Clinical Evaluation and Investigations in Women with Stress Urinary Incontinence: An Overview

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ABSTRACT

Urinary incontinence (UI) is defined as the complaint of any involuntary loss of urine. UI can be slightly bothersome or totally debilitating. For some women, the risk of public embarrassment prevents them from enjoying many activities with their family and friends. Women are four times more likely to be affected by UI compared with men. Stress urinary incontinence (SUI) is the most common type of UI in women below age 60 and accounts for almost 50% of incontinence in all women. The minimum evaluation in women with symptoms of uncomplicated SUI includes history, urinalysis, physical examination, assessment of urethral mobility, demonstration of SUI, and measurement of postvoid residual urine volume. Additional diagnostic evaluation with multichannel urodynamic testing is helpful in women with complicated SUI, especially before surgical treatment. Clinical decision should help the health care providers to perform preoperative multichannel urodynamic testing or refer to an expert in urology who is skilled in female pelvic medicine and reconstructive surgery.

Key words: Clinical evaluation, diagnosis, stress urinary incontinence, urinary incontinence, urodynamic studies

INTRODUCTION

Urinary incontinence (UI) is one of the manifestations of pelvic floor dysfunction and defined as the complaint of any involuntary loss of urine that can be objectively demonstrated (1,2). On the contrary, continence is the ability to hold urine within the bladder at all times except during micturition (3). The continence mechanism includes a sophisticatedly organized series of nerves, muscles, and connective tissue that dynamically influence bladder control. This arrangement allows prompt and complete bladder emptying and also maintains continence during tremendous increases in abdominal pressure (4). Both continence and micturition depend upon the lower urinary tract, consisting of the bladder and urethra, which is structurally and functionally normal (3). Women are four times more likely to be affected by UI compared with men (5). Thomas et al. have shown that UI occurs twice or more per month in at least a third of the female population above the age of 35 years (3).

Female UI is a public health problem due to its high prevalence (200 million people around the world), significantly poor quality of life and depression, and cost of its management (6). The Clinical Practice Guideline issued by the Agency for Health Care Policy and Research defined four types of UI: stress, urge, mixed, and overflow. Some authors include functional incontinence as a fifth type of incontinence (7). SUI, urge urinary incontinence (UUI), and mixed urinary incontinence (MUI) are the three most common types of UI (8). The most common type of UI is stress urinary incontinence (SUI) (9). The International Consultation on Incontinence defines SUI as an involuntary loss of urine on physical exertion, sneezing or coughing (10), and a rise in abdominal pressure (11-14).

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The prevalence of UI is expected to increase with a change in demographics and an increase in the elderly population (10). Female patients with UI are increasingly seen in the physician's office because of its high prevalence (20%–30% of middle-aged and 30%–50% of elderly women) and growing expectations for relief by women affected by it (5,16).It has been estimated that 21% of the population will be 65 years and older by the year 2050. Hence, the probable growth in the incontinent patient population presents an alarming challenge to the health care community (5). SUI is a significant clinical problem at any given time with estimates of between 12% and 44% of women (17). In general, SUI affects around 50% incontinent women and a majority of women are young or middle aged. (18). SUI affects up to 24% of postpartum women (19).

The risk factors for SUI in women include advanced age, advanced pelvic organ prolapse (POP), pregnancy, obesity, constipation, weak collagen, and chronic obstructive airway disease (11). Pathophysiologically, SUI can be the result of bladder neck/urethral hypermobility and/or neuromuscular defects (intrinsic sphincter deficiency) (11,13,14). Internal sphincter deficiency (ISD) is used to describe damage to the urethral sphincteric mechanism, regardless of etiology. The urethra might be damaged owing to fixation (as in cases of spina bifida), prior surgery, or denervation or muscle damage during childbirth. ISD and hypermobility can exist concomitantly and alone (20).

Diagnosis

The clinical evaluation of women with UI includes patient history, physical examination, and measures of incontinence severity (21). Moreover, the clinical evaluation in women with symptoms of uncomplicated SUI includes history, urine examination, physical assessment, revelation of SUI, evaluation of urethral mobility, and postvoid residual (PVR) urine volume measurement (22).

• History: History provides an important basis for treatment, although it is not diagnostic (23). The reason for history taking is to find out the type of UI that is troublesome to the patient, which is commonly classified as stress, urge, postural, insensible (spontaneous), continuous, coital, overflow (chronic urinary retention), nocturnal enuresis, or some combination thereof (22). Additionally, while defining symptoms related to the type of incontinence, it is important to know the duration of symptoms, previous treatment for this condition and outcome of treatment, previous surgery for this condition or other related conditions, and activities that produce or exacerbate symptoms (5). The number of voids, type of pad, frequency of pad used and changed per day, and the amount of pad saturation are major considerations (24). To assess symptoms related to bladder storage (frequency, nocturia, urgency, and incontinence) and emptying functions (hesitancy, intermittency, slow stream, feeling of incomplete emptying, straining to void, spraying of urinary stream, postmicturition leakage, need to immediately revoid, position-dependent micturition, and dysuria), the patients are interrogated (1). UI is a major quality-of-life issue, and it is essential to assess to what degree the patient's symptoms impact her lifestyle (1, 3). Several disease-specific quality-of-life instruments have been developed to provide detailed information on how UI affects patient lives (25). Validated questionnaires such as Incontinence Severity Index, Questionnaire for Urinary Incontinence Diagnosis, and Urogenital Distress Inventory are useful for assessing the quality of life. Incontinence Impact Questionnaire, Incontinence-Quality of Life Questionnaire, International Consultation on Incontinence Questionnaire (3,22), and King's Health Questionnaire (3) are useful for evaluating the severity and relative contribution of UUI and SUI symptoms. Women with uncomplicated SUI have characteristic symptoms of leakage on effort or physical exertion. A functional component to the incontinence is typically ruled out in absence of cognitive impairment, and fistula is ruled out in absence of continuous leakage in women with recent pelvic surgery or radiation exposure points. Following the urologic history, systematic medical and neurologic histories are elicited (22).

• Past medical history: In addition to specific details describing urinary symptoms, other medical factors may be associated with incontinence. Obstetric trauma may be associated with damage to the pelvic floor support, which may lead to SUI. For this reason, information describing a prolonged labor, operative vaginal

delivery, macrosomia, postpartum catheterization for urinary retention, and increased parity may be valuable. Prior radiation therapy for malignancy may lead to irritative voiding symptoms or intrinsic sphincteric deficiency, which predisposes to SUI (23). Diabetes, thyroid disease, and neurologic disorders can cause UI (5). Moreover, drug history (including nonprescription medications) should be obtained to find out the influence of any individual drug on the function of the bladder or urethra that causes UI or voiding difficulties (26). Medicines that can affect lower urinary tract function include anticholinergics, analgesics, calcium-channel blockers, antihistamines, psychotropic drugs, caffeine, alcohol, diuretics, narcotic, drugs, alpha-adrenergic blockers, and alpha-adrenergic agonists. Additionally, gynecologic, obstetric, and surgical histories should be obtained. The Third International Consultation on UI recommends outcome measures, such as voiding diaries, pad tests, or quality-of-life questionnaires. However, due to time constraints, logistic difficulties, and lack of familiarity with the tools, the aforementioned measures are seldom used by clinicians in routine practice (27).

• Urinary symptoms: Seventy-seven percent women with SUI report their symptoms to be troublesome, and of these, 28.8% report their symptoms to be moderately to extremely worrisome; the degree of problem is related to the severity of SUI (28). Most women may void eight times per day or less. Increased voiding may indicate UUI, urinary tract infection (UTI), calculi, or urethral pathology without a history that reflects increased fluid intake. This needs prompt additional evaluation. Furthermore, urinary frequency is commonly associated with interstitial cystitis (IC), and women with IC may void more than 20 times per day. In women with UUI or in those with systemic fluid management disorders such as congestive heart failure, nocturia may be noted (5, 24). Diagnostic clues are also provided by the volume of urine lost with each episode. Spontaneous detrus or contractions associated with UUI typically lead to loss of large volumes and may frequently involve loss of the entire bladder volume. On the contrary, women with SUI usually describe loss of smaller volumes and are often able to contract the levator ani muscles to temporarily stop their urine stream. Postvoid dribbling is characteristically associated with urethral diverticulum, which may frequently be mistaken for UI. Hematuria, even though a common sign of UTI, may also show underlying malignancy and can cause irritative voiding symptoms. The onset of symptoms may also give information regarding the etiology and treatment. For example, the onset of symptoms with menopause may suggest that a hypoestrogenic state underlies incontinence. These patients may benefit from estrogen replacement. In contrast, symptoms after hysterectomy or childbirth may reflect changes in tissue support or innervations (1,5,24). Postural UI is related to a change of body position. Nocturnal enuresis occurs during sleep. MUI involves both UUI and SUI. Continuous UI is continuous involuntary loss of urine. In insensible UI, a woman is unaware how it has occurred. UI occurring with coitus is coital incontinence; it can occur with penetration or intromission and at orgasm (29).

• Physical Examination: Abdominal examination includes bladder fullness/retention, abdominal masses or ascites, and scars (indicating previous relevant surgery or traumas). Renal area examination is done for tenderness and masses (1,30).

General inspection and neurologic evaluation: Initially, the perineum is inspected for the evidence of atrophy, which may be noted throughout the lower genital tract. Additionally, suburethral bulging may indicate a urethral diverticulum and should be excluded during inspection (24, 31).

A detailed neurologic evaluation of the perineum is also important for a woman with incontinence, as neurologic responses may be altered in an anxious patient who is in a susceptible setting; signs obtained during examination may not signify true pathology and should be interpreted with caution. Absence of bulbocavernosus reflex may reflect central or peripheral neurologic deficits. A normal circumferential anal sphincter contraction, colloquially called an "anal wink," should follow cotton swab brushing of the perianal skin. Thus, an absent wink may point out neurologic deficits in this neurologic distribution (5,24).

The vaginal examination is usually performed with the woman's bladder empty.

Vulval/urethral examination: Abnormalities such as atrophic changes, cysts, lichen sclerosis, or other tumors are inspected on vulval examination. Urethra is examined for urethral mucosal

prolapse, urethral caruncle, and diverticulum or urethral discharge on massage of urethra. Urethral diverticulum might be mistaken as a lump or tenderness along the line of the urethra (3,5,29).

Bimanual and rectovaginal examination: In general, these portions of the pelvic examination provide fewer diagnostic clues to the underlying causes of incontinence. Vaginal examination is conducted to examine vaginal length and mobility, scarring and/or pain, and estrogenization. The location of any vaginal pain should be noted (29). A positive cough stress test confirms the diagnosis of SUI (5,31).

However, bimanual examination may reveal an enlarged pelvic mass or a uterus enlarged by leiomyomas or adenomyosis. These may prompt incontinence through increased external pressure transmitted to the bladder. In addition, stool impaction is common in nursing home patients and may lead to bladder urgency and subsequent UI (24,31).

• Pelvic support assessment:

POP evaluation: Prolapse coexists with SUI in up to 50% cases. 33 Poor urethral support usually accompanies POP. For example, women with considerable prolapse are frequently unable to completely empty their bladder due to urethral kinking and obstruction. These women habitually must digitally elevate or reduce their prolapse to allow emptying. Therefore, an external evaluation for POP is specified for all women with UI (5,24).

POP examination should be performed with the woman's bladder empty, since an increase in bladder volume limits the degree of descent of the prolapse (32). The degree of prolapse may be worse later in the day than it is earlier in the day. Descent of one or more of the anterior vaginal wall, posterior vaginal wall, uterus (cervix), or apex of the vagina (vaginal vault or cuff scar after hysterectomy) is called POP (29). Baden-Walker classification system is useful in grading POP. In this system, the hymen is preferred as the landmark (at the vaginal orifice) to evaluate genital prolapse. According to half-way system, uterine prolapse is graded as follows: 0, no prolapse; 1, half way to hymen; 2, to the hymen; 3, half way past hymen; and 4, maximum descent (33). POPQ (Pelvic Organ Prolapse Quantification) system is an adaptation of the Baden-Walker half-way system (34). The main limitation of the POPQ system is a time-consuming procedure, more complex to learn and communicate verbally, than the original Baden-Walker system. Using the POPQ system, the maximal protrusion of two points (Aa and Ba) is measured in the anterior vaginal wall, two points (Ap and Bp) in the posterior wall, C at the cervix, and D at the posterior fornix in the middle compartments. All measurements can be done with a ruler in centimeters. The hymen is used as the reference point (0). Measurements inside the hymen are negative, and measurements outside the hymen are positive. The aforementioned six measurements and the length of the perineal body (pb), from the hymen to the anus, and the genital hiatus (gh) from the hymen to the urethral opening are done while the patient is doing maximum Valsalva. The total vaginal length (tvl) is measured without Valsalva (35).The grading of POPQ includes stage 0 to stage IV. Stage 0 is if no prolapse is confirmed and in stage I, the most distal portion of the prolapse is more than 1 cm above the level of the hymen. In stage II, the most distal portion of the prolapse is 1 cm or less proximal to or distal to the plane of the hymen, and in stage III, the most distal portion of the prolapse is more than 1 cm below the plane of the hymen. Complete eversion of the total length of the lower genital tract is >stage IV (24).

Pelvic floor muscle function (PFMF): PFMF is elicited on vaginal or rectal examination in which the pelvic floor muscles are palpated with the examining finger to check muscle quality (for example, symmetry and bulk) and whether or not, and to what degree, a woman can volitionally contract her muscles (31).

Different methods are used to assess voluntary pelvic floor muscle contraction and relaxation by visual inspection, digital palpation (circumferentially), ultrasound dynamometry, electromyography, or perineometry. Factors to be evaluated include muscle strength, muscular endurance, voluntary muscle relaxation, duration, coordination, repeatability, and displacement. It is desirable to document findings for each side of the pelvic floor individually, to recognize any unilateral defects and asymmetry (29). The International Continence Society (ICS) report, evaluation of pelvic floor muscle function, includes normal pelvic floor muscles, overactive pelvic floor muscles, underactive pelvic floor muscles, and nonfunctioning pelvic floor muscles, where no action is palpable (36).

Examination for levator (puborectalis) injury: The presence of major morphological abnormalities of the puborectalis muscle may be assessed by palpating the insertion of puborectalis on the inferior aspect of the os pubis. Palpation of the bony surface of the os because of the absence of the muscle is noted in an "avulsion injury" of the puborectalis muscle, and the muscle is absent 2–3 cm lateral to the urethra (37).

Perineal examination: The perineum should show no downward movement when the patient is asked to cough or do Valsalva maneuver. Ventral movement may occur because of the guarding actions of the pelvic floor muscles (36).

Rectal examination: Observations can include anal sphincter tone and strength, anal sphincter tear, presence or absence of rectocele and, if possible, differentiated from enterocele, perineal body deficiency, presence or absence of fecal impaction, and other rectal lesions such as intussusception, rectovaginal fistula, tumors, hemorrhoids, fissures, and other perianal lesions (anocutaneous fistula) (29).

• Basic evaluation of Uncomplicated and Complicated SUI:

Uncomplicated SUI: In uncomplicated SUI, women have UI-associated physical exertion, coughing or sneezing without voiding symptoms, absence of recurrent UTI, no history of prior surgery for SUI or extensive pelvic surgery, and medical conditions that can affect lower urinary tract function. On physical examination, a vaginal bulge beyond the hymen and urethral abnormalities are absent and urethral mobility is present. PVR urine volume is less than 150 mL, and urinalysis/urine culture is negative for UTI or hematuria (3,5).

Complicated SUI: In complicated SUI, women present with symptoms of urgency, UI related to chronic urinary retention, incomplete emptying, functional impairment, or continuous leakage. Women may present with a history of current UTI, previous extensive or radical pelvic surgery (e.g., radical hysterectomy), anti-incontinence surgery or complex urethral surgery (e.g., urethral diverticulectomy or urethrovaginal fistula repair), presence of neurologic disease, poorly controlled diabetes mellitus, or dementia. Women may present with voiding symptoms such as the need to immediately revoid, slow stream, hesitancy, spraying of urinary stream, intermittency, straining to void, feeling of incomplete voiding, postmicturition leakage, dysuria, and position-dependent micturition. Physical examination confirms vaginal bulge or known POPpelvic organ on examination prolapse beyond the hymen, genitourinary fistula, or urethral diverticulum, and absence of urethral mobility. The PVRpost void residual volume is greater more than or equal to 150 ml mL (22).

Table 1: Investigations of female.

General practitioner/outpatient (Level I)
Urinalysis Frequency/volume chart Pad test Stress test Postvoid residual urine volume
Simple urodynamic tests (Level II)
Filling cystometry Voiding cystometry Subtracted cystometry Q-tip test Bonney's test
Complex urodynamic tests (Level II)
Multichannel cystometry Uroflowmetry Cystometrography Pressure flowmetry Urethral pressure profile flowmetry Stress leak point pressure Urethrocystoscopy Videocystourethroscopy Urethral electrical conductance Ultrasound Intravenous urography Cysteurethrography Ambulatory urodynamic Combines cystometry, and uroflowmetry with radiological screening of bladder with urethra Electromyography (identifies neurological defect at the external or internal urethral sphincter) Magnetic resonance imaging: To show multicompartmental prolapse

• Diagnostic testing: An accurate diagnosis can be reached with appropriate investigations (3).The test has three levels: basic screening test (level I), simple urodynamic tests (level II), and complex urodynamic tests (level III) (Table 1).

1. Basic screening test (Level I): Urinalysis, voiding dairy, PVR urine measurement (23), stress test, and pad test (3,38).

• Urinalysis and culture: In all women with UI, urinalysis helps to exclude bacteriuria, hematuria, pyuria, glycosuria, and proteinuria. Urinalysis and urine culture are performed at an initial visit (38). Infection is treated, and persistent symptoms should prompt additional evaluation (1, 23, 24).

• Frequency–volume chart/Bladder diary: The simple noninvasive assessment such as bladder chart or bladder diary can be extremely useful in determining the cause of a woman's symptom.

(i) Frequency–volume chart (FVC): The recording of the time of each micturition and the volume voided for at least 24 h. More useful clinical data are usually provided by 2 or 3 days of recording (not necessarily consecutive) (3,5,29).

(ii) Bladder diary: The voiding diary is a 24-h record of the patient's fluid intake and output, pad usage, degree of incontinence, and episodes of incontinence (3,29,38). Evaluation of a 3- to 7-day diary is also helpful clinically to plan the management (38).

The voiding diary identifies polyuria, defined as excessive urine production, which requires further investigation to exclude diabetes (23).

1. PVR: This volume is routinely measured during incontinence evaluation. After a woman voids, the PVR may be measured with a handheld sonographic scanner or by transurethral catheterization (1,24,38). PVR test should be carried out within 10 min of a void, as it prevents the incidence of an artificially high result due to diuresis. A PVR volume of less than 50 mL is normal, and a volume of more than 200 mL is abnormal. Many women are unable to void well during an anxiety-ridden first visit. It is recommended to recheck the PVR volume at a future visit before embarking on further diagnostic tests (23,31). If using a handheld scanner, care must be taken in women with an enlarged leiomyomatous uterus, as this may falsely record a large PVR. In these instances, or if a scanner is not available, transurethral catheterization may be used to confirm residual bladder volume (24,31). A large PVR may often reflect one of several problems, including recurrent infection, urethral obstruction from a pelvic mass, or neurologic deficits. In contrast, a normally small PVR is often found in those with SUI (28). PVR is normal in SUI, UUI, and MUI.

2. Stress test/cough stress test/provocative stress test: It is an easy test that involves filling a patient's bladder to at least 300 mL or symptomatic fullness. This test is useful for diagnosing SUI, and considered positive when leakage is observed from the external urethral meatus during cough. The provocative stress test has demonstrated good sensitivity and specificity in diagnosing genuine SUI (GSUI) compared with other sophisticated testing methods (multichannel urodynamic studies). Scotti and Myers have reported that simple cystometry along with cough stress test is highly consistent in diagnosing GSUI. Wall et al. have reported that bladder filling without pressure measurement, combined with a cough stress test, is a simple, cost-effective, and consistent way of selecting patients with UUI related to detrusor overactivity from patients with straightforward SUI. Swift and Ostergard recommended that the cough stress remains a highly specific test, predominantly when combined with a prior negative cystometrogram (5,39).

The supine empty stress test (SEST) is performed with the empty bladder and said to be positive if the patient loses urine on cough. Lobel and Sand found that the SEST had 65%–70% sensitivity and 67%–76% specificity for predicting ISD. The interpretation of cough stress test is negative if no leakages occur with the cough stress test. The cough stress test is considered positive if instantaneous leakage occurs with the cough stress test. The cough stress test is positive (mixed) if leakages occur in spurts, and detrusor overactivity is considered if delayed leakage occurs with flow. If leakage occurs with empty bladder in a supine position, ISD is regarded (39).

• Clinical use of stress test: A negative cough stress test rules out most cases of SUI. A positive cough stress indicates a good correlation with the presence of SUI.

However, the diagnosis of SUI should be confirmed by multichannel studies if uninhibited detrusor contractions are observed during a cystometrogram, preceding the cough stress test.

Predominantly, if a conservative therapy is considered, the cystometrogram and cough stress test are not essential for a basic evaluation. However, in a more invasive treatment, the cystometrogram and cough stress test should be performed (39).

• Pad test: Incontinence can be confirmed by performing a pad weighing test.25 Pad testing is a noninvasive, simple, and effective method of quantifying the amount of urine loss in patients with UI. This test was initially proposed by Sutherst et al. in 1981 and modified by the Standardization Committee of the ICS in 1988. Pad testing may also be useful in documenting UI that is not discovered on clinical or urodynamic evaluation (40). Several pad tests have been described in the literature, such as short-term pad tests that last 15 min to 2 h and can be performed in the office and long-term pad tests that last 24–48 h and can be performed while patients go about their everyday life in their usual surroundings (41).

• Standardized 1-h pad test: The pad test is used for an objective quantification of UI. The subject is asked to drink 500 mL of water. Then, she applies a preweighed perineal pad to her perineum and spends the next hour walking around, performing normal household duties. She performs a series of exercises, including coughing and deep knee bending and washes her hands under running water before the pad is reweighed (3).

Versi et al. found that the 1-h pad test had a positive predictive value of 92% and a negative predictive value of 53% when screening for lower urinary tract dysfunction. Lose and Versi used the same test for diagnosing GSUI in patients who had no other urodynamic abnormality; the positive and negative predictive values were 91% and 72%, respectively (5,42).

2. Simple urodynamic tests (Level II): This level includes filling cystometry, voiding cystometry, and Q-tip test.

• Urodynamic studies (UDS): These tests are a dynamic assessment of the lower urinary tract and offer objective information about bladder and urethral function. However, they are invasive, embarrassing, expensive, and time-consuming. The aim of urodynamics is to achieve a diagnosis, and differentiating between SUI and OAB in a woman with a mixture of symptoms is arguably the most useful information these test provide (1).

• Indications for UDS: The indications for UDS are in patients with symptoms of voiding difficulty and neurological disease when conservative treatment has been tried and failed, prior to surgery, and when surgery has failed (1).

Despite these indications, UDS remain controversial. Leakage noted during testing is not always clinically relevant. In contrast, testing may be uninformative if the original offending maneuver or situation that led to incontinence cannot be reproduced during evaluation. Moreover, objective confirmation of the diagnosis is not always necessary, since empiric therapy in women with urge-predominant symptoms is reasonable (24).

• Simple cystometry: Objective measurements of bladder function are combined in a battery of tests termed cystometrics. Cystometrics may be simple or multichannel and differ in their sensitivity. Simple cystometrics allows determination of SUI and detrusor overactivity, as well as measurement of first sensation, desire to void, and bladder capacity. This procedure is easily performed using sterile water, a 60-mL catheter-tipped syringe, and urinary catheter, either Foley or Robnell. The urethra is sterilely prepared, the catheter is inserted, and the bladder is drained. A 60-mL syringe with its plunger removed is attached to the catheter and filled with sterile water. Water is added in increments until a woman feels: (1) a sensation of bladder filling, (2) an urge to void, and (3) her bladder maximum capacity.

Water volumes are noted at each three of these points. Changes in the fluid meniscus within the syringe are monitored. Any meniscus elevation indicates bladder contraction and establishes a diagnosis of detrusor overactivity. Once bladder capacity is reached, the catheter is removed, and the woman is asked to perform a Valsalva maneuver or cough while standing. Leakage indicates SUI. Advantageously, simple cystometrics are easy to perform, require inexpensive equipment, and can typically be completed by most gynecologists. The limitation of simple cystometric testing, however, is its inability to reflect changes found with ISD (24).

Simple cystometry is subject to two main sources of error. First, the intravesical pressure cannot be measured constantly during bladder filling. So, sequential bladder filling must be employed. Second, measurement of the intravesical pressure does not always precisely represent changes in detrusor pressure. Hence, subtracted cystometry is required, which involves measuring the intravesical and the intra-abdominal pressure simultaneously (3). The information that is obtained from a subtracted cystometrogram includes sensation, capacity, contractility, and compliance (25). The values for cystometry are as follows: normal: residual urine <50 mL; first desire to void: 150–250 mL; cystometric capacity: 400–600 mL; maximum detrusor pressure: filling: <15 cm water (voiding: <70 cm of water; multichannel: only 10% patients require it); peak flow rate: >15 mL/s; single channel (sensitivity 100%; specificity 51%) and multichannel: only 10% patients require it (3,38).

•Voiding cystometry: The filling catheter is removed before voiding to prevent any unnecessary urethral obstruction following the completion of filling cystometry. Allowing simultaneous measurement of detrusor pressure along with the urine flow rate, the intravesical and rectal pressure recording lines are left in situ. As with uroflowmetry, the patient is asked to void while sitting on a flowmeter in private. During normal voiding, a coordinated contraction of the bladder and at the same time relaxation of the urethra are observed, which are sustained until the bladder is empty. Women normally void with a detrusor pressure of less than 60 cm H2O and a peak flow of >15 mL/s for a voided volume of at least 150 mL. If detrusor pressure during voiding is reduced with low flow rates and a noteworthy postmicturition residual is observed then the patient is considered to have voiding difficulty. In women, voiding problems are probably secondary to impaired detrusor contractility and infrequently because of bladder outflow obstruction. Bladder outflow obstruction is exemplified by a raised detrusor pressure during voiding and low flow rate. Furthermore, the patient may use additional abdominal straining to improve the intravesical pressure.

Detrusor sphincter dyssynergia is pathological contraction of the external sphincter that occurs during a bladder contraction, mainly in women with overt neurological disease. Typically, a high detrusor pressure is observed during voiding related to poor flow rate. In a few women, urinary retention may happen, and therefore catheterization is necessary (3). The results of urodynamic investigation may be confounded by discomfiture or an unknown testing environment, as both relaxation of the urethral sphincter and initiation of voiding are subject to cortical influence (3).

Subtracted cystometry is performed to know true detrusor pressure (DP). The true DP is equal to intravesical–intra-abdominal pressure. The normal value is ≤10 cm H2O (300 mL) and ≤ 15 cm H2O (500 mL), with no abnormal detrusor activity during filling (38).

• Q-Tip test: This test was introduced by Crystle et al. (1972). It measures urethrovesical junction (UVJ) mobility (43). If a urethra is poorly supported, it may display hypermobility during increases in intra-abdominal pressures. To assess mobility, a clinician places the soft end of a cotton swab into the urethra to the UVJ. Failure to insert the swab to this depth typically leads to errors in the assessment of the UVJ support. Termed the Q-tip test, this evaluation may be uncomfortable, and application of intraurethral analgesia may prove helpful. Commonly, 1% lidocaine jelly

is placed on the cotton swab prior to insertion. Following placement, Valsalva maneuver is prompted, and the swab angle excursion at rest and with Valsalva maneuver is measured using a goniometer or standard protractor. An angle excursion at rest or with Valsalva maneuver greater than 30 degrees above the horizontal indicates urethral hypermobility, and may help in the direct planning of surgical treatment for SUI (5,24,43).

• Bonney's test: This test aims to see whether an uplift of the urethrovesical function stops the incontinence during times of raised intra-abdominal pressure, thus guiding the type of surgery required. With the patient in a dorsal position, light pressure is applied on the sides of the upper urethra without causing an uplift. A positive test is indicated by the control of urinary leakage from the vagina with closure of the internal sphincter by pressure. The usefulness of this test is not to demonstrate the patient remaining dry but to find the patient who continues to leak in spite of the correction of normal anatomic support and is thus suspicious of having a significant element of intrinsic urethral sphincter weakness of deficiency (44).

3. Complex urodynamic test (Level III): Certain patients require complex testing before surgical therapy can be performed. Patients who may benefit from multichannel subtracted urodynamic testing are older than 50 years of age with a history of radical pelvic surgery, pelvic irradiation, or both, incontinence or prolapse surgery, severe POP, no evidence of anterior vaginal relaxation, continuous incontinence, no urethral hyper mobility, hematuria with negative urine culture, possible urethral diverticulum, and inconclusive or confusing office evaluation (5).

Complex urodynamic test includes multichannel cystometry, pressure flow voiding studies, urethrocystoscopy, and urethral pressure profile.

• Multichannel cystometrics: As noted, simple cystometric testing does not identify ISD. This determination is important, since this diagnosis may potentially preclude certain surgical options. Additionally, multichannel cystometrics provides more information on other physiologic parameters of the bladder, not afforded by simple cystometrics. Multichannel cystometrics is more commonly performed by urogynecologists or urologists due to limited equipment availability and increased costs. Testing can be performed with a woman standing or seated upright in a specialized urodynamics evaluation chair (7,24). During testing, two catheters are used. One is placed into the bladder and the other into either the vagina or the rectum. The vagina is preferred unless advanced prolapse is evident because stool in the rectal vault may obstruct catheter sensors and lead to inaccurate readings. Additionally, vaginal placement for most women is more comfortable (24). Using catheters with a special transducer, the patient's bladder is filled with sterile saline at 75–100 mL/min. As the bladder is filled, the patient is instructed to note when she senses the first urge to void, a full bladder, and maximum holding capacity. Bladder and true DPs are measured during filling, and detrusor activity is recorded. True DP is calculated by subtracting abdominal pressure from bladder or vesical pressure. An increase in true DP associated with leaking and urgency confirms detrusor instability. Provocative testing is usually performed if bladder instability has not yet been demonstrated. Once a full bladder capacity is achieved or 300 mL has been infused, filling is stopped and the patient is asked to cough and then perform Valsalva maneuver. If these fail to stimulate a detrusor contraction, further provocative testing with running water can be performed. If SUI or detrusor instability has not been documented at this point, the patient should be challenged in the standing position. With a full bladder, the standing patient is asked to cough, bear down, heel bounce, and listen to the running water. Bladder stability is then confirmed if no detrusor contractions are documented in the sitting or standing position (5,24).

Ambulatory cystourethrovaginometry is an alternative to stationary cystometry. Ambulatory testing was developed to enhance detection of patients who have incontinence and who are unable to demonstrate their

leakage in the urodynamics lab. The ambulatory setup and catheter placement are similar to those used for stationary cystometry. The catheters, however, must be either taped or sutured in place. Leakage can be recorded using pads with special sensors or conductance rings on the catheter. Advantages of ambulatory cystometry also include antegrade bladder filling, which is more natural. Patients may also feel more relaxed about demonstrating incontinence episodes if the stress of performing is removed (5).

• Uroflowmetry: Initially, women are requested to empty their bladder into a commode connected to a flowmeter (uroflowmetry). After a maximal flow rate is recorded, the patient is catheterized to measure a PVR as well as to ensure an empty bladder prior to further testing. This test provides information on a woman's ability to empty her bladder. It can identify women with urinary retention and other types of voiding dysfunction (24). In women, for a volume of 150 mL of urine voided, the normal recording is a bell-shaped curve with a peak flow rate of at least 15 mL/s. In an asymptomatic woman undergoing incontinence surgery, a reduced flow rate may be important, as she is more likely to develop voiding difficulties in the postoperative period (3,5).

• Cystometrography: Following uroflowmetry, cystometrography is performed to determine whether a woman has urodynamic evidence of SUI or detrusor overactivity (DO). Moreover, this test provides information on bladder threshold volumes at which a woman senses bladder capacity. Delayed sensation or a sensation of bladder fullness only with large capacities may indicate neuropathy (5,24). Conversely, extreme bladder sensitivity may suggest sensory disorders such as IC. For the cystometrogram, a 6-F microtransducer catheter is inserted transurethrally into the bladder, and a second catheter is inserted into the vagina. For women with advanced prolapse who may not be able to accommodate or retain the second catheter in their vagina, the second catheter is placed in the rectum. The bladder is filled with 0.9% NS at a rate of 100 mL/min using a cystometric pump. During filling, a woman is asked to cough at each 50-mL interval. Additionally during filling, the volumes at which the first desire to void and maximal bladder capacity are reported are recorded (24).

From pressure readings, DO and/or urodynamic SUI may be identified. Once 200 mL of saline has been instilled, an abdominal leak point pressure is measured. The patient is asked to perform a Valsalva maneuver, the pressure generated by the effort is measured, and evidence of urine leakage is sought. If leakage is seen when a pressure of less than 60 cm H2O is generated, then criteria have been met for a diagnosis of intrinsic sphincteric deficiency. Using the true zero of intravesical pressure as the baseline, at a bladder volume of 200 mL, abdominal leak point pressures are measured. However, the volume at which this test is performed varies from institution to institution, with some choosing to use bladder capacity and others choosing to use 150 mL as the testing volume. Readings are obtained or calculated and include: (1) intra-abdominal pressure, (2) vesicular pressure, (3) calculated DP, (4) bladder volume, and (5) saline infusion flow rate. From these catheter readings, information regarding bladder, intra-abdominal, and DPs can be obtained (5, 24).

• Pressure flowmetry: This evaluation usually follows cystometrography and is similar to the uroflowmetry conducted at the beginning of urodynamic testing. A woman is asked to void into a beaker that rests on a calibrated weighted sensor. Maximum flow rate and PVR are once again recorded. However, during voiding, a woman now has a microtip transducer catheter in her bladder, which provides additional information regarding DP at maximum flow. This is particularly useful in women who may have incomplete bladder emptying. As noted earlier, in women with urinary retention, the offending source may be obstruction or poor detrusor contractility (3,5,24).

• Urethral pressure profilometry: The final part of UDS testing is the urethral pressure profile (UPP) (24). The resting UPP is a graphical record of pressure within the urethra at successive points along its length (3). Usually in this test, 200 mL volume is instilled in the bladder. However, again, this volume is often institution dependent. This test provides valuable information on the intrinsic properties of the urethra and aids in diagnosing ISD. A diagnosis of ISD is made if the MUCP is 20 cm H2O or less (24).

• Stress leak point pressure: This involves a dynamic assessment of urethral function in a patient with GSUI. With 150 mL of fluid in the bladder, the patient is asked to gradually bear down. The Valsalva pressure at which leakage occurs is measured. If leakage occurs at a relatively low pressure, that is, less than 60 cm H2O, intrinsic urethral function is poor, and a sling procedure should be considered (7,23).

• Urethrocystoscopy: Endoscopic evaluation of the urethra and bladder can detect urethral inflammation, urethral diverticulum, IC, and various bladder lesions. This procedure can be performed easily in the office setting if appropriate training for the examiner has been completed. If a urethral diverticulum is suspected or a postoperative patient presents with postoperative symptoms that cause concern, cystoscopy should be performed. However, it has limited use in diagnosing GSUI (5).

• Video cystourethrography: It is the single most informative investigation that combines cystometry, uroflowmetry, and radiological screening of the bladder and urethra (25). The whole investigation can be recorded on a video tape or computer with a sound commentary for immediate and later replay, which helps in facilitating diagnosis, audit, data storage, research, and education. It is particularly useful for patients in whom previous incontinence surgery has failed or who have mixed or unusual symptoms and neurological disorders. However, in other conditions, it has no advantage over subtracted cystometry (3).

CONCLUSION

UI can be a physically and mentally devastating disorder. SUI, UUI, and MUI are the three most common types, and of these, SUI is the most common in women. Obstetrician–gynecologists play an imperative role in diagnosing and treating SUI. The American Urogynecologic Society recommends history taking, urine examination, physical assessment along with POP, cough stress test, evaluation of urethral mobility, and measurement of PVR urine volume for assessing a patient with symptoms of uncomplicated SUI. However, in women with complicated SUI additional diagnostic evaluation with multichannel urodynamic testing mainly before surgical treatment is beneficial. The health care provider's decision regarding clinical judgment must direct to refer the patient to an expert with appropriate training and skills in female pelvic medicine and reconstructive surgery or to perform preoperative multichannel urodynamic testing.

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