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RESEARCH ARTICLE
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COMPARISON OF UROFLOWMETRIC PARAMETERS PRE AND POST TRANSURETHRAL RESECTION OF PROSTATE (TURP) IN BENIGN PROSTATIC HYPERPLASIA (BPH) USING MOBILE APPLICATION UROFLOWMETRY

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Abstract

Background: Benign prostatic hyperplasia (BPH) is a common cause of lower urinary tract symptoms in aging men. Transurethral resection of the prostate (TURP) is the gold standard surgical treatment, leading to significant improvements in urinary flow and symptom relief. Traditional uroflowmetry requires clinic-based equipment, whereas mobile application–based uroflowmetry offers a convenient, patient-centered alternative.

Objective: To compare uroflowmetric parameters before and after TURP in patients with BPH using mobile application uroflowmetry and to assess predictors of postoperative improvement.

Methods: This prospective comparative study included 180 male patients with BPH undergoing TURP at Department of Urology, PIMS Islamabad, from June 2024 to September 2024. Baseline demographic and clinical data were collected. Uroflowmetric parameters, including maximum flow rate (Qmax), average flow rate (Qavg), voided volume, and flow time, were measured pre- and post-operatively using a validated mobile uroflowmetry application. Symptom burden was assessed with the International Prostate Symptom Score (IPSS) and quality of life (QoL) scores. Postoperative complications were recorded. Data were analyzed using paired t-tests, chi-square tests, and multivariable logistic regression, with $p \leq 0.05$ considered significant.

Results: The mean age was 66.2 ± 8.4 years. Following TURP, Qmax improved from 8.2 ± 2.5 to 18.6 ± 4.3 mL/s ($p<0.001$), Qavg increased from 4.1 ± 1.3 to 9.2 ± 2.1 mL/s ($p<0.001$), and voided volume rose from 172 ± 46 to 238 ± 58 mL ($p<0.001$). Flow time decreased from 42.8 ± 11.7 to 28.6 ± 9.5 seconds ($p<0.001$). IPSS scores dropped from 21.2 ± 6.4 to 7.6 ± 3.8 ($p<0.001$), nocturia frequency reduced from 3.1 to 1.2 per night, and QoL scores improved from 4.8 to 1.9 ($p<0.001$). Complications included hematuria (8.3%), urinary tract infection (6.7%), transient incontinence (5.0%), retrograde ejaculation (22.8%), and urethral stricture (3.3%). Multivariable analysis showed that prostate size >60 mL (aOR 2.11, $p=0.004$), baseline Qmax <8 mL/s (aOR 2.62, $p<0.001$), and age <70 years (aOR 1.78, $p=0.02$) predicted greater improvement.

Conclusion: TURP significantly improves uroflowmetric parameters, symptom scores, and quality of life in patients with BPH. Mobile application–based uroflowmetry is a practical and reliable tool for pre- and postoperative assessment, offering a convenient and patient-friendly alternative to

conventional flowmetry. Larger prostate size, younger age, and lower baseline flow rates predict better outcomes.

Keywords: benign prostatic hyperplasia, transurethral resection of prostate, uroflowmetry, mobile application, urinary flow, patient-reported outcomes

Introduction

Benign prostatic hyperplasia (BPH) is among the most prevalent urological disorders in aging men, with prevalence rising sharply after the fifth decade of life. Studies indicate that nearly half of men above 50 years and up to 80% of men older than 70 show clinical or histological features of BPH [1]. Although not malignant, BPH significantly affects quality of life by producing lower urinary tract symptoms (LUTS) such as weak urinary stream, hesitancy, nocturia, frequency, and incomplete bladder emptying. These symptoms interfere with daily activities, sleep quality, and social participation, and have been linked to anxiety and reduced overall well-being [2]. The pathogenesis of BPH involves hyperplasia of stromal and epithelial elements within the prostate, largely driven by age-related hormonal changes and androgenic stimulation. Enlargement of the prostate contributes to bladder outlet obstruction, which in turn results in impaired voiding and compensatory detrusor changes. If left untreated, progression may lead to complications such as acute urinary retention, recurrent urinary tract infections, hematuria, bladder stones, and, in advanced cases, upper tract damage and renal insufficiency [3]. The need for timely diagnosis and objective assessment of obstruction is therefore critical in guiding management decisions. Uroflowmetry has long been recognized as one of the most reliable noninvasive diagnostic tools for evaluating voiding function in BPH. Parameters such as maximum urinary flow rate (Qmax), average flow rate (Qavg), voided volume, and flow curve morphology provide quantifiable insight into the severity of obstruction. Reduced Qmax values, particularly those below 10 mL/s, are strongly suggestive of significant bladder outlet obstruction [4]. In addition to aiding in diagnosis, uroflowmetry is central to monitoring treatment outcomes and remains a cornerstone in clinical evaluation.

For patients with moderate to severe symptoms unresponsive to medical therapy, transurethral resection of the prostate (TURP) continues to represent the gold standard surgical intervention. TURP has consistently demonstrated significant improvements in both subjective and objective parameters, with substantial increases in Qmax and decreases in post-void residual urine following the procedure [5]. Despite the advent of newer minimally invasive techniques, TURP remains the most widely performed and well-validated option for relieving obstruction caused by BPH [6][7]. Conventional uroflowmetry, however, requires clinical equipment and hospital attendance, which may be inconvenient and potentially anxiety-inducing, altering natural voiding patterns. To overcome these challenges, mobile health (mHealth) innovations have introduced smartphone-based uroflowmetry applications that allow patients to perform flow assessments at home using sound-based or volume-estimation algorithms. Early validation studies have shown strong agreement between mobile application–based measurements and standard uroflowmetry, suggesting that these tools are accurate, cost-effective, and user-friendly [8]. Such applications also enable repeated assessments over time, facilitating more comprehensive monitoring of treatment outcomes [9]. Previous research has consistently reported improvements in uroflowmetric parameters after TURP, with increases in Qmax, Qavg, and voided volume indicating effective relief of obstruction [10][11]. However, most of these studies have relied on conventional hospital-based flowmeters, and evidence remains limited on the role of mobile uroflowmetry for postoperative monitoring. Exploring the use of mobile applications for assessing pre- and post-TURP changes in uroflow parameters may not only validate their reliability but also enhance patient accessibility, compliance, and long-term follow-up. The present study was therefore undertaken to compare uroflowmetric parameters before and after TURP in patients with BPH using a mobile application–based uroflowmetry system. By analyzing objective changes in urinary flow in a real-world setting, this study aims to provide evidence supporting the

integration of mobile uroflowmetry into routine clinical practice for postoperative monitoring in BPH management.

Objective:
To compare uroflowmetric parameters before and after TURP in patients with BPH using mobile application uroflowmetry and to assess predictors of postoperative improvement.

Methodology
This was a prospective comparative study designed to evaluate changes in uroflowmetric parameters before and after transurethral resection of the prostate (TURP) in patients with benign prostatic hyperplasia, conducted at Department of Urology, PIMS Islamabad, from June 2024 to September 2024. A total of 180 patients diagnosed with BPH and planned for TURP were included in the study. Eligible participants were recruited using non-probability consecutive sampling after fulfilling the selection criteria.

Inclusion Criteria
- Male patients aged 50 years and above.
- Diagnosed cases of benign prostatic hyperplasia presenting with lower urinary tract symptoms.
- Patients scheduled for TURP as definitive management.
- Ability and willingness to use a mobile uroflowmetry application.

Exclusion Criteria
- Patients with proven prostate carcinoma.
- Patients with neurogenic bladder or known neurological disorders affecting micturition.
- Patients with urethral strictures, bladder stones, or active urinary tract infections.
- Patients unwilling to participate or unable to perform mobile application uroflowmetry.

Data Collection
After obtaining approval from the institutional ethics review board, written informed consent was secured from all participants. Baseline demographic data including age, symptom duration, and comorbidities were recorded. Preoperative uroflowmetry was performed using a validated mobile application–based system. Patients were instructed to void naturally into a standard container while the application recorded sound-based algorithms to calculate uroflow parameters, including maximum flow rate (Qmax), average flow rate (Qavg), voided volume, and flow time. Measurements were taken in a comfortable outpatient setting to minimize voiding anxiety. Following TURP, all patients were reassessed using the same mobile uroflowmetry application at a standardized follow-up interval after catheter removal (typically 4–6 weeks post-surgery). Postoperative parameters were documented in the same manner as preoperative recordings. In addition to uroflow values, patient-reported ease of using the mobile application and any postoperative complications were also recorded on a predesigned proforma. Confidentiality and anonymity of patient data were maintained throughout the study.

Statistical Analysis
All collected data were entered and analyzed using SPSS version 22.0. Quantitative variables such as Qmax, Qavg, voided volume, and flow time were expressed as mean ± standard deviation. The Shapiro–Wilk test was used to assess normality of data distribution. Pre- and post-TURP uroflowmetric parameters were compared using paired t-test for normally distributed variables or Wilcoxon signed-rank test for skewed data. Categorical variables such as ease of application use and presence of complications were presented as frequencies and percentages. A p-value ≤ 0.05 was considered statistically significant.

Results

The mean age of patients was 66 years, with most men falling in the 60–69 age group (45%), followed by 50–59 years (29%) and ≥70 years (26%). The mean BMI was 26.1 kg/m², with almost half (48%) classified as overweight and 20% as obese. Hypertension was the most common comorbidity, present in 51% of patients, followed by diabetes in 36% and ischemic heart disease in 15%. Smoking history showed 23% current smokers, 28% ex-smokers, and nearly half were never smokers. The mean duration of LUTS was about 5 years. The average prostate size was 59 mL, and mean serum PSA was 3.9 ng/mL. Most patients (56%) had severe LUTS on IPSS, 38% had moderate symptoms, while only 6% had mild symptoms. The mean post-void residual urine volume was 118 mL.

Table 1. Baseline Demographic and Clinical Characteristics of Patients (N = 180)

Variable	Total (N=180)
Age, years, mean ± SD	66.2 ± 8.4
Age groups, n (%)	
• 50–59 years	52 (28.9)
• 60–69 years	81 (45.0)
• ≥70 years	47 (26.1)
Body mass index (BMI), mean ± SD	26.1 ± 3.4
Hypertension, n (%)	92 (51.1)
Diabetes mellitus, n (%)	64 (35.6)
Ischemic heart disease, n (%)	27 (15.0)
Smoking status, n (%)	Current 42 (23.3), Ex-smoker 51 (28.3), Never 87 (48.4)
Duration of LUTS, years, mean ± SD	4.8 ± 2.1
Prostate size, mL, mean ± SD	58.6 ± 14.3
Serum PSA, ng/mL, mean ± SD	3.9 ± 1.6
IPSS severity, n (%)	Mild 11 (6.1), Moderate 68 (37.8), Severe 101 (56.1)
Post-void residual volume, mL, mean ± SD	118 ± 32

Uroflowmetry parameters improved markedly after TURP. The mean maximum flow rate (Qmax) increased from 8.2 mL/s before surgery to 18.6 mL/s after, a gain of more than 10 mL/s ($p<0.001$). The mean average flow rate (Qavg) more than doubled, rising from 4.1 to 9.2 mL/s ($p<0.001$). Mean voided volume also improved significantly, from 172 mL preoperatively to 238 mL postoperatively ($p<0.001$). Flow time decreased from 43 seconds to 29 seconds ($p<0.001$), reflecting more efficient voiding. These findings confirm significant objective improvements in urinary flow following TURP.

Table 2. Comparison of Uroflowmetric Parameters Pre- and Post-TURP (N = 180)

Parameter	Pre-TURP (Mean ± SD)	Post-TURP (Mean ± SD)	p-value
Maximum flow rate (Qmax), mL/s	8.2 ± 2.5	18.6 ± 4.3	<0.001
Average flow rate (Qavg), mL/s	4.1 ± 1.3	9.2 ± 2.1	<0.001
Voided volume, mL	172 ± 46	238 ± 58	<0.001
Flow time, sec	42.8 ± 11.7	28.6 ± 9.5	<0.001

Symptom scores and quality of life improved substantially postoperatively. The mean IPSS score dropped from 21.2 pre-TURP to 7.6 after surgery, showing a reduction of nearly 14 points ($p<0.001$). Nocturia episodes decreased from an average of 3.1 times per night to 1.2 ($p<0.001$). The proportion of patients reporting incomplete emptying fell from 37% before surgery to only 11% afterwards ($p<0.001$). Quality of Life scores also improved significantly, decreasing from 4.8 to 1.9 on a 6-point scale ($p<0.001$). These results demonstrate substantial relief of symptoms and improved patient satisfaction following TURP.

Table 3. Comparison of Symptom Scores and Quality of Life Pre- and Post-TURP (N = 180)

Parameter	Pre-TURP (Mean ± SD)	Post-TURP (Mean ± SD)	p-value
International Prostate Symptom Score (IPSS)	21.2 ± 6.4	7.6 ± 3.8	<0.001
Nocturia frequency (per night)	3.1 ± 1.2	1.2 ± 0.7	<0.001
Sense of incomplete emptying, n (%)	67 (37.2%)	19 (10.6%)	<0.001
Quality of Life score (1–6 scale)	4.8 ± 1.1	1.9 ± 0.8	<0.001

Complications were relatively infrequent. Hematuria requiring irrigation occurred in 8% of patients, urinary tract infection in 7%, and transient incontinence in 5%. Retrograde ejaculation was the most common postoperative event, affecting 23% of patients. Urethral stricture at 3 months was observed in only 3%. Importantly, more than half of the patients (54%) reported no significant complications following TURP, confirming the procedure's favorable safety profile.

Table 4. Postoperative Complications Following TURP (N = 180)

Complication	n (%)
Hematuria requiring irrigation	15 (8.3)
Urinary tract infection	12 (6.7)
Transient urinary incontinence	9 (5.0)
Retrograde ejaculation	41 (22.8)
Urethral stricture at 3 months	6 (3.3)
No significant complications	97 (53.9)

Subgroup analysis showed greater improvements in Qmax with larger prostates. Patients with prostate size <50 mL improved from 9.1 to 17.8 mL/s (+8.7, p<0.001), those with 50–70 mL glands improved from 8.0 to 18.9 mL/s (+10.9, p<0.001), and those with >70 mL glands improved from 7.5 to 19.5 mL/s (+12.0, p<0.001). Thus, although all patients benefited, men with larger prostates had the greatest gains in urinary flow.

Table 5. Subgroup Analysis of Qmax Improvement by Prostate Size (N = 180)

Prostate size group	Pre-TURP Qmax (mL/s) Mean ± SD	Post-TURP Qmax (mL/s) Mean ± SD	Mean Difference	p-value
<50 mL (n=53)	9.1 ± 2.4	17.8 ± 4.0	+8.7	<0.001
50–70 mL (n=79)	8.0 ± 2.6	18.9 ± 4.4	+10.9	<0.001
>70 mL (n=48)	7.5 ± 2.3	19.5 ± 4.6	+12.0	<0.001

Multivariable analysis identified predictors of significant Qmax improvement (>10 mL/s). Patients younger than 70 years had nearly twice the odds of improvement (aOR 1.78, p=0.02). Prostates larger than 60 mL were associated with a two-fold higher likelihood of significant flow gain (aOR 2.11, p=0.004). A baseline Qmax <8 mL/s was the strongest predictor, tripling the odds of improvement (aOR 2.62, p<0.001). Duration of symptoms, hypertension, and diabetes did not significantly influence outcomes. These findings suggest that younger patients, those with larger prostates, and those with more severe baseline obstruction benefit the most from TURP.

Table 6. Multivariable Predictors of Significant Qmax Improvement (>10 mL/s increase)

Predictor	Adjusted Odds Ratio (aOR)	95% CI	p-value
Age <70 years	1.78	1.12–2.84	0.02
Prostate size >60 mL	2.11	1.25–3.59	0.004
Baseline Qmax <8 mL/s	2.62	1.53–4.49	<0.001
LUTS duration >5 years	1.34	0.81–2.22	0.24
Hypertension	1.12	0.71–1.86	0.56
Diabetes mellitus	1.09	0.65–1.82	0.72

Discussion

This study evaluated changes in uroflowmetric parameters, symptom scores, and quality of life in 180 patients with benign prostatic hyperplasia before and after transurethral resection of the prostate, using a mobile application–based uroflowmetry system. The results demonstrate significant objective and subjective improvements following TURP, while also confirming the feasibility of digital health tools in monitoring surgical outcomes. The baseline characteristics of our cohort reflected the typical demographic of BPH, with a mean age of 66 years, high prevalence of comorbidities such as hypertension (51%) and diabetes (36%), and moderate-to-severe LUTS in the majority of patients. This is consistent with previous research, which has shown that BPH predominantly affects men over 60 years and often coexists with chronic medical conditions that may complicate management [12][13]. Uroflowmetry results revealed a marked increase in maximum flow rate, from 8.2 mL/s to 18.6 mL/s, alongside an increase in average flow rate from 4.1 to 9.2 mL/s. Voided volume improved by more than 60 mL, and flow time decreased substantially, indicating more efficient bladder emptying. These findings are comparable with previous research, which consistently demonstrated that TURP leads to an increase in Qmax of 10–12 mL/s and significant reductions in voiding time [14]. The magnitude of improvement in our study falls within this expected range, supporting the reliability of mobile application uroflowmetry as a monitoring tool.

Subjective outcomes also showed dramatic improvements. The mean IPSS score decreased from 21.2 preoperatively to 7.6 postoperatively, and nocturia episodes dropped from 3.1 to 1.2 per night. Quality of life scores improved by nearly three points. These results mirror previous research, which has reported reductions of 12–14 points in IPSS and significant improvements in quality of life following TURP [15][16]. The close similarity in symptom relief reinforces the established role of TURP as the gold standard surgical treatment for BPH. The safety profile observed in this study was consistent with expectations. While complications such as hematuria (8%), urinary tract infection (7%), and transient incontinence (5%) were reported, more than half of the patients experienced no adverse events. Retrograde ejaculation occurred in nearly one-quarter of patients, reflecting a well-known trade-off of TURP. Only 3% developed urethral stricture within three months. These findings are aligned with previous research, which has documented retrograde ejaculation in 20–30% of cases and low rates of serious complications [17][18]. This further highlights that TURP remains a safe and effective option for symptomatic relief. Subgroup analysis revealed that patients with larger prostates experienced greater improvement in flow rates, with those above 70 mL showing the highest gains. This supports previous research, which has shown that greater tissue removal in larger prostates correlates with more pronounced functional improvement [19]. Similarly, multivariable analysis identified prostate size >60 mL, baseline Qmax <8 mL/s, and age <70 years as independent predictors of significant improvement. Previous research has also reported that younger age and greater baseline obstruction are strong determinants of better surgical outcomes, confirming our findings [20].

An important aspect of this study was the use of a mobile application for uroflowmetry. The ability to capture pre- and post-TURP uroflow parameters outside of the hospital environment provides a more convenient, patient-friendly, and potentially more accurate reflection of natural voiding. Previous research has validated smartphone-based uroflowmetry against standard devices, showing high correlation in Qmax and voided volume. Our findings extend this evidence by demonstrating that mobile uroflowmetry can be effectively used to monitor surgical improvements in a large patient cohort. The strengths of this study include its relatively large sample size, prospective design, and use of both objective and subjective outcomes. The incorporation of mobile uroflowmetry adds innovation and clinical relevance, particularly in the context of patient-centered digital health. However, limitations include the single-center design, short-term follow-up of three months, and reliance on patient compliance for accurate mobile uroflowmetry measurements. Longer-term outcomes, particularly relating to durability of improvement and late complications, were not assessed.

Conclusion

It is concluded that transurethral resection of the prostate provides significant improvement in both objective uroflowmetric parameters and subjective symptom scores in patients with benign prostatic hyperplasia. Maximum and average flow rates increased markedly, voided volume improved, and voiding time decreased, accompanied by substantial reductions in IPSS and nocturia and marked improvement in quality of life. The procedure demonstrated an acceptable safety profile, with most complications being minor and self-limited. Larger prostate size, younger age, and lower baseline flow rates were predictors of greater postoperative benefit. The use of mobile application–based uroflowmetry proved to be a practical and reliable method for assessing pre- and post-operative outcomes, offering a convenient patient-centered alternative to conventional flowmetry. These findings support the role of TURP as the gold standard treatment for BPH and highlight the value of integrating mobile digital tools into routine follow-up.

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