Measurement of Post Void Residual Urine Volume Using Portable 3D Ultrasound Compared with Urinary Catheterization

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ABSTRACT

Objective: To find out correlation between the 3D ultrasound and conventional urethral catheterization in terms of measurement accuracy of post void residual urine (PVR) volume, pain score, and elapsed time among patients attending Urogynecology Clinic, Siriraj Hospital between December 2011 to December 2012.
Methods: With the approval of the institution's Ethics Committees, a total of 64 participants were enrolled. Participants with conditions that could affect bladder volume, including previous pelvic surgery and radiation, abnormal anatomy of genitourinary system, and contraindications for urethral catheterization were excluded. A questionnaire asking about demographic data and clinical presentation of each participant was completed. PVR volume was measured using the BladderScan® (BVI-9400), followed by urethral catheterization. Differences between PVR volume and elapsed time in both procedures were determined. At the end of each procedure every participant was asked to rate the pain score, from 0 (no pain) to 10 (most severe pain), according to the Visual Analog Scale.
Results: The mean age was 60 years old, ranging from 33 to 81. The mean body mass index (BMI) was 26.5 kg/m^2± 4.1. The PVR volume measured by the BladderScan® was significantly correlated with that measured by the conventional catheterization with the correlation coefficient of 0.92 ($p<0.001$). The mean pain score in the BladderScan® group was obviously less when compared with that of the catheterization group (0.59 ± 1.19 vs 3.00 ± 2.07; $p<0.001$). The mean time used in the BladderScan® group was significantly lower than that in the catheterization group.
Conclusion: The BladderScan® had high correlation, time saving and less pain compared to conventional urethral catheterization for measurement of the post-void residual urine volume.

Keywords: Post-void residual urine volume; BladderScan®; urethral catheterization; elapsed time; pain score (Siriraj Med J 2017;69: 110-113)

INTRODUCTION

Post-void residual (PVR) urine volume is a measure of the amount of residual urine left in the bladder after the urination is completed. PVR volume is an important assessment tool of the lower urinary tract function among patients with voiding disorder or pelvic organ prolapse, patients after undergoing radical or vaginal hysterectomy, and patients with spinal cord or brain injury.[1-3] This can be done in several ways, such as abdominal palpation, post-void intravenous pyelography (IVP) film, radionuclide technique, abdominal or vaginal ultrasound, and urethral catheterization.

The conventional urethral catheterization is the standard method used for measuring the PVR volume because of its high accuracy, although the use of this method can result in patient discomfort and pain. Also, it is likely to cause urinary tract infections (UTI) and injuries.[4-5,12-13,15-16] These are reasons why we should find

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substitutes which are less invasive, but which maintains the same level of accuracy. Measurement of the PVR volume by abdominal palpation is out of the question due to its inaccuracy. The post-void IVP film possesses the risk of radiation and contrast medium exposure, apart from being inaccurate.[4] Radionuclide technique, though accurate, is more expensive. Finally, both abdominal and vaginal ultrasounds are less invasive, less expensive, and easy to apply. Studies have found that the use of ultrasound can reduce the risk of UTIs.[5] These lead to the application of the ultrasound, instead of urethral catheterization, by many researchers studying the measurement accuracy.

Currently, a large number of studies have confirmed the accuracy of ultrasound in the measurement of the PVR volume, especially when exceeding 100 milliliters, in patients with urinary incontinence, patients having spinal cord or brain disorders, and patients in postoperative period, as well as in normal population.[1,3,4,6-10] However, there have been some limitations of its use in those with previous abdominal or pelvic surgery, neurogenic bladder, and pelvic mass because of the possibility of the bladder shape alteration resulting in calculation error of the urine volume.[1,4,9] Other factors that can affect the measurement accuracy of the ultrasound include the movement of the patient in relation to the ultrasound unit, the skills and experience of the sonographer, and the variety of formulas used to calculate the urine volume. As yet, there has been no evidence whether obesity can affect the accuracy of the measurement. With regard to these, we have become interested in the application of the portable 3D ultrasound (BladderScan®) in the measurement of the post-void residual urine volume due to its feasibility to be performed bedside, comfortableness, UTI risk reduction, time saving, low cost, and less dependence on measurement skill. In addition, there have been no studies on the measurement accuracy of this ultrasound machine among Thai population. The objective of our study was to find out the correlation between the portable 3D ultrasound (BladderScan®) and the conventional urethral catheterization in terms of measurement accuracy of the PVR volume, pain score, and elapsed time among patients attending Urogynecology Clinic, Siriraj Hospital.

MATERIALS AND METHODS

With the approval of The Institution's Ethics Committees (Si 196/2012) and the funding from Siriraj Routine to Research (R2R) Management Fund, we enrolled 64 women attending our Urogynecology Clinic, Siriraj Hospital between December 2011 and December 2012. All women were urogynecologically indicated to be examined for the PVR volume. Those having conditions that could affect the bladder volume, including previous pelvic surgery and radiation, abnormal anatomy of the genitourinary system, contraindications for urethral catheterization, and those being catheterized with the Foley's catheter or suprapubic cystostomy were excluded. Women who met the inclusion criteria were informed of the study protocol, relevant procedures, and possible adverse effects before giving written consents to join the study. Every participant was requested to complete a questionnaire asking about their demographic data and clinical presentation. The demographic data included age, body weight, height, and history of previous hysterectomy.

The PVR volume was measured by a trained nurse of our Urogynecology Clinic with more than 5 years of experience using both the BladderScan® and conventional urethral catheterization. The BladderScan® machine being used in this study was the BVI-9400 from Verathon Corporation[11]. After voiding, each participant was asked to lie down in a supine position. The PVR volume was measured using the BladderScan®, followed almost immediately (within one minute) by urethral catheterization in the lithotomy position using a 14 Fr rubber urethral catheter. For the BladderScan®, the ultrasound probe was applied on the anterior abdominal wall at the possible location of the bladder and moved to a more definite location as automatically guided by the machine until the data were completely analyzed. For urethral catheterization, this was performed in the usual fashion for collecting of the residual urine. The differences between the PVR volume measured by the BladderScan® and the catheterization method were determined.

Elapsed time was also measured in both procedures. With the BladderScan®, time started once the ultrasound probe was placed on the anterior abdominal wall and ended when the digital data of the PVR volume appeared on the monitor. For urethral catheterization, time started as soon as the urethra was cleaned and ended when the catheter was removed.

At the end of each procedure every participant was asked to rate the pain score, from 0 (no pain) to 10 (most severe pain), according to the Visual Analog Scale. All data were thoroughly recorded in the case record form which would later be statistically analyzed.

Statistical Analysis

All statistical analyses were performed using the Statistical Packages for the Social Sciences (SPSS) version 18 for Windows. The demographic data were expressed in terms of number, percentage, mean ± standard deviation (SD), median (ICR), maximum, and minimum. A paired T-test was used to determine the differences in pain

score and elapsed time between each method of PVR measurement. Intra-class correlation coefficient was calculated to identify potential correlation between the catheterized PVR volume and the PVR volume measured by the BladderScan®. Statistical significance was determined as a p-value of less than 0.05.

RESULTS

A total of 64 participants were enrolled in this study. All baseline characteristics are shown in Table 1. The mean age was 60 years old, ranging from 33 to 81. The mean body mass index (BMI) was 26.5 kg/m^2. The PVR volume measured by the BladderScan® was significantly correlated with that measured by the conventional catheterization with the correlation coefficient of 0.92 ($p<0.001$) as shown in Fig 1. The mean pain score in the BladderScan® group was obviously less when compared with that of the catheterization group (0.59 ± 1.19 vs 3.00 ± 2.07; $p<0.001$). Moreover, when compared in terms of elapsed time between the two groups, the mean time used in the BladderScan® group was significantly lower than that in the catheterization group. Finally, when speaking of the preferable method in PVR measurement for the next visit, 98.4% of the participants chose the BladderScan®.

TABLE 1. Baseline characteristics.

	Mean	SD
Age (yr.)	59.8	9.95
Height (cm.)	152.7	5.71
Weight (Kg.)	61.8	10.26
BMI (Kg/m^2)	26.4	4.11

Notes: Data are mean and SD, BMI = body mass index

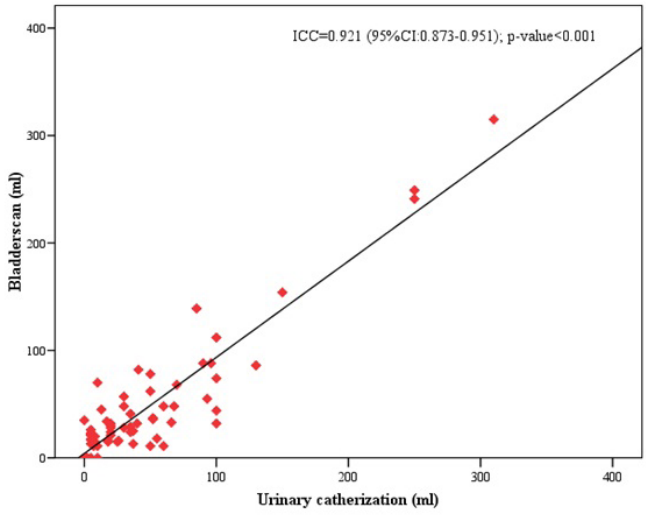

Fig 1. Correlation of PVR volume between BladderScan® and catheterization.

DISCUSSION

The post-void residual urine volume is an important investigation used for assessing the voiding function.[1] As a result, the measurement accuracy of the PVR volume is mandatory for making a diagnosis and planning for treatments. Although the urethral catheterization has been the gold standard for the PVR volume measurement, it is still an invasive procedure which can cause discomfort, pain, and UTI risk increment among patients.[12,13] Due to these disadvantages a more practical and less invasive technique, such as portable ultrasonography, has been proposed. With its feasibility, comfortableness, time saving, and low cost, the portable ultrasound might be the answer.

Many previous studies have established the accuracy of the portable 3D ultrasound in the measurement of the PVR volume by demonstrating a high correlation when compared with the urethral catheterization.[1,4,6-10,14] Fuse et al have found a high correlation between the portable 3D ultrasound and the urethral catheterization technique, with a correlation coefficient of 0.98, after scanning 110 patients using the BladderScan® (BVI-2000).[1] Goode et al, using the same methods. but a different model of the BladderScan® (BVI-2500), have demonstrated a sensitivity of 66% and a specificity of 96.5% in the ultrasound group.[4] Additionally, a study by Yong Hyun Park et al has confirmed the measurement accuracy of the two models of the BladderScan®, BioCon-500 and BVI-3000, with a correlation coefficient as high as 0.93 and 0.95, respectively.[10] Therefore, it can be confirmed that the portable 3D ultrasound is an accurate device and can replace the conventional catheterization technique.

Results from our study have reflected those from previous studies. Using the same methods but a different model of the BladderScan® (BVI-9400), we have also confirmed a high correlation between the BladderScan® and the conventional catheterization in the measurement of the PVR volume (r = 0.92). Furthermore, we have evaluated the differences between both techniques in terms of elapsed time and pain score. Our results have proved that the BladderScan® (BVI-9400) was definitely a time-saving instrument for assessment of the PVR volume; it caused almost no pain, and gained wide acceptance among our study population when compared with the conventional catheterization technique. (Table 2) (Table 3)

TABLE 2. Pain score and timing for BladderScan® and catheterization.

	Mean	SD
Visual analog scale		
Bladder scan	0.59	1.19
Catheterization	3.00	2.07
Time (sec.)		
Bladder scan	22.01	16.26
Catheterization	57.06	21.92

Note: Data are mean and SD

CONCLUSION

The BladderScan® is a very useful and patient-friendly instrument for assessment of the PVR volume. Apart from being as highly accurate as the conventional catheterization, it also possesses several extraordinary features, such as feasibility of use, being a less invasive technique, time saving, and higher patient comfort. Accordingly, it may be adopted as the method of choice for measurement of the post-void residual urine volume among patients.

TABLE 3. Paired T-test of pain score and time between BladderScan® and catheterization.

Bladder scan vs catheterization	Paired Differences				P-value
	Mean	SD	95% CI of Difference		
			Lower	Upper	
Visual analog scale	-2.40	1.91	-2.88	-1.92	<0.01
Time (sec.)	-35.05	25.19	-41.34	-28.75	<0.01

Notes: Data are mean, SD, 95% CI, and P-value
† Data were analyzed using t-test.
vs = versus, SD = standard deviation, CI = confidence interval

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