

## The Evaluation of Urinary System Ultrasonography, Uroflowmetry, and Voiding Diary Results in Children with Daytime Urinary Incontinence

### Gündüz İdrar Kaçırması Olan Çocukların Üriner Sistem Ultrasonografisi, Üroflowmetri ve İşeme Günlüğü Sonuçlarının Değerlendirilmesi

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#### ABSTRACT

**Objective:** The study aimed to examine the results of urinary system ultrasonography, uroflowmetry, and voiding diary for children with daytime urinary incontinence.

**Materials and Methods:** Patients aged 5-17 with daytime urinary incontinence were retrospectively analysed. Urinary system ultrasonography, uroflowmetry, and a two-day voiding diary were recorded. Comorbid diseases and surgeries were determined using a detailed history.

**Results:** Of the 1805 patients included in the study, 1039 (57.6%) were female, 766 (42.4%) were male, and the mean age was 7.9±2.8 years. Abnormal USG findings were detected in 385 (21.3%) patients. The highest bladder capacity detected in the voiding diary was below the expected bladder capacity in 41.2% of the patients; in comparison, the bladder capacity measured in the uroflowmetry was low in 65.4%. Constipation was the most common in the gastrointestinal system diseases group. In previous surgery, adenoidectomy was the most common procedure.

**Conclusions:** We suggest that these patients should be evaluated not only with bladder USG but also with upper urinary system USG. Pathology can also be detected in the upper urinary system. We think that a well-structured voiding diary provides sufficient data regarding bladder volume instead of bladder volume measured by bladder ultrasonography and/or uroflowmetry.

**Keywords:** Bladder capacity, children, ultrasonography, uroflowmetry, voiding diary

#### ÖZ

**Amaç:** Gündüz idrar kaçırma şikayeti ile başvuran çocuk hastalarda üriner sistem ultrasonografisi, üroflowmetri ve işeme günlüğü sonuçlarını incelemeyi amaçladık.

**Materyal ve Metot:** Çalışmada 5-17 yaş arası gündüz idrar kaçırması olan hastalar retrospektif olarak incelendi. Üriner sistem ultrasonografisi, üroflowmetri ve iki günlük işeme günlükleri kaydedildi. Ayrıntılı öykü ile ek hastalıkları ve ameliyatları belirlendi.

**Bulgular:** Çalışmaya alınan 1805 hastanın 1039'u (%57,6) kız, 766'sı (%42,4) erkekti ve yaş ortalaması 7,9±2,8 idi. Hastaların 385 (%21,3)'inde anormal USG bulgusu saptandı. İşeme günlüğünde tespit edilen en yüksek mesane kapasitesi, hastaların %41,2'sinde beklenen mesane kapasitesinin altındaydı; karşılaştırıldığında, üroflowmetrede ölçülen mesane kapasitesi %65,4 oranında düşüktü. Gastrointestinal sistem hastalıkları grubundan en sık kabızlık görüldü. Geçirilmiş cerrahi işlem olarak en sık adenoidektomi saptandı.

**Sonuç:** Bu hastalarda üst üriner sistemde de patoloji saptanabilmektedir bu nedenle, sadece mesane USG ile değil, detaylı üst üriner sistem USG ile de değerlendirilmesi gerektiğini düşünüyoruz. Ayrıca, iyi yapılandırılmış bir işeme günlüğünün, mesane ultrasonografisi ve/veya üroflowmetri ile ölçülen mesane hacmi değerlerine kıyasla daha yeterli veri sağladığını düşünmekteyiz.

**Anahtar Kelimeler:** Çocuk, işeme günlüğü, mesane kapasitesi, ultrasonografi, üroflowmetri

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**INTRODUCTION**

Daytime urinary incontinence is a common condition in children. It has been reported to affect 17-22% of children.<sup>1</sup> Contrary to adult population, where incontinence is always considered a pathological condition, incontinence should be evaluated in children by the developmental age and early urological history of the patient.<sup>2</sup>

In the literature, there are studies in which patients with daytime urinary incontinence are generally evaluated only by bladder ultrasonography.<sup>3,4</sup> The number of studies including detailed urinary system ultrasonography, simultaneous uroflowmetry and evaluation with voiding diary is limited. There is sufficient literature on the diagnosis and treatment approaches of urinary incontinence and bladder dysfunction.<sup>5</sup>

The anomalies detected by a detailed evaluation of the upper urinary system of children with daytime urinary incontinence and the data on bladder function of a well-structured voiding diary were the findings that caught our attention. Based on this, the study aimed to analyse retrospectively and evaluate the results of patients with daytime urinary incontinence symptoms followed by a single pediatric urologist.

**MATERIALS AND METHODS**

**Ethical Status:** Our study was approved by the Ethics Committee of the Health Sciences University Umraniye Training and Research Hospital (Date: 04.08.2022, decision no: B.10.1.TKH.GP.0.01/246). Informed consent was not obtained because of the retrospective observational design.

**Patients:** Patients aged 5-17 years who were followed up with symptoms of daytime urinary incontinence from the Pediatric Urology outpatient clinic of Umraniye Training and Research Hospital between 2017 and 2022 were retrospectively analysed. Patients with daytime urinary incontinence symptoms were included in the study. Patients with nocturnal monosymptomatic enuresis and urinary and/or neu-

ronal disorders affecting urinary continence or who had undergone surgical procedures were excluded from the study. The age, gender, and symptoms of the patients were determined. Urinary system ultrasonography, bladder-volume value from uroflowmetry parameters, complete urinalysis, and two-day voiding diary were recorded in all patients. Detailed anamnesis revealed the associated diseases and surgeries they underwent.

**Analysis:** All data were analysed retrospectively. Expected bladder capacity (BMC) was calculated according to the International Pediatric Continence Society (ICCS) formula [BMR = [30 x (age in age+1) mL].<sup>6,7</sup> The highest voiding volume detected in the voiding diary of the patients and the bladder volume measured in the uroflowmetric study performed when the children's voiding sensation was evident were evaluated. All ultrasounds were performed by who is an expert radiologist in pediatric sonography. All ultrasounds were performed using one sonography equipment of Toshiba Applio 500. Bladder wall thickness (BWT) in all cases was calculated in both posterior and lateral walls. The mean of these two measurements was assumed to be BWT. Electromyography (EMG) uroflowmeter was used in some selected patients. The EMG probe was not used in all patients due to its cost. Therefore, the evaluation of EMG uroflowmetry was not included in the study.

**Statistical Analyses:** In our study, simple statistics were used, and the mean±SD and % values of the groups were obtained from the statistical calculation in the Microsoft Excel Worksheet.

**RESULTS**

A total of 1805 patients were identified. Of these patients, 1039 (57.6%) were female, and 766 (42.4%) were male. The mean age of the patients was 7.9 ± 2.8 years. While the number of patients with only daytime urinary incontinence was 366 (20%), the number of patients with both night and daytime incontinence was 1439 (79.7%) (Table 1).

**Table 1.** Age, gender, and incontinence status of the patients.

Characteristics		n (%)	Age
<b>Gender</b>	Male	766 (42.4)	7.5 ± 2.3
	Female	1039 (57.6)	8.3 ± 3.1
	Total	1805 (100)	7.9 ± 2.8
<b>Only daytime incontinence</b>	Male	117 (6,4)	8.4 ± 2.9
	Female	249 (13,7)	9.2 ± 3.4
	Total	366 (20)	8.9 ± 3.2
<b>Day and night time incontinence</b>	Male	649 (35.9)	7.2 ± 2.0
	Female	790 (43,7)	8.0 ± 2.9
	Total	1439 (79,7)	7.7 ± 2.6

Urinary system ultrasonography was performed in all patients. Urinary system pathology was seen in 385 (21.3%) patients. These findings were increased bladder wall thickness, hydronephrosis, bladder trabeculation, duplex system anomaly, kidney stone, kidney cyst, bladder diverticulum, and horseshoe kidney. These findings are listed in the first column of the table below, from most common to rarest. The increase in bladder wall thickness was most common in patients with daytime and nocturnal incontinence, while it was second only in patients with daytime incontinence. Conversely, hydronephrosis was most common in patients with only daytime urinary incontinence, followed by increased bladder wall thickness. In some patients, more than one urological finding was detected (Table 2). Patients with hydronephrosis without an obstructive pattern and

duplex system anomalies were followed up conservatively. Vesicoureteral reflux was detected in 23 patients. Subureteric injection was performed in 4 patients, and open ureteroneocystostomy in 2 patients. Extracorporeal Shock Wave Lithotripsy (ESWL) was performed in 5 of the patients with kidney stones. Patients with kidney cysts were also followed conservatively. All patients with additional findings were followed up in the pediatric nephrology clinic. The mean increase in BWT was 4.1 mm. Grade 2 hydronephrosis was reported in one-third of the patients with hydronephrosis, and grade 1 hydronephrosis in two-thirds. No spinal anomaly or infravesical obstruction was detected in patients with trabeculation in the bladder. No urinary anomaly was observed in any of the patients with kidney stones.

**Table 2.** Urinary system ultrasound findings.

USG	Total patients with Urinary System pathology on USG (n:385; 21.3)		
	Number of Patients (n)	Only daytime incontinence (n)	Day and nighttime incontinence (n)
<b>BWT-increase</b>	155	22	133
<b>Hydronephrosis</b>	140	36	104
<b>Trabeculation</b>	59	9	50
<b>Duplex system</b>	22	6	16
<b>Kidney stone</b>	13	2	11
<b>Kidney cyst</b>	13	2	11
<b>Diverticulum</b>	6	1	5
<b>The horseshoe kidney</b>	1	0	1

BWT: Bladder wall thickness.

A daily voiding diary was performed, and the volume of urination detected in the diary was evaluated. In 41.2% of the patients, bladder capacity was below the expected bladder capacity; in 51.6%, it was equivalent to the expected bladder volume, and in 7.2%, the expected bladder closure was above the

expected bladder capacity (Table 3). The bladder volume detected in the first uroflowmetry examination was low at 65.4%, equivalent to the expected bladder volume in 21.8% and high in 12.7% of the patients (Table 3).

**Table 3.** Uroflowmetry and voiding diary bladder-volume values.

Characteristics	UFM / Voiding Diary Value				
	n (%)	Age Average ± SD	Male n (%)	Female n (%)	
<b>UFM</b>	Under	1181 (65.4)	8.0 ± 2.7	526 (68.7)	655 (63.0)
	No change	394 (21.8)	7.7 ± 2.9	171 (22.3)	223 (21.5)
	Above	230 (12.7)	8.3 ± 3.0	69 (9.0)	161 (15.5)
<b>Voiding Daily</b>	Under	743 (41.2)	8.1 ± 2.7	324 (42.3)	419 (40.3)
	No change	932 (51.6)	7.8 ± 2.9	400 (52.2)	532 (51.2)
	Above	130 (7.2)	8.2 ± 2.9	42 (5.5)	88 (8.5)

UFM: Uroflowmetry.

According to the data obtained from the detailed anamnesis, 401 (22.2%) patients had associated disease. The most common comorbidity was in the gastrointestinal tract. Constipation was the most common in this group, followed by celiac disease and gastroesophageal reflux (GER), while autism and hyperactivity disorder were the second most common neuropsychiatric diseases. On the other hand, it has been noted that other system diseases, such as rheumatologic, allergic, and cardiovascular systems,

are quite common (Table 4). There was a history of previous surgery in 198 (11%) patients. The most common was adenoidectomy, the second most common was inguinal hernia repair, and the third most common was tonsillectomy. Two patients were treated with local alternative medicine practices. Since a patient can undergo more than one surgical procedure, the data in the table represent the number of patients undergoing surgical procedures (Table 5).

**Table 4.** Associated diseases.

Disease Group		n	Female (n)	Male (n)
<b>Gastrointestinal</b>	(GER, Celiac Disease) + Constipation	146 [(20)+126]	60 [(7)+53]	86 [(22)+64]
<b>Neurological-Psychiatric</b>	Autism, hyperactivity	114	53	61
<b>Genitourinary</b>	VUR, ovarian cyst, undescended testicle	83	45	38
<b>Rheumatological</b>	FMF, Behçet Disease, JIA	58	34	24
<b>Allergic</b>	Eczema and allergic rhinitis	25	9	16
<b>Cardiac</b>	Aortic stenosis, ASD	18	8	10
<b>Endocrinological</b>	DM, Hypothyroidism	10	6	4

GER: Gastroesophageal reflux; VUR: Vesicoureteral reflux; FMF: Familial Mediterranean Fever; JIA: Juvenile Idiopathic arthritis; ASD: Atrial septum defect; DM: Diabetes mellitus.

**Table 5.** Previous surgical procedures.

Total patients who underwent surgery (n:198; 11%)			
Surgery Group	n	Surgery Group	n
Adenoidectomy	57	Hypospadias	7
High Ligasyon	49	ASD repair	6
Tonsillectomy	38	Subureteric injection	4
Orchiopexy	19	Frenuloplasty	3
Appendectomy	13	UNC	2
Tympanoplasty	10	Cupping	2
Eye surgery	10	Dental surgery	2
Arm fracture	10	Pyeloplasty	1

ASD: Atrial septum defect; UNC: Ureteroneocystostomy.

**DISCUSSION AND CONCLUSION**

In our study, it was found that hydronephrosis, increase in bladder wall thickness and trabeculation were the most common and various anomalies accompanied by ultrasound of the entire urinary system performed on the patients. When the bladder volume measurements detected in the voiding diary and uroflowmeter were evaluated, it was seen that the voiding diary could be more meaningful and reliable for assessing bladder capacity. With a detailed history, it has been observed that the associated diseases may be neuropsychiatric, rheumatological and allergic diseases apart from the gastrointestinal system.

Evaluation of children with daytime urinary incontinence is discussed in an overview without breaking down into lower urinary tract dysfunction (LUTD) subgroup classifications. By definition, it is a condi-

tion characterised by lower urinary tract symptoms such as urinary incontinence, frequent urination, urgency, and weak urine flow without significant uropathy or an underlying neurological disorder.<sup>10</sup> The diagnosis of urinary incontinence, a broader definition of lower urinary tract dysfunction, is mainly based on a comprehensive assessment of the patient's clinical history. Frequency, sense of urgency, when and how incontinence occurs, febrile urinary tract infection history and toilet position should all be evaluated. It is necessary to focus on the history of the child, such as drugs used for treating urinary incontinence and previous surgical procedures.

In this group of patients, a physical examination should be performed, and especially attention should be paid to examining the lumbosacral and urogenital

genital regions.

Urinary incontinence, enuresis, urgency, pelvic pain, and urine flow pattern are important. Lower urinary tract dysfunction can be triggered when girls unconsciously try to control urine flow with the pelvic floor to prevent their legs and toilet rim from getting wet. None of the symptoms described above are expected to occur in children over 5 years of age.

Daytime urinary incontinence is common in the pediatric population, but it is difficult to determine the exact prevalence because bladder control develops gradually during childhood. In our patient group, there were more female patients (57.6%) than males. In our series, the mean age of female patients was 8.3 years, and that of male patients was 7.5 years. In a UK study, the prevalence of incontinence decreased from 15.5% at age 4.5 to 4.9% at age 9.5. In a Korean cohort of children aged 5-13, daytime incontinence was 11.2%, and impingement incontinence was 16.8%.<sup>9</sup> The prevalence of urinary incontinence decreased from 31% at age 5 to 13.7% at age 9.<sup>10</sup> Differences in prevalence may also be due to cultural differences.

The highest prevalence of functional urinary incontinence is at age 7; girls of all age groups are more affected than boys.<sup>11</sup> The prevalence is higher in girls than boys, possibly due to anatomical differences.<sup>12</sup>

In patients presenting with urinary incontinence, bladder USG imaging is a noninvasive and practical procedure. In our study, unlike the literature highlights, all our patients were evaluated with USG of the urinary system together with the bladder. In this evaluation, it was seen that the second most common urinary pathology after the increase in bladder wall thickness (40.2%) was hydronephrosis (36.3%), which is a finding of the upper urinary system. Later, duplex system abnormalities, kidney stones, kidney cysts and horseshoe kidney anomalies were detected, respectively. Only in patients with daytime urinary incontinence was the most common finding of hydronephrosis (9.3%). In comparison, the increase in bladder wall thickness (5.7%) was the second most common finding of urinary system pathology. The bladder wall thickness measured on an empty bladder should be <3 mm.<sup>13</sup> Studies supplemented in the literature are usually in the form of an evaluation of the bladder with USG. Oktay et al.<sup>4</sup> demonstrated anatomical changes in pediatric incontinent patients' lower urinary tract structures. They also emphasised that these differences should be considered in diagnosing, following up, and treating patients with urinary incontinence. Another study showed a good reliability of bladder ultrasonography in children aged 7.3±1.1 years regarding bladder volume measurement.<sup>5</sup> An increase in bladder wall thickness, a common result in our series, has been

extensively studied in the literature as a prognostic factor in children with lower urinary tract symptoms.<sup>14,15</sup> However, there are reports stating that factors such as bladder volume at the time of measurement and the probe's location can affect bladder wall thickness measurements.<sup>5</sup>

In all our patients (school-age children), two-day urine measurements were performed on weekends to make the follow-up of the parents more reliable and to facilitate the application. In 51.6% of the patients, the highest volume measured daily was similar to the expected bladder capacity. However, on the other hand, it was found to be less than the expected bladder volume in 41.2% of the patients. In 130 patients (7.2%), it was higher than the expected bladder closure site. How long to keep a voiding diary is controversial. Recent studies have shown that a two-day bladder diary provides similar data as one for 3 days.<sup>16</sup> While the maximum voiding volume in the bladder log is the maximum value of the voiding volume during the working period, the exact performance of the bladder at a given bladder capacity is unknown. The literature evaluating the maximum bladder capacity measured by a urine diary in children with daytime incontinence is scarce. Some authors argue that uroflowmetry and PVR measurement are more appropriate tools to investigate bladder performance in healthy children because keeping a voiding diary is difficult and time-consuming.<sup>17</sup> Our study presents the bladder performance of children with daytime incontinence in their natural lives with high patient numbers and carefully made urination diary data. Therefore, although the uroflowmetry measurement values in the hospital environment give us critical ideas, we think that the measurement in the urine diary better reflects the child's bladder performance. In approximately 50% of our patients, the measured bladder capacity was below and above the expected bladder capacity. We think that this difference should be considered in treatment planning and evaluation of bladder wall thickness by ultrasonography.

We know that the parameters obtained from uroflowmetry depend on bladder capacity. It was observed that the bladder capacity was equivalent to the expected capacity in 21.8% of the patients but below the expected bladder capacity in 65.4%. In a large-scale study of uroflowmetry in children, the lowest acceptable age-specific bladder capacity for interpreting the uroflowmetry test was recommended as  $\text{age} \times 5 + 50$  mL in years.<sup>17</sup> As stated in this study, voided volume is important for a healthy UFM assessment. In addition, there are reports that the repetition of the uroflowmetric study does not increase the method's effectiveness in assessing the voiding function in children.<sup>18</sup> We know that bladder volume measurement is important when

evaluating UFM results, so we think that evaluating bladder volume together with urine diary measurement will help us more in the diagnosis and treatment process rather than UFM repeat.

The most common associated diseases detected in our patients were the gastrointestinal system. Constipation had the highest number of patients, with 126 (31.4%). It is strongly associated with constipation, recurrent urinary tract infection, vesicoureteral reflux, and dysfunctional voiding.<sup>19</sup> In a study of 234 children with chronic constipation and urinary incontinence, it was reported that 89% of the children improved their daytime wetting after their constipation was treated, and chronic urinary tract infections and infections were regressed in all children with anatomically normal urinary tract.<sup>20</sup>

In our series, the most common comorbidities after constipation were autism and hyperactivity disorder. Autism was found in 25 of 114 patients, and hyperactivity was found in the rest of them. The studies have reported that children with improved psychiatric disorders also improved their compliance with LUTD treatment.<sup>21</sup> However, we would like to state that rheumatological (14.4%), cardiac 6.2%, allergic (4.4%), and endocrinological (2.4%) diseases, which have yet to be emphasised much in the literature, are also seen in substantial numbers.

In conclusion, we think that ultrasonographic evaluation in this patient group should include not only the bladder but also the upper urinary system. According to the results we obtained in our study, various renal anomalies, including the upper and lower urinary system, can be detected. With this information, the treatment stages of the patient can be planned more effectively. Another issue to keep in mind is that different comorbidities can be seen in these patients, apart from the diseases we know. Regarding the treatment plan, we would like to state that it is valuable to consider the urination diary, USG, and UFM measurements together. We think that the measurement in a well-prepared voiding diary provides more adequate and reliable data than the bladder volume measured by ultrasonography and/or uroflowmetry. The weaknesses of our study are the evaluation of only the bladder volume parameter from the uroflowmetry parameters, the absence of EMG, and the evaluation of all patients with daytime urinary incontinence without lower urinary system dysfunction classification.

**Ethics Committee Approval:** Our study was approved by the Ethics Committee of the Health Sciences University Ümraniye Training and Research Hospital (Date: 04.08.2022, decision no: B.10.1.TKH.GP.0.01/246). Informed consent was not obtained because of the retrospective observatio-

nal design.

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