Functional Voiding Disorders In Children

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Introduction

In higher vertebrates, nature interposed the urinary bladder between the kidneys and the external environment to allow continence. The bladder functions as a storage organ that can empty to completion at an appropriate time and place. At times problems relating to the bladder are obvious as in an incontinent, dribbling child where the problem may be due to an anatomical or neurological anomaly. But at other times they may not be so obvious and children present to the paediatrician, with problems such as recurrent urinary tract infections or nocturnal enuresis with daytime symptoms. Under such circumstances it is important to consider a possible functional voiding disorder and evaluate the child. Early intervention may prevent renal damage due to retrograde effects of high pressure within the bladder. Managing these children requires an understanding of the functioning of the urinary bladder.

Normal voiding and its control

The essential foundation for understanding any disease process is a firm concept of the underlying anatomy and physiology of the system involved. The main functions of the urinary bladder are storage and voiding. The lower urinary tract functions as a group of interrelated structures, whose joint function is to bring about efficient and low pressure filling and storage with continence and periodic and voluntary urine expulsion at normal pressure. Bladder filling and urine storage require accommodation of increasing volumes of urine at a low intravesical pressure with appropriate sensation, an outlet that is closed at rest and remains so during increase in intra-abdominal pressure and does not have involuntary bladder contractions. Bladder emptying requires a coordinated contraction of the bladder smooth muscle of adequate magnitude, concomitant lowering of resistance at the level of the smooth and striated sphincter and the absence of anatomic obstruction. For

the purpose of efficient storage, the bladder has the ability to stretch as a watertight reservoir. It is equipped with adequate sphincter continence and an ability to inhibit spontaneous contractions. Contraction of detrusor muscles along with relaxation of the internal and external sphincters is necessary for micturition. The functions of the bladder are controlled by a complex integration of autonomic and somatic nervous system as depicted in Fig. 1. The somatic and the central nervous system ensure cortical control of voiding, thus preventing enuresis. Coordinated and complete urine release depends on intact innervation. Autonomic innervations to the urinary bladder accomplishes this through parasympathetic and sympathetic pathways. The sympathetic system is responsible for effective bladder filling and the parasympathetic system for micturition. Somatic nerves innervate the striated muscles of the bladder outlet. Coordinated voiding results from viscerosomatic integration between these autonomic and somatic pathways [1]. The central mechanisms influencing urinary tract function are organised as a simple on-off switching circuit with a reciprocal

Fig. 1 : Neurogenic control of bladder function

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relationship between the bladder and its outlet. Urine storage and release therefore is dependent on voluntary neural mechanisms that involve the brain and the spinal cord, preventing enuresis. Although neural input plays a role in maintaining continence, urine storage also relies on the visco-elastic and myogenic properties of the bladder wall.

At birth, micturition is thought to occur spontaneously as a spinal cord reflex. Between one to two years of age there is a gradual increase in the bladder capacity along with neural maturation of the frontal and parietal lobe. Thus, the fully mature system has a generous bladder capacity, voluntary control of the external sphincter and an ability of the cerebral cortex to initiate and inhibit a detrusor contraction for any bladder capacity to enable voiding under socially acceptable circumstances.

Voiding Disorders

Defined as an essentially functional and abnormal pattern of micturition in the presence of an intact neuronal pathway and no congenital or anatomical abnormality of the urinary tract. There may be an abnormality either during the filling phase or the evacuation phase. Based on uro-dynamic studies, the voiding disorders are classified as either an urge syndrome with detrusor instability when it is a filling phase disorder or a dysfunctional voiding when it is an evacuation phase disorder [2]. Dysfunctional voiding may be a staccato or fractional voiding if there is bladder sphincter in-coordination referred to as dysynergia, which may result in a low pressure hypotonic “lazy bladder” leading to overflow incontinence.

The importance of diagnosing voiding disorders cannot be underestimated from the current day knowledge of them being associated with recurrent urinary tract infections with or without a vesico-ureteric reflux and incontinence or enuresis with daytime symptoms like dribbling. They may cause significant distress to the child and parents. The persistence of voiding problems following fulguration of posterior urethral valves has long-term consequences that need attention.

Voiding Disorders and recurrent Urinary tract infections(UTI)

Impairment in the function of the lower urinary tract can be a cause for recurrent UTI [3,4]. The incidence of the problem is reported as 8.4% in girls and 1.7% in boys [5]. In a recent study of 114 children with recurrent UTI with or without reflux, detrusor instability was noted in 45% and detrusor sphincter dysynergia in 7% [6].

Voiding disorder and vesico-ureteric reflux

The knowledge of vesico-ureteric reflux seems to

have improved with better understanding of bladder function. Rather than relating the disorder to primary abnormalities of the vesico-ureteric junction, reflux may be caused by abnormalities of detrusor contraction and secondary effects on the junction [7,8]. Bladder assessment studies in infants have shown a high incidence of detrusor instability [9], which may in part explain the natural course of the reflux, which is known to regress with age [10].

Voiding disorders and nocturnal enuresis

Primary monosymptomatic nocturnal enuresis is rarely caused by abnormal uro-dynamics of the bladder. However, when it is accompanied with daytime symptoms like frequency, dribbling or straining, further evaluation for a voiding disorder is useful [11].

Voiding disorders and posterior urethral valves

Between 25-40% of patients with severe posterior valves develop chronic renal failure before adolescence and require transplantation [12]. Koff et al reported progressive hydro-uretero-nephrosis and renal injury in 35% of children, inspite of valve ablation to relieve the obstruction [13]. All these children had polyuria and nocturia. Poor bladder sensitivity to fullness was noticed by parents and confirmed by uro-dynamic studies. Around 60% of children with valves are reported to have a bladder dysfunction [12]. They may have increased post void residues due to bladder sphincter dysynergia or a decompensated bladder. There may be pseudo-residues due to return of refluxed urine into the bladder. At times a pseudo-pseudo-residue is noted due to a functional vesico-ureteric junction obstruction during bladder filling even at normal bladder pressures, and this urine in the ureters empties into the bladder after voiding. Under these circumstances the bladder needs to be handled early in order to prevent worsening of renal function. Every child treated for a posterior urethral valve in infancy needs to be followed up for persistence of a dilated upper tract, which then would need bladder assessment. Rarely dysfunctional voiding may be associated with hypercalciuria [14]. Plenty of oral fluids and a low salt diet may help relieve the symptoms.

Evaluation

Whenever a child presents with recurrent urinary tract infections in the absence of an anatomical abnormality or enuresis with diurnal symptoms, the bladder needs evaluation. It should also be evaluated in a child with a persistent vesicoureteric reflux for whom surgery is being planned or in a child operated for posterior urethral valves in infancy with a dilated upper tract. Children with ano-rectal anomalies too are at risk of development of bladder dysfunction. A history of frequency and hold

manoeuvres like squatting with or without dampness of the underpants suggests detrusor instability. Symptoms may get aggravated in the evening when the pelvic floor muscles get fatigued and the child has taken in more fluids through the day. Children may reduce fluid intake to minimise wetting and the powerful pelvic floor muscle contractions lead to postponement of defecation. Net result of the two is constipation. This further worsens bladder functioning.

A bladder sphincter dysynergia usually presents with incontinence, urinary tract infections and constipation. The overactive pelvic floor muscles may not relax during voiding and simulate a true detrusor sphincter dysynergia secondary to a neurological problem. Residual urine is usually present.

The lazy bladder presents with infrequent voiding, urinary tract infections and overflow incontinence. Abdominal pressure is the driving force for voiding. This situation may result from long standing over-activity of the pelvic floor but no data is available to support this view.

A detailed history should include a frequency-volume charting of urine output and oral fluid intake for two to three days with a record of accidents/wetting. This gives a good idea about the functional bladder capacity, abnormal drinking habits, presence of polyuria and severity of the voiding problem. Frequent passage of small quantity urine suggests a small functional capacity bladder or incomplete emptying. Dampness of underpants and accidents occurring between voiding suggest either detrusor instability or overflow incontinence. Information about bladder and bowel training and a history of constipation may give important clues. A dysfunctional voiding score has been described using a simple questionnaire for symptomatology, which correlates well with abnormal uro-dynamic studies [15].

Prior to evaluation for a functional voiding disorder, a neurological basis for the problem needs exclusion. A detailed examination should include the lower back to look for clues suggesting spinal and sacral anomalies and the abdomen for a palpable bladder/kidneys. Well-developed lower abdominal muscles may occasionally be noted, especially in girls who use them to aid voiding. The lower limbs are assessed for tone, power and sensations, and the perineum for ectopic ureters, epispadias or vaginal pooling and labial adhesions in girls.

Investigations

In most children with a voiding disorder a detailed clinical assessment with a frequency-volume charting of urinary output recorded by the parents and an ultrasonography of the abdomen is all that is required. Plain X-ray of the abdomen is important to look for

calculi, evidence of constipation and bony malformations. Where necessary, a MRI scan of the spine is helpful to detect occult problems of the spinal cord resulting in a neurogenic bladder that mimics a voiding disorder. Urinalysis for evidence of UTI and a baseline specific gravity/osmolality for a possible concentration defect are necessary. Dilation of the upper tract, bladder size, wall thickness and the presence of post-void residues should be noted on ultrasonography.

A micturating cystourethrogram (MCU) helps determine the presence of and severity of a reflux and delineates the posterior urethra if the child presents with an infection of the urinary tract. Presence of bladder wall irregularity, elongation of the bladder shape and filling of the posterior urethra [16] as well as the spinning top configuration of the bladder [17] during the cystogram may reflect bladder instability. The urodynamic study is carried out if there is a high index of suspicion of a voiding disorder. It is an invasive procedure and a simple uroflow study combined with EMG for pelvic floor muscles can delineate children requiring further evaluation.

The uro-dynamic study can be carried out during a natural fill; or by instilling saline at a rate of 10 ml/min by a pump or by gravity. Bladder access may be accomplished by transurethral catheterisation or rarely by the placement of a suprapubic cystostomy tube. It may be preferable to use a supra-pubic line inserted the previous day to enable a more physiological voiding study in a young child who may not be able to void with a catheter in situ. The visualisation of the posterior urethra is better with the suprapubic line. The filling medium may be either gas (carbon dioxide) or liquid (water, saline or radiographic contrast material). The advantage of liquid cystometry is that it facilitates detection of urinary incontinence and allows cystometry to be followed by a voiding study. When fluid is used it should be at or near body temperature. Antibiotic prophylaxis with amoxycillin or amikacin is recommended. Reference values for uro-dynamic studies in children are available [18] (Table 1). An overnight uro-dynamic study using natural fill may be accurate in predicting detrusor activity, is well tolerated and less embarrassing [19]. The indications for performing uro-dynamic studies are, any suspicion of a neurologic abnormality; nocturnal enuresis with diurnal symptoms especially in a pubertal child, associated with faecal incontinence; persistence of voiding difficulty after infection has been treated or recurrent urinary tract infections. Bladder trabeculation or sphincter spasm on voiding cystography needs further evaluation. The uro-dynamic patterns of voiding dysfunction in neurologically normal children are small capacity bladder, detrusor hyperreflexia, infrequent

voiding with the lazy bladder and the non-neurogenic neurogenic bladder (Hinman syndrome).

Table 1

Reference values for urodynamic study in children

Observation	Normal values
Duration of urination	20 seconds
Maximum flow rate	15-20 ml/sec
Pressure at urge to urinate	5-15 cm H ₂ O
Maximum detrusor pressure	8-100 cm H ₂ O
Residue	< 15% of excreted volume
Provocation test with coughing at initial and final phase	No incontinence

The advantage of a video-urodynamic study (VDS) is the real time visualisation of the VUR if present. It also gives an idea of the volume of fluid required to fill the bladder and the intravesical pressure before it begins to reflux. It gives good anatomical information regarding the bladder and its neck both during filling and voiding. Hoebeke et al reported detrusor instability in 58%, dysfunctional voiding in 32% and a lazy bladder in 4% of thousand children investigated for recurrent urinary tract infections, small bladder capacity not responding to treatment, or an abnormal uroflow/ultrasonography finding [20].

Treatment

The basis of treatment lies in the exclusion of neurological causes, treatment of intercurrent infections and re-institution of structured voiding patterns with good hydration, hygiene and timed voiding. It is essential that coexistent constipation be corrected [17]. Double voiding for children with a vesico-ureteric reflux is recommended.

In children with the urge syndrome and detrusor instability an anti-cholinergic medication like oxybutinin can be effective [21]. Side effects like blurring of vision, headaches and diarrhoea may be less with newer preparations like tolterodine which is well tolerated in adults [22]. It is effective and safe when administered in a dose of 1mg twice a day for children aged 5-10 years [23].

Biofeedback therapy can aid re-training children to develop relaxed voiding [24]. The five main components of behavioural intervention are bladder re-education initiative or patient education, scheduled voiding regimen with gradual increasing intervals, urgency control strategies, self-monitoring and positive reinforcement by the paediatrician. Computer games have been used successfully to help children relax the pelvic floor muscles [25].

In children with established dysfunctional voiding with large post void residues, it is imperative to lower

intravesical pressures in order to protect the upper tract. Clean intermittent catheterisation (CIC) can be instituted with training. A free overnight drain ensures low pressures through the night when the child may not void frequently enough. This is especially important for children with valve bladders requiring a renal transplant.

Conclusion

A functional voiding disorder needs to be considered in a child presenting with recurrent urinary tract infections, persistent vesicoureteric reflux or nocturnal enuresis with daytime symptoms like urge or dribbling. Children treated for posterior urethral valves need to be followed up and evaluated for voiding disorders, if they have a persistent dilated upper tract. A detailed evaluation culminating in an uro-dynamic study helps diagnose an unstable detrusor, bladder sphincter dysynergia or a lazy bladder.

Management is aimed at good hydration, relieving constipation and re-training the bladder with timed relaxed voiding. Anti-cholinergic medications help reduce bladder instability. In spite of these measures if large post-void residues or high intravesical pressures are noted the child needs CIC with a possible free overnight drainage. A Mitrofanoff conduit can aid CIC specially in girls attending school [26].

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