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Original Research Article

Descriptive Study of Ultrasonography Assessment of Urinary Bladder Wall Thickness among Healthy Children

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Abstract:

Introduction: The urinary bladder, when full, appears as a fluid-filled, echo-free cystic structure on ultrasound. Its shape can vary, ranging from round to ovoid or oblong. The bladder's wall is smooth and muscular, and its thickness can be assessed using ultrasound. In infants, the bladder wall is relatively thicker compared to other age groups.

Materials and Methods: This prospective study involved an ultrasonographic evaluation of urinary bladder wall thickness in 75 healthy children aged 5 to 12 years. All participants were free from any current urological conditions or history of bladder pathology. Bladder wall thickness was measured sonographically at three points—anterior, posterior, and lateral—using a high-frequency (6.0 MHz) ultrasound probe.

Results: The overall mean bladder wall thickness across all points was 1.9 mm. The mean anterior bladder wall thickness was 1.75 mm (± 0.21 mm), the mean posterior thickness was 2.0 mm (± 0.33 mm), and the mean lateral thickness was 1.98 mm (± 0.12 mm).

Conclusions: Significant differences were observed between the anterior, posterior, and lateral bladder wall measurements. Bladder wall thickness was positively correlated with age.

Introduction

The urinary bladder is an essential component of the urinary system, responsible for the temporary storage of urine before excretion. The bladder's structure and function can be assessed through various imaging techniques, with ultrasonography being a widely accepted, non-invasive method for evaluating bladder wall thickness. This measurement provides crucial insights into bladder health and can aid in the early detection of urological abnormalities [1].

In children, the thickness of the bladder wall varies with age, developmental stages, and individual health status. Ultrasonography, using high-frequency probes, offers an accurate, radiation-free method for studying bladder wall thickness across various age groups.

Monitoring this parameter is essential for understanding the normal physiological development of the bladder in healthy children, as deviations from normal thickness may indicate underlying urological conditions [2]. An increase in urinary bladder wall thickness has been associated with reduced voiding efficiency, suggesting that the severity and duration of bladder outlet obstruction (BOO) play a key role in thickening the bladder wall. A thickened bladder wall is less efficient in expelling urine, highlighting the importance of assessing bladder wall thickness in patients with lower urinary tract symptoms (LUTS).

Functional alterations in the detrusor muscle, which are commonly seen in conditions like LUTS and BOO, can contribute to urinary difficulties. Urinary tract infections (UTIs), a frequent cause of morbidity in children, can also lead to thickening of the bladder wall. However, these conditions often present with subtle symptoms, and younger children may be unable to communicate their discomfort effectively. Therefore, evaluating bladder wall thickness is crucial in diagnosing and managing pediatric urinary pathologies.

This descriptive study aims to assess urinary bladder wall thickness using ultrasonography in healthy children aged 5 to 12 years. By establishing reference values, this research seeks to contribute to the limited body of literature on bladder wall thickness in Indian children, providing valuable baseline data that could enhance early detection and diagnosis of paediatric urological conditions.

Methodology

This descriptive study was approved by the Institutional Ethical Committee. It was conducted over a 12-month period at a tertiary care hospital in Chengalpattu district, Tamil Nadu. The study included 75 healthy children, aged 5 to 11 years, of both genders. Children with a history of genitourinary surgery, genital abnormalities, or those being evaluated for urinary tract infections (UTI) were excluded from participation. All participants underwent ultrasonography in the supine position.

Ultrasonographic evaluations were performed using a GE Voluson ultrasound machine. The procedure was thoroughly explained to the parents, and informed consent was obtained. Transabdominal ultrasonography was conducted while the bladder was full, with the transducer placed approximately 1 cm above the pubic symphysis, either in the sagittal or transverse orientation. After identifying the bladder, real-time scanning was carried out systematically in the transverse, sagittal, and oblique sagittal planes. The anterior wall thickness was measured using a longitudinal scan in the midline, at a point halfway between the bladder's superior and inferior margins. The posterior wall thickness was recorded at the midpoint between the superior and inferior margins of the posterior wall. For lateral wall thickness, the transducer was rotated 90° from the anterior wall measurement to perform a transverse scan. Both lateral walls were measured at their midpoint, and the average of these measurements was used for the final lateral wall thickness. Each measurement was taken three times, and the average was used to obtain the final value. The collected data were compiled in MS Excel and analyzed using SPSS statistical software.

Result

The study included 75 participants who had ultrasonographically normal urogenital systems. The age range of the participants spanned from 5 to 12 years, with a mean age of 8 years (± 2.25 years), indicating that most of the children were in early school-going age.

The median age was found to be 8.5 years, showing that half of the study population was above this age and half below. Notably, the age of 12 years had the highest frequency among the participants, suggesting that more children at the upper end of the age range were represented in the study. Of the total 75 participants, 48 were boys and 27 were girls, ensuring a relatively balanced representation of both genders.

Table 1: Age wise distribution of study participants:

Age (in Years)	Boys	Girls	Total
5	4	1	5
6	5	2	7
7	4	2	6
8	9	4	13
9	9	6	15
10	10	4	14
11	4	5	9
12	3	3	6
Total	**48**	**27**	**75**

In terms of bladder wall thickness, the overall mean value for all participants was 1.9 mm, with a standard deviation of ± 0.16 mm, which reflects the general consistency of bladder wall thickness among the healthy children studied. The median thickness was also 1.9 mm, aligning with the mean value and further confirming the uniformity of the findings.

A significant positive correlation between bladder wall thickness and age was observed, indicating that as the children grew older, the bladder wall tended to thicken. However, an interesting exception was noted between the ages of 9 and 10 years, where a slight reduction in bladder wall thickness occurred, suggesting a possible transitional phase in bladder development during these ages. When comparing genders, the mean bladder wall thickness in boys was slightly higher at 1.89 mm (± 0.14 mm), compared to 1.87 mm (± 0.085 mm) in girls. However, this difference was not statistically significant, indicating that gender does not have a notable effect on bladder wall thickness within the age group studied.

The study also looked at the thickness of the bladder wall at specific anatomical points. The mean anterior bladder wall thickness was 1.81 mm (± 0.25 mm), with a median of 1.93 mm. This measurement showed a significant difference when compared to the posterior and lateral bladder wall thicknesses, suggesting that the anterior wall is slightly thinner. In boys, the mean anterior wall thickness was 1.9 mm (± 0.21 mm), while in girls, it was 1.80 mm (± 0.08 mm), but again, no significant difference between genders was found. The mean posterior bladder wall thickness was measured at 2.0 mm (± 0.29 mm), with a median of

1.95 mm, showing a clear and significant difference from the anterior and lateral bladder wall thicknesses. This indicates that the posterior wall tends to be thicker than the anterior wall. In boys, the mean posterior thickness was 2.06 mm (± 0.28 mm), while in girls it was slightly higher at 2.1 mm (± 0.17 mm), although this difference was not statistically significant. Similarly, the mean lateral bladder wall thickness was 2.03 mm (± 0.1 mm), with a median of 2.06 mm, and showed a significant positive correlation with age, meaning that as children aged, their lateral bladder wall thickness increased.

These findings help establish a comprehensive understanding of normal bladder wall thickness among healthy children, with age-related variations observed, but no significant differences between boys and girls.

Discussion

There are several radiologic techniques available for investigating bladder disorders, with ultrasonography being the most accessible, straightforward, non-invasive, and free from ionizing radiation. Using high-frequency transducers, ultrasonography allows for precise measurement of bladder wall thickness. With the appropriate gain settings, sonography can easily visualize the normal bladder wall, enabling accurate thickness measurements. Various pathological conditions, including urinary tract infections, bladder outlet obstruction, and neurogenic bladder, can affect bladder wall thickness. Prolonged bladder outlet resistance, whether mechanical or functional, may lead to increased wall thickness, diverticula, and alterations at the ureterovesical junction, with the severity of these abnormalities correlating with the degree of obstruction. Previous studies have supported these findings [3].

In this study, the mean bladder wall thickness was 1.96 mm in boys and 1.94 mm in girls, values that exceed those reported in other research. However, this difference between genders was not statistically significant ($P = 0.063$), corroborating similar observations from other studies. This indicates that the factors influencing bladder wall thickness are consistent across both sexes [5].

Furthermore, this study found a significant increase in bladder wall thickness with age ($P < 0.001$), aligning with other authors' findings. This suggests that, like other organs, the urinary bladder continues to grow throughout childhood, with older children exhibiting thicker bladder walls than younger ones. Interestingly, the decrease in mean bladder wall thickness observed in the 9-year-old group compared to the 8-year-old group may relate to a lower BMI in the former or could indicate a physiological trend suggesting a reduction in bladder wall thickness before the onset of pubertal growth spurts. This warrants further investigation [6,7]. The mean anterior bladder wall thickness in this study was 1.78 mm (± 0.13 mm), which significantly differed from both the mean posterior ($P < 0.05$) and mean lateral wall thicknesses ($P < 0.05$). This finding aligns with the results of other studies. The mean posterior bladder wall thickness was measured at 2.10 mm (± 0.15 mm), showing significant differences from both anterior and lateral wall thicknesses ($P < 0.05$) [8].

Notably, the posterior wall thickness was consistently greater than both the lateral and anterior wall thicknesses in this study. Although researchers have not extensively explained this pattern, several factors may account for it. The detrusor muscle of the bladder wall responds to pressure and volume load similarly to the myocardium of the heart, increasing in size under such conditions [11]. In the recumbent position during the study, the posterior bladder wall, being the most dependent, experiences greater pressure and volume load from the overlying urine than the lateral and anterior walls, potentially accounting for its marginally greater thickness.

Additionally, the epithelium of the bladder mucosa is of the transitional type, flattening when distended. In a supine position, the posterior wall epithelium is the least distended, while the anterior epithelium is the most distended and thinnest, with the lateral wall epithelium falling in between. Although embryological factors could contribute to variations in bladder wall thickness, they likely play a minor role since only the supraregional area differs in origin from the rest of the bladder, which was not assessed in this study.

Urinary tract infections (UTIs) are a prevalent cause of morbidity in children, and functional changes in the bladder wall can be observed in several clinically significant conditions. Therefore, measuring bladder wall thickness is essential for evaluating patients presenting with lower urinary tract symptoms (LUTS).

Conclusion

This study evaluated the urinary bladder wall thickness in children, revealing a significant increase with age. No notable difference in bladder wall thickness was found between boys and girls. Additionally, children with a higher body mass index exhibited thicker bladder walls compared to those with a lower body mass index.

The measurements of the anterior, posterior, and lateral bladder wall thicknesses were statistically different from one another, indicating that the mean of these three points should be considered when determining overall bladder wall thickness.

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