Tzu Chi Medical Journal 24 (2012) 51–55

Contents lists available at SciVerse ScienceDirect

Tzu Chi Medical Journal

journal homepage: www.tzuchimedjnl.com

Original Article

Videourodynamic differential diagnosis of voiding dysfunction in Taiwanese women

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ARTICLE INFO

Article history:
Received 12 February 2012
Received in revised form
20 March 2012
Accepted 13 April 2012

Keywords:
Dysuria
Lower urinary tract symptoms
Videourodynamics
Women

ABSTRACT

Objective: Voiding dysfunction in women is common, but the differential diagnosis of the underlying pathophysiology is not easy. This study analyzed lower urinary tract dysfunction in women with voiding dysfunction based on videourodynamic study (VUDS).
Patients and Methods: A total of 781 consecutive women with complaints of difficult urination were included. All patients underwent VUDS and a final diagnosis was made. The clinical symptoms and video urodynamic characteristics were analyzed.
Results: Difficult urination was the main symptom in 446 patients and an associated symptom in 335. A normal VUDS tracing was found in 96, detrusor overactivity in 112, bladder oversensitivity in 128, and interstitial cystitis in 40. The other 405 women were classified as having voiding dysfunction, including 178 with detrusor underactivity, 55 with detrusor overactivity and inadequate contractility, 88 with dysfunctional voiding, 20 with bladder neck dysfunction, 10 with urethral stricture, and 54 with poor pelvic floor muscle relaxation. Difficult urination was the main symptom in 62%, urinary retention in 11.2%, and frequency, urgency, or urgency incontinence in 24.6% of all patients with voiding dysfunction. A total of 93.8% of patients had both storage and empty symptoms, whereas only 6.2% had empty symptoms alone. Urodynamic parameters could only differentiate bladder outlet obstruction and detrusor underactivity based on voiding detrusor pressure in all patients with voiding dysfunction.
Conclusion: Storage and voiding symptoms are common in women with voiding dysfunction. VUDS is the best diagnostic tool in the differential diagnosis of female voiding dysfunction.

1. Introduction

Lower urinary tract symptoms (LUTS) are symptoms reported by patients' based on their perception of how their bladder feels. The real pathophysiology of LUTS might be difficult to interpret based on symptoms alone. As in men, LUTS in women also include storage, voiding, pain, and postmicturition symptoms [1]. Among female LUTS, difficult urination is common, but the differential diagnosis of the underlying pathophysiology is not easy [2]. It is essential to clearly differentiate different underlying urethrovesical dysfunctions before giving appropriate treatment for women with voiding dysfunction.

Women with complaints of difficult urination are commonly seen in urological outpatient clinics. Unlike male patients, bladder outlet obstruction (BOO) is seldom diagnosed in women with voiding dysfunction. A detailed urodynamic study is usually necessary in the differential diagnosis of voiding dysfunction [3]. Videourodynamic study (VUDS) provides comprehensive investigation of lower urinary tract dysfunction (LUTD). By combining pressure flow, uroflow, and image studies, LUTD can be identified according to characteristic VUDS findings. Bladder neck dysfunction (BND), dysfunctional voiding (DV), urethral stricture (US), and poor relaxation of the pelvic floor muscles (PRPF) can also be delineated in addition to detrusor disorders such as detrusor underactivity (DU) or detrusor hyperactivity and inadequate contractility (DHIC) [4].

This retrospective study analyzed the VUDS data from a large cohort of women with voiding dysfunction in order to evaluate the correlation between clinical symptoms and the underlying detrusor or bladder outlet disorders.

Conflict of interest: none.

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1016-3190/$ – see front matter
doi:10.1016/j.tcmj.2012.05.001

1.1. Patients and methods

The patients included in this study were from a total of 1605 consecutive women who had undergone first time VUDS for LUTS from August 1996 to July 2010. Approval for the study and data collection was obtained from the Institutional Review Board of the hospital. Patients with a complaint of difficult urination were selected for the study. Patients with chronic urinary tract infection (UTI), urodynamic stress urinary incontinence, pelvic organ prolapse, frank neurogenic voiding dysfunction, previous lower urinary tract surgery, previous antiincontinence surgery, a previously established diagnosis of interstitial cystitis/painful bladder syndrome (IC/PBS), or previous genitourinary tract malignancy were excluded from the analysis.

The LUTS were classified as storage symptoms (frequency, urgency, urgency urinary incontinence [UUI], nocturia), voiding symptoms (difficult urination, hesitancy, slow stream, intermittency, straining to void, urinary retention), pain symptoms (bladder pain, urethral pain, perineal pain), and postmicturition symptoms (terminal dribble, feeling of incomplete emptying, postmicturition leakage). Difficult urination was classified as the main symptom if patients reported it as their chief complaint. If patients complained of difficult urination in association with other main symptoms, then it was classified as an associated symptom. Methods, definitions and units conformed to the standards jointly recommended by the International Continence Society and the International Urogynecological Association, except where specifically noted [5].

VUDS was performed using a multichannel urodynamic system (Life-Tech Inc., Stafford, TX, USA) and a C-arm fluoroscope (Toshiba, Tokyo, Japan). VUDS was performed before any treatment was given. The patient was positioned in the supine position and a 6-Fr dual channel urethral catheter was inserted transurethrally to record intravesical pressure and an 8-Fr rectal balloon catheter was used to record intra-abdominal pressure. VUDS was performed by infusion of warmed normal saline containing 20% Urografin at a filling rate of 30 mL/minute with the patient in a sitting position. The C-arm fluoroscope was positioned 45 degrees from the buttocks so that the urethra could be lengthened and the bladder neck, urethral sphincer, and distal urethra could be clearly identified. VUDS was repeated if abnormal findings were noted during the first examination. The first sensation of filling, full sensation, cystometric bladder capacity (CBC), detrusor pressure (Pdet), maximum flow rate (Qmax), bladder compliance, and postvoid residual (PVR) were recorded. The potassium chloride (KCl) test using 0.4 M KCl solution was performed if patients presented with increased bladder sensation (IBS) during the urodynamic study [6].

A voiding Pdet of more than 35 cm H_2O was defined as high voiding pressure [4,7], 10–35 cm H_2O was defined as normal voiding pressure, and lower than 10 cm H_2O was defined as low voiding pressure. Patients with a high or normal voiding pressure and those with a low voiding pressure and a normal flow rate were considered as having normal detrusor contractility, while those with a low voiding pressure and low flow rate and/or a large PVR (more than 150 mL) were considered to have low detrusor contractility. Bladder compliance at bladder capacity was measured by dividing the change in cystometric volume by the change in Pdet.

Detrusor overactivity (DO) was defined as urodynamic evidence of spontaneous detrusor contractions occurring during bladder filling (phasic DO) or occurring before uninhibited detrusor contraction voiding at reaching bladder capacity (terminal DO) [1,5]. If DO was associated with incomplete bladder emptying and a PVR of more than 150 mL, then DHIC was considered [8]. Patients with DO without BOO or DHIC were considered to have idiopathic DO (IDO). If patients did not have DO and the voiding Pdet was less than 10 cm H_2O and they needed to void by abdominal straining or were unable to void, then DU was diagnosed.

If patients had a strong desire to void at a CBC of less than 350 mL and without occurrence of DO, then they were considered to have bladder oversensitivity [9]. When bladder pain was elicited during bladder filling and the KCl test showed a positive result, the VUDS finding was suggestive of IC/PBS [10]. If patients did not have a sensation of normal bladder fullness at a bladder capacity of more than 500 mL, then they were considered to have reduced bladder sensation. Patients with low detrusor contractility and a large PVR were classified as having DU if no DO was elicited, and they were classified as having DHIC if DO was elicited and incomplete bladder emptying was noted.

BND was diagnosed if VUDS revealed a narrow bladder neck together with a high or normal Pdet [11]. When VUDS showed a high Pdet, open bladder neck, and a narrow midurethra during the voiding phase, DV due to urethral sphincter discoordination was considered [12]. If patients had a narrow distal urethra and a low Qmax regardless of a high or normal Pdet, they were considered to have US. Patients diagnosed with US underwent cystoscopic confirmation. Patients who could not adequately relax their pelvic floor muscles and in whom VUDS showed a low voiding pressure and intermittent flow pattern were considered to have PRPF [4].

The final diagnosis of LUTD was made based on the above mentioned characteristic VUDS findings. According to the VUDS results, the underlying LUTDs were classified. Storage and empty symptoms were analyzed, and the urodynamic parameters were analyzed and compared among different LUTD subgroups in women with voiding dysfunction. The patient subgroup with normal VUDS findings served as the control arm for comparison. Statistical analysis was performed by analysis of variance (ANOVA) and posthoc analysis among different LUTD subgroups. A p value of less than 0.05 was considered significant.

2. Results

A total of 446 women with difficult urination as the main symptom and 335 women with this as an associated symptoms were included in this study. Table 1 lists the definitive VUDS diagnoses in all 781 women. Nonvoiding dysfunction was found in 376 women, including 96 with a normal VUDS tracing, 112 with DO, 40 with IC/PBS, and 128 with bladder oversensitivity. The other 405 (52%) women had true voiding dysfunction characterized by low detrusor contractility (including DU in 44% and DHIC in 13.6%) or bladder outlet disorders (BND in 4.9%, US in 2.5%, DV in 21.7%, PRPF in 13.3%). These results are shown in Fig 1.

For analysis of women with true voiding dysfunction, only those with low detrusor contractility (DU and DHIC) and bladder outlet

Table 1
Videourodynamic classification of 781 women with difficult urination symptoms.

VUDS diagnosis	As main symptom, $n = 446$ (%)	As associated symptom, $n = 335$ (%)
Normal UDS tracing	54 (12.1)	42 (12.5)
Detrusor overactivity	58 (4.7)	54 (16.1)
Interstitial cystitis	5 (1.1)	35 (10.4)
Bladder oversensitivity	79 (17.7)	49 (14.6)
Detrusor underactivity	119 (26.7)	59 (17.6)
DHIC	21 (4.7)	34 (10.1)
Bladder neck dysfunction	17 (3.8)	3 (0.9)
Urethral stricture	8 (1.8)	2 (0.6)
Dysfunctional voiding	54 (12.1)	34 (10.1)
Poor relaxation of PFM	31 (7)	23 (6.9)

DHIC = detrusor overactivity and inadequate contractility; PF = pelvic floor muscles, UDS = urodynamic study; VUDS = video urodynamic study.

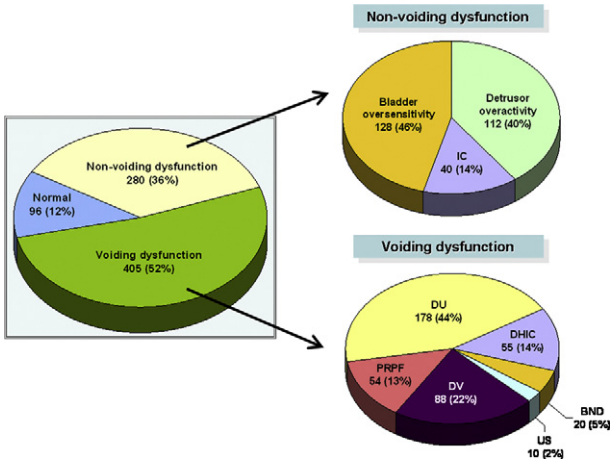

Fig. 1. Distribution of lower urinary tract dysfunctions in 781 women with symptoms of difficult urination, including 96 with normal urodynamic findings, 280 with non-voiding dysfunction, and 405 with voiding dysfunction. IC = interstitial cystitis, BND = bladder neck dysfunction, DU = detrusor underactivity, DHIC = detrusor overactivity and inadequate contractility, PRPF = poor relaxation of the pelvic floor, US = urethral stricture.

disorders (BND, US, DV, PRPF) were included. The mean age of the DHIC patients (75.1 ± 10.2 years) was significantly higher than that in the other voiding dysfunction subgroups (DU 64.1 ± 17.4; BND 61.9 ± 15.7; US 65.8 ± 18.9; DV 52.4 ± 19.0; PRPF 56.2 ± 13.0) and normal UDS controls (55.7 ± 13.9; $p = 0.000$).

Table 2 shows the main clinical symptoms in all voiding dysfunction subgroups. Difficult urination with or without urinary retention was the most common clinical symptom in both the voiding dysfunction and normal VUDS subgroups. Interestingly, urinary retention was only seen in women with DU or DHIC, and was seldom found in women with true BOO, such as BND, US or DV. Storage symptoms as the main LUTS were noted in 17% of women with DU, 24% with DHIC, 15% with BND, 20% with US, 37% with DV, and 33.3% with PRPF. Frequent urination was the second most common symptom in women with PRPF and DV, as well as in women with DU. Pain symptoms were only noted in a few patients with voiding dysfunction. UUI was frequently found in women with DHIC, but was not so frequently in women with BOO.

If we classified LUTS as comprising storage, voiding, pain, and postmicturition symptoms, then most of the voiding dysfunction subgroups had both storage and empty LUTS. Empty symptoms alone were only noted in women with DU but were not frequently found in other subgroups. Pain symptoms were associated with storage and empty symptoms in women with PRPF, but they were less frequently noted in other subgroups (Table 3).

The urodynamic parameters in these voiding dysfunction subgroups are shown in Table 4. Among all subgroups and urodynamic parameters, Pdet was significantly higher in women with BOO (BND, US, and DV) and lower in women with DU or DHIC, but it was similar to the normal VUDS subgroup and women with PRPF. All voiding dysfunction subgroups had a low Qmax compared with the normal VUDS subgroup, and women with DU had the lowest Qmax among all the subgroups. All subgroups showed a significantly greater PVR and lower bladder compliance than the normal VUDS subgroup. DO was noted in all women with DHIC, 90% of those with US, 65% of those with BND, 64% of those with DV, and none with PRPF.

Table 3
Lower urinary tract symptoms of patients with voiding dysfunction.

	Storage LUTS alone	Empty LUTS alone	Storage + empty LUTS	Storage + empty + pain LUTS
Normal UDS ($N = 96$)	0	1 (1.0%)	82 (85.4%)	13 (13.5%)
DU ($N = 178$)	0	23 (13%)	148 (83.6%)	6 (3.4%)
DHIC ($N = 55$)	0	0	49 (89.1%)	6 (10.9%)
BND ($N = 20$)	0	0	20 (100%)	0
US ($N = 10$)	0	0	10 (100%)	0
DV ($N = 88$)	0	1 (1.1%)	81 (93.1%)	5 (5.7%)
PRPF ($N = 54$)	0	1 (1.9%)	36 (66.7%)	17 (31.5%)
Total ($N = 405$)	0	25 (6.2%)	344 (85.4%)	34 (8.4%)

BND = bladder neck dysfunction; DU = detrusor underactivity; DHIC = detrusor overactivity and inadequate contractility; PRPF = poor relaxation of pelvic floor; US = urethral stricture; UUI = urgency urinary incontinence.

3. Discussion

Voiding dysfunction in women is not uncommon and can significantly affect the quality of their life. The results of this study revealed that voiding dysfunction in women could have varied etiologies and clinical presentations. It consists of a constellation of symptoms involving both storage and empty phases of the micturition cycle. The etiologies of voiding dysfunction can be low detrusor contractility (57.5%) or bladder outlet disorders (42.5%). However, it is not possible to differentiate these etiologies of voiding dysfunction based on clinical symptoms alone.

Voiding dysfunction can be defined as impaired bladder emptying, and presents with a mixture of LUTS. The etiology of voiding dysfunction can be impaired detrusor contractility or bladder outlet dysfunction as a result of urethral overactivity or anatomic pathologies causing incomplete emptying. [2] Assessment of voiding dysfunction is important in women and girls in the prevention and treatment of urinary incontinence, retention, urinary tract infection, and subsequent kidney damage [3]. Accurate diagnosis is essential to select the correct treatment and prevent complications such as UTI and upper urinary tract deterioration.

Although difficult urination is a common symptom in women visiting urological clinics for LUTS, true voiding dysfunction was only seen in 52% of patients in this study. Women with bladder sensory disorders including bladder oversensitivity, IC/PBS, and DO

Table 2
Main clinical symptoms of patients with voiding dysfunction.

	Frequency	Urgency	UUI	Difficult urination	Urinary retention	Bladder pain	Micturition pain
Normal UDS ($N = 96$)	27 (28.1%)	2 (2.1%)	0	54 (56.3%)	2 (2.1%)	5 (5.2%)	2 (2.1%)
DU ($N = 178$)	27 (15.3%)	1 (0.6%)	2 (1.1%)	119 (67.2%)	27 (15.3%)	0	1 (0.6%)
DHIC ($N = 55$)	1 (1.8%)	1 (1.8%)	12 (21.8%)	21 (38.2%)	17 (30.9%)	2 (3.6%)	1 (1.8%)
BND ($N = 20$)	1 (5.0%)	0	2 (10%)	17 (85.0%)	0	0	0
US ($N = 10$)	1 (10%)	1 (10%)	0	8 (80.0%)	0	0	0
DV ($N = 88$)	22 (25.3%)	6 (6.9%)	4 (4.6%)	54 (62.1%)	1 (1.1%)	0	0
PRPF ($N = 54$)	18 (33.3%)	0	0	31 (57.4%)	0	5 (9.3%)	0
Total ($N = 405$)	70 (17.4%)	9 (2.2%)	20 (5.0%)	250 (62.0%)	45 (11.2%)	7 (1.7%)	2 (0.5%)

BND = bladder neck dysfunction; DU = detrusor underactivity; DHIC = detrusor overactivity and inadequate contractility; PRPF = poor relaxation of pelvic floor; US = urethral stricture; UUI = urgency urinary incontinence.

Table 4
Urodynamic parameters among groups with voiding dysfunction and normal urodynamic group.

	CBC (mL)	FSF (mL)	FS (mL)	Pdet (cmH_2O)	Qmax (mL/s)	PVR (mL)	Compl	DO
Normal UDS ($N = 96$)	482 ± 100	215 ± 107	395 ± 77.5	18.8 ± 8.98	20.5 ± 7.95	25.7 ± 44	121 ± 122	0
DU ($N = 178$)	381 ± 162	294 ± 114	359 ± 101	5.57 ± 4.79	5.31 ± 7.61	268 ± 201	65.6 ± 97.3	0
DHIC ($N = 55$)	310 ± 103	213 ± 90	294 ± 112	12.6 ± 7.6	6.03 ± 4.59	206 ± 113	50.7 ± 58.2	55 (100%)
BND ($N = 20$)	313 ± 176	151 ± 76.2	222 ± 117	64.3 ± 24.5	5.75 ± 4.10	155 ± 178	69.6 ± 96.1	13 (65%)
US ($N = 10$)	272 ± 148	116 ± 61.2	180 ± 88.1	62.4 ± 30.8	6.90 ± 3.31	126 ± 78.9	29.0 ± 27.3	9 (90%)
DV ($N = 88$)	314 ± 156	146 ± 60.7	210 ± 73.7	48.2 ± 17.7	9.44 ± 6.63	120 ± 131	70.2 ± 93.7	56 (64%)
PRPF ($N = 54$)	377 ± 140	166 ± 63.7	276 ± 81.9	20.1 ± 8.7	9.70 ± 5.85	108 ± 101	75.7 ± 72.7	0

BND = bladder neck dysfunction; CBC = cystometric bladder capacity; Compl = compliance; DO = detrusor overactivity; DU = detrusor underactivity; DHIC = detrusor overactivity and inadequate contractility; FS = full sensation; FSF = fist sensation of filling; Pdet = detrusor pressure; PRPF = poor relaxation of pelvic floor; PVR = postvoid residual; Qmax = maximum flow rate; US = urethral stricture.

and those with normal VUDS findings comprised 48% of the patients with symptoms of difficult urination. Women with increased bladder sensation or DO might feel difficult urination when their bladders are not full enough during voiding. Obstructive symptoms, such as slow stream, dribbling, and straining, are often reported by patients with painful bladder syndrome and IC. One study reported that 48% of IC/PBS patients had BOO, and an increasing severity of IC/PBS was associated with higher voiding pressures [13]. It is not easy to differentiate true voiding dysfunction from nonvoiding dysfunction based on voiding symptoms alone. However, currently there are no standard guidelines or questionnaires for the differential diagnosis of voiding dysfunction in women with LUTS.

Among all investigation tools, video urodynamics is considered the gold standard for the diagnosis of voiding dysfunction. If a pressure flow study is not performed, then women with LUTS may have voiding abnormalities that are missed by cystometrography alone [14]. In dysfunctional voiding, hypertonicity and instability of the external urethral sphincter during filling cystometry and impaired external sphincter relaxation during emptying are pathognomonic findings [12]. Pressure-flow analysis could reveal the existence of BOO and the contractility of the detrusor [11].

Interestingly, in this study, storage symptoms were the main LUTS in about 15%–37% of women with voiding dysfunction. However, most of the voiding dysfunction subgroups had both storage and empty symptoms, with or without pain. In addition to the patients with DU, few patients with voiding dysfunction complained of storage or empty symptoms alone.

A diagnosis of voiding dysfunction cannot be made by simple urodynamic study such as uroflowmetry, cystometry or postvoid residual volume. A pressure flow study to investigate the voiding pressure and flow rate during the voiding phase is essential. Compared with the normal VUDS subgroup, the CBC and the bladder compliance were significantly smaller in the other voiding dysfunction groups, indicating that patients with voiding dysfunction might also have a sensory disorder of the bladder. BOO (BND, US, DV) was characterized by a high Pdet and low Qmax and low detrusor contractility (DU, DHIC) by a low Pdet and low Qmax. All voiding dysfunction subgroups had a large PVR. Without VUDS, the actual vesicourethral dysfunction cannot clearly be determined.

Low detrusor contractility due to DU or DHIC was the most common etiology of voiding dysfunction in women, and was seen in 57.5% of women with voiding dysfunction in this study. It is not surprising to find the mean age of women with DU was significantly older than those in the other voiding dysfunction subgroups. Aging women might have multiple medical diseases and loss of systemic energy, which causes the detrusor to contract inadequately and results in a large PVR or urinary retention [15]. Structural and functional changes accompanying aging may result in altered bladder afferent function, with subsequent reflex impairment of detrusor voiding function [16]. Although DU is somewhat reversible, women with low detrusor contractility and a large PVR should be managed with clean intermittent catheterization until bladder function has recovered [17].

In this study, we also found that the bladder first and full sensations were reduced in women with DU and DHIC. Although the bladder capacity was smaller than in the controls, patients had an impaired bladder sensation with (in DHIC) or without (in DU) DO causing urinary incontinence or urinary retention. Previous study has provided electrophysiologic evidence that indicates an association between impaired A-delta as well as C fiber bladder afferent pathways and poor emptying function in women with diabeten with detrusor underactivity [18]. Geriatric urge incontinence, especially in combination with reduced bladder sensation, is associated with specific cortical abnormalities such as frontal and global cortical underperfusion and cognitive impairment [19].

Pelvic floor dysfunction involves the development of hypertonic and dysfunctional muscles resulting in elimination problems, chronic pelvic pain, and voiding disorders [20]. DV is a condition characterized by lack of coordination between the urethral sphincter and detrusor during voiding [3]. PRPF is a condition in which the pelvic floor muscles fail to relax in initiation or during micturition. Although these two LUTD are possibly due to different etiologies, they may present with similar symptoms. Storage symptoms are even more common than voiding symptoms in women with DV [12]. We found that most women with PRPF presented with both storage and voiding symptoms, but it is not easy to differentiate between PRPF and DV without VUDS.

This study also revealed that PRPF was commonly found in women with voiding dysfunction. VUDS frequently shows that a woman is a nonvoider or needs to void with the aid of abdominal straining [21]. Therefore, free voiding uroflowmetry is important to establish a diagnosis of PRPF. Only in women with consistent uroflow-metric findings between free uroflow and VUDS can a diagnosis of PRPF be made. The Pdet in PRPF is normal and the CBC is significantly greater than in female BOO, suggesting that the voiding dysfunction among women with PRPF is probably due to pelvic floor muscle dysfunction but not anatomic BOO.

In this study, difficult urination was the most common main symptom in patients with anatomical BOO (85% in BND and 80% in US). Although difficult urination was also commonly found in patients with DV and PRPF (62.1% and 57.4%, respectively), more women with DV had storage symptoms such as frequency, urgency, and UUI as main symptoms. This difference in presenting symptoms between these BOO subgroups could be due to different pathophysiology in functional and anatomical bladder outlet disorders in DV and BND or US. Patients with increased urethral sphincter tone and pelvic floor muscle hyperactivity not only have increased urethral resistance but also increased bladder sensation or they develop DO through neuromodulation, resulting in different types of sensory dysfunctions [22].

4. Conclusion

This study revealed that LUTS in women with voiding dysfunction involves several different vesicourethral conditions. Storage and voiding symptoms are common in women with voiding dysfunction. However, the differential diagnosis of these LUTD cannot be based on LUTS alone. VUDS provides the best tool for investigation of voiding dysfunction in women.

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