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RESEARCH ARTICLE

ULTRASONOGRAPHIC ASSESSMENT OF BLADDER WALL THICKNESS IN HEALTHY INDIAN SUBPOPULATION

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ABSTRACT

Background: Ultrasound of abdomen and pelvis is a commonly advised investigation in our clinical practice. Bladder wall thickness (BWT) can be easily assessed by ultrasonography. A consensus on the normal values of bladder wall thickness is lacking. There are no studies regarding normal BWT in Indian subpopulation. **Objective:** Our aim was to determine normal bladder wall thickness by ultrasound in adult healthy Indian subpopulation and to study the impact of age and sex on the normal bladder wall thickness. **Design:** Cross-sectional study. **Setting, and Participants:** We studied 200 patients, undergoing ultrasound (USG) of abdomen and Pelvis for non-urological causes from January 2016 to January 2017. At a bladder volume of >250ml; anterior, posterior, right and left lateral bladder wall thickness were measured. Mean of all the four wall thickness was taken to obtain the mean bladder wall thickness. Outcome Measurements and Statistical Analysis: Data was analyzed using Excel software. The differences of the mean analysis variables were tested with t- test, ANOVA and p- value < 0.05 was considered statistically significant. **Results and Limitations:** Mean BWT in our study population was 3.08 ± 0.76mm. Gender did not have a significant impact on the normal bladder wall thickness. **Conclusions:** Bladder wall thickness as measured by ultrasonography offers a simple, non-invasive and reliable method to predict various pathologies. In lieu of different wall thickness of different walls of bladder, one needs to measure the thickness of all the four walls and take their mean to obtain the mean BWT. Bladder wall thickness of any individual above the normal deduced values in our study should raise a suspicion of pathology. **Patient Summary:** We studied 200 patients undergoing ultrasound (USG) abdomen and pelvis for non-urological causes. We found that mean BWT in our study population representing Indian population was 3.08 ± 0.76mm.

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INTRODUCTION

Ultrasound of abdomen and pelvis is a commonly advised investigation in our clinical practice. Cystitis and bladder wall thickening are common findings in majority of ultrasound reports done for various pathologies. Bladder wall thickness (BWT) can be easily and quickly assessed by ultrasound. Ultrasound offers a non-invasive, simple, quick, accurate and easily available tool to image the urological and in particular bladder pathologies.[1, 2, 3] Increased bladder wall thickness can predict bladder pathologies like cystitis, bladder outlet obstruction, voiding dysfunction and malignancy. Hence, we need to have a clear demarcation between the normal and abnormal values of bladder wall thickness. A consensus on the values of upper limit of the normal bladder wall thickness is lacking.

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There are various studies defining the normal values of the bladder wall thickness, but to the best of our knowledge there are no studies regarding BWT in Indian subpopulation. Our aim was to determine normal bladder wall thickness by ultrasonography in adult healthy Indian subpopulation separately in males and females so as to define the normal values. We also focused our work to define whether age and sex have any impact on the normal bladder wall thickness.

PATIENTS AND METHODS

We studied 200 patients (111males+ 89 females), with a mean age of 35.16 ± 12.37 years undergoing ultrasound (USG) abdomen and pelvis for non-urological causes from January 2016 to January 2017. The patients with any history of urological complaints, urolological interventions, catheterization, pregnant females, and females with pelvic organ prolapse were excluded from the study. All the patients

were briefed about the study and their written consent was obtained. The study was approved by the institutional ethical committee.

Volume of bladder was calculated by the formula

Bladder Volume = [axbxcx0.55] (ml), where, a – transverse diameter; b – supero-inferior diameter; c – antero-posterior diameter

The minimum requirement of bladder volume for calculation of BWT was 250ml. If the bladder volume was less than 250ml, then the patient was asked to drink more water till bladder volume was greater than 250ml. USG was then performed by a single radiologist using PHILIPS HD 11 X E Ultrasound and Colour Doppler machine (7.5 MHz, 3.5 and 5 MHZ sector probe). At a bladder volume of >250ml; Anterior, posterior, right and left lateral bladder wall thickness were measured. We measured the thickness of bladder wall as the distance from the interface of urine and internal mucosal layer of bladder (i.e. inner part of mucosal hyperechoic line) to the outer part of adventitial hyper echoic line [Figure 1]. Mean of all the four wall thickness was taken to obtain the mean bladder wall thickness.

Statistical Analysis

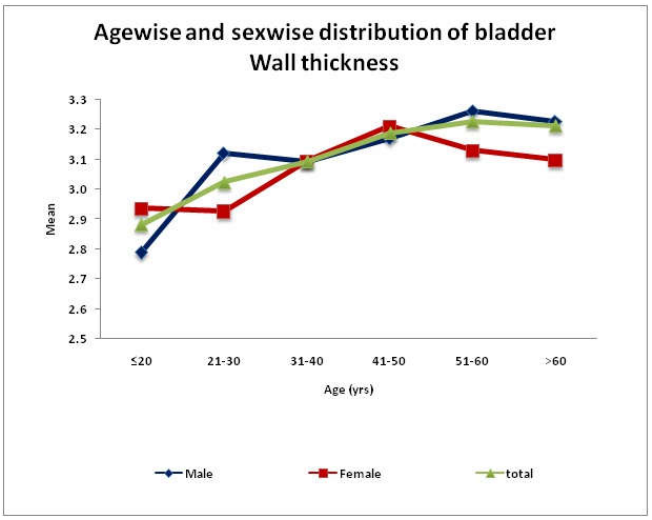
All characteristics were summarized descriptively. For continuous variables, the summary statistics of N, mean, standard deviation (SD) were used. For categorical data, the number and percentage were used in the data summaries. For continuous data, the differences of the mean analysis variables were tested with the t- test, ANOVA. p- Value < 0.05 was considered statistically significant. Data was analyzed using Excel software.

RESULTS

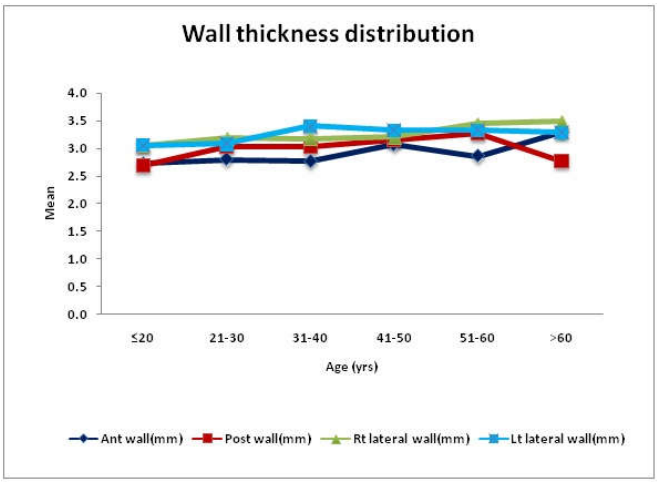
We studied 200 patients, 111 males and 89 females with a mean age of 35.16 ± 12.37 years (18-70). Age wise mean bladder wall thickness is summarized in Graph 1. The mean bladder volume was 349.21 ± 85.8 ml. The mean bladder wall thickness in our study population was 3.08mm (2.32 - 3.84mm). The BWT in males was 3.12mm (2.36 - 3.88mm) and in females was 3.03mm (2.26 - 3.8mm). Although the bladder wall in males was thicker than in females, the difference was not statistically significant (*P= 0.105*).

Figure 1. Ultrasound image of bladder with wall thickness measured between the two white lines

Bladder wall thickness varied with age both in males and females, however the difference was not statistically significant [Graph 1]. The wall thickness distribution of the patients is summarized in Graph 2. Although there was an age wise variation of each of the wall thickness, the variation was not statistically significant.



Graph 1.



Graph 2.

Table 1. Significance of bladder wall thickness

	Bladder volume(cc)		Age(yrs)	
	r value	p value	r value	p value
Mean BWT	0.032	0.652	0.162	0.022*
Ant wall(mm)	-0.004	0.956	0.148	0.036*
Post wall(mm)	0.083	0.242	0.079	0.266
Rt lateral wall(mm)	-0.011	0.878	0.14	0.048
Lt lateral wall(mm)	0.035	0.626	0.139	0.049

Note: *means significant at 5% level of significance (p<0.05)

We found that anterior bladder wall (2.85 ± 0.71 mm) was the thinnest wall followed by posterior wall (3.03 ± 0.72 mm) and right lateral wall (3.21 ± 0.79 mm), while left lateral wall of

bladder (3.24 ± 0.74 mm) was the thickest one. Table 1 depicts the Pearson's coefficient and the level of significance defining the correlation of BWT with the Bladder volume and with age of the patient. It shows no significant correlation between BWT and bladder volume, which signifies that once the bladder is filled beyond 250cc, the changes in the BWT on further bladder filling are insignificant. However, there is a significant positive correlation between the BWT and age.

Table 2. Literature Review

S.NO.	STUDY	NO. OF PATIENTS	MEAN BWT IN MALES	MEAN BWT IN FEMALES	LEVEL OF SIGNIFICANCE
1.	Matthias Oelke[3] et al	55	1.4	1.3	*significant
2.	Hakenberg OW[4] et al	338(172M +166F)	3.3	3.08	*significant
3.	Blatt H[5] et al	69	2.1	1.9	not significant
4.	Kanyilmaz S [6]et al	95	2.1	1.9	not significant
5.	Our study	200	3.12 ±0.76	3.03±0.77	not significant

DISCUSSION

Transabdominal USG is a noninvasive & simple method to assess the BWT for evaluation of lower urinary tract. We measured the BWT at a bladder volume of >250 ml. This was done owing to the fact that there is progressive thinning of detrusor muscle of the bladder with continued bladder filling, only until bladder filling of 250 ml, after which the BWT remains stable until the maximum bladder filling (Manieri, 1998). This peculiar response of the bladder wall to the bladder filling is not well understood, however it is described across various studies (Oelke, 2006 and Muller, 2001). It is recommended to determine BWT when bladder is filled >50% of their capacity in both children and adults (Oelke, 2006). In adults a bladder volume of 250 ml roughly corresponds to this capacity. Hence, we ensured that bladder be filled to a minimum volume of 250 ml before assessing the bladder wall thickness. Adding more, at the conclusion of the study we found that there is no substantial correlation between BWT and the bladder volume, which reaffirms the knowledge that beyond 250 ml volume, BWT remains unchanged irrespective of further bladder filling. It is of utmost importance to choose appropriate probe for accurate measurements of BWT (Oelke, 2006). The Resolution of ultrasound and the depth of the penetration are dependent on the frequency of the ultrasound waves. 3.5 MHz waves have more depth of penetration than 7.5 MHz ultrasound waves however gives less resolution at the anterior bladder wall, hence we measured anterior wall thickness using 7.5MHz ultrasound probe and rest of BWT using 3.5MHz probe. We measured the thickness of bladder wall as the distance from the interface of urine and internal mucosal layer of bladder(i.e. inner part of mucosal hyper echoic line) to the outer part of adventitial hyper echoic line. Oelke M (Oelke, 2006), et al opined that only detrusor wall thickness should be measured instead of bladder wall thickness due to technical ease in the measurement of the former and due to the fact that alteration of only detrusor wall thickness occurs in case of bladder outlet obstruction. We however believe that since the measurement of bladder wall thickness also includes mucosal and adventitial thickness, by measuring BWT separately from detrusor wall thickness we can also have an idea of mucosal and adventitial pathologies in addition to bladder outlet obstruction.

Few ultrasound studies on healthy subjects concluded that bladder wall is thicker in men as compared to women (Oelke, 2006). It was reasoned that longer urethra in men that passes through the prostate causes increased workload of the detrusor, hence increasing the BWT (Oelke, 2006). Matthias Oelke (Oelke, 2006), et al, Hakenberg OW [7]et al [Table 2] in their studies found that BWT in healthy men was significantly higher than women, this was contrary to the findings deduced in our study. We found that although BWT in healthy men was more than that in women, the difference was not statistically significant. Our findings were similar to the findings of Blatt H [8] et al and Kanyilmaz S (Kanyilmaz, 2013) et al. We found that BWT varied with age in both the sexes, but the difference was not statistically significant. The reason behind our finding is unclear, but is probably due to the fact that we included only healthy individuals (with no LUTS) in our study. However, we found a positive correlation between the mean BWT and the age of the patient. Contrary to our finding, Hakenberg OW [7] found that BWT increases with age in both the sexes. Similarly, M.M. Ali (2015) et al in his study found that there in positive correlation between BWT and age, which can be attributed to the presence of hidden BOO (Bladder Outlet Obstruction) in elderly males. In our study we observed that the mean anterior and mean posterior wall thickness; mean anterior and mean lateral wall thickness; mean posterior and mean lateral wall thickness were significantly different from each other. However, there was no statistically significant difference between the mean right and mean left lateral wall thickness. These observations underscore the need to measure all the individual wall thickness and take the mean of the four to obtain the correct mean BWT. These findings were contrary to the findings of Kojima M et al. (Kojima, 1996), and Cvitkovic- Kuzmic A et al. (2002), who found that for an individual all parts of bladder have the same thickness.

By knowing the normal reference values of BWT, various bladder pathologies can be predicted . Ultrasound guided measurement of BWT is a simple and noninvasive method of predicting Bladder outlet obstruction. In cases of BOO, there is increased BWT as a result of compensatory smooth muscle hypertrophy of the detrusor secondary to contractions against a closed urethral sphincter (Khullar, 1996; Robinson, 2002 and Serati, 2010). Studies have authenticated the reliability of BWT measurement for predicting BOO (Panayi, 2010), and found it to correlate with uroflowmetry and post-void residual, which are the other measures for diagnosing BOO (Gilpin, 1985 and Landau, 1994). Increased BWT is a sign of BOO and its early detection helps avoiding complications including renal failure, calculi etc (Kuo, 2009). Authors believe that increased bladder wall thickness can be a valuable sign of detrusor overactivity (Hakenberg, 2000; Cvitkovic-Kuzmic, 2002; Khullar, 1996; Kuo, 2009; Cruz, 2009). The increased BWT in these cases is believed to be due to detrusor hypertrophy caused by increased isometric detrusor contraction against a competent urethral sphincter. M. M. Ali *et al.* (Ali 2015). carried out a study to evaluate the usefulness of measurement of BWT in cases of detrusor overactivity and found that ultrasonographic assessment of BWT is a sensitive tool in the prediction of detrusor overactivity.

There are very few studies defining normal bladder wall thickness, and this study also affirms that mean BWT is comparable between Indian and Caucasians population, even in presence of important differences in uroflowmetry patterns between the two populations (Agarwal, 2014 and Barapatre, 2009). There are various imaging modalities to predict bladder pathologies available in current time. First in the list is Uroflowmetry which hints towards BOO/ Voiding dysfunction. Urodynamic evaluation including Pressure- flow studies reliably establishes the diagnosis of BOO and can even distinguish between BOO and Voiding dysfunction. Kanyilmaz S et al (Kanyilmaz, 2013) in his study measured Ultrasound estimated Bladder weight by portable ultrasound to predict bladder pathologies. Plain X ray KUB, Intravenous Urography, CT Scan KUB (plain and contrast), MRI pelvis, Cystography are other investigations that can be used in evaluation of bladder pathologies. Small sample size was one of the limitations of our study. Secondly, we did not use any objective method to rule out the urological/ bladder pathology. Further studies comparing the BWT in healthy and diseased individuals are required to validate our findings in future.

Conclusion

Bladder wall thickness as measured by ultrasonography offers a simple, non-invasive and reliable method to predict various pathologies. Gender does not have a significant impact on the normal bladder wall thickness. In lieu of different wall thickness of different walls of bladder, one needs to measure the thickness of all the four walls and take their mean to obtain the mean BWT. Bladder wall thickness of any individual above the normal deduced values in our study should raise a suspicion of pathology. However, further studies comparing BWT in normal and diseased individuals are required to validate our findings in Indian subpopulation.

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