

Residual Urine Measurement in Children with Voiding Disorders: Comparison between Ultrasonographic Bladder Scanning and Catheterization

Özel ŞK^{1*}, Tunç T², Alataş İ³ and Güvenç Ü⁴

¹Department of Pediatric Surgery, İstanbul Bilim University Faculty of Medicine, İstanbul, Turkey

²Neonatology Unit, Darıca State Hospital, İzmit, Turkey

³Department of Neurosurgery, İstanbul Bilim University Faculty of Medicine, İstanbul, Turkey

⁴Department of Pediatric Surgery, Kanuni Sultan Süleyman State Hospital, İstanbul, Turkey

***Corresponding author:** Ş. Kerem Özel, İstanbul Bilim University, Faculty of Medicine, Department of Pediatric Surgery, İstanbul, Turkey, Tel: +90 5336279058; Email: keremozel@yahoo.com

Research article

Volume 2 Issue 2

Received Date: June 22, 2017

Published Date: July 29, 2017

Abstract

Postvoid residual urine (PVR) measurement with a bladder scanning portable ultrasonographic device is an easy and non invasive method. Its use has been wide spread in men and women however its accuracy and reliability in children is still under debate. The aim of this study was to investigate the reliability of PVR measurement with real time bladder scanning in comparison with catheterization in children with voiding disorders.

Postvoid residual urine measurements were routinely undertaken in patients to whom urodynamics were done, prospectively. Urinary catheterization was routinely done in all patients for cystometry. After uroflowmetry, residual urine was measured with a portable ultrasound device which readily measured the amount of PVR. After this measurement, bladder was emptied via the cystometry catheter and the drainage was noted. The age, sex and the diagnosis of the patients were also noted. The comparison between two measurements were done with paired sample t test.

A total of 114 measurements were done in 89 patients. Mean age was $9\pm 0,4$ years (between 5 months to 21 years). There were 54 girls and 35 boys. The indication for urodynamics was nonneurogenic causes in 55 and neurogenic, in 34 patients. Mean PVR with ultrasonographic measurement was $56,6\pm 6,6$ ml and $56,7\pm 7,4$ ml with catheter. The difference between two measurements was statistically insignificant.

Real time ultrasonographic measurement with a bladder scanning device may be an easy, feasible, and reliable method to detect PVR in children with voiding disorders. This method may be preferred in appropriate indications like residual urine measurement in uroflowmetry+EMG studies where urinary catheterization is not necessary.

Keywords: bladder dysfunction; bladder scan; post-void residual; children

Introduction

The initial evaluation of lower urinary tract dysfunction in children is comprised of history, physical examination, urinalysis, voiding diary, basic urodynamic tests such as uroflowmetry and/or electromyography and residual urine measurement. Postvoiding residual (PVR) urine measurement is an important part of this evaluation as elevated PVR may predict recurrent urinary tract infection in children [1]. PVR measurement is also important in the follow up of treatment success in nonneuropathic bladder dysfunction [2] and determination of incomplete emptying may make the indication of clean intermittent catheterization clear so that kidney functions can be protected in children with neuropathic bladder dysfunction [3]. PVR measurement can be successfully achieved with either urinary catheterization or ultrasonographic methods. Ultrasonographic PVR measurement was first described in 1967 but this method was first defined in children in 1976 [4,5]. Although this method gained enthusiasm in late 80's and well documented in adult studies, there are very limited information in pediatric practice.

The aim of this study was to establish the practicability and accuracy of PVR measurement with portable ultrasonographic bladder scanning in comparison with urinary catheterization in a group of children with both neuropathic and nonneuropathic bladder dysfunction.

Patients and Methods

Patients who had indication for urodynamic study either for nonneurogenic or neurogenic bladder dysfunction were included in the study. PVR urine measurement was done after completion of voiding in nonneurogenic bladder dysfunction patients and after

cessation of leaking in neurogenic group patients. For each measurement, at the end of the voiding phase during the urodynamic study, first PVR was measured with a portable USB ultrasonographic probe (Scanmaster®, MMS, USA) and PVR was calculated automatically with the computer software of the device (Figure 1). Correct positioning of the bladder was required for optimal volume measurement. Just after this measurement, PVR was again measured while the residual urine was withdrawn via the urodynamic catheter which was readily inserted for the urodynamic study. Thus the measurements are consecutive values reflecting the same actual PVR. Age, gender and the cause of bladder dysfunction were also noted.

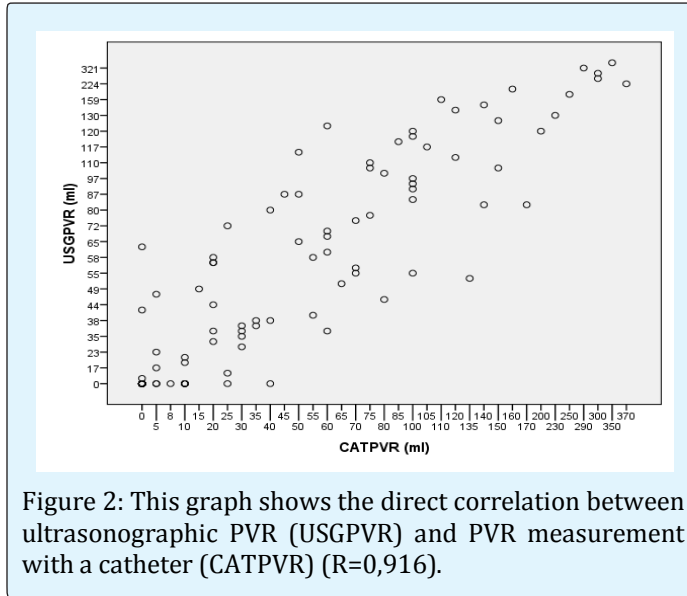
Two groups of values were formed; Group 1, ultrasonographic PVR values and Group 2, PVR measured with urodynamic catheter. The values were first compared with paired samples t test and then the correlation between the two values were analyzed using Pearson correlation and R value of the correlation was found. $p < 0,05$ is considered to be statistically significant. A computer program (SPSS v.16) was used for the statistical analysis.

Results

A total of 114 measurements were done in 89 patients. Mean age of the patients was $9 \pm 0,4$ years (between 5 months and 21 years of age). There were 54 girls and 35 boys. The indication for urodynamics was nonneurogenic causes in 55 and neurogenic, in 34 patients. Mean PVR with ultrasonographic measurement was $56,6 \pm 6,6$ ml and $56,7 \pm 7,4$ ml with catheter ($p = 0,97$). There was a direct correlation between ultrasonographic and conventional PVR measurement with catheter ($R = 0,916$) (Figure 2).



Figure 1: Screen appearance of ultrasonographic PVR measurement. The target should be in the middle of the yellow area to achieve a correct calculation. The ultrasonographic view shows the bladder filled with residual urine.



Discussion

Complete bladder emptying is an important physiological activity in the genitourinary system. Bladder emptying can be affected due to pathologies of neurogenic or nonneurogenic origin. Elevated PVR may be a cause of urinary tract infection as well [1]. Incomplete emptying can be diagnosed with the detection of PVR. Ultrasonographic PVR determination was first described in 1967 [4]. This modality was reported in children in 1976 [5]. There is very limited information about the efficacy and accuracy of ultrasonographic PVR measurement in children in the literature. Our current information comes mostly from adult studies. Pediatric studies were limited as the lowest limit of urine detected ultrasonographically was shown to be approximately 42 ml in earlier studies [6]. Thus the reliability of ultrasonographic measurement in children may be regarded as a technical issue related with the bladder volume as anatomically pediatric bladder volume is lower than adult bladder volume. In most of the studies, ultrasonographic PVR measurement with an automated real-time calculation is found to be as affective as catheterization [7-10]. However other studies found this modality to be limited and less accurate than catheterization [6, 11]. In the studies that are against the use of ultrasonographic PVR measurement, we see that conventional ultrasonography was used to measure PVR. In the studies that are in favor of this technique, bladder scanners specially designed for this purpose are observed to be used instead. Ultrasonography is operator

dependant and bladder scanners may give a better and a more accurate calculation for PVR.

In children however, as mentioned above, the experience is limited. After the initial reports, in 1989, Erasmie and Lidelfelt showed that ultrasonographic PVR measurement has a correlation value of $R=0,96$ when compared to catheterization in children [12, 13]. In 1990, Massagli et al. concluded, in their study with neurogenic bladder patients, that ultrasound scanner is as accurate as catheterization and is inexpensive and easy as well [14]. In 2009, Chang and Yang did a study about the normal values of PVR in healthy children. In their study, they measured the PVR ultrasonographically and found that a PVR value of over 20 ml to be more significant for the definition of abnormal PVR [15].

In this study, we measured the same PVR, one with an ultrasound bladder scanner and the other with a bladder catheter. As the same PVR was measured and compared, this method is a practical way to test the accuracy of the technique. We observed that almost the same values were found with the bladder scan and there was a high correlation between the two results. The graph of the results shows the linear correlation (Figure 2). These results are not age dependant or related with other factors like obesity or sedentary life and readily shows the accuracy of ultrasonographic measurement. The gender or the diagnosis of the patients are not regarded as a determinant factor for the results as correct measurement is purely related with the volume of PVR, only.

In conclusion, real-time ultrasonographic measurement of PVR with a portable bladder scanning device is as accurate as catheterization in children. This technique is easy, feasible and reliable. It is also recommended to avoid the discomfort and risk of urinary tract infection as well as potential urethral injury due to urethral catheterization. This modality can also be preferred in children and can be safely used during clinical decision making.

References

1. Chang SJ, Tsai LP, Hsu CK, Yang SS (2015) Elevated postvoid residual urine volume predicting recurrence of urinary tract infections in toilet-trained children. *Pediatr Nephrol* 30(7): 1131-1137.

2. Kibar Y, Piskin M, Irkılata HC, Aydur E, Gok F, et al. (2010) Management of abnormal postvoid residual urine in children with dysfunctional voiding. *Urology* 75(6): 1472-1475.
3. Özel ŞK, Ulman I (2016) Contemporary urological management of spina bifida. *J Pediatr Res* 3(4): 168-174.
4. Holmes JH (1967) Ultrasonic studies of the bladder. *J Urol* 97(4): 654-663.
5. Harrison NW, Parks C, Sherwood T (1976) Ultrasound assessment of residual urine in children. *Brit J Urol* 47(7): 805-814.
6. Mainprize TC, Drutz HP (1989) Accuracy of total bladder volume and residual urine measurements: comparison between real-time ultrasonography and catheterization. *Am J Obstet Gynecol* 160(4): 1013-1016.
7. Al-Shaikh G, Larochele A, Campbell CE, Schachter J, Baker K, et al. (2009) Accuracy of bladder scanning in the assessment of postvoid residual volume. *J Obstet Gynecol Can* 31(6): 526-532.
8. Choe JH, Lee JY, Lee KS (2007) Accuracy and precision of a new portable ultrasound scanner, the BME_150A, in residual urine volume measurement: a comparison with the Bladder Scan BVI 3000. *Int Urogynecol J Pelvic Floor Dysfunct* 18(6): 641-644.
9. Coombes GM, Millard RJ (1994) The accuracy of portable ultrasound scanning in the measurement of residual urine volume. *J Urol* 152 (6): 2083-2085.
10. Ding YY, Sahadevan S, Pang WS, Choo PW (1996) Clinical utility of a portable ultrasound scanner in the measurement of residual urine volume. *Singapore Med J* 37(4): 365-368.
11. Abdelwahab HA, Abdalla HM, Sherief MN, Ibrahim MB, Shamaa MA (2014) The reliability and reproducibility of ultrasonography for measuring the residual urine volume in men with lower urinary tract symptoms. *Arab J Urol* 12(4): 285-289.
12. Erasmie U, Liddefelt KJ (1989) Accuracy of ultrasonic assessment of residual urine in children. *Pediatr Radiol* 19(6-7): 388-390.
13. Liddefelt KJ, Erasmie U, Ballgren I (1989) Residual urine in children with acute cystitis and in healthy children: assessment by sonography. *J Urol* 141(4):916-917.
14. Massagli TL, Jaffe KM, Cardenas DD (1990) Ultrasound measurement of urine volume of children with neurogenic bladder. *Dev Med Child Neurol* 32(4): 314-318.
15. Chang SJ, Yang SS (2009) Variability, related factors and normal reference value of post-void residual urine in healthy kindergarteners. *J Urol* 184(4): 1933-1938.