Improving Variations in Bladder Ultrasound Assessment of Post-Void Residual Urine Volume in Moderate Bladder Outlet Obstruction

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ABSTRACT

Objectives: This study aimed to assess the accuracy of post-void residual (PVR) urine volume measurements in patients with moderate bladder outlet obstruction.
Materials and Methods: This prospective observational study was conducted between January and December 2019. The inclusion criteria were male patients with symptoms of moderate bladder outlet obstruction. On the other hand, patients with a history of diabetes, symptoms of urinary tract infection, and positive urine for pyuria, as well as patients using medications, such as diuretics, alpha-blockers, and anticholinergic drugs, were excluded. The patients were asked to drink 1000 mL of water one to two hours before the initial ultrasound scan. Pre-void bladder capacity was measured, followed by a post-void ultrasound for residual urine volume measurement at three intervals: immediately after voiding, 15-20 minutes after the first void, and one week later with an empty bladder. Assessment of per-void capacity was carried out, based on the patient's subjective sensation of bladder fullness (a strong desire to void).
Results: A total of 78 male patients, with the mean age of 60 years, were included in this study (27 cases in group I; 37 cases in group II; and 14 cases in group III). The mean PVR volume was 92 mL in the first measurement, 62 mL in the second measurement, and 60 mL in the third measurement. Significant differences were found between the first and second PVR measurements and between the first and third PVR measurements ($P<0.05$). However, no significant difference was found between the second and third PVR measurements ($P=0.107$). On the other hand, significant differences were found between groups I and II and between groups I and III ($P<0.05$) in the three PVR measurements. Nevertheless, there was no significant difference between groups II and III in the three PVR measurements ($P=0.204$, 0.56, and 0.487 for the first, second, and third PVR measurements, respectively).
Conclusion: A bladder ultrasound must be performed and interpreted carefully to avoid further unnecessary medications, investigations, or procedures. We recommend a second PVR measurement in patients with bladder outlet obstruction. Also, it is suggested to conduct similar studies in different conditions to confirm our findings.
Keywords: Post-void, Residual urine, Bladder ultrasound

Introduction

Ultrasonography is routinely used in urological outpatient clinics, with a high accuracy rate (96%) if performed by a well-trained urologist [(1)]. It is an imaging modality, which facilitates real-time assessment of many body organs. It has many advantages in clinical practice, as it is an informative, reliable, non-invasive, sensitive, cost-effective, and available technique, which is simple to learn and interpret. Moreover, it plays a critical role in the initial diagnosis of bladder diseases, indicating the need for further investigations, follow-ups, and surgical management of benign prostatic hyperplasia (BPH) and bladder outlet obstruction (BOO) [(1-5)].

Post-void residual (PVR) volume is defined as the urine volume (mL) left in the bladder at the end of micturition [(6)]. The assessment of residual urine volume provides a clinical diagnostic tool to evaluate many urological problems, including BPH and BOO [(7)]. The accuracy of PVR measurement using transabdominal ultrasound has been demonstrated in many studies [(8-11)]. In routine clinical practice, PVR volume is usually measured during a comprehensive assessment of the urinary

tract. In this type of assessment, patients are required to drink large amounts of fluids so that they have a full bladder and feel a strong desire to void [12-14]. However, this assessment is often inconvenient for patients and results in PVR volume variations after repeated measurements. Therefore, its application in clinical practice has been limited, and bladder ultrasounds must be interpreted cautiously [9, 14].

With this background in mind, this study aimed to assess the accuracy of PVR volume measurements in patients with moderate bladder outlet obstruction.

Materials and Methods

This prospective observational study was conducted between January and December 2019. The inclusion criteria were male patients with symptoms of moderate bladder outlet obstruction, based on the International Prostate Symptom Score (IPSS) system (IPSS score=8-19). The exclusion criteria were as follows: 1) history of diabetes; 2) symptoms of urinary tract infection (UTI); 3) positive urine for pyuria; and 4) use of medications, such as diuretics, alpha-blockers, and anticholinergic drugs.

All patients were informed to drink 1000 mL of water one to two hours before the ultrasound. A pre-void bladder ultrasound was performed to assess the bladder capacity, followed by a post-void ultrasound scan. Assessment of per-void capacity was carried out, based on the patient's subjective sensation of bladder fullness (a strong desire to void). Moreover, a post-void bladder scan was performed at three intervals: immediately after voiding; 15-20 minutes after the first void; and one week later, to measure PVR with an empty bladder [15]. The bladder volume was calculated using the prolate ellipsoid method, based on the following formula [16]:

Volume= Length × Width × Height × 0.52 (on two dimensions)

All patients were instructed to void in a sitting position. Two definitions of significant PVR were considered in this study: PVR volume >50 mL [14] and PVR volume >20% of pre-void volume [17]. Patients were divided into three groups, according to the pre-void bladder volume: group I (bladder volume >701 mL), group II (bladder volume of 501-700 mL), and group III (bladder volume <500 mL). An Aloka 3.5 MHz Extended Pure Harmonic Detection (ExPHD) system, with a portable 10.4-inch LCD monitor, was used in this study.

Results

A total of 78 consecutive patients, who met the inclusion criteria, were included in this study. The mean age of the subjects was 60 years (SD=9), ranging from 45 to 79 years. Overall, 27 (34.6%) patients were in group I, 37 (47.4%) patients were in group II, and 14 (17.9%) patients were in group III. A paired t-test was used to compare the three PVR volumes. A significant difference was found between the first and second PVR measurements and between the first and third measurements ($P<0.05$). However, no significant difference was found between the second and third PVR measurements ($P=0.107$).

Moreover, to determine significant differences in PVR volume based on the pre-void volume, a one-way ANOVA test was conducted (significance level<0.05). A post-hoc test was also used to find significant differences between each pair of groups. The results showed a significant difference between groups I and II and between groups I and III ($P<0.05$) in three measurements of PVR volume. On the other hand, no significant difference was found between groups II and III in terms of PVR volume in the first, second, and third PVR measurements ($P=0.204$, 0.56, and 0.487, respectively).

Based on the definition of significant PVR volume >50 mL, 55 (70.5%) patients had significant PVR volumes in the first PVR measurement, 32 (41.0%) patients had significant PVR volumes in the second measurement, and 30 (38.5%) patients had significant PVR volumes in the third measurement. Overall, a significant difference was found between the three PVR measurements ($P<0.05$). On the other hand, according to the definition of significant PVR vol-

ume >20% of pre-void volume, 17 (21.8%) patients had significant PVR volumes in the first measurement, 10 (12.8%) patients had significant PVR volumes in the second measurement, and 9 (11.5%) patients had significant PVR volumes in the third measurement. Overall, a significant difference was found between the three PVR measurements (P<0.05).

Moreover, Pearson's Chi-square test was used to compare PVR volumes between the two definitions. The difference in PVR volume was significant between the two definitions in the first, second, and third PVR measurements (χ^2=9.09, P=0.003; χ^2=16.489, P<0.001; and χ^2=16.278, P<0.001, respectively).

Discussion

In this study, we evaluated the variations in PVR measurement, according to different definitions. To be more objective in patient selection, we used the IPSS system as part of our inclusion criteria, and patients with moderate obstruction (IPSS score=8-19) were recruited [18]. Generally, IPSS is a validated questionnaire, developed in 1992 by the American Urological Association to assess the severity of baseline symptoms and response to treatment and to detect disease progression.

In clinical practice, urologists routinely measure the residual urine volume in the bladder by ultrasound. In this regard, Mohammad Moslemi et al. concluded that office urologist-operated ultrasound could be easily used with high levels of accuracy. They showed that complete or partial diagnosis by ultrasound could be achieved in 695 (96%) out of 724 patients [19]. Generally, ultrasound is a crucial imaging study for the evaluation of PVR volume. It is routinely used in outpatient urological clinics as part of the clinical assessment [19]. In this regard, Lewis-Jones et al., in a prospective study, found that by using a urinary tract ultrasound, combined with plain abdominal imaging, there was a 58% reduction in the number of intravenous pyelogram examinations while maintaining the diagnostic accuracy [20].

During urinary bladder sonography, two phases can be evaluated, that is, the full bladder phase for evaluating the bladder wall thickness, intramural bladder pathologies, bladder capacity, and prostate gland and post-void phase for measuring the amount of residual urine volume in the bladder with high accuracy (approximately 90%). To improve bladder emptying, we asked all patients to void in a sitting position, based on the results of a study by EL-Bahnasawy et al., who concluded that the flow rate and bladder emptying were better in a sitting position than a standing position [21].

The findings of the present study showed a high PVR volume after the first void, compared to the second and third voids, and the mean PVR volumes were 92, 62, and 60 mL, respectively. This difference was affected by the pre-void volume, and a significant difference was found between groups I and II and between groups I and III. On the other hand, no significant difference was found between groups II and III in the three PVR measurements. This finding can be explained by the short bladder filling time, which may lead to abnormal bladder function during filling and voiding and acute decompensation of the detrusor muscle; consequently, these measurements do not objectively represent the patient's residual urine volume [22]. Other studies, which have examined the effect of pre-void volume on the accuracy of PVR measurements, confirm this finding [15, 22].

PVR measurement can help identify urinary retention, determine the proper treatment approach, and prevent further complications. However, there is a lack of consensus on how to define a high PVR volume. In this study, we compared two definitions for significant PVR volume. The first definition represents significant PVR as PVR volume >50 mL [16], whereas the second definition represents significant PVR as PVR volume >20% of pre-void volume [17]. The present results demonstrated a significant difference between the two definitions. Incomplete bladder emptying and incorrect detection of significant PVR due to improper measurements may lead to the prescription of unnecessary medications and invasive procedures (e.g., urodynamic study and surgical interventions) and impose costs on patients due to unnecessary interventions.

Conclusion

Based on the present results, a bladder ultrasound must be performed and interpreted carefully to avoid unnecessary procedures. Overfilling the bladder in a short period may result in a temporarily decompensated bladder and detrusor muscle fatigue. Consequently, the bladder does not contract properly to empty urine, leading to the return of a large amount of urine in the bladder after voiding, and consequently, inaccurate PVR measurements; therefore, we recommend a second PVR measurement in these patients. Also, it is suggested to conduct similar studies in different conditions to confirm our findings.

Declarations

Funding
The study is not funded through any source.

Conflict of Interest
The author declares no conflict of interest.

Ethics Approval
The study was approved by the Institutional Ethical Committee at the Faculty of Medicine, Mu'tah University

Consent to Participate
Informed consent was obtained from patients. Their personal information such as names, initials or hospital numbers was kept confidential.

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