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Urodynamic Predictors for Voiding Recovery after Transurethral Resection of Prostate in Benign Prostatic Hyperplasia Patients with Significant Post-voiding Residual Urine

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ABSTRACT

Background: Detrusor underactivity (DU) is a frequent clinical issue that is poorly understood. Both the diagnosis and the course of treatment are challenging and unpredictable. In men, DU and bladder outlet obstruction (BOO) frequently coexist. Prostatic surgery may enhance voiding efficiency (VE).

Aim: To improve the outcome of transurethral resection of the prostate (TURP) by selecting Benign Prostatic Hyperplasia (BPH) patient with significant post-voiding residual urine who could benefit from surgery and could void normally after TURP. **Patients and methods:** This is a clinical trial – single arm study included 24 male patients above 50 years old with BPH and significant postvoiding residual urine who underwent TURP. Urodynamic predictors were assessed.

Results: There was significant difference between patients with good and poor outcomes regarding IPSS pre-operatively, Qmax, postvoid residual (PVR), Voiding Efficiency and BCI

Conclusion: The success rate of prostatectomy was 83.3% and about 16.7% had poor outcomes. Patients with higher BCI had good prognosis.

Keywords: Urodynamic, BPH, TURP, Voiding recovery.

INTRODUCTION

For people with problematic prostates, the gold standard of care is still transurethral resection of the prostate (TURP). Lower urinary tract symptoms (LUTS) that are resistant to treatment or have side effects such persistent acute urine retention (AUR) [(1)]. The urodynamic term for the restriction of the outflow during voiding is bladder outlet obstruction (BOO), which is characterised by decreased urine flow rate and increased detrusor pressure [(2)]. The two most common causes of voiding UTS in males are detrusor underactivity (DU) and benign prostatic obstruction (BPO). Both diseases frequently result in a weak urinary stream, excessive postvoid residual (PVR) urine, or AUR. According to urodynamic studies (UDS), "A contraction of diminished power and/or duration, leading in prolonged bladder emptying and/or failure to attain complete bladder emptying within a suitable time range" is how the International Continence Society defines DU [(3)].

The symptoms of DU and BPO differ, and the two disorders interact. Above all, BOO is regarded as one of the primary causes of DU. They may follow the same treatment criteria in addition to having the same symptoms. Improved voiding and reduced risk of urinary tract infection or upper urinary tract degeneration are the main targets of treatment [(4)].

As there is yet no adequate therapy to make the bladder more contractile, several therapies for DU and urine retention efforts have been concentrated on lowering resistance at the bladder outflow while awaiting spontaneous bladder recovery [(5)].

The existence of BPO before to surgery is linked to better surgical outcomes as indicated by reductions in postvoiding residual urine and improvements in symptoms, quality of life, maximum flow rate, and flow rate[(6)].

This study aimed to improve the outcome of TURP by selecting BPH patient with significant post-voiding residual urine who could benefit from surgery and could void normally after TURP.

PATIENTS AND METHODS

Our single-arm clinical trial, involved 24 male patients with BPH over 50 years old and significant postvoiding residual urine who underwent TURP in Urology Department, Zagazig University Hospitals.

Inclusion criteria: Male patient with severe LUTS (IPSS score >20) and significant PVR ≥ 300 cc, patients with prostatic specific antigen (PSA) ≤ 4 ng/dl, age between 50-70 years old and decreased Q max < 10 ml/sec.

Exclusion criteria: Patient with neurological disorder, patients with documented prostate cancer and patients unfit for surgery.

Preoperative evaluation:

All participants in the study underwent the following procedures: **Medical History** including age, main compliant, medical and surgical history, IPSS (International Prostate Symptom Score) and duration of urethral catheter fixation.

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Physical Examination: General, abdominal, genital examination and DRE. **Investigations:** including complete blood count, urine culture & sensitivity, coagulation profile, kidney, liver, and other functional tests, PSA, abdominal and pelvic ultrasonography for prostate size and PVR.

Urodynamic Pressure Flow Studies including bladder capacity, compliance, sensation, leakage, Pdet@Qmax and BCI.

Uroflowmetry (initial voiding test): The client is instructed to arrive at the appointment with a comfortably full bladder. The patient should be urged to sit down so they can urinate into the voiding flow/volume transducer funnel that is fitted under the commode. Telling the patient to place any tissues or wipes in the designated bin or bag rather than the flowmeter. In order to develop a regular voided pattern, the patient must feel at ease and comfortable throughout the test while maintaining the utmost privacy. Following that, it is important to record the highest void flow rate, volume and maximum measured flow (Qmax) (15-20 ml/sec for males), which is considered normal. Then, using a drainage catheter and measurement container, the PVR volume should be determined.

Calculation of Voiding Efficiency: voided volume/total bladder capacity x100%. **Colhan *et al.*** [7] mentioned that VE ≥ 90 % reflects good bladder emptying function and we used this value to judge the outcomes of patients if they have good or poor outcomes.

Filing cystometry (Cystometrogram): The apparatus must be calibrated, adjusted to a pressure reference level and zero at atmospheric pressure must be created. For the test, the patient should ideally be sitting down. Introduce a catheter into the rectum and a catheter into the bladder using aseptic technique. Complete the test form with the patient's first reported milliliter, normal and strong urination urge, pain, and volume of spilled urine (if applicable). Recording the bladder's total capacity at the end of filling is important.

Bladder compliance: The ratio of the change in detrusor pressure to the change in bladder volume (DV/DP). The International Continence Society advises using two standard points when calculating compliance: (1) the detrusor pressure and corresponding bladder volume at the beginning of bladder filling (typically zero) and (2) the detrusor pressure and accompanying bladder volume at cystometric capacity or right before the start of a detrusor contraction that generates considerable leakage. Detrusor hyperactivity is a urodynamic finding that is distinguished by uncontrollable detrusor contractions during the filling phase.

Voiding cystometry: Allow the patient to void into the toilet, and while the pressure lines are still in, record the peak maximum void pressure, flow rate, and residual volume. The patient's dignity and privacy must be upheld during this voiding phase, and if necessary, staff members should leave the room. True bladder pressure is measured by detrusor pressure (Pdet). It is determined by deducting the vesical pressure (Pves), measured using a bladder catheter, from the abdominal pressure (Pabd) measured with a rectal catheter. Pdet = Pves – Pabd. To confirm proper subtraction, ask the patient to cough both before and after urinating.

Calculation of Bladder Contractility Index (BCI): Pdet Qmax + 5 Qmax (≥150 means normal BCI, 100:150 means average contraction, < 100 detrusor underactivity)

Surgical procedure: Bipolar TURP performed for patients fulfilled the inclusion criteria.

Postoperative evaluation:

- The duration of urethral catheterization.
- There was no need to catheter reinsertion in our patients post catheter removal after surgery.
- The voiding pattern subjectively as patient describes (normal, weak or absence).

Follow up: The patients underwent follow up 2 weeks after urethral catheter removal for the following reasons: IPSS, uroflowmetry, PVR and voiding Efficiency.

Ethical approval: The research ethics council at our institution authorised the study protocol, and all participants provided signed informed permissions before being included in the study.

Data Analysis

Statistical programme for social science (SPSS) version 25 software was used to organise, tabulate, and statistically analyse the acquired data (SPSS Inc., USA). Differences were examined for categorical variables using the 2 chi square test.

RESULTS

Out of 30 patients who fulfilled all our inclusion criteria, 24 were eligible for study. Four patients (13.3%) lost follow up, 2 (6.6%) refused to continue the study (response rate: 80%). The mean age of the 24 study subjects was 58.25 ± 7.01 years and the mean BMI was 24.75±2.34 kg/m^2 (Table 1).

Table (1): Age and BMI distribution among studied group (N=24)

Age	**Mean ± SD**	**58.25±7.01**
	Median (Range)	**58.5 (50-70)**
BMI	**Mean ± SD**	**24.75±2.34**
	Median (Range)	**24.7 (19.6-28.1)**

BMI: body mass index, SD: standard deviation

The mean IPSS pre-operative was 27.66±3.45 among the study subjects while the mean IPSS postoperative was 13.54 ± 6.58 (Table 2).

Table (2): IPSS distribution among studied group (N=24)

	Pre	Post	P
IPSS	**27.66 ±3.45**	**13.54±6.58**	**0.00****

IPSS: International Prostate Symptom Score

As regards pre-operative investigations, the mean Q max of the 24 study subjects was 5.42 ± 1.94 ml/min, the mean PVR was 344.59 ± 121.6 cc and the mean V E was 38.32 ± 13.69%. At follow-up postoperatively, the mean Q max was 18.43 ± 8.61 ml/min, the mean PVR was 60.36 ± 23.56 cc and the mean V E was 84.79 ± 12.27% (Table 3).

Table (3): IPSS, Q max, PVR and V E pre- and post- among studied group (N=24)

	Pre-operative	Post-operative	P
Q max	**5.42±1.94**	**18.43±8.61**	**0.00****
PVR	**344.59± 121.6**	**60.36±23.56**	**0.00****
Voiding Efficiency	**38.32± 13.69**	**84.79±12.27**	**0.00****

As regards V E, Qmax and PVR postoperatively, 20 (83.3%) subjects had good outcomes with mean Qmax 20.02 ± 6.86 ml/sec, PVR 56.83 ± 17.96 cc and V E 87.10 ± 11.41 % while 4 (16.7%) subjects had poor outcomes with mean Qmax 8.32 ± 3.70 ml/sec, PVR 98.25 ± 28.93 cc and V E 67.74 ± 5.28 % (Table 4).

Table (4): Postoperative outcomes as regards V E, Qmax and PVR

	poor outcome (4 patients)	Good outcome (20 patients)	P
Q max post op.	**8.32±3.70**	**20.02±6.86**	**0.00****
PVR post op.	**98.25±28.93**	**56.83±17.96**	**0.00****
Voiding Efficiency post op.	**67.74±5.28**	**87.10±11.41**	**0.00****

The mean age of subjects with good outcome was 59.25 ± 9.10 years. The mean age of subjects with poor outcome was 58.05 ± 6.80 years with no significant difference between both groups (p=0.762). The mean BMI of subjects with good outcome was 25.00 ± 3.75 kg/m^2. The mean BMI of subjects with poor outcome was 24.70 ± 2.10 kg/m^2 with no significant difference between both groups (p=0.887) (Table 5).

Table (5): Analysis of age and BMI in relation to good and poor outcome

	Poor outcome	Good outcome	P
Age (Years)	**58.05±6.80**	**59.25±9.10**	**0.762**
BMI (kg/m^2)	**24.70±2.10**	**25.00±3.75**	**0.887**

The mean IPSS preoperatively of subjects with good outcome was 27.35 ± 4.08. The mean IPSS of subjects with poor outcome was 29.25 ± 3.33. There was no discernible difference between both groups (p=0.321). The mean Qmax of subjects with good outcome was 6.16 ± 2.03 ml/min. The mean Qmax of subjects with poor outcome was 2.92 ± 0.68 ml/sec. The Qmax of subjects with good outcome was significantly higher than those with poor outcome (p=0.003*).

The mean PVR of subjects with good outcome was 331.05 ± 122.9 cc. The mean PVR of subjects with poor outcome was 370.0 ± 53.54 cc with no discernible difference between both groups (p=0.108). The mean V E of subjects with good outcome was 42.75 ± 13.85%. The mean V E of subjects with poor outcome was 18.02 ± 6.87%. The voiding efficiency of subjects with good outcome was significantly higher than those with poor outcome (p=0.009*). The mean BCI of subjects with good outcome was 106.21 ± 28.96. The mean BCI of subjects with a dismal result was 51.55 ± 8.38. Subjects with positive outcomes had BCIs that were considerably higher than those with negative outcomes. (p=0.001) (Table 6).

Table (6): Analysis of IPSS preoperatively, Qmax, PVR, Voiding Efficiency and BCI in relation to good and poor outcome

	Poor outcome	Good outcome	P
IPSS pre op	**29.25±3.33**	**27.35±4.08**	**0.321**
Q max pre op.	**2.92±0.68**	**6.16±2.03**	**0.003***
PVR pre op.	**370.0±53.54**	**331.05±122.9**	**0.108**
Voiding Efficiency pre op.	**18.02±6.87**	**42.75±13.85**	**0.009***
BCI	**51.55±8.38**	**106.21±28.96**	**0.001****

IPSS: International Prostate Symptom Score,

BCI's receiver operating characteristics (ROC) research revealed that >73.8 with 80.0% sensitivity and 74.6% specificity was the optimal cutoff value. The area under the curve was 0.81, p value=0.045 and 95% confidence interval (CI) was 0.596 and 1.000 for lower and upper boundaries respectively (Table 7).

Table (7): ROC analysis of BCI of study subjects

Area	Cutoff	P	95% Confidence Interval		Sensitivity	Specificity
			Lower Bound	Upper Bound		
0.81	**>73.8**	**0.045***	**0.596**	**1.000**	**80.0%**	**74.6%**

DISCUSSION

Our study included 24 male BPH patients above the age of 50 with significant postvoiding residual urine who underwent TURP in Urology Department, Zagazig University Hospitals, during the period from September 2020 to November 2021. The average subject age with good outcome was 59.25 ± 9.10 years. The mean age of subjects with poor outcome was 58.05 ± 6.80 years and there was no significant difference between both groups (p=0.762). The mean BMI of subjects with good outcome was 25.00 ± 3.75 kg/m^2. The mean BMI of subjects with poor outcome was 24.70 ± 2.10 kg/m^2 and There was no discernible difference between both groups (p=0.887). The mean IPSS preoperatively of subjects with good outcome was 27.35 ± 4.08 while of subjects with bad outcome was 29.25 ± 3.33 with no discernible variation between both groups preoperatively (p=0.321). The mean IPSS postoperatively of subjects with good outcome was 11.75 ± 3.05, while of subjects with bad outcome was 22.84 ± 4.24 and there was significant decrease in IPSS postoperatively mainly in subjects with good outcomes (p=0.001).

The mean Qmax preoperatively of subjects with good outcome was 6.16 ± 2.03 ml/min while of subjects with bad outcome was 2.92 ± 0.68 ml/min and there was significant difference between subjects with good and poor outcome (p=0.003). The mean Qmax postoperatively of subjects with good outcome was 20.02 ± 6.86 ml/min while of subjects with bad outcome was 8.32 ± 3.70 ml/min and there was significant difference between both groups (p=0.00).

The mean PVR preoperatively of subjects with good outcome was 331.05 ± 122.9 ml while of subjects with bad outcome was 370.0 ± 53.54 ml with no significant difference between both groups (p=0.108). The mean PVR postoperatively of subjects with good outcome was 56.83 ± 17.96 ml, while of subjects with bad outcome was 98.25 ± 28.93 ml and there was significant difference between subjects with good and poor outcome (p=0.00). The mean VE preoperatively of subjects with good outcome was 42.75±13.85%, while of subjects with bad outcome was 18.02±6.87% and there was significant difference between subjects with good and poor outcome (p=0.009). The mean VE postoperatively of subjects with good outcome was 93.85±5.36%, while of subjects with bad outcome was 67.74±5.28% and there was significant difference between subjects with good and poor outcome (p=0.00). The mean BCI of subjects with good outcome was 106.21±28.96. The mean BCI of subjects with poor outcome was 51.55±8.38. Subjects who had a positive outcome had considerably higher BCIs than those who had a negative outcome (p 0.001).

Han *et al.* [8] examined the impact of transurethral prostate resection (TURP) in men with weak bladder contractility who did not respond to medication therapy. The records of 71 people who had preoperative urodynamic testing were reviewed retrospectively among patients who received TUR-P for lower urinary tract symptoms. Based on the bladder outlet obstruction index and the bladder contractility index, the patients were divided into two groups: group A (25 patients) had an unobstructed and weak bladder contractility, and group B (46 patients) had an obstructed and/or normal bladder contractility. Patients in group B demonstrated a more notable improvement in terms of the IPSS, and they expressed more satisfaction with the TURP than group A patients. Patients with weak bladder contractility experienced IPSS/QoL and PVR scores have improved significantly following TURP, and more than 60% reported being happy with the procedure's outcomes. The retrospective non-controlled form of their investigation, the severity of the symptoms and QoL score, and the reduced prostate size in those with mild BC but no obstruction were its significant drawbacks. This might have an impact on both groups' outcomes. Additionally, they labelled the patients with BOOIs less 40 as unobstructed. In fact, the ICS nomogram indicates that in the BOOI range of 20 to 40, persons are equivocally obstructed. And in certain instances, persons may actually experience obstruction and benefit from TURP in group A**.**

Our study was prospective and showed success rate 83.3%. Smaller sample size could be the cause of this disparity. We evaluated the voiding recovery in BPH patients with significant postvoiding residual without considering the cause of their voiding symptoms whatever it was detrusor underactivity (DU) or benign prostatic obstruction (BPO). In addition the follow-up was shorter, but we documented the changes in voiding

ability after prostatectomy and found that IPSS had significant improvement (p=0.001).

Ou *et al.* [9] assessed the effectiveness of TURP in treating BPH patients with detrusor hypocontractility as detected by urodynamic examination (UDs). The study involved 20 patients, whose average age was 74.20 ± 7.93 years (range: 57–88). A 12-month median follow-up period was used (range: 10–16). IPSS/QoL, Qmax, PVR, and Pdetmax all considerably improved after TURP. They came to the conclusion that in BPH patients with hypocontractile detrusors, UDs may only have a very limited effect in detecting BOO. On these patients with unknown BOO, TURP may have a positive outcome. Based only on the results of the UD, these patients shouldn't be summarily eliminated from surgical indications. This study resembles ours as both are prospective, comparable number of patients but their follow up was 12 months while ours was 2 weeks post catheter removal. They didn't identify DU using BCI. They also recommended prostatectomy in patients with BPH and DU even with equivocal BOO, which is poorly evaluated by UDs.

In our study, we checked BCI and VE as predictors for voiding recovery after TURP and found that the BCI of subjects with good outcome was significantly higher than those with poor outcome (p=0.001) and also preoperative VE (p=0.009), while no significant difference was found between subjects with good and poor outcome regarding the PVR (p=0.108).

Tanaka *et al.* [10] aimed to determine whether the degree of preoperative bladder outlet obstruction (BOO), detrusor underactivity (DU), or detrusor overactivity (DO) affected the short-term outcome of transurethral resection of the prostate in patients with lower urinary tract symptoms suggestive of benign prostatic hyperplasia (LUTS/BPH) (TURP). In this study, 92 patients with LUTS/BPH who were 50 years or older and regarded good candidates for TURP were investigated. Before TURP, BOO, DU, and DO were determined using a pressure-flow investigation and filling cystometry.

Three months following the procedure, the TURP's effectiveness was assessed. Preoperative urodynamics revealed BOO, DU, and DO in 60%, 40%, and 48% of patients, respectively. Following TURP, 76% of patients demonstrated "excellent" or "good" overall effectiveness, while just 13% qualified as "poor/worse." As the preoperative degree of BOO worsened, the efficacy increased. In contrast, TURP's outcome was unaffected by DO or DUA. The procedure most likely had a negative effect on people who had DO but no BOO. They also recommended the surgery in DU even with equivocal BOO as it achieved satisfied results [10].

In comparison with **Tanaka *et al.*** [10] our concern was about voiding LUTS related to BPO and voiding recovery in BPH patients with significant postvoiding residual urine volume not about all causes of LUTS. Although our follow up period is shorter, we all recommend TURP for treating lower urinary tract symptoms.

Lee and Kuo [11] Retrospective analysis was done on a total of 60 males who had had TURP or TUIP between the years of 1998 and 2015 and had urodynamic DU and voiding dysfunction. A voiding efficiency (VE) of less than 33%, a post-void residual (PVR) urine volume greater than 300 mL, and low detrusor pressure (40 cmH2O) were used to define DU. A VE of >50% following therapy and an enhanced quality of life were considered satisfactory outcomes. At a mean follow-up of 12 months, 49 patients (81.7%) had successfully completed their treatments. 38/44 (86.4%) and 11/16 (68.8%) of the patients who underwent TURP and TUIP had satisfactory results, respectively. At baseline, the bladder compliance and detrusor pressure (Pdet) were considerably higher in the satisfactory group compared to the unsatisfactory group. After therapy, the urodynamic parameters significantly were improved in the group that received satisfactory results. 34 (69.4%) of the patients who had a favourable outcome had their detrusor function return within three months. They came to the conclusion that the majority of patients with DU recover their detrusor function and voiding efficiency within three months of receiving active surgical treatment, such as TURP or TUIP [11].

Similarly, in our study, 20 (83.3%) subjects were improved after TURP while 4 (16.7%) were not improved. No significant difference was found between subjects with good and poor outcome regarding the age and IPSS. We found that the BCI and VE are predictors of good voiding recovery after TURP. On the contrary, our study is a prospective study with short follow up period.

Wu *et al.* [12] reported that male patients who had transurethral prostate surgery in the last 20 years and had a modest total prostate volume and DU (TPV, 40 mL) were studied retrospectively. Prior to and following the procedure, video-urodynamic investigations were carried out. The urodynamic parameters were noted, and the change in VE was used to estimate the effectiveness of the medication. A successful postoperative VE was one of 50%. There were 48 patients in total, with a mean age of 74.4 ± 10.0.

A mean follow-up time of 24.9 to 30.5 months was used. At the most recent checkup, 29 individuals (60.4%) had successful outcomes. Only one patient recovered more than six months following the operation, making up 21 (72.4%) of the patients who were healed in one

month. Following surgery, there was maximum flow rate and voiding volume, and postvoid residual urine all were improved and VE. Patients who experienced a positive outcome had higher detrusor pressure at rest (p =.029) and a higher maximal flow rate (p =.034) than those who did not recover. Age and other factors between the recovery and non-recovery groups were not significantly different. They came to the conclusion that prostatic surgery would be advantageous for patients with low prostate volumes and DU they had higher baseline detrusor pressure and maximum flow rates [(12)].

Although, our study was a prospective study but we used the same parameters. Additionally, there was no discernible difference between subjects with good and poor outcome regarding the age and IPSS. The little follow-up period is one of the study's primary flaws, small case number and the study from a single center. Although we excluded patients in poor health status and those with any neurological or microneuropathic disorders such as diabetic cystopathy to limit these factors, which can directly impair the process of voiding.

The high rate of effective voiding function recovery, however, raises the possibility that BOO procedures like TUIP or TURP, which increase Pdet and Qmax at baseline, can effectively improve VE. In certain studies. Detrusor hypocontractility was employed as a marker to indicate a poor prognosis following transurethral prostate removal (TURP) [(13, 14)].

CONCLUSION

Although surgery such as TURP is the most important method to treat BPH patients especially with significant postvoiding residual urine, the pressure flow studies (PFS) play an important role in assessing the detrusor contractility and so can be used to predict the outcome of prostatectomy in those patients, their satisfaction postoperatively and the success rate of the intervention. From our study we concluded that the success rate of prostatectomy in such men was 83.3% and about 16.7% had poor outcomes. So, patients with higher BCI had good prognosis.

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