Comparative Safety and Short-Term Effectiveness of Monopolar Transurethral Resection Enucleation of the Prostate in Enlarged Prostate

Ramna Nadeem, Muhammad Hummam Siddique, Noor Ul Ain Zehra, Wajahat Aziz and Hammad Ather

Department of Urology, Aga Khan University Hospital, Karachi, Pakistan

ABSTRACT

Objective: To evaluate the short-term safety and effectiveness of monopolar transurethral resection of the prostate (M-TURP) *versus* monopolar transurethral enucleation of the prostate (M-TUEP) in a tertiary-care urology unit.

Study Design: A descriptive study.

Place and Duration of the Study: Department of Urology, Aga Khan University Hospital, Karachi, Pakistan, from July 2024 to July 2025.

Methodology: Fifty men aged ≥40 years with symptomatic enlarged prostate who had undergone either M-TURP (n = 25) or M-TUEP (n = 25). Preoperative demographics, International Prostate Symptom Scores (IPSS), uroflowmetry parameters, laboratory values, and ultrasound findings were recorded. Operative variables and postoperative outcomes, including haemoglobin drop, electrolyte changes, complications, capsular perforation, irrigation duration, IPSS, maximum and average flow rates (Qmax and Qave), trial without catheter success, and quality of life, were assessed. Independent t-tests, paired t-tests, and chi-square tests were applied where appropriate.

Results: Baseline characteristics were statistically similar between groups. Significant improvements were observed postoperatively in IPSS (27.18 to 4.50), Qmax (6.76 to 18.65 ml/sec), Qave (3.11 to 11.29), and postvoid residual volume (189.64 to 69.70) across the entire cohort ($p < 0.001$). No significant differences were found between M-TURP and M-TUEP regarding haemoglobin drop, transfusion requirements (2 *vs* 1, $p = 0.55$), or electrolyte changes (137 ± 18.2 *vs*. 136.6 ± 4.3, $p = 0.389$). Capsular perforations were fewer in the TUEP group compared to the TURP group (2 *vs*. 9, $p = 0.037$). More catheters were successfully removed in the TUEP group *versus* the TURP group (24 *vs*. 17; $p = 0.023$), indicating better functional outcomes with TUEP. The overall complication profile also showed no statistically significant differences.

Conclusion: M-TUEP is safe in short-term clinical effectiveness comparable to M-TURP. As a monopolar technique requiring no additional equipment, it offers a practical alternative in low-resource settings.

Key Words: *Benign prostatic hyperplasia, Lower urinary tract symptoms, Transurethral resection of the prostate, Transurethral enucleation of the prostate, Monopolar enucleation, Monopolar resection, Prostate surgery, Uroflowmetry, International Prostate Symptom Score, Feasibility study.*

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INTRODUCTION

Lower urinary tract symptoms (LUTS) in ageing men are usually caused by benign prostatic hyperplasia (BPH), a progressive condition that can affect quality of life (QoL). The prevalence of these symptoms increases with age.[1,2] Management of BPH accounts for a considerable part of the workload in tertiary-care hospitals in low- and middle-income countries, as well as in urology services in many other health systems, contributing to high healthcare utilisation, hospitalisation, and surgical interventions.

There are several treatment options for BPH, including conservative and medical therapies, minimally invasive surgical procedures, and open or endoscopic prostatectomy. Among surgical options, monopolar transurethral resection of the prostate (M-TURP) has traditionally been considered the reference standard for small- and medium-sized prostates because of its reliability in improving LUTS, as well as its popularity, technical accessibility, and relatively low cost.[3,4] In M-TURP, resection is performed piecemeal, which may be less effective for large glands, leading to longer operating time and increased irrigation requirements. Additionally, it is associated with perioperative complications, including bleeding requiring transfusion, clotting, transurethral resection (TUR) syndrome, and electrolyte imbalance, which may be particularly significant in older patients with comorbidities.[5-7] These limitations have prompted the development of alternative transurethral methods that aim to resect more tissue in a manner that is anatomically complete and less morbid.

Correspondence to: Dr. Ramna Nadeem, Department of Urology, Aga Khan University Hospital, Karachi, Pakistan
E-mail: ramna.nadeem16@hotmail.com

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Monopolar transurethral enucleation of the prostate (M-TUEP) is primarily designed to replicate the open simple prostatectomy procedure by enucleating the entire adenoma along the surgical capsule without removing the capsule itself.[8] Although the technique was first described several decades ago, it has since been adapted for use with various energy sources, including bipolar and laser technologies. However, in many resource-limited publicly funded settings, advanced laser or bipolar systems are either unavailable or impractical, leaving monopolar technology as the default option. In this context, M-TUEP has gained interest as a feasible adaptation that utilises existing monopolar infrastructure and employs an enucleation principle similar to that of more sophisticated energy sources.

For both procedures, short-term effectiveness is evaluated using objective and subjective outcome measures, such as the enucleation ratio or weight of resected tissue and operative time (measures of enucleation effectiveness), success in trial without catheter (TWOC), changes in the International Prostate Symptom Score (IPSS), and uroflowmetry parameters, including maximum and average flow rates (Qmax and Qave), as well as reduction in post-void residual urine (PVR) on ultrasound.[9,10]

Safety assessment involves measuring haemoglobin drop and transfusion requirements; monitoring for TUR syndrome, postoperative haematuria, clotting, re-catheterisation, urinary infection, incontinence, capsular perforation, and postoperative irrigation period; and evaluating complications using the Clavien-Dindo grading system.[11-13] Combining these short-term outcomes offers insight into the feasibility and early clinical performance of the surgical procedure.

Considering these gaps and the lack of evidence in clinical practice for evaluating the safety (haemoglobin drop, electrolyte abnormalities, transfusion, complications, and Clavien-Dindo grade) and short-term effectiveness (IPSS, uroflow-metry, PVR, and TWOC) of M-TURP compared to M-TUEP,[14-18] this prospective cohort feasibility study was conducted to compare both M-TURP and M-TUEP for these parameters. By systematically assessing these parameters within a single-centre environment, this feasibility study aimed to provide locally relevant data to guide the implementation of M-TUEP and support future multi-centre, long-term comparative studies.

METHODOLOGY

This descriptive study was conducted at the Department of Urology, Aga Khan University Hospital, Karachi, Pakistan, from July 2024 to July 2025. The patients were adult males presenting with LUTS secondary to an enlarged prostate and scheduled for M-TURP or M-TUEP. Ethical approval was obtained from the Institutional Review Committee of the hospital (Approval No. 2024-10330-30187; dated: 24 July 2024). All procedures were performed by consultant urologists experienced in both techniques to ensure procedural consistency and minimise variability due to the operator.

Eligibility criteria for participants were men aged ≥40 years with symptomatic enlarged prostate who had undergone either M-TURP or M-TUEP. Patients were excluded if they had uncontrolled diabetes mellitus, neurological conditions such as Parkinson's disease or myasthenia gravis, neurogenic bladder, high-volume painless retention, urethral stricture disease, known coagulopathy, prostate carcinoma, were undergoing repeat TURP, or had any comorbidities requiring simultaneous treatment. Following informed consent, each participant was assessed at baseline, which included measurement of prostate size by ultrasound, IPSS, uroflowmetry parameters (Qmax and Qave), and ultrasonographic pre- and PVR. Laboratory tests were performed before the operation, which included haemoglobin, haematocrit, platelets, creatinine, and sodium. A structured questionnaire was also used to record pre-operative medications, comorbidities, and antiplatelet or anticoagulant therapy.

Subjects were randomly assigned to two groups based on the operative intervention performed; Group 1 underwent M-TURP, and Group 2 underwent M-TUEP. All surgeries were conducted under spinal or general anaesthesia using the conventional monopolar resectoscope system with glycine irrigation in both methods. In TURP, endoscopic resection was performed in a piecemeal manner using a Karl Storz resectoscope. In TUEP, enucleation of all lobes was performed one by one using a Collings knife (Karl Storz) and then removed in a piecemeal manner.

Parameters measured included resection time or enucleation time, total volume of irrigation used, weight of prostatic tissue resected or enucleated, and enucleation efficiency (the ratio of enucleated weight to enucleation time). Real-time intraoperative events such as capsular perforation, bleeding, transfusion requirements, or suspicion of TUR syndrome were documented. After 24 hours, haemoglobin, haematocrit, creatinine, and sodium levels were monitored. Records included the duration of postoperative irrigation, catheterisation, hospital stay, and complications. The Clavien-Dindo grading system was used to classify complications. TWOC was performed according to local protocols, and the result was recorded as successful or unsuccessful. Patients were re-examined after 1 month, with repeat uroflowmetry, PVR measurements, and IPSS assessments. Additionally, QoL questions were documented before the procedure and at follow-up using the standardised IPSS indicators.

Statistical analysis was conducted using SPSS 26. Quantitative variables, including age, prostate size, Qmax, Qave, PVR, IPSS, operative time, haemoglobin, haematocrit, platelets, creati-nine, and sodium, were expressed as means and standard deviations. Categorical variables such as comorbidities, pre-operative medications, transfusion requirements, types of complications, and Clavien-Dindo grades were represented as frequencies and percentages. The independent samples t-test was used for

between-group comparisons of continuous variables (M-TURP *vs.* M-TUEP). Changes in symptom scores, uroflowmetry parameters, and laboratory values from pre- to post-operation were analysed using the paired t-tests across the entire cohort. Categorical variables between the two groups, including postoperative complications, capsular perforation, TWOC success, and duration of hospital stay, were examined using the chi-square or Fisher's exact test. A p-value of <0.05 was considered statistically significant.

RESULTS

This study involved 50 patients, 25 in the TURP group and 25 in the TUEP group. Baseline demographic and clinical profiles of both groups were similar, with no significant differences in age, prostate size, symptom burden, urinary flow rate, residual urine volume, or laboratory indices. Table I summarises the baseline parameters, confirming that both treatment groups were comparable, thereby eliminating selection bias, and allows for more reliable postoperative comparisons.

Likewise, both groups were comparable in pre-operative use of alpha-blockers and combination therapy (alpha-blocker with 5-alpha reductase inhibitor; p = 0.185). The use of antiplatelet and anticoagulant medications before surgery did not depict any notable differences between the groups (Table I). Comorbidities and the use of preoperative medications were also similar across the two groups, indicating that the overall preoperative risk profile did not differ between patients who underwent TURP or TUEP.

Table I: Baseline demographic and pre-, peri-, and postoperative characteristics.

Variables	TURP Group (n = 25) Mean ± SD	TUEP Group (n = 25) Mean ± SD	p-values
Age (years)[1]	68.84 ± 5.565	67.84 ± 7.459	0.594
Prostate size (g) [1]	69.32 ± 16.822	69.76 ± 26.302	0.944
IPSS score[1]	27.28 ± 4.659	27.08 ± 4.377	0.876
Qmax (mL/s) [1]	7.104 ± 3.671	6.416 ± 2.928	0.467
Qave (mL/s) [1]	3.188 ± 1.091	3.040 ± 1.570	0.701
Pre-void volume (mL) [1]	477.84 ± 276.16	413.40 ± 185.60	0.338
PVR (mL) [1]	204.80 ± 236.31	174.48 ± 163.72	0.600
Haemoglobin (g/dL) [1]	13.336 ± 1.806	13.532 ± 1.477	0.676
Haematocrit (%)[1]	36.95 ± 5.69	39.21 ± 4.90	0.139
Platelets[1]	260.12 ± 54.50	299.24 ± 121.25	0.148
Creatinine (mg/dL) [1]	0.864 ± 0.251	0.968 ± 0.249	0.149
Sodium (mmol/L) [1]	135.55 ± 25.68	138.60 ± 3.81	0.560
Alpha-blocker use[2]	4 (16.0%)	8 (32.0%)	0.18
Combination therapy[2]	21 (84.0%)	17 (68.0%)	0.32
Antiplatelet use[2]	6 (24.0%)	11 (44.0%)	0.136
Anticoagulant use[2]	5 (20.0%)	4 (16.0%)	0.71
Enucleation effectiveness[1]	0.8820 ± 0.295	0.873 ± 0.28	0.9
Operative time (min)[1]	44.12 ± 20.61	54.92 ± 26.47	0.11
Irrigation volume (L)[1]	22.76 ± 11.61	18.16 ± 7.37	0.101
Resected tissue (g)[1]	38.60 ± 20.25	50.88 ± 29.18	0.90
Capsular perforations present[2]	9	2	0.037
Perioperative transfusions[2]	2	1	0.55
Successful TWOC[2]	17	24	0.023
QoL category before surgery[2]			0.392
Mostly dissatisfied	7 (28.0%)	7 (28.0%)	
Unhappy	15 (60.0%)	15 (60.0%)	
Terrible	1 (4.0%)	3 (12.0%)	
QoL category after surgery[2]			0.221
Delighted	2 (8.0%)	5 (20.0%)	
Pleased	16 (64.0%)	18 (72.0%)	
Mostly satisfied	5 (20.0%)	1 (4.0%)	

[1]Continuous variables are expressed as mean ± SD and their p-values were calculated using the independent sample t-test. [2]Categorial variables are presented as frequencies (percentages) and their p-values were calculated using the chi-square test.

Table II: Postoperative functional, laboratory outcomes, and complications.

Variables	TURP Group Mean ± SD	TUEP Group Mean ± SD	p-values
IPSS (1 month)[1]	4.16 ± 1.405	4.84 ± 4.955	0.512
Qmax (mL/s) [1]	19.112 ± 1.629	18.184 ± 4.311	0.319
Qave (mL/s) [1]	11.280 ± 1.865	11.292 ± 2.756	0.986
PVR (mL) [1]	83.92 ± 52.52	55.48 ± 68.67	0.107
Postoperative haemoglobin (g/dL) [1]	12.128 ± 2.031	12.904 ± 1.686	0.148
Haemoglobin drop (g/dL) [1]	1.168 ± 1.022	0.760 ± 1.350	0.234
Postoperative haematocrit (%)[1]	33.708 ± 6.328	38.004 ± 6.346	**0.020**
Creatinine (mg/dL) [1]	0.908 ± 0.266	0.904 ± 0.215	0.954
Sodium (mmol/L) [1]	137.60 ± 4.47	135.72 ± 4.19	0.132
Complications[2]			
None[2]	19 (76.0%)	(64.0%)	
Haematuria[2]	2 (8.0%)	1 (4.0%)	
Clot retention[2]	0 (0.0%)	1 (4.0%)	
Re-catheterisation[2]	1 (4.0%)	3 (12.0%)	0.642
UTI [2]	2 (8.0%)	1 (4.0%)	
TUR syndrome[2]	1 (4.0%)	2 (8.0%)	
Clavien–Dindo Grade I–III[2]	5 (20.0%)	9 (36.0%)	0.416

[1]Continuous are expressed as mean (SD) and their p-values were calculated using the independent sample t-test. [2]Categorial variables are presented as frequencies (percentages) and their p-values were calculated using the chi-square test.

Table III: Comparisons of preoperative and postoperative parameters.

Parameters	Preoperative mean ± SD	Postoperative mean ± SD	p-values
IPSS[1]	27.18 ± 4.475	4.50 ± 3.621	<0.001
Qmax (mL/s)[1]	6.760 ± 3.304	18.648 ± 3.259	<0.001
Qave (mL/s)[1]	3.114 ± 1.340	11.286 ± 2.329	<0.001
PVR (mL)[1]	189.64 ± 201.78	69.70 ± 62.19	<0.001
Haemoglobin[1]	13.434 ± 1.63	12.516 ± 1.889	<0.001
Haematocrit[1]	38.08 ± 5.38	35.856 ± 6.63	0.001
Creatinine[1]	0.91 ± 0.25	0.90 ± 0.23	0.726
Sodium[1]	137 ± 18.2	136.6 ± 4.3	0.873

[1]*Continuous variables are expressed as mean (SD) and their p-values were calculated using the paired sample t-test.*

Comparison of operative and perioperative results showed that the two methods were similar in terms of surgery duration, amount of tissue resected or enucleated, and the volume of irrigation fluid used. Table I indicates that TURP (44.12 ± 20.61 minutes) has a shorter operative time than TUEP (54.92 ± 26.47 minutes); however, this difference is not statistically significant (p = 0.11). Similarly, no significant statistical difference was observed in resected prostate tissue volume (38.60 ± 20.26 g *vs*. 50.88 ± 29.18 g; p = 0.90), despite more tissue being resected in the M-TUEP group; nor was there any significant difference in irrigation fluid requirements. The enucleation effectiveness was found to be comparable in both groups, indicating that both methods have similar operative efficiency.

The TUEP group had fewer capsular perforations compared with the other group (2 *vs*. 9, p = 0.037), and the success rate of catheter removal was significantly higher in the TUEP group than in the TURP group (24 *vs*. 17, p = 0.023), indicating better functional outcomes in the TUEP group. The need for transfusion, duration of bladder irrigation, and stay in hospital were all similar in both groups (Table I). Duration of hospital stay was similar in both groups (1, 2, 3 days; 3 *vs*. 5, 21 *vs*. 20, 1 *vs*. 0, respectively, p = 0.467).

Significant improvements in functional parameters such as LUTS and urinary flow were observed between the groups at 1-month follow-up, with no significant differences between the methods. Although the PVR measured postoperatively was numerically less in the TUEP group (55.48 mL *vs*. 83.92 mL in the TURP group), the difference was not statistically significant (p = 0.107). Serum sodium levels remained unchanged in both groups, confirming the renal safety of both procedures. All these data indicate that both methods yield effective and comparable short-term improvements in urinary function. Along with this, when comparing pre- and post-procedure changes between the groups, there is significant improvement in IPSS, Qmax, Qave, and PVR without a significant drop in sodium levels (Table II and III).

Both M-TURP and M-TUEP demonstrate desirable safety profiles, with low rates of early complications. The incidence of haematuria, clot retention, urinary tract infection, re-catheterisation, re-admission, or TUR syndrome showed no significant difference statistically between the groups (Table II). Additionally, the overall distribution of Clavien-Dindo complication grades (p = 0.416) was similar. The TWOC success rate differed between the groups (TUEP: 24 patients *vs*. TURP: 17 patients; p = 0.023, Table I), supporting improved early functional recovery. Both monopolar TURP and monopolar TUEP demonstrated comparable early complications according to the Clavien–Dindo classification (p = 0.416).

QoL scores improved after 1 month compared with preoperative levels, but the change was not significantly different between the two techniques at 1-month follow-up (Table I). The distribution of QoL categories varied numerically but did not reach statistical significance at baseline or after one month in the two groups (p = 0.392 *vs*. 0.221, respectively, at baseline and after one month).

DISCUSSION

Most existing research focuses on traditional M-TURP, bipolar, and laser enucleation techniques, with few studies offering insights primarily on monopolar systems for endoscopic enucleation. This study emphasised the benefits of enucleation over traditional resection, including more comprehensive tissue removal, improved urinary flow, better symptom scores, and potentially lower retreatment rates, especially in larger glands.[19,20] There are relatively fewer head-to-head comparative data directly comparing monopolar TURP with monopolar TUEP in standard clinical practice, especially within single-centre tertiary hospitals in developing countries.[21,22] Additionally, only a few studies examine long-term outcomes, along with short-term feasibility, peri-operative safety, and early functional efficiency, which are critical when introducing a new technique and assessing whether it should be more widely adopted.[23-25]

This study shows that both procedures offer significant clinical benefits, with no statistically significant differences in most perioperative and early functional outcomes, consistent with the existing literature, which indicates that short-term symptoms and functional performance are similar between enucleation and resection-based transurethral surgeries performed with monopolar or bipolar energy.[3,4,11] The findings suggest that M-TUEP is a viable alternative to M-TURP, especially in settings where resource limitations prevent regular access to laser or bipolar enucleation systems.[8,14,20] The importance of the baseline homogeneity in the final results of resection or enucleation has been previously considered in comparative trials,[7,9,10] and findings in this study also demonstrate high internal validity.

The primary finding of this feasibility study was a significant reduction in symptom severity and improvement in voiding function in both groups. The results showed a significant reduction in IPSS, with notable improvements in Qmax and Qave, along with significant decreases in PVR. These findings align with previous reports of early symptom improvement and enhanced flow parameters following transurethral prostate surgery.[1,2,5] There were no significant differences in postoperative parameters between M-TURP and M-TUEP regarding Qmax, Qave, IPSS, or PVR. This is consistent with comparative reports indicating that enucleation-based and resection-based procedures show similar early functional outcomes with either monopolar or bipolar energy.[3,8,12]

Enucleation performance, which is usually considered a surrogate for tissue removal efficiency, was also comparable across groups. Although laser-based enucleation is often associated with a higher adenoma removal rate and a lower retreatment rate,[15,17,24] monopolar enucleation may not necessarily show the same benefits due to variations in energy delivery, visualisation, and the learning curve. The similar enucleation ratios observed in this study may indicate that prostate size and operator experience were similar in both methods. Although the resected volume and procedure duration in the TUEP group were higher, these differences were not statistically significant. The irrigation volume was also statistically similar, aligning with the existing literature, which shows that monopolar enucleation does not significantly increase surgeons' workload when they are well-trained.[3,14,21]

The same was true for safety outcomes. Certain parameters, such as haemoglobin drop, electrolytes, and postoperative creatinine levels, showed no statistically significant differences between the two groups. These findings are consistent with other studies that demonstrated that monopolar enucleation produces bleeding and fluid absorption patterns similar to those of monopolar or bipolar resection.[6,7,18,22] Capsular perforation, which has traditionally been considered a risk during deep enucleation, was less frequent in the TUEP group when using monopolar energy systems, as recent data suggest that experienced surgeons can reduce capsular complications despite monopolar energy use.[8,19]

Other postoperative complications, such as haematuria, clot retention, urinary tract infection, re-catheterisation, TUR syndrome, re-admission, and emergency visits, were rare and showed no significant differences among the groups. This aligns with previous randomised and non-randomised studies comparing TURP and endoscopic enucleation procedures, in which most adverse events are low grade and can be managed conservatively.[9,11,13,22] A higher success of catheter removal was observed in the TUEP group, supporting the conclusion that TUEP is more effective at restoring early voiding function.

There were no statistically significant differences in duration of hospital stay or postoperative irrigation, which have practical implications for resource-limited centres. The available literature highlights greater variation in hospital stay after TURP or TUEP, mainly influenced by surgeon preference and departmental practices rather than the surgical method itself.[14,20,25] This study suggests that adopting M-TUEP is unlikely to increase inpatient bed occupancy or irrigation requirements significantly.

This study has certain limitations. First, this is a single-centre study. Second, the sample size was small, which can affect generalisability. It was a non-randomised study and, therefore, may be subject to potential bias. Fourth, the follow-up duration was limited to one month, precluding assessment of long-term effectiveness.

The results of this feasibility study show that M-TUEP, although technically more demanding, has comparable short-term safety and slightly improved functional outcomes when performed with conventional monopolar tools. This is especially significant for low-resource tertiary care settings where upgrading to more advanced laser or bipolar platforms may not be feasible. This study is presented as part of the growing body of evidence in the global literature that alternative enucleation methods can be safely incorporated into routine practice without compromising initial outcomes.[8,14,20,25] However, further research, including larger multicentre studies and data on retreatment rates, is needed to determine whether M-TUEP provides long-term advantages over M-TURP with respect to symptom relief and the risk of re-emergence.

CONCLUSION

Both procedures improved IPSS, uroflowmetry, and residual urine, with no significant difference. Safety measures, including haemoglobin drop, transfusions, TUR syndrome, electrolyte changes, and complications, were similar, except that capsular perforation was less common with TUEP. Postoperative outcomes, hospital stay, and quality of life were comparable, with more successful catheter removals in TUEP. M-TUEP is a practical, safe option using a monopolar system, broadening surgical choices without advanced technology. Larger studies are required to confirm long-term benefits and re-operation rates.

ETHICAL APPROVAL:

Ethical approval was obtained from the Institutional Ethical Review Committee of the Aga Khan University Hospital, Karachi, Pakistan (Approval No. 2024-10330-30187; dated: 24 July 2024).

PATIENTS' CONSENT:

This study involved prospectively reviewing patient records with no direct patient interaction; the requirement for informed consent was waived by the Ethical Review Committee.

COMPETING INTEREST:
The authors declared no conflict of interest.

AUTHORS' CONTRIBUTION:
HA: Conceptualisation, supervision, methodology, editing, and review.
WA: Data analysis, supervision, and reviewing.
RN: Methodology, institutional approval, data collection, analysis, writing, review, and editing.
MHS, NUAZ: Writing the original draft and data collection.
All authors approved the final version of the manuscript to be published.

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