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Correlation between Lower Urinary Tract Scoring System, Behavior Check List, and Bladder Sonography in Children with Lower Urinary Tract Symptoms

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Purpose: The Pediatric Lower Urinary Tract Scoring System (PLUTSS) is a standardized questionnaire used for screening and evaluation of the response of children with lower urinary tract symptoms (LUTS) to therapy. We presumed that adding the Child Behavior Check List (CBCL) and bladder volume wall index (BVWI) to the PLUTSS would increase its validity in the detection of children with LUTS.
Materials and Methods: One hundred twenty-two children aged 5 to 15 years with LUTS were enrolled in the study. Seventy-two healthy, age-matched children without urinary complaints were considered as controls. The PLUTSS and CBCL were filled out for all children. Sonography was performed to measure BVWI. Chi-square test and likelihood ratio were used to compare frequencies, receiver operating curve (ROC) analysis was used to evaluate the correlation, and Cohen's kappa was used to measure the agreement between variables. p-values <0.05 were considered significant.
Results: Behavior problems were significantly more common in children with LUTS than in healthy children ($p<0.05$). The frequency of thick, thin, and normal BVWIs did not differ significantly in the two groups ($p>0.05$). ROC analysis showed that there was no correlation between PLUTSS, CBCL, and BVWI in either the LUTS subgroup or in the controls ($p>0.05$). The PLUTSS had the highest sensitivity and specificity, and adding the two other tests decreased its validity for the diagnosis of children with LUTS.
Conclusions: The PLUTSS by itself was the best predictor of LUTS. The CBCL and BVWI were not helpful in making a diagnosis; however, the CBCL was useful in the detection of behavior problems in children with non-monosymptomatic enuresis.

Key Words: *Enuresis; Pediatrics; Questionnaires; Ultrasonography; Urinary bladder*

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INTRODUCTION

The Pediatric Lower Urinary Tract Scoring System (PLUTSS) is a standardized questionnaire that is used to screen children with bladder dysfunction and for follow-up of their response to treatment [1-3]. A normal score predicts bell-shaped uroflowmetry in 35% of cases [4]. The psychological effect of bladder dysfunction, however, is ignored in the PLUTSS. The Child Behavior Check List (CBCL) is a parental questionnaire that is used to diagnose childhood behavioral problems and contains 113 questions. It is useful for finding the co-occurrence of problems such as anxious/depressed; withdrawn/depressed; somatic complaints; social, thought, and attention problems; rule-breaking; and aggressive behaviors. Of these, the first three are categorized as the "internalizing score" (INTS), and the last two as the "externalizing score" (EXTS). There is also a total clinical score (TCS) that measures the scores for all items. The cutoff point of 63 for T-values is used to evaluate the INTS, EXTS, and TCS on the basis of population norms [5]. A large longitudinal study in children with soiling habits and wetting episodes showed a higher rate of behavior and emotional problems in these children [6,7]. Another index used for bladder dysfunction is the bladder volume wall index (BVWI) for renal volume, which is a reliable method for differentiating between normal and abnormal bladder function [8,9]. This study aimed to evaluate whether adding the CBCL and the BVWI to the PLUTSS would increase its validity in the detection of children with lower urinary tract symptoms (LUTS).

MATERIALS AND METHODS

Between March 2008 and March 2010, 135 children (88 female, 47 male) aged 5 to 15 years with a history of LUTS and 75 healthy children (52 female, 23 male) were entered into the study after consent was given by their parents (Fig. 1). The study was approved by the ethical committee of the Tehran University of Medical Sciences and followed the institution's Review Board for Human Subjects guidelines. It was performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki. Inclusion criteria were the presence of LUTS, age (more than 5 years), and absence of acute urinary tract infection (UTI) in the month before enrollment.

Thorough physical, mental, and drug histories were taken, and a complete physical exam was done. Those with cerebral palsy; mental retardation; any known psychological disorder [including attention deficit hyperactivity disorder (ADHD), depression, bipolar disorder, or schizophrenia]; any anorectal, lumbosacral, or urinary tract abnormalities; Hirschsprung's disease; or previous bladder or abdominal surgery were excluded from the study. Recurrent UTIs were defined as a history of at least two episodes of acute pyelonephritis, the occurrence of one episode of upper UTI and of cystitis, or three events of cystitis [10]. LUTS were defined as the presence of at least one of the following symptoms during micturition: decreased (≤three times/day) or increased (≥six times/day) voiding frequency, urgency, dysuria, hesitancy, straining, a poor or interrupted urine stream, postvoid dribbling, incomplete bladder emptying, holding maneuvers, or being incontinent [11]. It was further subclassified into voiding postponement, urge incontinency, and nocturnal enuresis. Enuresis was defined as bedwetting in the absence of daytime incontinence [11]. The control group was selected from those children who were referred to the general outpatient clinic for routine check-ups without renal disease, UTI, or incontinency. They were asked to fill a diary chart of the amount of fluid intake, urine output, and wetting episodes in 2 consecutive days. Urine analysis and urine culture were checked for every child before further evaluation. In the case of UTI, sonography was postponed for 4 weeks until the presence of a negative urine culture.

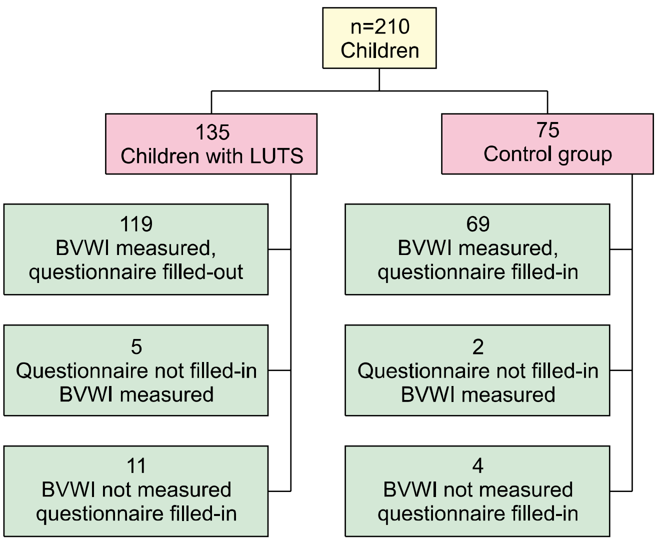


FIG. 1. The number of filled-out questionnaires and measurements of BVWI for children who were enrolled in the study. LUTS: lower urinary tract symptoms, BVWI: bladder volume wall index.

A GE Logic 500 sonography system was used for all patients with both 7.5 MHz linear and 5 MHz convex probes. Kidney and bladder sonography was performed in all children to rule out any urological abnormalities and also to measure BVWI. First, in the supine oblique position, the maximum renal diameters were measured for each kidney, and then the renal volume was calculated. The patient was asked to drink water as desired. After 20 minutes or at the first urge, the patient's bladder volume index (BVI) was calculated by multiplying the maximum AP and side-to-side internal diameters of the bladder (in mid-transverse plane) and maximum dome-to-bladder outlet (in mid-sagittal plane) in the supine position. It was accepted and recorded only if the calculated BVI was equal to or more than 70% of expected BVI for age from the standard table. Otherwise, the calculation was repeated until the measured BVI exceeded 70% of expected BVI, or if the patient was irritable, unable to tolerate a full bladder, or became incontinent. At the next step, the patient was asked to empty the bladder completely and postvoid BVI was determined by the same method. The bladder emptying efficacy (full bladder volume minus postvoid bladder volume divided by full bladder volume) was measured and is presented as a percentage. Then, the postvoid bladder mean wall thickness was calculated in the mid- transverse view with maximum acceptable image zoom by adding the measures of anterior, anterolateral, and posterolateral wall thickness divided by three. At this stage, the BVWI was measured by dividing the calculated BVI (cm^3) in the full state by mean bladder wall thickness (cm). This was used to determine the BVWI% by dividing calculated BVWI by expected BVWI for age and total renal volume from the standard table [12]. BVWI% <70 was classified as low capacity, thick wall bladder; BVWI% between 70 and 130 was considered normal; and BVWI% >130 was classified as high capacity, thin wall bladder.

1. Questionnaires

The PLUTSS is a standardized questionnaire that contains 15 items about wetting episodes, urinary frequency, and voiding pattern. The items of the PLUTSS questionnaire were translated into Farsi by a translator who was familiar with medical terms and were filled out twice on 2 separate days, once by the physician and another time by the parent. The validity of the translated PLUTSS questionnaire was assessed by its internal consistency by using Cronbach's alpha. A Cronbach alpha of >70 was accepted. The questionnaire that was completed and returned by the parents was included in the study. The internal consistency of the translated questionnaire as evaluated by Cronbach's alphawas 0.74 (95% confidence interval: 0.7-0.78). Information about the age of starting toilet training, episodes of UTI, desire of the child to use an outdoor washing room, and family history of enuresis or wetting was also recorded. A PLUTSS score <8.5 was considered normal.

The Achenbach Child Behavior Check List (CBCL) is a parental questionnaire that is used to diagnose childhood behavioral problems. Usually, a cutoff of 63 for the T-value is used to evaluate the test [7]. The CBCL that had been previously validated for Iranian children by the Institute for Cognitive Science Studies was filled out by the parents and scored to internalization and externalization by using the cutoffs of the 63rd and 90th percentiles of normal children. The radiologists, the psychologist, and the physician were unaware of the results of the other tests.

2. Statistical analysis

The data are presented as mean±SD and frequency. Independent Student's t-test and ANOVA were used to compare mean value, chi-square and likelihood ratio were used for any-rows x any-columns tables, and Cohen's kappa was used to measure the agreement between questioners and sonography results. A value of "1" indicates perfect agreement and "0" indicates no agreement. Receiver operating curve (ROC) analysis was performed to determine sensitivity, specificity, and predictive values. p-values <0.05 were considered significant.

RESULTS

All children with LUTS who came to the outpatient clinic were enrolled in the study, and 75 age-matched healthy children who were brought to the clinic for routine checkups were included as controls. From 204 PLUTSS questionnaires filled out by parents, the mean score was 13±5.8 in children with LUTS compared with 2.4±1.9 for control children ($p<0.0001$). Voiding postponement was seen in 31 out of 135 children (23%), urge incontinence in 21 (16%), monosymptomatic enuresis (MSE) in 54 (40%), and non-MSE in 29 children (22%). Seven of 75 control children had sometime daytime wetting ($p<0.0001$). Seventy- four children (57%) with LUTS voided less than four or more than seven times per day compared with 25 (34%) children in the control group (p=0.002). The need to strain during voiding was reported in 19 children with LUTS (14.6%) and in 3 control children (4.1%) (p=0.019). A total of 36 patients (27.7%) and 8 healthy children (10.8%) had interrupted voiding (p=0.005). A feeling of incomplete emptying of the bladder after voiding was reported in 40 (30.8%) patients and in 8 (10.8%) control children (p=0.001). Urgency and rush to toilet were seen in 80 (61.5%) patients compared with 23 (31%) control children ($p<0.0001$). Sixty children with LUTS (46.2%) had a history of wetting on the way to toilet, whereas only 4 (5.4%) children in the control group did ($p<0.0001$). Twenty children (15.4%) with LUTS felt pain during voiding compared with two (2.7%) control children (p=0.004). The reason for dysuria in the control group was washing the perinea with soap while taking a shower. Among the patients with LUTS, 43 patients (33.1%) had not everyday bowel evacuation and all had constipation (hard stool and pain during defecation), and this was reported for 20 (27%) controls without constipation ($p>0.05$).

Children with LUTS had higher rates of TCS and EXTS T-value >63 ($p<0.05$). There was no statistically significant correlation between CBCL scores and sex or age. TCS, EXTS, and INTS T-value >63 were more common in children with non-MSE ($p<0.05$). The frequency of EXTS and TCS T-value >63 was higher in children with holding maneuver than in those with urge incontinence. As shown in Table 1, the mean INTS, EXTS, and TCS of control children were in the normal zone; the mean values for non-MSE children were in the abnormal zone; and the mean values in the other three subgroups were in the borderline zone for TCS.

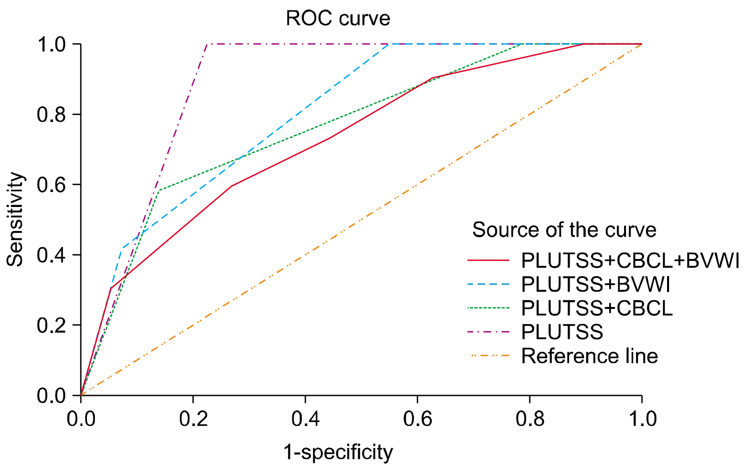
Urinary tract sonography was performed in 197 children. The BVWI was calculated on the basis of age and total renal volume. Estimated BVWI based on age was significantly different from estimated BVWI based on total renal volume. There was no correlation between BVWI and detection of vesicoureteral reflux ($p>0.05$) or the frequency of UTI ($p>0.05$). Mean postvoid residual was not significantly different between the groups [26±25.5 ml vs. 20.5±21 ml] ($p>0.05$).

There was no agreement between BVWI and PLUTSS ($p>0.05$); poor agreement between PLUTSS, INTS (kappa =0.16, p=0.019), and EXTS (kappa=0.19, p=0.002); and fair agreement with TCS T-value >63 (kappa=0.3, $p<0.001$). It was shown that PLUTSS had the highest sensitivity and specificity and area under the curve (AUC) (Fig. 2) for diagnosis of children with LUTS. By using ROC analysis, there was no correlation between the number of UTIs, the age of toilet training, the presence of vesicoureteral reflux, the report of BVWI, or the score of the questionnaires ($p>0.05$). Table 2 shows the domain of behavior problems in each subgroup of cases.

Table 1. Child Behavior Check List, urinary tract questionnaire, and bladder sonography results in healthy children and children with lower urinary tract dysfunction

	INTS Mean (SD) [INTS>63 n(%)]	p-value [LR]	EXTS Mean (SD) [EXTS>63 n(%)]	p-value [LR]	TCS Mean (SD) [TCS>63 n(%)]	p-value [LR]	PLUTSS Mean(SD) [PLUTSS>8.5 n(%)]	p-value [LR]	BVWI Mean (SD) [BVWI<70->130 n(%)]	p-value [LR]
Control	58.3 (9.4) [23 (31)]	0.04 [9.7]	53.7 (10.8) [14 (19)]	0.001 [13.3]	58 (11.2) [23 (31)]	0.001 [20.6]	2.4 (1.9) [0]	<0.001 [164]	111.5 (53.6) [37 (51)]	NS [1.2]
Non-MSE	65 (11.2) [17 (61)]		63.9 (8.4) [15 (54)]		68.5 (8.6) [22 (79)]		17.6 (5.3) [28 (100)]		95.3 (41.4) [15 (52)]	
MSE	58 (11.3) [17 (32)]		56.8 (10.7) [15 (28)]		61.4 (11) [25 (47)]		13.5 (5.1) [42 (79)]		96 (55) [25 (54)]	
Urge incontinence	60 (12.9) [9 (45)]		53.9 (10.9) [4 (20)]		60.2 (12.5) [8 (40)]		11.2 (6.7) [11 (55)]		93.5 (38.8) [8 (40)]	
Voiding postponement	61.5 (10.5) [14 (48)]		59.2 (13.1) [11 (38)]		63.6 (12.5) [16 (55)]		9 (3.5) [13 (45)]		118.5 (64.7) [15 (50)]	

Data are presentented as mean (SD) and in brackets as the number (percentage) of the patients above the cutoff point. INTS: internalized score, EXTS: externalized score, TCS: total clinical score, PLUTSS: Pediatric Lower Urinary Tract Scoring System, BVWI: bladder volume wall index, LR: likelihood ratio, MSE: monosymptomatic enuresis. ANOVAs test was used to compare the mean differences.



Diagonal segments are produced by ties.

Area under the curve

Test result variable(s)	Area	Std. error	Asymptotic sig	Asymptotic 95% confidence Interval Lower bound	Upper bound
PLUTSS+CBCL+BVWI	.729	.040	<0.001	.652	.807
PLUTSS+BVWI	.803	.033	<0.001	.738	.867
PLUTSS+CBCL	.763	.038	<0.001	.690	.837
PLUTSS	.888	.026	<0.001	.838	.938

PLUTSS: pediatric lower urinary tract scoring system, BVWI: bladder volume wall index, CBCL: Child Behavior Check List

Fig. 2. Receiver operating curve (ROC) curve for the pediatric lower urinary tract scoring system (PLUTSS), Child Behavior Check List (CBCL), and bladder volume wall index (BVWI) for children with lower urinary tract symptoms compared with controls. The table shows area under the curve.

DISCUSSION

This study showed that PLUTSS was superior to BVWI in the differentiation of healthy children from patients with LUTS. There was poor to fair agreement between the CBCL and PLUTSS and no agreement with BVWI. BVWI has been shown to have a good correlation with urodynamic findings and response to desmopressin in children with MSE [13,14]. The similar distribution of BVWI in both groups in our study was opposite to our expectation, and the ROC curve showed that BVWI alone could not differentiate between healthy children and cases with LUTS or its subgroups. In addition, there was no correlation between BVWI and voiding frequency or PLUTSS results. It has been reported that expressing BVWI according to age is associated with a wide range, and Yeung et al concluded

TABLE 2. Receiver operating curve analysis for questionnaires and bladder sonography for subgroups of children with lower urinary tract symptoms compared with controls

	Non-MSE (n=28)			MSE (n= 53)			Urge incontinence (n=20)			Voiding postponement (n=29)		
	AUC	p-value	95% CI	AUC	p-value	95% CI	AUC	p-value	95% CI	AUC	p-value	95% CI
PLUTSS	1	<0.001	1-1	0.9	<0.001	0.84-0.98	0.79	<0.001	0.64-0.93	0.74	<0.001	0.62-0.86
BVWI	0.5	NS	0.37-0.62	0.51	NS	0.4-0.62	0.42	NS	0.27-0.56	0.49	NS	0.36-0.61
CBCL	0.73	<0.001	0.62-0.84	0.58	NS	0.47-0.68	0.54	NS	0.39-0.69	0.62	NS	0.49-0.75
INTS	0.64	0.026	0.52-0.76	0.57	NS	0.47-0.66	0.57	NS	0.42-0.71	0.57	NS	0.45-0.69
Anxious/depressed	0.74	<0.001	0.62-0.86	0.52	NS	0.42-0.63	0.51	NS	0.34-0.68	0.58	NS	0.44-0.7
Withdrawn/ depressed	0.62	0.011	0.54-0.8	0.49	NS	0.39-0.6	0.6	NS	0.46-0.75	0.68	0.005	0.56-0.8
Somatic complaints	0.62	NS	0.5-0.74	0.44	NS	0.34-0.55	0.49	NS	0.34-0.66	0.44	NS	0.32-0.57
EXTS	0.67	0.008	0.54-0.79	0.6	0.032	0.51-0.69	0.5	NS	0.36-0.64	0.58	NS	0.46-0.7
Delinquent behavior	0.75	<0.001	0.65-0.86	0.58	NS	0.48-0.68	0.46	NS	0.3-0.61	0.58	NS	0.45-0.7
Aggressive behavior	0.78	<0.001	0.68-0.87	0.59	NS	0.49-0.7	0.47	NS	0.32-0.62	0.6	NS	0.47-0.74
TCS	0.73	<0.001	0.62-0.84	0.64	0.003	0.55-0.73	0.57	NS	0.42-0.71	0.6	NS	0.48-0.72
Social problems	0.75	<0.001	0.64-0.85	0.56	NS	0.46-0.67	0.59	NS	0.45-0.73	0.56	NS	0.43-0.69
Thought problems	0.69	0.004	0.58-0.81	0.45	NS	0.34-0.67	0.45	NS	0.31-0.59	0.59	NS	0.46-0.7
Attention problems	0.76	<0.001	0.65-0.87	0.57	NS	0.47-0.68	0.51	NS	0.35-0.67	0.6	NS	0.46-0.74

PLUTSS: Pediatric Lower Urinary Tract Scoring System, BVWI: bladder volume wall index, CBCL: Child Behavior Check List, INTS: internalized score, EXTS: externalized score, TCS: total clinical score, MSE: monosymptomatic enuresis, AUC: area under the curve, CI: confidence interval

that the BVWI reported on the basis of total renal volume has a higher validity [14]. Furthermore, the normogram of BVWI and total renal volume in healthy Chinese children has been constructed [12]. We found a discrepancy between expected BVWI calculated for age and for renal volume, and a wide range for expected BVWI was observed when presented either as age or renal volume.

The CBCL has been used in some studies to evaluate behavior problems in children with incontinency or bladder dysfunction. Zink et al found that children with daytime incontinence had higher EXTS and INTS than did children with nighttime wetting [9]. In our study, the frequency of abnormal INTS was twice as common in children with LUTS as in normal children. Schast et al reported a higher mean score for the PLUTSS in children with ADHD or learning disabilities [15]. Bael et al found that the TCS and EXTS improved after therapy in children with dysfunctional voiding, but that the scores did not change for urge incontinence [16]. In contrast, our study showed that patients with both urge incontinency and voiding postponement had higher TCS, INTS, and EXTS than did controls. Von Gontrad et al compared the CBCL score in day/night wetting, primary/secondary enuresis, MSE/non-MSE, and urge incontinence/postponement maneuver in 164 children. He found that the TCS and INTS were significantly higher in patients with secondary enuresis but not in the other groups [7]. In general, we observed that children with LUTS had more behavior problems than did healthy children. Patients with non-MSE had the highest frequency of TCS, EXTS, and INTS. However, the abnormal CBCL in our study group was consistent with other studies, but the rate of EXTS was higher in our children [7]. A study on a large number of children aged 7 to 8 years showed that children who soil frequently have a higher rate of behavior and emotional problems and that this difference was also considerable in children with occasional soiling problems [6]. The CBCL has correlation with psychiatric disorders; however, none of our patients had a known or apparent psychiatric disorder. We did not enroll these patients in our study. Our study showed that non-MSE children had highly abnormal CBCL scores, and their mean scores were in the abnormal zone in contrast with the other subgroups, which were in either the borderline or the normal zone. There is still the possibility that the CBCL may be more useful in LUTS associated with psychiatric disorders than in patients with urological disorders. The PLUTSS had the highest sensitivity and specificity in discriminating healthy children from children with LUTS, and surprisingly, BVWI had low value for screening these children. The numerous items in the CBCL and the need to adjust on the normogram made completing the CBCL a time-consuming process. Some items in the PLUTSS need to be discussed with the parents to be understood. Some children could not tolerate a full bladder, and most needed to void three times to measure postvoid residue. In addition, the lower number of controls compared with cases was a limitation of this study. There is also the possibility of hidden, not yet identified psychiatric disorders in the cases. Further study is needed, especially focusing on children presenting with non-MSE.

CONCLUSIONS

The PLUTSS by itself was the best predictor of LUTS. The CBCL and BVWI did not play a determinant role in making a diagnosis. There was no agreement between the PLUTSS and BVWI, and poor to fair agreement with the CBCL. The CBCL was useful in detecting behavior problems in children with non-MSE.

Conflicts of Interest

The authors have nothing to disclose.

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