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Correlation Between Preoperative Parameters of Sonography Videourodynamic Studies and Postoperative Outcomes in BPH Patients

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Abstract **Original Research Article**

Objective: To investigate the correlation between preoperative parameters of sonography videourodynamic studies (SVUDS), including maximum detrusor pressure (Pmax), bladder contractility index (BCI), prostate volume (PV), and intravesical prostatic protrusion distance (IPP), and postoperative efficacy in patients with benign prostatic hyperplasia (BPH) undergoing transurethral resection of the prostate (TURP), and to evaluate their predictive value for postoperative outcomes. ***Methods:*** Retrospective analysis of 74 BPH patients who underwent TURP at Shaoyang Central Hospital and The Second Affiliated Hospital of Guilin Medical University from August 2018 to August 2024. Preoperative Pmax, BCI, PV, IPP, and pre- and postoperative maximum urinary flow rate (Qmax) were collected. Postoperative Qmax improvement (postoperative Qmax − preoperative Qmax) was used to assess efficacy. Patients were divided into a good efficacy group (improvement ≥5.0 ml/s, n=49) and a poor efficacy group (improvement <5.0 ml/s, n=25). Univariate analysis was performed to compare differences between groups, and statistically significant parameters were further analyzed using ROC curves. ***Results:*** The median Qmax increased from 6.5 (4.8, 9.2) ml/s (preoperative) to 15.0 (9.6, 20.2) ml/s (postoperative). Univariate analysis showed no significant differences in preoperative Pmax or BCI between groups (P>0.05), while preoperative PV and IPP were significantly lower in the good efficacy group (P<0.05). ROC analysis revealed diagnostic efficacy (AUC) for PV and IPP as 0.656 and 0.682, respectively (P<0.05). Optimal cutoff values were PV >89.0 ml (specificity=0.918, sensitivity=0.440) and IPP >16.50 mm (specificity=0.531, sensitivity=0.760). ***Conclusion:*** Prostate volume (PV) and intravesical prostatic protrusion distance (IPP) correlate with postoperative urinary flow rate improvement. PV >89.0 ml demonstrates high specificity, while IPP >16.5 mm shows high sensitivity in predicting poor postoperative Qmax improvement (<5 ml/s).
Keywords: Benign prostatic hyperplasia; Prostate volume; Intravesical prostatic protrusion; Maximum urinary flow rate; sonography videourodynamic studies.

INTRODUCTION

Benign prostatic hyperplasia (BPH) is one of the common benign tumors in the urinary system, primarily manifesting as lower urinary tract symptoms (LUTS) such as urinary frequency, urgency, difficulty voiding, and nocturia. Transurethral resection of the prostate (TURP) remains the "gold standard" treatment [1]. However, 7%–11% of patients postoperatively experience an inability to void spontaneously due to detrusor decompensation, and 7.9% of patients continue to have persistent storage-phase symptoms [2].

Current domestic and international urological guidelines recommend surgical intervention for patients with complications such as recurrent urinary retention, hematuria, urinary tract infections, bladder stones, or secondary upper urinary tract hydronephrosis [3]. However, there is still no clear standard for the optimal timing of surgery in clinical practice for BPH patients with LUTS [4], leading to delayed surgery in some patients who require it, thereby increasing surgical risks and postoperative complication rates [5]. Recent studies have explored the correlation between preoperative indicators and the efficacy of TURP in BPH patients. This study investigates this correlation, with results as follows.

1 MATERIALS AND METHODS

1.1 Case Data

This study retrospectively analyzed clinical data of BPH patients who underwent TURP in the Department of Urology at Shaoyang Central Hospital and The Second Affiliated Hospital of Guilin Medical University from August 2018 to August 2024. A total of 74 patients met the study criteria. All patients underwent preoperative sonography videourodynamic studies (SVUDS) and postoperative outpatient follow-up with regular clinical data recording.

1.2 Inclusion and Exclusion Criteria

Inclusion criteria: ① Postoperative pathological diagnosis of benign prostatic hyperplasia; ② Patients undergoing TURP performed by the same surgeon; ③ Complete preoperative urodynamic and prostate ultrasound data; ④ Signed informed consent.

Exclusion criteria: ① Neurogenic bladder dysfunction; ② Bladder outlet obstruction unrelated to BPH; ③ Prior prostate/urethral/pelvic surgery; ④ Concurrent bladder tumors or calculi; ⑥ Significant urinary tract anatomical abnormalities (e.g., large bladder diverticulum or ectopic ureteral orifice); ⑦ Spinal cord injury or congenital malformations causing lower urinary tract dysfunction; ⑧ Diabetes mellitus or severe urinary tract infections.

1.3 Sonography video urodynamic studies Protocol

The SVUDS combined an ultrasound scan with multichannel UDS (Aquarius XT, Laborie, USA) and could synchronously integrate urodynamic measurement values with sonographic images sequences by Aquarius XT own software (UDS.V14, Laborie, USA). Prior to the examination, patients were instructed to maintain moderate bladder filling (volume ≥200 mL). In the lithotomy position, routine disinfection and draping were performed. A digital color ultrasound system was employed for transabdominal scanning to acquire three-dimensional data via sagittal and transverse planes, measuring prostate volume (PV) and intravesical prostatic protrusion distance (IPP). A 7F dual-lumen catheter was then inserted transurethrally, and a single-lumen catheter was placed rectally to measure abdominal pressure. After calibration, all catheters were securely connected to the urodynamic equipment. Room-temperature saline was infused into the bladder at 25–50 mL/min for pressure-flow studies until the patient reached maximal tolerance. The patient was instructed to void into a flowmeter, and post-void residual (PVR) was recorded after urination ceased.

1.4 Postoperative Follow-up

All patients underwent outpatient follow-up within 6 months postoperatively. A dedicated technician performed urinary flow rate testing (after ensuring a bladder volume of 150–400 mL), and Qmax was recorded.

1.5 Postoperative Efficacy Evaluation

Postoperative maximum urinary flow rate (Qmax) improvement and absolute Qmax were used as primary efficacy indicators. A Qmax improvement (postoperative Qmax − preoperative Qmax) ≥5.0 mL/s was defined as "good efficacy", while <5.0 mL/s was defined as "poor efficacy" [18].

1.6 Statistical Analysis

Data analysis was performed using SPSS 27.0. Normally distributed continuous variables were expressed as "mean ± standard deviation", and non-normally distributed data as "median (interquartile range)". For normally distributed data, group comparisons used ANOVA followed by independent samples t-test (if variances were homogeneous); non-normally distributed data were analyzed using the Mann-Whitney U test. Statistically significant parameters from univariate analysis were further evaluated via ROC curves to determine predictive efficacy and optimal cutoff values, with the Youden index balancing sensitivity and specificity. All hypothesis tests were two-tailed, with $\alpha=0.05$.

2 RESULTS

2.1 Comparison of Qmax Before and After Surgery in All Patients

This study included 74 BPH patients. The median Qmax increased from 6.5 (4.8, 9.2) mL/s (preoperative) to 15.0 (9.6, 20.2) mL/s (postoperative). See Figure 1.

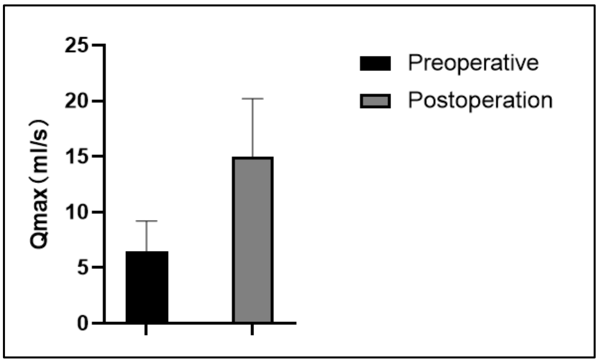

Figure 1. Qmax before and after TURP

2.2 Parameters associated with postoperative Qmax improvement value

2.2.1 Univariate Analysis

Among the 74 BPH patients, 49 were in the good efficacy group and 25 in the poor efficacy group. No statistically significant differences were observed in preoperative Pmax or BCI between the two groups (P > 0.05). However, significant differences were found in preoperative PV and IPP (P < 0.05), with both PV and IPP being significantly smaller in the good efficacy group compared to the poor efficacy group. See Table 1.

Table 1: Preoperative urodynamic parameters of the two groups

Item	Good efficacy group（n=49）	Poor efficacy group（n=25）	t/z	P
Pmax	88.53±30.69	93.50±30.69	0.658	0.513
BCI	107.87±30.48	117.94±38.19	1.232	0.222
PV	59.00（40.00,80.00）	75.00（47.50,102.50）	2.190	0.029
IPP	15.36±7.62	21.27±8.36	3.054	0.003

2.2.2 ROC curve analysis

Using a postoperative Qmax improvement value <5 mL/s as the diagnostic threshold for poor efficacy, analysis of Table 2 revealed: The diagnostic efficacy (AUC) of PV and IPP was 0.656 and 0.682, respectively, with statistically significant differences (P < 0.05). As shown in Figure 2: The optimal cutoff values were PV >89.0 mL (specificity = 0.918, sensitivity = 0.440) and IPP >16.50 mm (specificity = 0.531, sensitivity = 0.760).

Table 2: ROC curve characteristics of preoperative parameters in predicting postoperative Qmax improvement <5 mL/s

Feature	AUC（95%CI）	P	Cut-off	Sensitivity	Specificity	Youden Index
PV	0.656（0.518-0.794）	0.029	89.000	0.440	0.918	0.358
IPP	0.682（0.556-0.807）	0.011	16.500	0.760	0.531	0.291

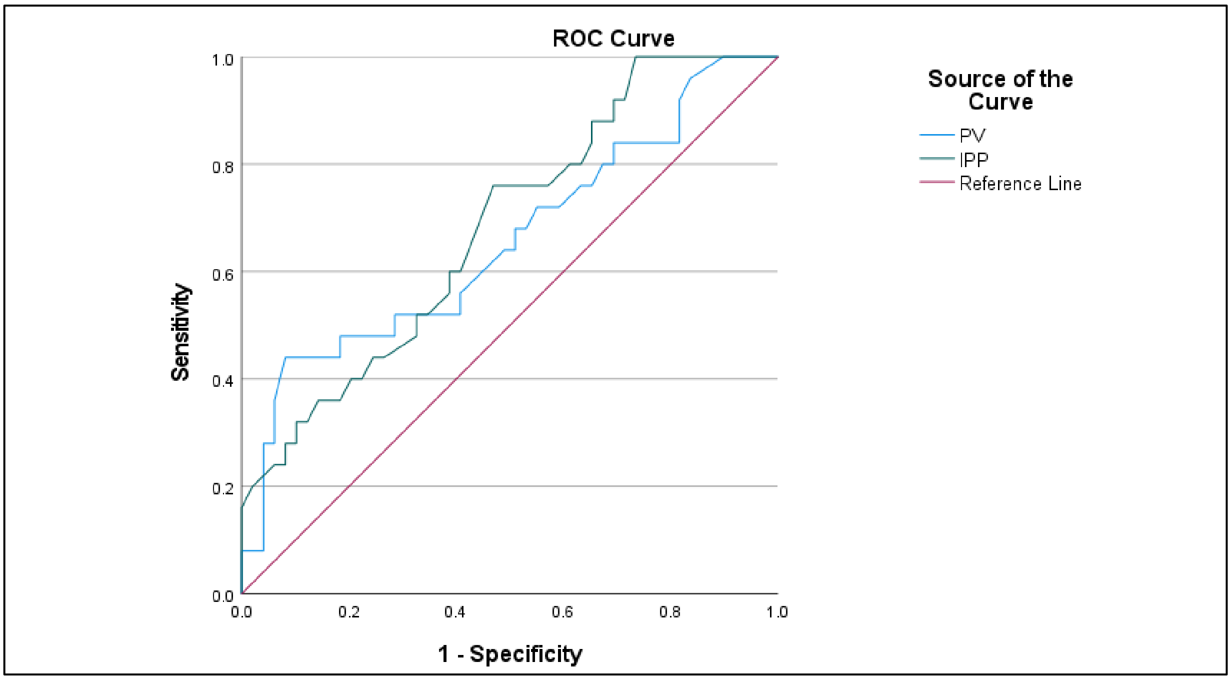

Figure 2: ROC curve of preoperative parameters in predicting postoperative Qmax improvement <5 mL/s

3. DISCUSSION

Benign prostatic hyperplasia (BPH) is a common benign tumor of the urinary system in middle-aged and elderly males. With the increasing aging population, the incidence of BPH continues to rise. Transurethral resection of the prostate (TURP), as the "gold standard" for surgical treatment of BPH, has been widely applied in clinical practice [6]. Studies have shown that most BPH patients achieve good postoperative outcomes after TURP, but 10%–30% of patients still experience poor efficacy or even symptom exacerbation [7]. Therefore, research on patients with suboptimal postoperative outcomes has become critically important.

Urination involves complex mechanisms, broadly categorized into driving forces and resistance. Lower urinary tract symptoms (LUTS) caused by BPH, including dysuria, urinary frequency, urgency, and nocturia, are associated with impaired driving forces and increased resistance. Under various mechanisms, prostate enlargement in BPH patients compresses the urethra, elevating urinary resistance and leading to urinary retention. This triggers LUTS. In early stages, prostate enlargement primarily causes anatomical obstruction, but compensatory bladder processes (e.g., detrusor hypertrophy) allow patients to benefit significantly from TURP. However, prolonged obstruction leads to detrusor decompensation, reduced contractility, low bladder compliance, or even upper urinary tract damage. At this stage, even complete obstruction relief fails to restore satisfactory voiding. Thus, early surgical intervention to relieve bladder outlet obstruction (BOO) before detrusor impairment is crucial for improving postoperative outcomes.

This study analyzed the correlation between preoperative urodynamic parameters and postoperative efficacy in BPH patients undergoing TURP, revealing the predictive value of prostate volume (PV) and intravesical prostatic protrusion (IPP). The findings provide critical insights for preoperative outcome prediction, as discussed below.

PV and IPP, common ultrasound indicators combined with urodynamic studies, play significant roles in predicting postoperative outcomes. For patients with smaller PV, TURP demonstrates superior perioperative safety, with notable improvements in postoperative maximum urinary flow rate (Qmax), post-void residual (PVR), and quality of life (QOL) scores [8][9]. However, Liu et al. [10] found no statistical correlation between PV and TURP efficacy. Other studies suggest that patients with PV of 40–80 mL exhibit significant Qmax improvement [11], while excessively small PV may complicate surgical targeting and reduce symptom relief rates [12]. In this study, PV differed significantly between the good and poor efficacy groups, with the latter showing larger PV. ROC analysis indicated that PV >89.0 mL predicted poor efficacy with 91.8% specificity but only 44% sensitivity. The cutoff value of 89 mL diverges from the internationally accepted threshold (80 mL), possibly due to population characteristics, measurement discrepancies, or limited sample size. IPP, a manifestation of BPH characterized by median lobe protrusion into the bladder, induces BOO and associated storage/voiding symptoms. It serves as a non-invasive diagnostic marker for BOO in LUTS-dominant cases. Prostatic enlargement creates a "ball-valve effect", disrupting the funnel-shaped bladder neck and increasing urethral angulation, thereby elevating voiding resistance. Studies identify IPP as an independent risk factor for TURP outcomes [13]. Patients with IPP ≥10 mm exhibit higher complication rates [14], yet surpassing this threshold correlates with better postoperative functional recovery [15,16]. Controversy persists, as some argue that significant protrusion increases surgical difficulty and impairs bladder compensation, reducing improvements in IPSS and PVR [17]. This study found significantly higher IPP in the poor efficacy group. ROC analysis suggested IPP >16.5 mm predicts poor Qmax improvement, albeit with limited efficacy. Larger IPP may exacerbate resistance and bladder decompensation, diminishing postoperative Qmax improvement. Thus, IPP's predictive value requires integration with detrusor function assessment. Patients with high IPP should undergo urodynamic evaluation and timely surgery.

In conclusion, the degree of BOO correlates with postoperative voiding outcomes in BPH patients undergoing TURP. Severe BOO predicts poorer results. Preoperative measurement of PV and IPP aids in prognostic evaluation, guiding clinical decision-making for TURP.

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Competing interests: The author reports no conflicts of interest in this work.

Data availability

The data that support the findings of this study are not openly available due to reasons of sensitivity and privacy protection and are available from the corresponding author upon reasonable request. Data is located in controlled access data storage at The Second Affiliated Hospital of Guilin Medical University and Shaoyang Central Hospital.

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