Original Research Article

Assessment of urinary bladder wall thickness among healthy children using ultrasonography

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Abstract

Background: The full urinary bladder is an echo-free cystic structure containing fluid or urine. The bladder shape varies from round to ovoid to oblong. The bladder has a thin, smooth muscular wall whose thickness can be discerned with ultrasound; it is proportionately thicker in infants than in other age groups. **Materials and Methods:** A prospective study of the ultrasonographic evaluation of the urinary bladder wall thickness in 100 normal healthy children aged 5 - 11 years was carried out. All the study participants were normally healthy, without any present urologic condition or history of urinary bladder pathology. All the participants of this study had sonographic measurements of the anterior urinary bladder wall thickness, posterior bladder wall thickness and lateral bladder wall thickness using a high frequency (6.0MHz) ultrasound probe. **Result:** The mean bladder wall thickness of all points was 1.95 mm. The mean anterior bladder wall thickness was 1.78 mm with a standard deviation of 0.23 mm. The mean posterior bladder wall thickness was 2.10 with a standard deviation of 0.31 mm. The mean lateral bladder wall thickness was 1.98 mm with a standard deviation of 0.10 mm. **Conclusions:** There was a significant difference in all the measurements at the different points (anterior, posterior and lateral). Urinary bladder wall thickness showed a significant positive relationship with age.
Keywords: Ultrasonography, Urinary bladder wall thickness, children.

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INTRODUCTION

The urinary bladder is a hollow spherical organ located in the true pelvis behind the pubic symphysis. It is located anterior to the end of both ureters. The urethra and the bladder form the lower urinary tract. The urinary bladder is a simple organ. The bladder is vital for storing urine and voiding stored urine. The thickness of the urinary bladder wall is a good indicator of how healthy it is. Hence there is a need for normal values of the wall thickness. The detrusor smooth muscle is the primary muscle component of the urinary bladder wall.[1] Hypertrophic growth of detrusor muscle in response to urinary outlet obstruction is well documented in humans. Demographic, anatomic and urodynamic factors affect the bladder wall thickness.[2] An increase in the thickness of the urinary bladder wall was found to be linked with a decrease in voiding efficiency, which may indicate that the duration of suffering from bladder outlet obstruction and, or the degree of bladder outlet obstruction is responsible for the generation of a thickened bladder wall. That bladder with a thickened wall cannot efficiently expel urine.[1-3] Therefore, measurement of the bladder wall must be considered critical in evaluating patients with lower urinary tract symptoms (LUTS). Functional changes of the detrusor can be found in several clinically essential conditions, e.g., lower urinary tract symptoms (LUTS) and bladder outlet obstruction (BOO). Urinary tract infections (UTIs) are a common cause of morbidity in children.[2-5] All these Urinary bladder pathologies will lead to increased bladder wall thickness. The symptoms are not always evident to parents, and younger children cannot describe how they feel. That is why it is necessary to examine the urinary

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bladder wall for increased thickness. Sonographic evaluation of the bladder wall requires no ionising radiation and contrast agent. The investigation is more readily affordable and less time-consuming. It is both patient and operator friendly and is available in our environment. Hence suitable for the investigation of children. The main aim of this study was to determine normal values of urinary bladder wall thickness in our environment in order to delineate clearly between normal and morbid conditions.

MATERIALS AND METHODS

Our study was a prospective observational nature study. This study protocol was approved by the Institutional Scientific and Ethical Committee.

Enrolment of Subjects: This study was conducted during August 2019 and August 2021. It was carried out at the Department of Radiology, Chettinad Hospital and Research Institute, Kelambakkam, Chennai. One hundred healthy boys as well as girls aged 5 to 11 years (median age 8 years) were recruited for this study. Those who have willingly signed the informed consent form and self-declaration related that he does not suffer from any other metabolic disorders were considered for this study. Subjects with a previous history of genitourinary surgery, genital abnormality and those being investigated for UTI were not considered for this study. Patient position: Supine position for the ultrasonography of each subject was used. Imaging examination: All the 100 subjects were evaluated with the help of the aid of the 5.5-7.5MHZ linear transducer from a Philips HD11XE ultrasound machine [Here, you can mention the ultrasound machine details used in that particular hospital]. The experimental procedure was explained, and informed consent was obtained directly from the parents. Each subject was made to lay supine position with a full bladder. Transabdominal ultrasonography was performed after the application of coupling gel. Scanning was initiated by placing the transducer approximately 1 cm above the pubic symphysis either in the sagittal or transverse orientation. Once the bladder was identified, real-time scanning was done systematically in the transverse and sagittal planes and the oblique sagittal planes. Anterior wall thickness was taken on a longitudinal scan in the midline at a point midway between the superior and inferior margin of the bladder. Next, the posterior wall thickness was measured at the midpoint of its superior and inferior margins. At the point where the anterior wall thickness was measured, the transducer was rotated through 900 for a transverse scan. The measurement of both lateral walls was taken at the midpoint of the lateral walls, and the mean was used as the lateral wall thickness. Each measurement was taken at least three times, with the average found to give the final measurement.

Statistical analysis: The consolidated and compiled data were analysed with SPSS statistics software.

RESULTS

One hundred subjects were studied, and all had an ultrasonographically normal urogenital system. The age range of subjects in this study was 5-11 years with a mean age of 9.27 years and a standard deviation of 2.07 years with a median of 8 years. The age of 11 years has the highest frequency (Table 1). There were 64 boys and 36 girls participated in this study (Table 1).

Table 1: Comparison between the age of participants with gender

Age Group (Years)	Gender		Total
	Boys	Girls	
5	5	1	6
6	8	3	11
7	7	5	12
8	9	10	19
9	11	8	19
10	13	6	19
11	11	3	14
Total	**64**	**36**	**100**

The mean bladder wall thickness of all subjects in this study was 2.08 mm with a standard deviation of 0.17 mm and a median of 1.87 mm. There was a significant positive correlation with age ($P<0.001$) (Table 2). However, between ages 8 and 9 years, there was a reduction in bladder wall thickness. The mean bladder wall thickness of boys was 1.96 mm with a standard deviation of 0.14 mm, and the mean bladder wall thickness in girls was 1.89 mm with a standard deviation of 0.087 mm. These figures did not show any significant difference between the bladder wall thickness for boys and girls (P-value is 0.054) (Table 2).

Table 2: Comparison of participants' age with the distribution of urinary bladder wall thickness

Age (Years)	Boy (mm)	Girl (mm)	Bladder Wall Thickness (mm)
5	1.81 ± 0.04	1.83 ± 0.07	1.80 ± 0.20
6	1.85 ± 0.09	1.85 ± 0.06	1.84 ± 0.21
7	1.91 ± 0.05	1.85 ± 0.03	1.88 ± 0.13
8	1.96 ± 0.06	1.95 ± 0.02	1.95 ± 0.12
9	1.92 ± 0.03	1.95 ± 0.05	1.94 ± 0.19
10	2.06 ± 0.10	2.02 ± 0.03	2.05 ± 0.29
11	1.95 ± 0.06	1.95 ± 0.06	2.06 ±0.13

Data is presented as ±SD

The mean anterior bladder wall thickness was 1.80 mm with a standard deviation of 0.22 and a median of 1.91 mm. It has a significant positive correlation with age (P<0.001). There was a significant difference between these values and that of posterior and lateral bladder wall thickness (P<0.005 and P=0.002, respectively) (Table 3). The mean anterior bladder wall thickness in boys was 1.80 mm with a standard deviation of 0.19 mm. In girls, it was 1.71mm with a standard deviation of 0.07mm. The difference between boys and girls was statistically insignificant (P=0.587) (Table 3).

Table 3: Comparison of participants' age with the urinary bladder wall thickness distribution.

Age (Years)	Anterior Wall Thickness(Mm)		Posterior Wall Thickness(Mm)		Lateral Wall Thickness(Mm)	
	Boy	Girl	Boy	Girl	Boy	Girl
5	1.70 ±0.20	1.60 ±0.21	1.79 ±0.66	2.01 ±0.04	1.93 ±0.16	1.88 ±0.21
6	1.45 ±0.45	1.46 ±0.05	2.11 ±0.28	2.13 ±0.31	1.98 ±0.04	1.96 ±0.03
7	1.68 ±0.08	1.64 ±0.15	2.02 ±0.07	1.97 ±0.08	2.02 ±0.17	1.95 ±0.16
8	1.85 ±0.19	1.82 ±0.20	2.05 ±0.18	2.05 ±0.13	1.98 ±0.11	1.97 ±0.06
9	1.78 ±0.24	1.76 ±0.24	2.03 ±0.16	2.09 ±0.18	1.96 ±0.19	1.99 ±0.12
10	1.96 ±0.13	1.82 ±0.24	2.16 ±0.47	2.22 ±0.46	2.07 ±0.04	2.01 ±0.08
11	1.95 ±0.05	1.64 ±0.21	2.34 ±0.21	2.24 ±0.11	1.99 ±0.05	1.97 ±0.08

Data is presented as ±SD

The mean posterior bladder wall thickness was 2.03 mm with a standard deviation of 0.31mm and a median of 1.97 mm. There was a significant positive correlation with age (P<0.001). There was a significant difference between it, anterior bladder wall and lateral bladder wall thickness (P<0.001 and P=0.023). The mean posterior bladder wall thickness in boys was 2.08 mm with a standard deviation of 0.24 mm, and for girls, it was 2.16 mm with a standard deviation of 0.19 mm. No statistical significance was found between boys and girls participants comparison. The mean lateral bladder wall thickness was 2.01 mm with a standard deviation of 0.11 mm and a median of 2.04 mm. It has a significant positive correlation with age (P<0.001). A comparison of anterior and posterior bladder wall thicknesses shown statistically significant differences (P=0.003 and P=0.023, respectively). The mean lateral bladder wall thickness in boys was 2.01 mm with a standard deviation of 0.19 mm, and in girls, it was 1.97 mm with a standard deviation of 0.67mm. Comparing the figures in boys and girls shows that there was no significant difference (P=0.838).

DISCUSSION

There are different radiologic methods of investigation of bladder disorders. Ultrasonography is the one that is more readily available, simple, non-invasive and without ionisation hazard. Ultrasonography, especially using high-frequency transducers, makes precise measurement of bladder wall thickness possible.[1] On sonography with the appropriate gain setting, the normal bladder wall can be easily seen and its thickness measured. Many pathological causes such as urinary tract infection, bladder outlet obstruction and neurogenic bladder can influence the bladder wall thickness. Long term bladder outlet resistance (mechanical or functional) can lead to increased thickness, diverticula and disarrangement of ureterovesical junction. The degree of these abnormalities depends on the severity of obstruction. This was further supported by the works of earlier published studies.[1-4] In this study, the mean bladder wall thickness in boys was 1.96 mm and for girls 1.94 mm. This was also higher than the mean for the sexes in other studies. This difference in the figures of both genders was not statistically significant (P=0.063). This observation was in agreement with other studies.[4-6] The result of this study shows that there was no difference in bladder wall thickness between the genders. This indicates that the same factors govern bladder wall thickness in both boys and girls gender. This study also highlights that bladder wall thickness increases with age, which was statistically significant (P< 0.001). Other authors also reported similar

findings. It may be correct to infer from this study and previous works that older children have a thicker bladder wall than younger children.[6-8] This implies that the urinary bladder grows progressively during childhood, just like other organs. The bladder appears fully grown in adults, and the bladder wall thickness does not increase significantly with age. The drop in mean bladder wall thickness of the 9-year-old group over the 8-year-old group in this study may be due to the relative lower BMI of the 9-year-old compared to that of the 8-year-old group. It may also be physiological, suggesting a reduction in bladder wall thickness before the pubertal growth spurt; these may warrant further investigations. The mean anterior bladder wall thickness in this study was 1.78mm with a standard deviation of 0.13mm, and there was a significant difference between it and the mean posterior wall thickness ($P<0.05$) and between it and the mean lateral wall thicknesses($P<0.05$). Other authors report similar findings.[4,5,8] The mean posterior bladder wall thickness is 2.10 mm with a standard deviation of 0.15 mm. There was a significant difference between it and the anterior and the lateral bladder wall thicknesses ($P<0.05$). It is important to note that the posterior wall thickness was consistently greater than the lateral and anterior bladder wall thickness in this study. Researchers did not provide the reason for this pattern; however certain factors may explain it. The detrusor muscle of the bladder wall reacts to pressure, and volume load in the same fashion as the myocardium of the heart by increasing in size, the posterior bladder wall in a recumbent position in which the study was done is the most dependent and subjected to more pressure and volume load from the overlying urine than the lateral and the anterior walls, these may explain the marginally thicker posterior walls. Also, the epithelium of the mucosa is of the transitional variety.[9-11] It flattens when distended; when the subject is lying on his back, the posterior wall epithelium is the least distended. The thickest, anterior epithelium is the most distended and the thinnest, while the lateral wall epithelium is of intermediate distension and thickness. Embryology may not play a significant role here since only the supraregional area has a different origin from the rest of the bladder, and it was not measured in this study. Urinary tract infections (UTIs) are a common cause of morbidity in children. Functional bladder wall changes can be found in several clinically essential conditions. Therefore, measurement of the bladder wall must be considered critical in evaluating patients with lower urinary tract symptoms.

CONCLUSION

This study determined the urinary bladder wall thickness in children, which was observed as significantly increase with age. There was no significant difference in bladder wall thickness between boys and girls. Those with a higher body mass index have a thicker bladder wall than those with a lower body mass index. The measurements of the anterior, posterior and lateral bladder wall thicknesses are statistically different from each other, and the mean of these three points should be arrived at in finding bladder wall thickness.

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