Original Article

Normal bladder wall thickness measurement in healthy Iranian children, a cross-sectional study

Atoosa Adibi, Afarin Kazemian[1], Ali Toghiani[2]

Department of Radiology, [1]Medical School, Isfahan University of Medical Sciences, [2]Young Researchers and Elite Club, Najafabad Branch, Islamic Azad University, Najafabad, Isfahan, Iran

Abstract

Background: Normal bladder function is necessary for micturition. Many causes such as urinary tract infection, bladder outlet obstruction, and neuropathic bladder can influence bladder wall thickness (BWT). This study was designed to determine normal BWT in Iranian children.

Materials and Methods: This was a cross-sectional study done in Isfahan in 2012 comprising 82 children aged 2-14 years without any urinary complaint. We measured thickness of posterior and lateral walls of the bladder in all children. Mean bladder wall thickness (MBWT) and mean bladder volume (BV) were also calculated.

Results: In this study, we included 82 children (40 boys and 42 girls). Patients' mean age was 6.43 ± 2.89 years, mean weight was 21.32 ± 8.40 kg, mean height was 111.57 ± 20.51 cm, and mean Body Mass Index was 17.12 ± 4.93. Mean lateral bladder wall thickness (LBWT) was 1.75 ± 0.32 mm and mean posterior bladder wall thickness (PBWT) was 1.59 ± 0.34 mm. Mean BV was 111.65 ± 72.11 ml and MBWT was 1.67 ± 0.28 mm. BVW all Index (BVWI) was 1249.05 ± 701.67.

Conclusions: LBWT was1.75 ± 0.32 mm and PBWT was 1.59 ± 0.34 mm.

Key Words: Reference values, ultrasonography, urinary bladder

Address for correspondence:
Dr. Atoosa Adibi, Department of Radiology, Isfahan University of Medical Sciences, Isfahan, Iran. E-mail: a_adibi@med.mui.ac.ir

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INTRODUCTION

Evaluating the morphology and function of bladder wall is very important because normal bladder function is necessary for micturition. Some pathological conditions such as vesicoureteral reflux, detrusor overactivity, dysfunctional voiding and bladder obstruction, and neuropathic bladder may cause increase in bladder wall thickness (BWT). BWT is increased during urinary tract infection (UTI), chemotherapy, urinary stones, and inflammation.[1-7] Internal changes in urinary bladder could be evaluated by cystoscopy or cystography, but as these tests are harmful because of their intervention or radiation, safer tests are needed such as transabdominal ultrasonography (US). US could be used as an accurate, safe, and non-interventional method.[8,9]

Mean values of normal BWT were mentioned in some studies with significant differences between different races. Hekenbery reported mean bladder wall thickness (MBWT) in men of 3.3 mm and that in women of 3 mm in the adult population.[10] In another study, it was reported that MBWT was 4-6 mm. They reported no difference between genders and different

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ages.[11] Another study reported MBWT of 3 mm when bladder was full and 5 mm when bladder was empty.[11]

MBWT in children had variable ranges in different studies. Sorkhi *et al*.[2] reported mean posterior wall thickness of 2 ± 0.36 mm and mean lateral thickness of 1.8 ± 0.34 mm. Uluocak reported mean posterior thickness of 1.57 mm and mean lateral wall thickness of 1.49 mm.[1]

Many studies had evaluated normal BWT in adults, but there are few reports on BWT in children.[12] We designed this study to evaluate normal BWT in Iranian pediatrics because of anatomical variations in different races, and the need for normal reference values during pediatric bladder ultrasound evaluation.

MATERIALS AND METHODS

This is a cross-sectional study comprising 82 participants with no urinary complaints who were referred to a sonography office in 2012. Patients were selected using convenience time-based sequential sampling method, and informed consent was obtained from their parents. Cases were included according to the following criteria:

- Absence of any history of urinary symptoms or previous medical history relating to urinarysystem such as congenital urinary malformations, UTI, voiding dysfunction, or enuresis
- Absence of ultrasound findings such as urinary stone, pelvicaliceal stasis, ureteric dilation, renal pathology, and bladder malformation
- Absence of urinary tract surgery history
- Absence of systemic diseases such as chronic metabolic diseases and neurologic disease
- After participants were hydrated and felt the first urge to void, bladder ultrasounds were performed.

BWT in all cases was calculated in both posterior and lateral walls. Mean of these two measurements was assumed as MBWT. All ultrasounds were performed by one of authors who is an expert radiologist in pediatric sonography (AA). All ultrasounds were performed using one sonography equipment of General Electrics Company (Voluson730Expert) with a curvilinear 3-7-MHz multifrequency probe and a linear 6-10-MHz multifrequency transducer, if required.

MBWT (MBWT = Lateral wall thickness + Posterior wall thickness/2), bladder volume (BV) (BV = bladder height × bladder width × anteroposterior length of bladder × 0.52), Bladder Volume Index (BVI) (BVI = bladder height × bladder width × anteroposterior length of bladder), and Bladder Volume Wall Index (BVWI) (BVWI = BVI/mean thickness of bladder in centimeter) were calculated for each participant.

BWT was measured from the interface of urine and internal mucosal layer of bladder to outer part of hypoechogenic muscular layer, in the middle of the left or right lateral walls, and in the middle of the posterior wall to rectum.

Tests such as *t*-test, Pearson correlation test, and ANOVA were used in SPSS software (18th version) for analyzing data.

RESULTS

In this study, we included 82 children (40 boys, 42 girls). Mean age of the participants was 6.43 ± 2.89 years, mean weight was 21.32 ± 8.40 kg, mean height was 111.57 ± 20.51 cm, and mean Body Mass Index (BMI) was 17.12 ± 4.93. Independent *t*-test showed that there was a significant difference in age and weight between groups. Gender-based differencesin age, weight, height, and BMI are summarized in Table 1.

Mean lateral bladder wall thickness (LBWT) was 1.75 ± 0.32 mm; mean posterior bladder wall thickness (PBWT) was 1.59 ± 0.34 mm. Mean BV was 111.65 ± 72.11 ml and MBWT was 1.67 ± 0.28 mm. BVWI was 1249.05 ± 701.67. Gender-based differences in these factors are summarized in Table 2. Pearson

Table 1: Mean age, weight, height, and body mass index with gender differentiation

	Male	Female	*P* value between males and females
Age (year)	6.98±3.29	5.91±2.37	0.047
Weight (kg)	23.26±9.91	19.47±6.21	0.02
Height (cm)	115.32±21.08	108±19.53	0.053
BMI (kg/m^2)	16.96±3.28	17.27±6.14	0.387

BMI: Body mass index

Table 2: Bladder sonographic indices with sex differentiation

	Male	Female	*P* value between males and females
Lateral bladder wall thickness (mm)	1.81±0.30	1.70±0.32	0.055
Posterior bladder wall thickness (mm)	1.66±0.34	1.53±0.33	0.041
Mean bladder wall thickness (mm)	1.76±0.25	1.61±0.29	0.025
Bladder volume (ml)	128.57±84.74	95.54±53.82	0.018
Bladder volume wall index	1372.36±765.51	1131.61±621.52	0.06

correlation analysis results are summarized in Table 3.

It was showed that MBWT in males is significantly higher than females using Independent *t*-test, but considering age in males group and the correlation between age and MBWT, we had used ANOVA test and then we found that there was no correlation between sex and MBWT ($P = 0.202$).

Pearson correlation test showed a correlation between weight and both BV ($P = 0.001$, $r = 0.675$) and MBWT ($P = 0.001$, $r = 0.563$). There was a correlation between patients' age and their BV and MBWT. We used linear regression test, and new results had showed correlation between patients' weight and their BV ($P = 0.001$, $r = 0.372$) and MBWT ($P = 0.002$, $r = 0.266$).

DISCUSSION

In this study, mean LBWT was 1.75 ± 0.32 mm and mean PBWT was 1.59 ± 0.34 mm. Mean BV was 111.65 ± 72.11 ml and MBWT was1.67 ± 0.28 mm. BVWI was 1249.05 ± 701.67. Our results showed that no correlation between gender and MBWT, whereas correlation was found between patients' weight and their BV and MBWT. Uluocak in 2007evaluated 224 Turkish children aged between 7 and 15 years. He reported a mean anterior BWT of 1.42 mm, mean PBWT of 1.57 mm, and mean LBWT of 1.49 mm. A significant correlation was found between BMI and MBWT in his study.[1] Posterior wall thickness in our results and Uluocak's findings were the same; LBWT in our study was more than that reported in Uluocak's. More studies are required for documenting this finding.

We also found an inverse correlation between BMI and MBWT, but Uluocak found a direct correlation. Oelke and Wijkstra[13] in 2008 reported that in school-age children MBWT was between 1.42 and 1.57 mm. Our results showed that bladder wall was thicker in our study. Jequier evaluated 410 individuals aged below 19 years and 10 adults in the United States. He reported that MBWT was 2.76 mm when bladder was empty and 1.55 mm when bladder was distended.[14]

Leung *et al.*[15] evaluated 3376 children aged between 15 days and 17 years. They found a correlation between age and BWT, and our results agree with their findings.

Sorkhi *et al.*[2] evaluated 106 Iranian children aged 8-15 years in 2009. They reported that MBWT was 1.79 ± 0.28 mm, mean anterior wall thickness was 1.5 ± 0.31 mm, posterior wall thickness was 2 ± 0.36 mm, right lateral wall thickness was 1.8 ± 0.34, and left lateral wall thickness was 1.8 ± 0.36 mm. Comparing our results with that of this study, MBWT and LBWT were approximately the same, but our findings showed a thinner posterior wall. This could be due to the difference in age of the study population (7.44 vs. 6.4).[2]

Kuzmic *et al.*[16] reported 1.2 ± 0.4 mm, 1.2 ± 0.4 mm, 1.2 ± 0.4 mm, and 1.2 ± 0.4 mm for normal detrusor thickness of anterior, posterior, right lateral, and

Table 3: Correlations between evaluated factors are listed

	MBWT	BVWI	PBWT	LBWT	BV (or BVI)	BMI	Age	Weight	Height
MBWT		*P*=0.006	*P*=0.001	*P*=0.001	*P*=0.001	*P*=0.031	*P*=0.001	*P*=0.001	*P*=0.001
		r=0.273	*r*=0.859	*r*=0.839	*r*=0.514	*r*=-0.207	*r*=0.520	*r*=0.563	*r*=0.591
BVWI	*P*=0.006		*P*=0.019	*P*=0.017	*P*=0.001	*P*=0.320	*P*=0.001	*P*=0.001	*P*=0.001
	r=0.273		*r*=0.229	*r*=0.236	*r*=0.950	*r*=-0.052	*r*=0.528	*r*=0.563	*r*=0.535
PBWT	*P*=0.001	*P*=0.019		*P*=0.001	*P*=0.001	*P*=0.103	*P*=0.001	*P*=0.001	*P*=0.001
	r=0.859	*r*=0.229		*r*=0.444	*r*=0.447	*r*=-0.141	*r*=0.412	*r*=0.476	*r*=0.471
LBWT	*P*=0.001	*P*=0.017	*P*=0.001		*P*=0.001	*P*=0.027	*P*=0.001	*P*=0.001	*P*=0.001
	r=0.839	*r*=0.236	*r*=0.444		*r*=0.427	*r*=-0.231	*r*=0.474	*r*=0.481	*r*=0.536
BV (orBVI)	*P*=0.001	*P*=0.001	*P*=0.001	*P*=0.001		*P*=0.325	*P*=0.001	*P*=0.001	*P*=0.001
	r=0.514	*r*=0.950	*r*=0.447	*r*=0.427		*r*=-0.051	*r*=0.610	*r*=0.675	*r*=0.614
BMI	*P*=0.031	*P*=0.320	*P*=0.103	*P*=0.027	*P*=0.325		*P*=0.194	*P*=0.215	*P*=0.001
	r=-0.207	*r*=-0.052	*r*=-0.141	*r*=-0.213	*r*=-0.051		*r*=-0.097	*r*=0.088	*r*=-0.423
Age	*P*=0.001	*P*=0.001	*P*=0.001	*P*=0.001	*P*=0.001	*P*=-0.097		*P*=0.001	*P*=0.001
	r=0.520	*r*=0.528	*r*=0.412	*r*=0.474	*r*=0.610	*r*=e0.194		*r*=0.860	*r*=0.863
Weight	*P*=0.001	*P*=0.001	*P*=0.001	*P*=0.001	*P*=0.001	*P*=0.215	*P*=0.001		*P*=0.001
	r=0.563	*r*=0.563	*r*=0.476	*r*=0.481	*r*=0.675	*r*=0.088	*r*=0.860		*r*=0.837
Height	*P*=0.001	*P*=0.001	*P*=0.001	*P*=0.001	*P*=0.001	*P*=0.001	*P*=0.001	*P*=0.001	
	r=0.591	*r*=0.535	*r*=0.471	*r*=0.536	*r*=0.614	*r*=-0.423	*r*=0.863	*r*=0.837	

BVWI: Bladder volume wall index, PBWT: Posterior bladder wall thickness, LBWT: Lateral bladder wall thickness, BVI: Bladder volume index, BMI: Body mass index, MBWT: Mean bladder wall thickness

left lateral wall, respectively, in 62 children aged 20 months to 18 years.

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