surgery after obstructed mid-urethral slings, achieves a cure of urgency in around 60% of patients.[18] A handful of nomograms have been studied in women to establish BOO, although a consensus about which to use has not been reached to date. In the present study the Solomon-Greenwell nomogram[11] was selected to define BOO, which has a good concordance with the classic video urodynamic definition reported by Nitti et al.[19] and the authors find it practical for every-day usage.

On the other hand, diagnosing DU in women is complicated since they usually void with lower detrusor pressures. Many women do not require a perceivable detrusor contraction to micturate, only by relaxing their pelvic floor muscles they may obtain an adequate micturition due to their lower urethral resistance.[20] The ICS defines DU as "a contraction of reduced strength and/or duration, resulting in prolonged bladder emptying and/or a failure to achieve complete bladder emptying within a normal time span." This definition is quite ambiguous, and does not state the exact urodynamic parameters to make the diagnosis. The criteria here used and proposed by Gammie et al.[12] for DU includes the three components that the authors consider must be on the definition: flow, pressure and residual volume. Also, this definition is concordant but at the same time stricter than others.[21]

The relationship between DU and OAB has been addressed over the last years in the literature. In fact, storage symptoms are frequent in this population, with urgency being reported in over 50% of urodynamically proven DU patients.[22] The ICS proposes the term coexistent overactive-underactive bladder "COUB syndrome" that is characterized by storage and emptying symptoms that are suggestive of urodynamic detrusor overactivity/underactivity. One hypothesis to explain the relationship between DO and DU is that COUB detrusor is over activated during the filling phase precluding it from getting a complete rest. This waste of energy, which is needed to perform on the next voiding phase, would explain the poor contraction due to muscle exhaustion. This chronic fatigue would lead to increased muscle thickening, alteration of muscle structure, progressive ischemia, inflammation, oxidative damage, fibrosis, and finally impaired contractility.[23]

Using these nomograms and definitions we found that 23% of female patients with OAB had urodynamic voiding dysfunction (19.7% with BOO and 2.3% with DU). Applying different and more permissive definitions compared to our research, Cho et al. analyzed 163 women with OAB. Like us, they defined FVD as either BOO (Qmax of $\leq$15 ml/s with a PdetQmax of $>$20 cmH_2O) or DU (Qmax $\leq$15 ml/s and PdetQmax $\leq$20 cmH_2O), they found a prevalence of FVD in OAB population has high as 52%, with BOO in 42.9% and DU in 8.6%.[6] This marked higher proportion of obstructed and underactive patients is most likely explained by the looser criteria they used to define either BOO or DU.

Similar to our results, Gammie et al. assessed a massive record of pressure flow study done in men and women, looking to describe the signs/symptoms and urodynamic parameters of DU.[12] For women, DU was defined using our same criteria. Albeit the fact that they excluded patients with detrusor overactivity, they found that DU women had a higher number of daytime micturitions and a smaller cystometric capacity compared with normal women. Contrary to our findings, they observed some voiding symptoms (weak stream, hesitancy and intermittency) were statistically related to the presence of DU, which we might have found, had we had a bigger sample.

We found that women with BOO have more DO (75% vs. 43% in Group III). This marked DO would explain why they had a smaller bladder capacity, since a strong contraction precludes from filling completion. These uninhibited contractions would also be the reason for frequent nighttime awakenings. It seems these patients' symptoms are mainly explained by severe and frequent involuntary bladder contractions leading the clinical picture. Conversely, women with DU were found to have frequent daytime micturition (11 vs. 8 times in Group III) and hence a small voided volume (266 ml vs. 429 ml in Group III). These patients' symptoms seem to be commanded by poor bladder emptying and not by detrusor overactivity itself.

The main limitation of our study is its retrospective nature. Also, it is important to note that the symptoms were obtained in a directed manner, not using a validated questionnaire. Urinary frequency and number of incontinence pads were patient reported, a formal bladder diary was not used. To improve the quality of information, electronic records with a structured database could be implemented along with bladder diaries and validated questionnaires. There is an important selection bias, since we analyzed only patients that were submitted to a UDS and not the whole OAB population. The main reason for being submitted to this test was because they had mixed urinary incontinence, so the prevalence of FVD on the real-world OAB population might differ. Furthermore, the fact that we had a high prevalence of mixed incontinence, could be selecting patients with a lower-resistance urinary tract, this could underestimate the real prevalence of obstruction in the whole female OAB population. The small number of patients defined with DU precluded us from finding more predictors.

5 | CONCLUSION

FVD was found in 23% of patients with overactive bladder. BOO is more frequent than DU, and should be suspected in patients with higher night-time frequency, presence of detrusor overactivity and a high PVR. Instead, DU should be suspected in patients with a smaller voided volume.

CONFLICT OF INTERESTS

The authors declare that there are no conflict of interests.

AUTHOR CONTRIBUTIONS

Fernanda Santis-Moya and Carlos Ignacio Calvo contributed to project development, data analysis, manuscript writing. Tania Rojas contributed to project development, data collection. Arturo Dell'Oro, Paulina Baquedano, and Alvaro Saavedra contributed to data collection and manuscript editing.

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