

Review Article

The diagnosis and treatment of lower urinary tract dysfunction in children: a clinical perspective

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ABSTRACT

The abnormalities in the filling and/or emptying phases of the bladder, with no obvious anatomical or neurological abnormality are considered as Functional disorders of the lower urinary tract (LUT). The term lower urinary tract dysfunction (LUTD) includes a wide spectrum of disorders with variable clinical presentation. LUTD is a common problem seen in daily practice that accounts for up to 40% of paediatric urology clinic visits in a year. The fact that it has been reported to affect 5–20% of all children highlights the clinical significance of this disorder. A thorough literature review of the studies, recommendations and practice guidelines of LUTD in children was done based on the clinical experience of the management of these children over the past decades. All the currently relevant information was summarized under the specific headings pertaining to diagnosis, classification and therapy. Any functional disturbance in voiding (abnormal holding and/or voiding pattern) that occurs beyond the expected age of completion of toilet training, in the absence of anatomical or neurological causes, is considered a Voiding disorder. LUTD include a wide spectrum of clinical entities that inhibit the development of normal urinary control and originate from behavioural factors that affect toilet training. LUTD is often associated with functional constipation and emotional/behavioural disorders. LUTD can lead to vesicoureteral reflux (VUR) and recurrent urinary tract infections (UTIs) with a significant risk of progressive renal scarring. The evolution of the understanding of the physiological basis of these disorders, aetiological factors, clarity in nomenclature and categorisation and advances in functional assessment have enabled the prospect of more definitive diagnosis and better therapy. Greater insight into the correlation of the findings of functional studies with specific disorders have facilitated more scientific and targeted therapy. The recognition of the importance of treatment of underlying factors and the use of escalating treatment protocols involving multiple specialists have aided to develop a more holistic and comprehensive therapeutic regime.

Keywords: Bowel bladder dysfunction, Dysfunctional voiding, Functional constipation, Lower urinary tract disorders, Uroflowmetry, Urodynamic study, Urotherapy, Voiding disorders

INTRODUCTION

Functional disorders of the lower urinary tract (LUT) include abnormalities in the filling and/or emptying phases of the bladder, with no obvious neurological or anatomical abnormality. The term lower urinary tract dysfunction (LUTD) includes a wide spectrum of disorders with variable clinical presentation. LUTD is

commonly encountered in daily practice and accounts for up to 40% of paediatric urology clinic visits annually. The importance of this condition is highlighted by the fact that it has been reported to affect 5–20% of all children. A greater understanding of the pathophysiology, effective functional assessment and standardization of nomenclature has enabled better management of this group of conditions.

REVIEW

In most children, voiding control is usually established by four to five years of age. When lower urinary tract symptoms (LUTS) occur beyond that age, the condition is referred to as LUTD. Any functional disturbance in voiding (abnormal holding and/or voiding pattern) that occurs beyond the expected age of completion of toilet training, in the absence of anatomical or neurological causes, is considered a Voiding disorder.¹⁻⁴

These include a broad spectrum of clinical entities that inhibit the development of normal urinary control and may originate from behavioural factors that affect toilet training. LUTD is often associated with functional constipation and emotional/behavioural disorders such as anxiety, social isolation, depression and aggressiveness. LUTD can lead to vesicoureteral reflux (VUR) and recurrent urinary tract infections (UTIs) with a significant risk of progressive renal scarring.³⁻⁶

Classification of lower urinary tract dysfunction (LUTD)

The International Children's Continence Society (ICCS) classification of Lower Urinary Tract Dysfunction.¹⁻⁴ An age of five years or more (four years of age for bowel dysfunction) is the reference point used by the ICCS, because this age is used scientifically to characterize urinary incontinence disorders. Bladder and bowel dysfunction (BBD). Overactive bladder (OAB). Voiding postponement. Underactive bladder. Dysfunctional voiding. Bladder outlet obstruction. Stress incontinence. Vaginal reflux. Giggle incontinence. Extraordinary daytime urinary frequency (EDUF). Bladder neck dysfunction

There is considerable overlap between the conditions, borderline cases are very common and the symptom complexes often evolve with time. (A child with features of urge incontinence to begin with, can continue to have symptoms of voiding dysfunction/ voiding postponement and evolve to have features of underactive bladder.)

Symptomatology in lower urinary tract dysfunction³⁻⁶

Definitions

Urinary Incontinence is defined as an uncontrollable leakage of urine, which can be continuous or intermittent. Continuous incontinence or constant leakage of urine, is seen in conditions like urinary sphincter damage/ ectopic ureter. Intermittent incontinence refers to urinary leakage in small volumes during day/ night/ both.

Primary incontinence is defined as involuntary voiding in children less than five years of age who have never been previously dry. Secondary incontinence denotes involuntary voiding in children, who have previously been dry for more than six months.

Daytime (Diurnal) incontinence refers to involuntary urination occurring during the daytime. Enuresis is defined as involuntary voiding during sleep in children more than five years of age. This symptom of bedwetting is also called Nocturnal Enuresis.

Primary enuresis is defined as involuntary voiding during sleep in children more than five years of age who have never been dry. Secondary enuresis refers to involuntary voiding during sleep in children more than five years of age, who have previously been dry for more than six months. Monosymptomatic enuresis refers to involuntary voiding during sleep, without daytime urinary tract symptoms. Non-monosymptomatic enuresis refers to involuntary voiding during sleep, along with diurnal urinary tract symptoms.

LOWER URINARY TRACT SYMPTOMS (LUTS)

The symptoms of LUTD can be classified based on their relation to the voiding and/or storage phase of bladder function.

Symptoms related to storage function of urinary bladder³⁻⁶

Voiding frequency: Increased or decreased

If a child more than five years of age/ after attainment of bladder control, regularly voids eight or more times daily, it indicates increased daytime frequency. Three or fewer voiding per day indicate decreased daytime frequency.

Diurnal incontinence

This is the classical symptom associated with LUTD.

Association with enuresis

Children with enuresis associated with any other LUTS are diagnosed as non-monosymptomatic enuresis. LUTS relevant to this definition are increased/ decreased voiding frequency, daytime incontinence, urgency, hesitancy, straining, weak stream, intermittency, holding manoeuvres, a feeling of incomplete emptying, postmicturition dribble and genital/LUT pain.

Urgency

This is defined as the sudden and unexpected experience of an immediate need to void. The term is applicable only after the age of five years or attainment of bladder control, whichever is earlier.

Nocturia

This is defined as the need for the child, older than five years, to awaken at night to void. This is a common symptom and not necessarily indicative of LUTD.

Symptoms related to voiding³⁻⁶

These symptoms may not be reported by the child or observed by the parent, but have to be elicited in the clinical history.

Hesitancy refers to difficulty in the initiation of voiding/ the presence of a significant waiting period before the start of voiding. Straining refers to the application of abdominal pressure to initiate and maintain voiding, by the child. Weak stream refers to the observation of weak force of ejection of urinary stream. Intermittency refers to the occurrence of voiding in several discrete spurts, rather than in a continuous stream. This may be physiological up to 3 years of age.

Other LUTS

Holding manoeuvres refers to observable posturing/ strategies to postpone voiding or suppress urgency. These include standing on tiptoe, the classical “Vincent’s curtsy,” forceful crossing of the legs or squatting with heel pressed into the perineum. Feeling of incomplete emptying is a significant complaint in older children and adolescents. Postmicturition dribble refers to involuntary leakage of urine immediately after voiding has finished. Genital and LUT pain are usually nonspecific and difficult to localize.

COMORBIDITIES COMMONLY ASSOCIATED WITH LOWER URINARY TRACT DYSFUNCTION^{3-5,7-9}**Constipation/bowel dysfunction**

When constipation and LUTD are both present, the condition is referred to as BBD. Nearly half of all the patients presenting with LUTS also have evidence of functional constipation. Children with functional constipation are up to eight times more likely to have LUTD.

Behavioural disorders/ psychological associations

20-40% of children with LUTD have associated behavioural disorders. Behavioural disorders that evolve from stressors or adverse events that occurred at the time of toilet training have a contributory role in functional aetiology of LUTD. The evaluation of paediatric LUTD should thus include the detailed screening for psychosocial comorbidities.

Urinary tract infection (UTI)

The association between UTI and LUTD was most often noted for LUTD which are associated with urinary stasis (OAB). These two entities can form a vicious cycle by aggravating each other. It is important to recognize and treat associated or underlying LUTD in the management of UTI.

Vesico-ureteric reflux

Voiding against a closed sphincter increases intravesical pressure and contributes to the development and persistence of VUR. Targeted therapy for LUTD improves the spontaneous resolution rates for VUR. The patients with combined BBD and VUR are at higher risk for developing recurrent UTI than children with BBD/ VUR alone.

DIFFERENT TYPES OF LOWER URINARY TRACT DYSFUNCTION IN CHILDREN³⁻⁹

Bladder and bowel dysfunction denotes the constellation of LUTS associated with constipation and/or encopresis. The faecal loading in the rectum can cause chronic pelvic spasms, which result in incomplete bladder emptying and significant postvoid residual urine. Bladder symptoms such as urgency, frequency and incontinence are caused by problems in emptying and/or storage.

Overactive bladder is characterized by frequent episodes of an urgent need to void, countered by contraction of the pelvic floor muscles and holding manoeuvres. The hallmark of OAB is urgency and, thus, children with this symptom can be said to have an OAB. OAB may be associated with incontinence secondary to detrusor overactivity. OAB often presents in association with other types of LUTD, such as voiding postponement and dysfunctional voiding.

Voiding postponement is characterized by low daytime voiding frequency (three times/day or lesser), but is not associated with any postvoid residual urine. The child performs holding manoeuvres to postpone voiding. There is a high incidence of psychological comorbidity or behavioural disorders.

Dysfunctional voiding is characterized by contraction of urethral sphincter during voiding, discordant bladder and perineal activity, with or without postvoid residual urine and even storage symptoms like incontinence. There is failure to relax the bladder neck during voiding. This term should not be used loosely to denote all kinds of LUTD.

Underactive bladder describes the need to raise intra-abdominal pressure to initiate, maintain and complete voiding (straining). This is associated with low voiding frequency during the day (three times/day or lesser) associated with high postvoid residual urine. Detrusor underactivity is classical.

Giggle incontinence (*Enuresis Risoria*) is characterized by apparently complete voiding that occurs specifically during or immediately after laughing.

It is not a form of stress incontinence or due to weakness of the sphincter. Bladder function is otherwise normal. This is classically seen in school-age females. This has to

be distinguished from more common situations of sudden episodes of incontinence as in OAB. Vaginal reflux (vaginal entrapment and vaginal voiding) is characterized by incontinence after normal voiding in the absence of other LUTS. Prepubertal, toilet-trained girls with moderate incontinence episodes, consistently occurring within 10 minutes after normal voiding, are considered to have vaginal reflux.

Extraordinary daytime-only urinary frequency (EDOUF) /Pollakiuria refers to voiding frequently and with small volumes (average voided volumes are less than 50% of bladder capacity) during daytime only. The symptoms are limited only to the daytime, unlike in OAB. It is seen in early childhood (4–6 years of age) and associated with personal/ familial stressor events and usually runs a benign course. Children with EDOUF are predominantly male.

Bladder–neck dysfunction/ internal sphincter/primary bladder–neck dysfunction (PBNB) is a non-neurogenic entity characterized by failure of the bladder neck to relax and permit flow, causing functional obstruction at the bladder neck. The presentation is with LUTS, which are typical of other more common LUTD.

DIAGNOSIS OF LOWER URINARY TRACT DYSFUNCTION^{7-10,13}

Diagnosis of LUTD is essentially based on clinical history, physical examination, Bladder diary, symptoms score such as the dysfunctional voiding score system (DVSS), associated with uroflowmetry (UFM) and bladder ultrasonography to measure postvoid residual urine volume

Differential diagnosis of paediatric urinary incontinence

Anatomic

Ectopic ureter, Posterior Urethral Valves, Epispadias, Labial adhesions. Habitual, Behavioural (Voiding postponement), Functional (Hinman syndrome), Neurogenic bladder, Developmental defects, Endocrine disorders, Renal disorders, Genetic/ Syndromic (Neuromuscular disorders)

INVESTIGATIVE MODALITIES IN LOWER URINARY TRACT DYSFUNCTION

Urine flow measurements (Uroflowmetry-UFM)

The most commonly performed diagnostic procedure in paediatric functional urodynamic evaluation is the measurement of urine flow and residual urine with ultrasound scan. UFM is simple to perform, non-invasive and fast. It provides important data such as voided volume, voiding time, maximum flow rate, flow curve pattern and rate of flow. Flow measurement is one of the

cornerstones of diagnosis in LUTD. The addition of pelvic floor EMG recordings to this can increase the diagnostic value.^{9,10,13,14}

Urodynamic testing

Urodynamic studies investigate the filling and emptying phase of bladder function. Urodynamic testing in children with LUTD, without neurological abnormalities is only recommended in the situations like persistent failure of therapy, underactive bladder and significant bilateral dilation of the upper urinary tract on US.

Bladder storage function should be described in terms of bladder sensation, detrusor activity, bladder compliance and bladder capacity during filling cystometry. Urethral function in children is assessed by pelvic floor EMG.

Pressure flow studies constitute cystometric evaluation during voiding phase include observations including detrusor underactivity, dysfunctional voiding, detrusor-sphincter dyssynergia etc. observations regarding voided volume, residual urine and urine output (polyuria) also constitute part of Urodynamic assessment.^{13,14}

Urological evaluation in lower urinary tract dysfunction

The children who are detected to have hydronephrosis on US should undergo the standard evaluation, including selective use of voiding cystourethrogram (VCUG), intravenous urogram (IVU), Cystoscopy and isotope renal studies. VCUG demonstrates the presence and grade of VUR, bladder morphology (capacity, shape, postvoid residue and presence of wall irregularities/trabeculations) and configuration of urethra (persistent or intermittent narrowing in the region of external sphincter).^{15,16}

TREATMENT OF LOWER URINARY TRACT DYSFUNCTION

Principles of therapy

The underlying aetiology of symptoms is to be identified and targeted. Provide symptomatic relief of incontinence, constipation, UTI. Diagnose and treat comorbidities like behavioural disorders.

Prevent and protect upper tracts from progressive damage from UTI and VUR. Escalating regime/ stepwise approach, from the least invasive to more invasive therapies.

The clinical management aims at the appropriate sequential and selective use of multiple modalities and establishing a continuum between different therapies. These depend on the specific problems in a particular child. These broad guidelines require a great degree of individualization, which is critical to a successful outcome.^{15-17,20}

Therapeutic modalities

Urotherapy, constipation and bowel management, behaviour modification, biofeedback therapy, clean intermittent catheterization, pharmacotherapy (anticholinergics, α -blockers), botulinum toxin, neuromodulation.

Urotherapy

This conservative mode of treatment aims to rehabilitate the LUT and involves different therapeutic modalities and multiple healthcare professionals. It should be the initial step in the escalating protocol of management.

It involves combination of education, behaviour modification, treatment of constipation and cataloguing of voiding patterns and is termed standard urotherapy. Urotherapy is classified as standard therapy and specific interventions. Standard urotherapy includes the following:

Education of the child and parents regarding the basic anatomy and physiology helps to clarify LUT function. It is important to explain and create an understanding on how the particular child deviates from normal.

Instruction on how to resolve LUTD (bowel management/ treatment of constipation behaviour modification, timed voiding protocol).

Lifestyle advice, it includes diet modification, adequate fluid intake, regular bladder and bowel emptying patterns, review of optimal posture during voiding, avoidance of holding postures and proper hygiene.

Documentation of symptoms and voiding habits, using bladder diaries or frequency-volume charts and specifically developed mobile applications.

Support, confidence-building and encouragement by regular follow-up with the caregiver.

Specific interventions of urotherapy include various forms of pelvic floor muscle retraining (biofeedback), neuromodulation and intermittent catheterization.^{15-17,20}

Constipation and bowel management

Based on clinical history and physical examination, it is an essential prerequisite is to identify bowel dysfunction, which is frequently associated with LUTD.

The bowel management regime should be continued throughout the course of therapy to maximize beneficial effect on the LUTD resolution. It has been observed that relief of constipation can even result in disappearance of symptoms such as daytime urinary incontinence and enuresis.^{11,17-19}

Behaviour modification

The primary aim of the structured behaviour modification program is to establish normal micturition habits. Children should be encouraged to void prior to having a sense of urgency, to ensure complete bladder emptying and avoid abdominal straining. It is vital to set an individualized voiding regimen is so as to establish a consistent voiding routine for a particular child. The classic regimen advocates timed voiding with frequent voids scheduled every 2 hours during the day.^{17,18}

Biofeedback

The essential concept of biofeedback is the modulation of a bodily function in response to an auditory or visual representation of that function. This technique uses a non-invasive urodynamic instrumentation to measure, record and provide direct, instantaneous information to the child about the voiding function. The visual and auditory feedback (occasionally with interactive video games, called animated biofeedback) allows the child to become aware of and gain control over LUT function. This is done by teaching them how to voluntarily relax their sphincter and pelvic floor musculature during voiding.^{15,16,21}

Clean intermittent catheterization

In dysfunctional voiding and in children who postpone micturition, the detrusor muscle stretches and the bladder becomes chronically overdistended. This leads to bladder wall thickening resulting in OAB or an underactive bladder with the end result of myogenic failure. In these cases, large postvoid residual urine volumes, urinary incontinence and recurrent UTIs from stasis are common. CIC is a safe and effective treatment strategy to attain continence and reduce the rate of recurrent UTI in these children.^{15,16,18,19}

Pharmacotherapy

The feasible targets for therapeutic benefit from pharmacological therapy are the bladder body (specifically the detrusor muscle) and the bladder outlet (specifically the bladder neck and proximal urethra). Drugs that act on the detrusor muscle include bladder relaxants and anticholinergic therapies that facilitate storage by relaxing the detrusor smooth muscle.

The other objective is to improve bladder emptying by targeting the bladder outlet using α -adrenergic antagonists (α -blockers).

Therefore, anticholinergic agents and α -blockers are used to improve bladder filling and emptying respectively. These medications are generally initiated if the conservative measures have been exhausted or as part of an escalating treatment protocol.^{15,16,22,23}

Botulinum toxin

In refractory cases of LUTD, a new investigational pharmacologic approach to therapy is the reversible chemical denervation using botulinum neurotoxin type A (BoNTA). BoNTA is directly injected into the detrusor muscle (in patients with OAB) or external urinary sphincter (in patients with dysfunctional voiding) under cystoscopic guidance.^{18,19,24}

Neuromodulation

The objective of neuromodulation in LUTD is to block the afferent limb of the sacral reflex arc resulting in inhibition of detrusor contraction. Cutaneous (presacral area) and percutaneous approaches via peripheral nerves (implantable device at the posterior S3 foramen) have been employed.

The treatment options include sacral neuromodulation with implanted electrode (SNM), pudendal nerve stimulation and percutaneous tibial nerve stimulation (PTNS). Presacral transcutaneous electrical neurostimulation (TENS) has been successfully used for refractory OAB. SNM has been approved for use in urinary urgency/frequency, urge incontinence, pelvic floor dysfunction and nonobstructive urinary retention.^{15-17,25}

Assessment of outcome in lower urinary tract dysfunction

Researchers and/ or clinicians should recognize three basic principles of treatment outcomes according to the ICCS. The symptom frequency during baseline and after treatment each should be documented. The assessment of treatment response should be based on pretreatment baseline registration symptom frequency. This permits the patient grouping into responders and nonresponders. The response during treatment should be noted, as well as the response after cessation of treatment for a specified period; and these two responses may not be the same.

CONCLUSION

The evolution of the understanding of the physiological basis of these disorders, aetiological factors, clarity in nomenclature and categorisation and advances in functional assessment have enabled the prospect of more definitive diagnosis and better therapy. Greater insight into the correlation of the findings of functional studies with specific disorders have facilitated more scientific and targeted therapy. The recognition of the importance of treatment of underlying factors and the use of escalating treatment protocols involving multiple specialists have aided to develop a more holistic and comprehensive therapeutic regime.

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