DOI: 10.14744/ejmi.2019.33602
EJMI 2019;3(2):95–99

Research Article

The Importance of Residual Urine Measured After the Second Miction in the Evaluation of Benign Prostatic Hyperplasia Patients with Lower Urinary Tract Symptoms

Erdal Karavas,[1] Erkan Hirik[2]

[1]Department of Radiology, Erzincan Binali Yildirim University Faculty of Medicine, Erzincan, Turkey
[2]Departments of Urology, Erzincan Binali Yildirim University Faculty of Medicine, Erzincan, Turkey

Abstract

Objectives: Examine the correlation between the results of bladder voiding after uroflowmetry (PVR_1) and second voiding (PVR_2), and to investigate the factors affecting this in patients presented with lower urinary tract symptoms (LUTS) due to benign prostatic hyperplasia (BPH).

Methods: The study included fifty-five male patients presented to the urology outpatient clinic with LUTS and followed up with the diagnosis of BPH. The study was designed as self-controlled and prospective. All patients' medical records were taken and physical examinations, biochemistry, PSA tests and urinalysis were performed. Patients with diseases other than BPH were excluded from the study. Ultrasound (US) of the urinary tract was started when the patients felt the first urge to urinate. The size of prostate gland was measured from the dimensions. Immediately after bladder voiding on uroflowmetry device following the examination, PVR_1 was measured using US. Following the measurement, the patient was kept waiting for five minutes and PVR_2 was measured again with US immediately after the second bladder voiding. A PVR of ≥50 mL was considered as residual urine.

Results: The difference between PVR_1 and PVR_2 was statistically significant ($p<0.001$). Moreover, the PVR_1 results of ≥50 mL reduced under 50 mL in 38.2% of the patients in PVR_2 ($p<0.001$). The difference obtained by subtracting PVR_2 volume from PVR_1 volume was positively correlated with the total volume of urine ($p<0.001$, $r=0.57$). There was a statistically significant difference in the total volume of urine ($p=0.001$) in the grouping by considering 50 mL as the limit in PVR_1 and PVR_2. There was a weak negative correlation between Qmax and PVR_1 ($p=0.005$, $r=-0.37$) and PVR_2 ($p=0.001$, $r=-0.45$). The patients with a PVR_2 value of 50 mL or higher had a statistically lower Qmax value than the patients with a PVR_2 value below 50 mL ($p=0.002$), but there was no significant difference with the PVR_1 of the same equation ($p=0.084$).

Conclusion: In the evaluation of the patients with the diagnosis of BPH with LUTS, we are of the opinion that the patient should be managed by considering the PVR value measured following the second voiding of the patient after routine uroflowmetry.

Keywords: Benign prostatic hyperplasia, lower urinary tract symptoms, measurement, postvoiding residual volume, ultrasonography

Cite This Article: *Karavas E, Hirik E. The Importance of Residual Urine Measured After the Second Miction in the Evaluation of Benign Prostatic Hyperplasia Patients with Lower Urinary Tract Symptoms. EJMI 2019;3(2):95–99.*

Benign prostatic hyperplasia (BPH) is the most important cause of bladder neck obstruction in elderly men. BPH increases with age and is diagnosed in 80% of men until 60 years of age and in 50% of men until 80 years of age.[1, 2] In general, obstruction and lower urinary tract complaints due to enlarged prostate include frequent urination, nocturia or nocturnal polyuria, urinary urgency, weak urinary flow. The etiology of benign prostatic hyperplasia has not been clearly defined. Various scoring systems have been created to evaluate the severity of the symptoms, the sys-

Address for correspondence: Erdal Karavas, MD. Erzincan Binali Yildirim Universitesi Tip Fakultesi, Radyoloji Anabilim Dali, 24100 Erzincan, Turkey
Phone: +90 446 212 22 22 **E-mail:** erdalkaravas@hotmail.com

Submitted Date: February 10, 2019 **Accepted Date:** March 05, 2019 **Available Online Date:** March 08, 2019

tem accepted by urologists worldwide is the International Prostate Symptom Score (IPSS).[3, 4] In addition to these subjective complaints, objective parameters to evaluate patients and plan their treatment include uroflowmetry, prostate volume, residual urine and prostate specific antigen (PSA) tests.

One of the simplest and most useful measuring methods is the uroflowmetry method, which can be used to measure urine flow rate with a simple flow measurement. Uroflowmetry measures urine volume, urination time, delay time, the time taken to reach maximum urinary flow rate, maximum urine flow rate and mean urine flow rate. Flow rate measurements similarly provide information in parallel to lower urinary tract Ultrasound (US).[5, 6] In males with lower urinary tract symptoms (LUTS), a voided volume of ≥150 mL and a voiding time less than 11.5 seconds on uroflowmetry have been accepted normal.[6] In the evaluation of patients presenting with LUTS, the measurement of postvoid residual urine (PVR) using US is also a useful examination.[7]

PVR is defined as the volume of residual urine in the bladder post micturition.[8] PVR measurement is a screening test guiding to assess LUTS and plan patient's treatment. [9] Most clinicians agree that a volume of 50-100 mL for PVR should be abnormal.[10] Although urethral catheterization is the gold standard for PVR measurement, it is known to produce wrong results in the case of prolonged time between urination and PVR measurement.[8, 11]

The aim of this study was to examine the correlation between the results of bladder voiding after uroflowmetry (PVR_1) and second voiding (PVR_2) and to investigate the factors affecting this in patients presented with LUTS due to BPH.

Methods

Fifty-five male patients presented to the urology outpatient clinic with LUTS were included in the study. The study was designed as self-controlled and prospective. All patients' medical records were taken and physical examinations, biochemistry, PSA tests and urinalysis were performed. Patients with diabetes mellitus, urinary tract infection or neurogenic bladder diseases were excluded from the study. The patients did not take fluid before US examination of the urinary tract. When they first felt urinary urgency, the examination was started. US examination was performed transabdominally by a single radiologist with twelve years of experience using a 2-5 MHz convex transducer (Hitachi Hi Vision Preirus; Tokyo; Japan, 2013). Assuming the elliptical shape of the prostate gland, the size was measured from the anteroposterior, transverse and sagittal planes.[12] The bladder volume was calculated with the equation of height x width x depth x (0.6).[13] The initial residual urine volume (PVR_1) was measured with US immediately after bladder voiding on uroflowmetry device. Following the measurement, the patient was kept waiting for five minutes and the second residual urine volume (PVR_2) was measured again with US immediately after the second bladder voiding. A PVR of ≥50 mL was considered as residual urine.[10]

The data were evaluated with IBM SPSS Statistics 25.0 (IBM Corp., Armonk, New York, USA) statistical package software. Descriptive statistics were given as the number of units (n), percentage (%), median (M), the first quartile (Q1) and the third quartile (Q3) values. Normality of numerical variables was evaluated using the Shapiro-Wilk test and Q-Q plots. The difference between two measurements of non-normally distributed variables was analyzed with the Wilcoxon Test. Correlations between numerical variables were evaluated using the Spearman's Rank-Order Correlation. Whether there is a difference between the grouped PVR values was tested with the McNemar test.

Results

Fifty-five patients admitted to the urology outpatient clinic between December 2017 and February 2018 were included in the study. The mean age of the patients was 62.6±9.4 (min 43, max 83 years of age). The mean PSA value was 1.67 (0.91-2.78) ng/mL, prostate volume was 30 (24-45) mL, and Qmax was 14.7 (9.3-19.7) mL/sec. The total volume of urine during urinary urgency was 260 mL (190-375), while PVR_1 was 61 mL (37-104), PVR_2 was 30 mL (11-45).

The difference between PVR_1 and PVR_2 was statistically significant. The PVR_2 values were lower than the PVR_1 values (Table 1).

Table 1. The difference between PVR_1 and PVR_2

	Measurements		p
	1 $M\ (Q_1\text{-}Q_3)$	2 $M\ (Q_1\text{-}Q_3)$	
PVR (mL)	61 (37-104)	30 (11-45)	<0.001

Table 2. Grouped PVR

		PVR_2		Total	p
		<50 n (%)	≥50 n (%)		
PVR_1	<50	22 (40.0)	0 (0.0)	22 (40.0)	<0.001
	≥50	21 (38.2)	12 (21.8)	33 (60.0)	
	Total	43 (78.2)	12 (21.8)	55 (100)	

Twenty-one patients with a PVR_1 of >50 mL (38.2% of all patients) exhibited a reduction under 50 mL in PVR_2. This change was statistically significant (Table 2).

The change in PVR (PVR-difference) was moderately positively correlated with the total volume of urine. PVR_1 was also negatively correlated with Qmax and was moderately positively correlated with the total volume of urine. Whereas PVR_2 was weakly positively correlated with PSA and the total volume of urine and was weakly negatively correlated with Qmax (Table 3).

Those with a PVR_1 of ≥50 were found to have higher values of PSA and the total volume of urine than the group with <50. There was no difference between the other variables (Table 4).

Those with a PVR_2 ≥50 were found to have lower Qmax values and a higher total volume of urine values than the group with <50. PSA value is susceptible to significance. There was no difference between the other variables (Table 5).

Table 3. Correlation of PVR_1, PVR_2 and PVR difference with other variables (n=55)

	PVR_1	PVR_2	PVR difference
Age			
Rho	0.086	0.154	0.037
p	0.533	0.262	0.790
Prostate volume			
Rho	0.104	0.082	0.138
p	0.449	0.551	0.316
PSA			
Rho	0.245	0.343	0.082
p	0.072	0.010	0.550
Qmax			
Rho	-0.373	-0.446	-0.201
p	0.005	0.001	0.141
Total volume of urine			
Rho	0.547	0.366	0.571
p	<0.001	0.006	<0.001

Table 4. Comparison of grouped PVR_1 with other variables

	PVR_1		p
	<50 *M (Q_1-Q_3)*	≥50 *M (Q_1-Q_3)*	
Age	61.5 (55.3-69.3)	63.0 (57.5-68.0)	0.830
Prostate volume (mL)	30.0 (20.8-38.5)	32.0 (27.0-52.0)	0.154
PSA (ng/mL)	1.08 (0.74-2.07)	2.05 (0.90-3.81)	0.044
Qmax (mL/sec)	16.45 (12.17-23.85)	12.00 (8.40-18.45)	0.084
Total volume of urine (mL)	306.5 (224.4-392.3)	442.0 (365.5-566.0)	0.001

Table 5. Comparison of grouped PVR_2 with other variables

	PVR_2		p
	<50 *M (Q_1-Q_3)*	≥50 *M (Q_1-Q_3)*	
Age	61.0 (55.0-70.0)	63.0 (61.3-65.0)	0.481
Prostate volume (mL)	30.0 (22.0-42.0)	30.5 (24.8-54.5)	0.775
PSA (ng/mL)	1.30 (0.75-2.59)	2.62 (1.78-4.30)	0.051
Qmax (mL/sec)	15.80 (11.90-21.80)	8.60 (5.77-13.42)	0.002
Total volume of urine (mL)	368.0 (269.0-448.0)	565.5 (399.8-837.0)	0.003

Conclusion

In patients with benign prostatic hyperplasia, LUTS may affect the individual's daily life of people. IPSS, prostate volume, detrusor resistive index, intravesical prostatic protrusion, capsular artery resistive index, intraprostatic pressure measurement, PVR, uroflowmetry, bladder wall thickness and pressure flow study are widely used parameters in the evaluation of patients with BPH-related LUTS. Uroflowmetry with PVR is a simple, noninvasive, reliable test used for the evaluation of patients with intravesical obstruction. However, uroflowmetry measurements may be affected by various factors such as age, gender, urine volume, patient's psychological status, urethral catheterization and voiding position.[14, 15] The aim of this study was to examine the correlation between the results of bladder voiding after uroflowmetry (PVR_1) and second voiding (PVR_2) and to investigate the factors affecting this in patients presented with LUTS and diagnosed with BPH.

The difference between PVR_1 and PVR_2 volume was statistically significant (p<0.001). Moreover, the PVR_1 results of ≥50 mL reduced under 50 mL in 38.2% of the patients in PVR_2 and again there was a significant difference. As the first study on the evaluation of patients with BPH-related, this self-controlled study LUTS revealed the significant difference of second PVR value to be examined in a single session from the PVR value to be examined once. The accuracy of PVR measurement is important to determine the efficacy of medical and surgical treatments for LUTS.[16] It supports the notion that residual urine volume measurement in an uncomfortable, stressful environment, usually during uroflowmetry procedure, is an important factor and the patient might be mismanaged by the clinician with the wrong results obtained. High PVR is thought to be associated with LUTS severity. An inaccurate measurement may lead to unnecessary drug therapy and surgery.[17, 18]

It appears that the reliability of PVR_1 decreases with the in-

crease in patient's bladder fullness since the difference obtained by subtracting PVR_2 volume from PVR_1 volume was positively correlated with total volume of urine (p<0.001, r=0.57) and there was a statistically significant difference in total volume of urine (p=0.001) in the grouping by considering 50 mL as the limit in PVR_1 and PVR_2 (p=0.001). These results also support the view in the literature that the bladder will not completely empty due to being overfull.[17, 18] Therefore, we are of the opinion that more reliable results could be obtained by making the patient re-micturate after 5 minutes, if the bladder is too full.

In our study, the weak negative correlation between Qmax and PVR_1 (p=0.005, r=-0.37) and PVR_2 (p=0.001, r=-0.45) results becomes more significant in PVR_2. In addition, the patients with a PVR_2 value of ≥50 mL had a statistically lower Qmax than those with a PVR_2 value of <50 mL (p=0.002), but no significant difference with PVR_1 of the same equation (p=0.084) reduces the reliability of the result in view of PVR_2. These results show that the PVR_2 results of ≥50 mL were more significantly correlated with LUTS findings.

Although there was a significant difference with PSA in the comparisons of PVR values with PSA, if the PVR_1 value is higher than 50 mL (p=0.044), and there was no significant difference in the same comparison with PVR_2 (p=0.051), the values were close. Despite the positive significant correlation between PSA and PVR_2 values (p=0.01, r=0.34), there was no statistically significant correlation between PSA and PVR_1 (p=0.25, r=0.07). The fact that there was no significant difference in other results demonstrates the value and importance of PVR measurement for clinician while evaluating LUTS findings.

BPH is caused by prostate enlargement and prostate volume increases with advancing age in males.[1, 2] Prostate volume is not correlated with the severity of LUTS, and therefore, cannot be used by clinicians for surgical decision. Prostate volume can be used to select surgical technique.[18] In our study, there was no statistically significant difference in the comparisons of PVR values with age and prostate volume (p>0.05).

In conclusion, we are of the opinion that the patient should be managed by considering the PVR value measured following the second voiding after routine uroflowmetry in the evaluation of patients with the diagnosis of BPH with LUTS.

Disclosures

Ethics Committee Approval: The study was approved by the Erzincan Binali Yildirim University Ethics Committee (2017-15/04).

Peer-review: Externally peer-reviewed.

Conflict of Interest: None declared.

Authorship Contributions: Concept – E.K.; Design – E.K.; Supervision – E.K., E.H.; Materials – E.K., E.H.; Data collection &/or processing – E.K.; Analysis and/or interpretation – E.K., E.H.; Literature search – E.K., E.H.; Writing – E.K., E.H.; Critical review – E.K., E.H.

References

1. Isaacs JT. Importance of the natural history of benign prostatic hyperplasia in the evaluation of pharmacologic intervention. Prostate Suppl 1990;3:1–7.
2. Michael Garraway W, Kirby RS. Benign prostatic hyperplasia: Effects on quality of life and impact on treatment decisions. Urology 1994;44:629–36.
3. Barry MJ, Fowler FJ, O'Leary MP, Bruskewitz RC, Holtgrewe HL, Mebust WK, et al. The American Urological Association symptom index for benign prostatic hyperplasia. The Measurement Committee of the American Urological Association. J Urol 1992;148:1549–57.
4. AUA Guideline on Management of Benign Prostatic Hyperplasia (2003). Chapter 1: Diagnosis and Treatment Recommendations. J Urol 2003;170:530–47.
5. Tanaka Y, Masumori N, Itoh N, Tsukamoto T, Furuya S, Ogura H. The prediction of bladder outlet obstruction with prostate volume, maximum flow rate, residual urine and the international prostate symptom score in patients with lower urinary tract symptoms. Hinyokika Kiyo 2001;47:843–7.
6. Park KK, Lee SH, Kim YJ, Choi YD, Mah SY. Association between urinary hesitancy symptoms and uroflowmetry measured urinary hesitancy time in men with lower urinary tract symptoms. Neurourol Urodyn 2011;30:578–82.
7. Belal M, Abrams P. Noninvasive Methods of Diagnosing Bladder Outlet Obstruction in Men. Part 1: Nonurodynamic Approach. J Urol 2006;176:22–8.
8. Asimakopoulos AD, De Nunzio C, Kocjancic E, Tubaro A, Rosier PF, Finazzi-Agrò E. Measurement of post-void residual urine. Neurourol Urodyn 2016;35:55–7.
9. Özlülerden Y, Toktaş C, Zümrütbaş AE, Gülten MC, Başer A, Yapıcı O, et al. Can feeling of incomplete bladder emptying reflect significant postvoid residual urine? Is it reliable as a symptom solely? Investig Clin Urol 2018;59:38.
10. Kelly CE. Evaluation of voiding dysfunction and measurement of bladder volume. Rev Urol 2004;6 Suppl 1:S32–7.
11. Ozden E, Turgut AT, Gögüs C, Kosar U, Baltaci S. Effect of premicturitional bladder volume on the accuracy of postvoid residual urine volume measurement by transabdominal ultrasonography: rate of bladder fullness is of great importance for preventing false-positive residue diagnosis. J ultrasound Med 2006;25:831–4.
12. Işıkay L, Turgay Akgül K, Nuhoğlu B, Özdemir G, Ayyıldız A, Çavumirza T, et al. Lower urinary tract symptoms, prostate volume, uroflowmetry, residual urine volume and bladder wall thickness in Turkish men: a comparative analysis. Int Urol

Nephrol 2007;39:1131–5.
13. Hakenberg OW, Linne C, Manseck A, Wirth MP. Bladder wall thickness in normal adults and men with mild lower urinary tract symptoms and benign prostatic enlargement. Neurourol Urodyn 2000;19:585–93.
14. Bossuyt PM. Towards complete and accurate reporting of studies of diagnostic accuracy: the STARD initiative. BMJ 2003;326:41–4.
15. Unsal A, Cimentepe E. Voiding position does not affect uroflowmetric parameters and post-void residual urine volume in healthy volunteers. Scand J Urol Nephrol 2004;38:469–71.
16. Zhao Z, Zeng G, Zhong W, Mai Z, Zeng S, Tao X. A Prospective, Randomised Trial Comparing Plasmakinetic Enucleation to Standard Transurethral Resection of the Prostate for Symptomatic Benign Prostatic Hyperplasia: Three-year Follow-up Results. Eur Urol 2010;58:752–8.
17. Alivizatos G, Skolarikos A, Albanis S, Ferakis N, Mitropoulos D. Unreliable residual volume measurement after increased water load diuresis. Int J Urol 2004;11:1078–81.
18. Okçelik S, Soydan H, Ateş F, Yılmaz Ö, Malkoç E, Şenkul T, et al. Correlation Between Residual Volume of Male Patients After Uroflowmetry and Random Residual Volume. LUTS Low Urin Tract Symptoms 2018;10:186–9.