A comparison of urodynamic studies in children with lower urinary system dysfunction

Neval Kocaoğlu, İbrahim Adaletli, Sebuh Kurugoglu, Haluk Emir*, Nur Canpolat**

İstanbul University Cerrahpaşa Medical Faculty Department of Radiology, İstanbul, Turkey
*İstanbul University Cerrahpaşa Medical Faculty Department of Pediatric Surgery, İstanbul, Turkey
**İstanbul University Cerrahpaşa Medical Faculty Pediatric Nephrology, İstanbul, Turkey

Summary

Aim: The purpose of this study was to determine the role of sonographic measurement of bladder wall thickness in children with lower urinary system dysfunction.

Material and Method: In this study, we reviewed 114 pediatric patients who underwent urodynamic studies for lower urinary system dysfunction between 2007-2009 at İstanbul University Cerrahpasa Medical Faculty. The patients were classified according to presence of unstable detrusor contractions and bladder wall thicknesses. Informed consent was obtained from their parents.

Results: Anatomical causes were found in 12 patients and neurological causes were found in 40 patients in our study group. 61 patients constituted the idiopathic group. While urodynamic study detected unstable detrusor contractions in 66 patients, it did not determine contractions in 48 patients. Bladder wall thickness was found to be thin in 22 of 66 patients who were found to have unstable detrusor contractions on ultrasonography. In 44 patients (44/66) bladder wall thickness was found to be thick.

Conclusions: Our study suggests that the measurement of bladder wall thickness alone can not diagnose lower urinary system dysfunction correctly and cannot replace urodynamic studies. Sonography and urodynamic studies are complementary rather than alternative modalities in evaluation and management of children with lower urinary system dysfunction. *(Turk Arch Ped 2011; 46: 233-7)*

Key words: Bladder, ultrasonography, urinary system dysfunction, urodynamic studies

Introduction

Lower urinary system dysfunction is a common urological problem in children. It is a large morbidity group which has many subgroups. Causes, pathophysiologies and treatment modalities show variance. Urodynamic studies provide accurate information about lower urinary system functions. However, the indication should be right, since it is an interventional diagnostic method.

Urinary ultrasonography gives functional information including bladder capacity, bladder wall thickness and post-urination residual urine volume as well as anatomical data. Ultrasonographic evaluation of the bladder is being used with an increasing frequency in screening lower urinary system dysfunction as a sensitive and non-interventional method.

In this study, bladder wall thicknesses on ultrasonography were retrospectively evaluated in children in whom unstable detrusor contractions were found by urodynamic studies.

Material and Method

In this study, pediatric patients who were followed up and treated in Cerrahpaşa Medical Faculty between 2007 and 2009 because of lower urinary system dysfunction and whose urodynamic studies had been performed were evaluated retrospectively.

Urinary system sonographic examination of the patients was performed in our clinic using Siemens G60 S device (Siemens, Sonoline G60S, Germany) and 3.5 and 8.5 mHz convex transducer. On urinary system ultrasonography, renal

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dimensions, parenchyma thickness and echogenicity, pelvicaliceal system and urethers, bladder capacity, post-mixion wall thickness and presence of residual urine were evaluated in detail.

Urodynamic studies were performed in the Urodynamics Laboratory in the Division of Urology, Department of Pediatric Surgery using Aymed Dyno videourodynamics device (Aymed Dyno videourodynamics, Turkey). Urine cultures were sent in all patients before urodynamic study. If any infection was present, the procedure was postponed and the patient was called back after appropriate treatment for reevaluation. Drugs acting on the detrusor muscle were discontinued three days before the day of appointment. Preventive trimethoprim/sulphomethoxasole treatment was administered starting one day before the procedure and continued for two days after the procedure. The child was recommended to eat watery and soft food. Intestinal cleaning was performed by rectal enema 1 or 2 days before the procedure depending on the presence of fecal incontinence. The child was told to hold his/her urine for about 2-3 hours before the procedure. Information about the procedure was given to the families and patients before the procedure and informed consent was obtained.

The study was performed by a specialist and two experienced nurses. The parents were allowed to stay in the room during the procedure. At the beginning of the procedure, the perineal region was cleaned with antiseptic solution and dried. Superficial pediatric electrodes were placed just near the external anal sphincter at the 3 and 9 o'clock positions and on the thigh region. A 6F double-lumen catether was used to fill the bladder and a 4.5 F rectal balloon catether was used to measure abdominal pressure. Urodynamic procedure was performed in the lithotomy position. The bladder was filled with sterile 0.9% serum physiologic at 25-36ºC by giving 10% of the expected bladder capacity in one minute. Bladder capacity, intra-abdominal pressure, bladder pressure, detrusor pressure, electromyographic (EMG) activity of the pelvic floor muscles and residual urine volumes were evaluated.

All subjects were classified according to presence of unstable detrusor contractions during the filling phase of the bladder and bladder wall thickness on ultrasonography and divided into four groups. Patients in each group were evaluated according to the cause and were classified as anatomical, neurological and idiopathic. Differences between the groups and inside the group were evaluated in terms of detrusor stability and bladder wall thickness.

Results

In our study, a total of 114 patients with lower urinary system dysfunction were evaluated. The ages of the subjects ranged between 3 months and 12 years. The mean age was 6 years 7 months. 49 of the subjects were male, 65 were female.

An anatomical cause was found in 13 patients, a neurological cause was found in 40 patients and 61 patients

constituted the idiopahtic group (Figure 2). Urodynamic study revealed unstable detrusor contraction in 66 patients and no
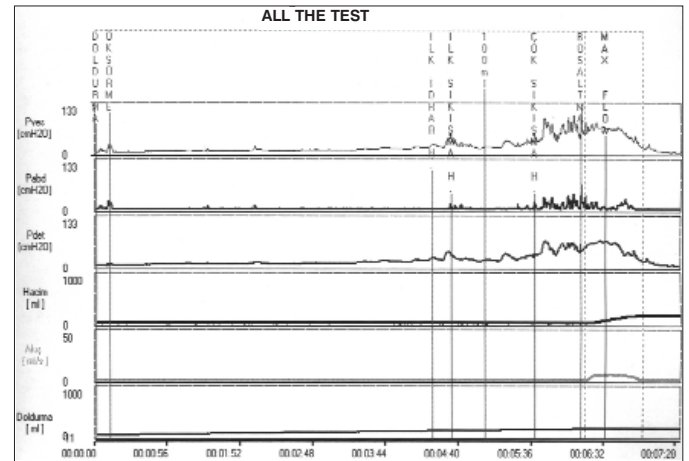

Figure 1A. Hypersensitive detrusor contractions were observed beginning from a volume of 130 ml during the filling phase in the urodynamic study in the 5 year-old boy followed up with the diagnoses of urge incontinance and enuresis. No incontinance was found. Plateau urination shape was observed.
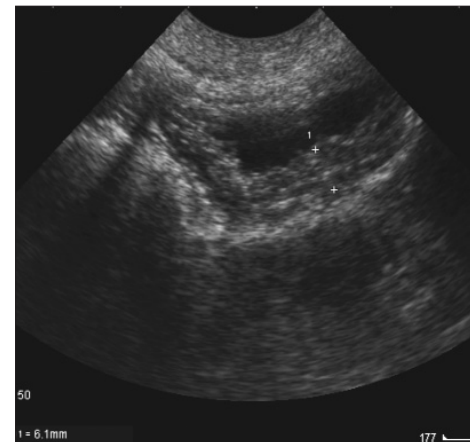

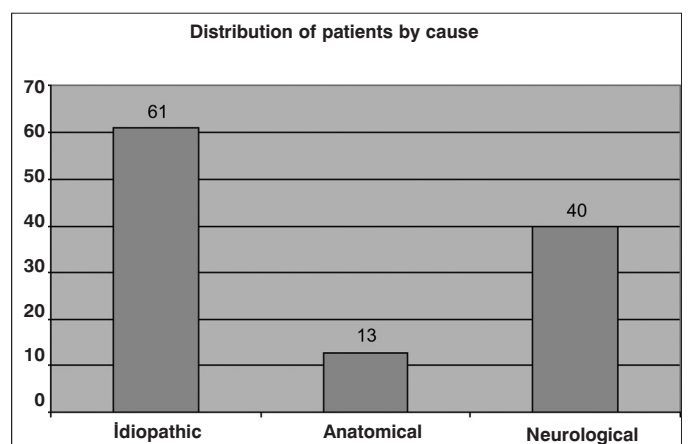Figure 1B. Bladder wall was found to be thick (8mm) on ultrasonography. No residual urine was found.

Figure 2. Distribution of the patients with lower urinary dysfunction by cause.

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contraction was found in 48 patients. Bladder wall thickness was found to be thin in 22 of 66 patients with unstable detrusor contractions. Bladder wall was found to be thick in 44 of 66 patients with unstable detrusor contractions (Figure 1A and 1B).

Sample case

A 5 year-old boy followed up in the pediatric nephrology clinic with the diagnoses of urge incontinance and enuresis.

No thickness was observed in the bladder wall in 22 patients (22/48) with stable contractions. The bladder wall was found to be thick in 26 (26/48) patients (Figrue 3-4). When the group with increased bladder wall thickness and unstable detrusor contractions on urodynamic examination was evaluated according to causes, an anatomical cause was found in five patients including posterior urethral valve or anterior urethral stricture. Neurological causes were found in 11 patients. 28 patients constituted the idopathic group outside these two groups (Figure 5).

When the patients with thick bladder wall on ultrasonography and without unstable detrusor contraction on urodynamic study
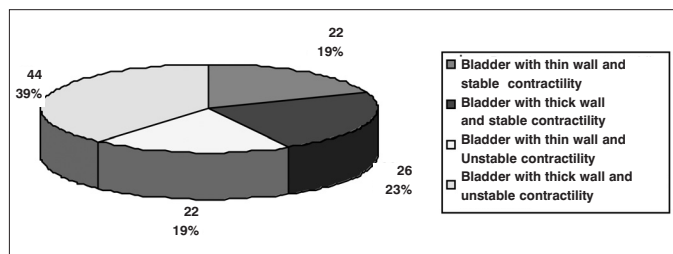

Figure 3. Distribution of patients by bladder wall thickness and detrusor stability
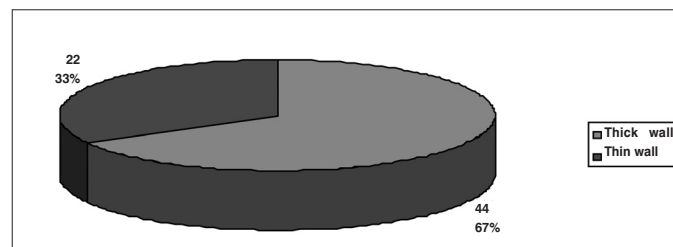

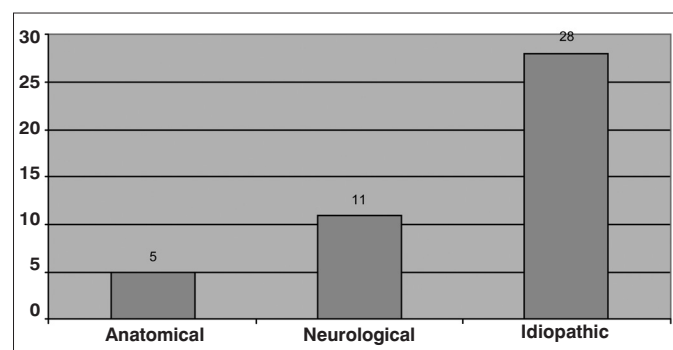Figure 4. Bladder wall thickness in patients with unstable detrusor contractions

Figure 5. Distribution of patients according to causes in patients with unstable detrusor contraction-bladder with thick wall

were classified according to causes, 4 of a total of 26 patients in this group had an anatomical cause, 13 had a neurological cause and 9 patients constituted the idiopathic group. When the patients who did not have a thick bladder wall, but had unstable detrusor contractions on urodynamic examination classified according to causes, 2 of 22 patients had an anatomical cause, 9 had a neurological cause and 11 patients constituted the idiopathic group. In 39% of the patients (n=24) with urinary system dysfunction in the idiopathic group, the bladder wall was thin and in 61% (n=37), the bladder wall was thick (Figure 6). In 36% of the patients (n=22) with lower urinary system dysfunction in the idiopathic group, unstable detrusor contractions were not observed and in 64% (n=39), unstable detrusor contractions were observed (Figure 7).

Discussion

Lower urinary system dysfunction is a rather common clinical problem. It has a wide spectrum. It can be classified in three groups according to causes: anatomical, neurological and idiopathic. Spinal anomalies constitute the main cause among neurological causes and posterior urethral valve leading to obstruction at the exit of the bladder is the most commonly observed cause among anatomical lesions. In the idiopathic group, delay in neurological maturation or behavioral disorders during toilet training have beed suggested (1,2).

Independent of the cause, the aim is to prevent upper urinary system dysfunction, because a intra-bladder pressure above 40 cm H2O for a long time may lead to disruption of upper urinary system drainage, infections, vesicoureteral reflux, development of scar and renal failure (3,4). Lower urinary system dysfunction not treated successfully has been reported to be one of the most important causes of recurring urinary tract infection (5-7).
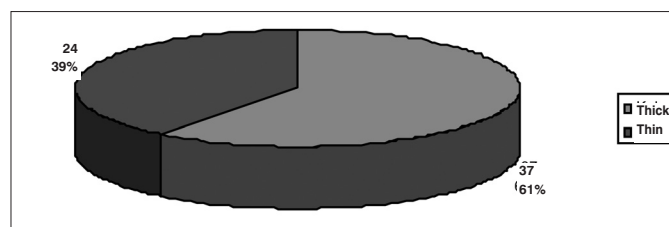

Figure 6. Bladder wall thickness in patients with lower urinary system dysfunction in the idiopathic group
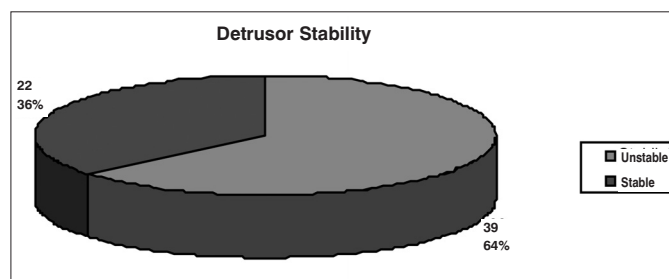

Figure 7. Detrusor stability in patients with lower urinary system dysfunction in the idiopathic group

The relation of lower urinary system dysfunction and vesicouretheral reflux (VUR) has been studied in many studies (8-11). Primary VUR is the most common form and is caused by proceeding of distal ureters in a short mucosal tunnel. However, secondary VUR which is observed less commonly develops secondary to increased intra-bladder pressure due to anatomical, neurological or idiopathic causes (8). In the study performed by Silva et al. (9), lower urinary system dysfunction was found in 114 of 671 patients (17%) with VUR. Vesicoureteral reflux is observed in approximately 20-50% of children with lower urinary system dysfunction (10). In the study performed by Leonardo et al. (11), this rate was found to be 25% and it was found that the possibility of development of renal scar was four fold higher in these children. In children in whom clinical improvement could not be provided after antireflux surgery, accompanying lower urinary system dysfunction should be investigated (12,13).

Bladder wall can be examined easily on ultrasonography in patients with lower urinary system dysfunction. Bladder wall thickenning can be determined using low frequency (3,5-5 MHz) probes. However, high frequency (>7 MHz) probes can show the three layers of the bladder wall. While the detrusor muscle which constitutes the middle layer appears hypoechogenic, the serosa and mucosa layers appear hyperechogenic. On our daily practice, we do not measure the detrusor muscle alone, when evaluating bladder wall. We believe that the thickness of the mucosa and serosa layers are negligible.

Yeung et al. (14) compared bladder wall volume index (BWVI) and urodynamic findings in a total of 61 children with recurring urinary tract infections. When calculating bladder wall volume index, bladder volume index was measured at the time when the child felt urgency at the highest level. Bladder volume index=longitudinal x horizontal x antero-posterior diameter. Using the Formula of BWVI= MVI/BWT three patient groups were identified according to the shape of the bladder: BWVI>130 (increased capacity, thin wall), BWVI = 70-130 (normal), BWVI<70 (decreased capacity, thick wall). Normal urodynamic appearance was found in 14 of 16 children with normal wall thickness and unstable detrusor contractions were found in 33 of 36 children with a thick wall. In our study, unstable detrusor contractions were found in 44 of 70 children with a thick wall.

In anatomical and neurological lower urinary system dysfunction, long-term streching in the bladder wall and increased intra-bladder pressure cause demage to the wall. Typical histological changes occur in this condition which is called "streching demage". It results in loss of bladder compliance and elasticity, decrease in functional bladder volume, increased storing pressure, loss of contractions and residual urine in the bladder (15). Chronic excessive streching leads to molecular and cellular changes in the bladder. Extracellular matrix and connective tissue deposits and bladder smooth muscle cell hyperplasia and hypertrophy are named "fibroproliferation". Bağlı et al. (16) found fibroblast growth factor (FBGF) to be higher in 97 patients with meningomyelocele compared to the control group without miction problem in their study and concluded that FBGF release was increased in the demaged bladder wall.

Ultrasonographical measurement of the bladder wall in healthy children has been studied by many investigators in the literature. In the study performed by Jequier et al.(17), mean bladder wall thickness was found to be 1.55 mm and the upper limit of bladder wall thickness was considered to be 3 mm for a full bladder. In the study performed by Uluocak et al. (18), mean thicknesses of the anterior, posterior and lateral walls were found to be 1.42 mm, 1.57 mm and 1.49 mm, respectively. A trabeculated and/or thick bladder wall on ultrasonography may be an indirect finding of an excessively active bladder. Other ulstrasonographic findings of an excessively active bladder include bladder diverticle, small bladder capacity and presence of residual urine after urination (2). A bladder wall thickness of more than 3-4 mm in thepresence of urine of 50% of the predicted bladder's capacity should arise suspicion of hypersensitivity of the detrusor muscle (19,20).

In our study, the bladder wall was found to be thick in 44 of 66 patients with unstable detrusor contraction. When the group who was found to have increased bladder wall thickness and unstable detrusor contractions on urodynamic study was evaluated according to causes, an anotomical cause including posterior urethral valve (PUV) or anterior urethral stricture was found. 11 patients had a neurological cause. 28 patients constituted the idiopathic group outside these two groups. Urodynamical problems in children with neurogenic bladder include unstable detrusor contractions, absence of detrusor reflex, decreased compliance and detrusor-sphincter dissynergy. In neurogenic bladder the mechanism responsible for upper urinary system involvement is detrusor-sphincter dissynergy and increased intra-bladder pressure developing secondarily. The addition of excessive detrusor activity enhances the involvement of upper urinary system. Continuously high intra-bladder pressure predispose to fibroproliferative changes and development of a bladder with decreased compliance and capacity in time.

In children with neurogenic bladder, measurement of bladder wall thickness is an important screening method to show upper urinary system involvement (21,22). Tanaka et al.(23) showed that upper system involvement was more prominent in children with urodynamical risk factors and a bladder wall thickness of more than 3.3 mm (23). In our study, we examined 39 patients with a diagnosis of neurogenic bladder. The bladder wall was found to be thin in 13 patients (33.3%) and thick in 26 patients (66.6%). Only 7 of 39 patients (18%) urinated normally. 32 patients (82%) had an appearance of urination dysfunction or could not urinate at all. All patients who urinated dysfunctionally had thick bladder walls.

In our study, a history of operation because of posterior urethral valve was present in 10 patients. In this group, three patients were in the pre-pubertal period and did not have upper urinary system dilatation on ultrasonography. Bladder volumes were appropriate for age and bladder wall

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thickening and post-urination residual urine were not found in these patients. However, observing no pathology on ultrasonography should not be enough in the follow up process in this high-risk patient group. Urodynamic study performed following ultrasonography did not reveal urination dysfunciton in two patients. In one patient, unstable detrusor contractions and appearance of "staccato" were found. In the long-term follow-up of children with a histroy of posterior urethral valve, evaluation of only upper urinary system dilatation will not be enough. In these children, bladder capacity, wall thicknesses and degrees of bladder emptying should be evaluated ultrasonographically in terms of development of detrusor dysfunction with time. Urodynamic studies should absoluteley be done at certain times in these patients. Treatment process and mode can change according to these studies.

Most patients with lower urinary system dysfunction present with signs and symptoms including recurring urinary tract infection, urgency, urge, incontinence, nocturia, nocturnal and/or day time enuresis, hesitancy and intermittent urination without an underlying neurological or anotomical cause. 61 of our 114 patients in our study constituted the idiopathic group in whom no neurological or anatomical cause could be found. In this group, 37 of the patients (60.7%) had a thick bladder wall and 24 (39.3%) had a thin bladder wall. In the group with a thick bladder wall, the prominent diagnoses included urge incontinance and urinary tract infection (18/37). The most common diagnosis in the group with thin bladder wall was association of urge incontinance and urinary tract infection (10/24). When subjects with idiopathic lower urinary system dysfunction were classified according to detrusor stability, unstable detrusor contractions were found in 39 patients (64%) and not found in 22 (36%) patients. In the group with unstable detrusor contractions, the association of urge incontinance and urinary tract infection (19/39) was again prominent among other diagnoses.

Urodynamical assessment is a source diagnostic method to determine lower urinary system dysfunction (24). However, it is not easily performed especially in children, since it is an interventional technique. Measurement of bladder wall thickness by ultrasonography which is a non-interventional diagnostic method can be used as a complementary tool in determining lower urinary system dysfunction, choosing treatment method, evaluating the response to treatment and in follow-up. In our study and in other studies in the literature, overlapping and similarities in bladder wall thicknesses can be observed even in different disease groups and in presence of different urodynamical findings. Lower urinary system dysfunctions is a dynamical disease group which shows modification in time and is manifested with different signs and symtoms. Ultrasonography and urodynamic study are not alternatives for each other, but complementary methods in evaluation of patients with lower urinary system dysfunction, in determining the treatment plan and in follow-up of patients.

Conflict of interest: None declared.

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