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Original Article

Comparison Of Urinary Bladder Volume In Children Using Suprapubic Ultrasonic Bi-Planner Technique With Voided Urine Volume

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Abstract

Accurate determination of intravesical residual urine volume as well as bladder capacity is of significant importance in children. The ability to confirm these measurements non invasively in children avoids discomfort, urethral trauma and the introduction of urinary tract infection. Also, by avoiding the need for catheterization this technique permits more physiological assessment and allows for repeated examinations without fear and anxiety on the part of the patients. In this prospective study we assess the accuracy of the real time, hand held, ultrasonic device using suprapubic views and bi-planar technique to determine intravesical volumes.

Real time ultrasonography with suprapubic views and the described bi-planar technique to determine intravesical urine volume is simple, accurate and reproducible. It also is rapid and noninvasive, and can detect accurately an empty bladder in children.

A strong correlation was found between the estimated bladder volume with our method and voided urine volume (0 ml, residual volume) .This study concluded that the modality used in this study has the potential to provide useful and reproducible information in the clinical evaluation of bladder function in children.

Introduction

Ultrasonogram is useful for general screening at the urinary tract. It is the examination of choice in defining renal cysts, detecting renal masses, kidney size and contour, diagnosing and following hydronephrosis, and evaluating the bladder by measuring its maximum cystomatric capacity, post voidal residue, wall thickness, any mass lesion and vesicle calculus. It is a useful adjunct in demonstrating renal calculi[1].

Bladder volumes are measured by ultrasonogram before and after micturation using the standard technique in the bladder volume in mm is 0.7IIDW (whose D is the depth and it is the maximum diameter in the sagital plane and W is the maximum transverse diameter in the transverse plane, all measurements are in centimeter). Voided volumes of less than 200 ml are at little clinical relevance, so it is important to establish by ultrasound that the bladder is sufficiently full, overfull bladders are to be avoided as such a state will inhibit micturation. Once the full bladder has been scanned and its volume measured, the patient voids having been asked to void as normally as possible and not to try and impress with superimposed abdominal staining. Immediately after voiding the bladder is rescanned and any residual urine measured. If there is a large residue (100 ml or more), the bladder should be rescanned after second void and that residual assessed[2].

Non-invasive urine volume measurement is an important tool in the management of dysfunctional and neuropathic bladders in children. Ultrasound imaging devices have been used for many years for this purpose. An automated scanner (Bladder scan) is now available and has been recommended by a number of authors, but there is conflicting evidence in the literature regarding the accuracy and appropriate clinical application of the device. If used correctly, ultrasound imaging provides more accurate results and can compare with the cost, convenience and case of use of the automated method. Low cost, highly portable ultrasound imaging devices are now available and should be used in preference to the Bladder scan[3].

In a study Harrison and associates assessed residual urine volume in children using ultrasonography. They reported up to

50 percent error in the estimation of intravesical urine volumes with their technique[4].

The advantages of automated determination of PVR are convenience and rapidity of the measurement. A major disadvantage of automated scanners is that no additional anatomical information is available. When PVR is determined by real-time 2D scanning, the shape of the bladder, bladder-wall thickness and the presence or absence of trabeculation can be evaluated. Bladder diverticulas, foreign bodies and bladder tumors can all be visually assessed. The volume and shape of the prostate can also be determined in most patients. Pelvic conditions including patient obesity, ascites, bladder diverticula, ovarian cysts and lymphoceles may increase the inaccuracy of automated measurements. These conditions are readily recognized during 2D scanning.

Accurate residual urine determination is important measurement in children. A suprapubic ultrasonic method using a bi-planner volume estimation technique has been developed to obtain this information in non-invasive manner [5]. The bladder of a pre pubertal child principally is a superficial intra abdominal organ that is examined easily by a suprapubic ultrasonic approach. Conversely, the post pubertal bladder is a pelvic organ and this situated behind the pubis therefore, the ultrasonic window of the adult bladder may be partially obscured, particularly by bowel gas. This anatomical position is responsible for failures to detect residual of up to 50ml in adults. Ultrasonic method accurately detects the empty bladder in children and can provide reliable estimates of bladder volume. This study was designed to correlate the actual volume and ultrasonic measure of bladder volume in children with the aim to confirm the ability of bladder capacity measurement non-invasively in children. It helps our physician and other urinary bladder related diseases.

Material And Methods.

This prospective purposive study was conducted in the department of Radiology & Imaging, Sir Salimullah Medical College Hospital, Dhaka from July 2004 to June 2006. Children aged between 5 to 15 years attending in the department for USG of KUB region were the study population. Total 45 cases were selected according to inclusion and exclusion criteria. The inclusion criteria were age between 5 to 15 years, patients who can completely follow the instruction. The exclusion criteria were age less then 5 years and more then 15 years, patient with complain of dribbling or narrow stream, patient with H/O frequency of micturation, patient with significant PVR, Patients who can not follow the instruction.

Intravesical bladder volume was measured in children with a suprapubic ultrasound bi-planner technique. The equipment used for these examinations was a TOSHIBA real time ultrasonic machine with a 3.5 MHz recording head. The probe was hand held for all examinations while the children were lying in the supine position and the probe was pressed over the suprapubic area.

Four steps were performed to determine bladder volume.

1. A rectangle was drawn on the transverse plane using on screen electronic calipers (the area of the rectangle corresponded to the area at the bladder image) and this represented the width of the box.)
2. The same maneuver then was repeated with the bladder image projected in the sagital plane (this was the height of the box).
3. The anteroposterior dimension of the bladder was visualized in both of these planes (this dimension was identical in the transverse and saggital rectangles, and represented the depth of the box.
4. With these data on each patient for the width, height and depth of the rectangular box, the values of the 3 volume, which we considered as the bladder volume.

Data were collected from structured questionnaires. A statistical analysis package program SPSS-WIN 10.01 version was used to measure of dispersion (mean, standard deviation) paired and unpaired t-test and the correlation test were performed to detect statistical significance of the study by p value.

Results

Total 45 patients were selected for ultrasonic evaluation of lower urinary tract. Maximum age was 14 years and minimum age was 5 years, mean age was 9.2$\pm$3.01.

Out of 45 patients who were evaluated in this study, among them 27(60%) were male and 18(40%) were female. The majority of cases show a percentage of error lower than or similar to the 10.70. For calculation 45 cases divided in three groups according to voiding volume. In Group-I, 0-199cc, Group-II, 200-299cc and Group-III, 300-399cc (Table-1).

Paired student t-test was done which is non-significant. In the present study, both paired and unpaired‘t’ test was done group wise, sex wise & between total voided & calculated volume.
Group wise paired t-test was done between voided and calculated volume was found P>0.50 in Group-I, P>0.10 in Group-II and P>0.05 in Group-III which was non significant shown. Again paired t-test was done between total voided and calculated volume where P>0.05 which was also non significant(Table-1).

Table-I : Percentage error in the calculated volume (irrespective of sex)

Group	No. Case	Mean Real volume (cc)±SD	Mean calculated volume (cc) ±SD	P Value	Error %
I	27	133.04±13.77	132.14±15.18	>0.05	10.70
II	3	251.67±12.58	224.33±5.13	>0.10	10.76
III	15	331.00±20.28	299.52±23.87	>0.05	9.60

Sex wise unpaired t-test was done between voided and calculated volume in male where P>0.10 in Group-I, P>0.10 in Group-II and P>0.10 in Group-III which was non significant. Unpaired t-test was done between total voided and calculated volume of male where P>0.10 which was non significant (Table-II).

Table-II : Upaired ‘t’ test in male between voided and calculated urine volume (sex wise)

Real Volume	No. Cases		calculated volume (cc) Mean±SD	P Value
I (0-199)	12	138.75±14.50	140.65±17.27	>0.10
II (200-299)	3	230.00±2.00	224.33±5.13	>0.10
III (300-399)	12	327.75±21.76	308.65±29.24	>0.10
Total (0-399)	27	232.69±92.16	224.61±83.69	>0.10

In female unpaired‘t’ test was done between voided and calculated volume where P>0.10 in Group-I, P>0.50 in Group-III which was non significant. Unpaired t-test was done between total voided and calculated volume of female where P>0.10 which was non significant. In all the test p value was found non significant, this was correlation the above study (Table-III).

Table-III : Upaired ‘t’ test in female between voided and calculated urine volume (sexwise)

Real Volume	No. Cases	Real volume (cc) Mean+SD	Calculated volume (cc)Mean+ SD	P Value
I (0-199)	15	128.47 ±11.67	125.34 ±9.04	>0.10
II (200-299)	0			
III (300-399)	3	333.33 ±11.55	322.23 ±21.36	>0.50
Total (0-399)	18	162.61 ±79.37	158.17 ±76.34	>0.10

To see the correlation between voided volume and estimated volume of urine Pearson’s r linear correlation co-efficiencies test was done. The r value is +0.972, P<0.001 is highly significant.

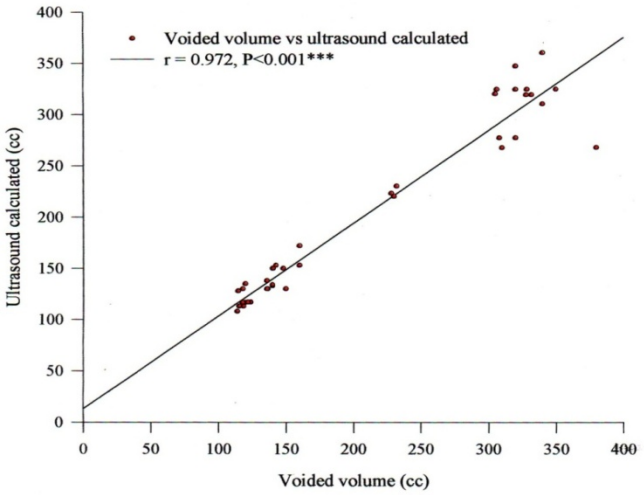

Fig-I: Correlation between voided & calculated urine volume.

Discussion

Significant residual urine more than 5 ml in children reduces effective bladder storage, predisposes to urinary infection instability or low bladder compliances and increases intravesical pressure against which ureter deliver urine from upper tract. Thus, it may be a significant factor in the pathogenesis of hydronephrosis, reflux, pyelonephritis and potentially significant factor in the function of bladder storage and emptying. Ultrasonography is a noninvasive investigation tool. This is further diminishes the anxiety of the child. This technique also avoids the potential risks of the alternative methods of residual urine volume estimation, including potential urethral injury or nosocomial infections from urethral catheterization, or radiation exposure from radiogical and nuclear medicine methodologies. We confirmed the accuracy of our ultrasound methodology.[6]

The images were obtained with a static type of ultrasonic device aided by a mechanical arm in the suprapubic area. These examinations are more cumbersome than our technique and, thus require the child to be immobilization for longer periods. However they also share a high accuracy rate in the estimates [7].

Functional bladder capacity is a very important factor in the diagnosis of children with voiding disorders. Because Japanese children are thought to have somewhat is smaller functional bladder capacity compared with Western children [8].

Other methods consider 1 or 2 dimensions of the bladder and use a rigid mathematical formula to compare the bladder to a fixed geometric figure. These methods result in inaccuracies varying from 12.9 to 20 percent in adults [6.]

Several other studies have used 3-dimensional bladder measurements with Pearson's linear correlation coefficient ranging from 0.90 to 0.97. In contrast to our method these techniques used 3 dimensions of the bladder, which were not necessarily perpendicular, and then integrated the multiplication of these dimensions into a simple binomial equation. These studies also were done with adults. Our methods use 3 variable perpendicular axes forming a rectangular box. This figure considers the fact that the bladder shape changes during filling. In our study voided volume was correlated with calculated volume by Pearson's r linear correlation test, where r =+0.993, $p<0.001$, which is correspond above test.

It is not believe that any existing method fulfills those requirements that make ultrasound the ideal method for the investigation of bladder residual urine. It has no contraindications, it is free of risk for the patient, it is an almost comfortable exploration that can be repeated as often as required and it is not feared by children. When all of these features are considered in relation to bladder catheterization the advantages of ultrasound are evident. However, the method has the disadvantage of inaccuracy of calculation. Undoubtedly, catheterization is the most accurate methods but routine practice rarely demands absolute accuracy. We are convinced that an error such as we have obtained is perfectly tolerable in any clinical situation and the consequences of a slightly imperfect calculation are to be preferred to the discomfort, the risk of infection and so forth inherent in catheterization.

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