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# Intra-Prostatic Epinephrine injection in Bipolar Transurethral resection of large prostate: Exploring Its Role in Optimizing Surgical Outcomes

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**Research Article**

**Keywords:** Benign prostatic hyperplasia, bipolar transurethral resection of the prostate, epinephrine, blood loss, hemostasis, intraprostatic injection

**Posted Date:** November 3rd, 2026

**DOI:** https://doi.org/10.21203/rs.3.rs-11340674/v1

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**Additional Declarations:** No competing interests reported.

# Abstract

### Background

Benign prostatic hyperplasia (BPH) is a common condition in aging men, with transurethral resection of the prostate (TURP) remaining the gold standard surgical intervention. Perioperative bleeding represents one of the most significant complications, particularly in large prostates. Intraprostatic epinephrine injection has been proposed as a hemostatic adjunct. This study evaluates the efficacy of intraprostatic epinephrine injection during bipolar TURP in reducing blood loss and improving surgical outcomes.

### Methods

In this single-center randomized controlled trial, 80 men with symptomatic BPH and prostate volumes of 80–100 mL were allocated equally to bipolar TURP with intraprostatic injection of either epinephrine (200 mcg in 20 mL saline) or saline alone. Patients with cardiovascular comorbidities were excluded. Perioperative blood loss (irrigation-fluid hemoglobin method), transfusion requirement, resection time, operative vision, complications, and follow-up functional outcomes were compared.

### Results

Baseline characteristics were comparable between groups. Epinephrine reduced perioperative blood loss (median 87.5 vs 132.5 mL, $p < 0.001$) and eliminated blood transfusion (0% vs 12.5%, $p = 0.021$). Operative vision was rated excellent or good in 97.5% versus 85% ($p = 0.048$). Resection time was shorter (50.9 vs 77.6 minutes, $p < 0.001$) despite greater resected tissue weight (81.6 vs 71.4 g, $p < 0.001$), and postoperative hemoglobin decline was smaller ($p < 0.001$). Postoperative serum sodium and creatinine remained comparable between groups. Hospital stay was shorter with epinephrine ($p = 0.004$). Hypertension and arrhythmia occurred in 5% of epinephrine patients versus none of the controls ($p = 0.494$), other early complications were comparable. At follow-up, the epinephrine group showed a smaller residual prostate volume (7.6 vs 16.9 mL, $p < 0.001$) and a lower post-void residual volume ($p = 0.015$), with comparable symptom scores, flow rates, retrograde ejaculation, and re-operation rates.

### Conclusions

Intraprostatic epinephrine during bipolar TURP significantly reduces bleeding and transfusion requirements, improves visualization, and enables faster, more complete resection without increasing cardiovascular risk. It is a simple, inexpensive, and readily available adjunct that merits routine use for large-volume prostates.


# Introduction

One of the most prevalent urological conditions that affects ageing men globally is benign prostatic hyperplasia (BPH). The Global Burden of Disease 2021 reports that the global reported cases of BPH

increased by 115.23% from 1990 to 2021, reaching 137.88 million, with projections indicating continued increases through 2035, particularly concentrated in the 60-79 age group (1).

While medical management remains first-line therapy following initial diagnosis, surgical intervention becomes necessary in patients who fail conservative treatment or develop complications including recurrent urinary retention, hematuria, bladder stones, or renal impairment (2). Longstandingly, transurethral resection of the prostate (TURP) has been recognized as the most effective surgical treatment for BPH, involving endoscopic resection of prostatic tissue using monopolar or bipolar electrocautery (3).

Perioperative haemorrhage continues to be one of the most difficult complications of TURP, regardless the significant progress made in surgical techniques. The incidence perioperative bleeding increases substantially with larger gland volumes, reaching 9.5% when resected tissue exceeds 60 grams and exceeding 29% for resection weights above 100 grams (4). Such bleeding complications contribute to clot retention, anemia, prolonged hospitalization, and increased healthcare costs (5).

The pathophysiology of bleeding during TURP is multifactorial. Capsular perforation exacerbates haemorrhage, and venous bleeding occurs through exposed prostatic sinuses that are generated during resection (6). The urothelium and urine discharge high concentrations of plasminogen activators, which stimulate fibrinolytic activity and perpetuate haemorrhage. The prostatic tissue contains rich vascularization (7). Larger prostates require longer operative times and more extensive tissue resection, further amplifying blood loss. Recent data from Charite University Hospital demonstrated that resection weights above 60 grams represent a critical threshold, with significantly higher complication rates and hemoglobin loss (4).

The evolution from monopolar to bipolar TURP has addressed several limitations of the traditional technique. In comparison to monopolar TURP, bipolar TURP exhibited significantly reduced incidences of blood transfusion and thrombus retention (8). The bipolar technique utilizes saline irrigation, eliminating the risk of transurethral resection syndrome, while the confined current flow provides superior hemostasis (9). Nevertheless, bleeding in large-volume prostates remains clinically significant even with bipolar technology (5).

Various pharmacological strategies have been investigated to minimize perioperative blood loss during TURP. Preoperative 5-alpha reductase inhibitors (finasteride and dutasteride) reduce micro vessel density in prostatic tissue but require weeks of pretreatment (10). Tranexamic acid, a synthetic antifibrinolytic agent, has shown efficacy in reducing blood loss, although optimal dosing and route remain debated (11). Other approaches include intraprostatic injection of various agents directly into the prostatic parenchyma prior to resection.

Epinephrine, a potent alpha- and beta-adrenergic agonist, induces rapid vasoconstriction when injected locally into tissues. This pharmacological property makes it an attractive candidate for reducing bleeding

in highly vascular organs such as the prostate (12). However, data specifically addressing large-volume prostates (80-100 g) treated with bipolar TURP still inadequate.

The current research was designed to assess the potential advantages of intraprostatic epinephrine injection during bipolar TURP specifically in patients with large prostates (80-100 g), assessing its impact on intraoperative blood loss and need for blood transfusion. By focusing on this subgroup, we aim to provide guidance for optimizing surgical outcomes in patients at highest risk for bleeding complications.

# Patients and Methods

This prospective, randomized, double blinded, single-center study was performed at the Urology Department of Benha University Hospital between April 2025 and March 2026. The study protocol was approved by the Institutional Review Board of Benha Faculty of Medicine, and all participants provided written informed consent before enrollment.

### *Patients*

A total of 80 male cases with symptomatic BPH requiring surgical intervention were included. Inclusion criteria comprised age > 40 years, prostate volume between 80 and 100 mL as measured by transrectal ultrasound (TRUS), International Prostate Symptom Score (IPSS) > 8, maximum urinary flow rate (Qmax) < 15 mL/s, and failure of medical therapy. Exclusion criteria included uncontrolled hypertension, unstable angina, recent myocardial infarction, arrhythmias, or severe heart failure, significant coagulopathy or anticoagulant use, hyperthyroidism or pheochromocytoma, treatment with 5-alpha reductase inhibitors within the preceding 3 months, and genitourinary malignancy, urinary tract lithiasis, or prior urological surgery within 3 months.

Using computer-generated randomization, cases were assigned to two groups randomly in a 1:1 ratio. Group A (epinephrine group) comprised 40 patients who received an intraprostatic injection of epinephrine (200 mcg diluted in 20 mL of normal saline). Group B (control group) comprised 40 patients who were administrated an intraprostatic injection of 20 mL of 0.9% normal saline. Sequentially numbered sealed envelopes were employed to guarantee allocation concealment.

*Sample Size Calculation*

The sample size was calculated utilizing G*Power software version 3.1.9.7 according to the previous study by Zohaib et al. (2023), who reported blood transfusion requirements of 0% and 30% in the epinephrine and saline groups, respectively (12). A total sample size of 80 patients (40 per group) was determined to be sufficient to detect this difference with 95% power at an alpha level of 0.05.

### ***Surgical Technique***

All procedures were implemented under spinal anesthesia. Preoperative assessment included measurement of hemoglobin and hematocrit levels, serum sodium, potassium, and creatinine, and prostate-specific antigen (PSA), IPSS and quality-of-life (QoL) scoring, Qmax determination, post-void residual volume (PVRV) measurement, and prostatic volume estimation by TRUS and digital rectal examination. Body mass index (BMI), the presence of hydroureteronephrosis, and preoperative catheterization status were also recorded. Diagnostic cystoscopy was performed using a 21 Fr rigid cystoscopy sheath with a 30-degree optical lens to examine the urethra, prostate, and urinary bladder.

The designated solution was injected utilizing an endoscopic 23-gauge, 35-cm, 8-mm urethral needle. In Group A, 10 mL of the epinephrine solution (200 mcg/20 mL) was injected into the median lobe, and 5 mL was injected into each lateral lobe. In Group B, equivalent volumes of normal saline were injected at the same sites. The injections were administered to the peripheral lobes at the 5-o'clock and 7-o'clock positions, the median lobe, and the apical tissue, which were deemed to be the most susceptible to haemorrhage. Bipolar electrocautery was employed to cauterize these sites five minutes following injection.

TURP was subsequently conducted with bipolar electrocautery utilizing a 26-French continuous-flow resectoscope. Continuous cardiac monitoring was maintained throughout the procedure to detect any rhythm or blood pressure changes attributable to epinephrine absorption. The resection time was recorded in minutes, and the resected tissue chips were weighed in grams.

***Assessment of Outcomes***

The irrigation fluid haemoglobin concentration method was employed to quantify blood loss. The bladder was irrigated for 24 hours postoperatively, and fluid collections were taken at three intervals: immediately after surgery (V1), 6 hours postoperatively (V2), and 24 hours postoperatively (V3). Each irrigation fluid container was supplemented with 5,000 units of heparin to prevent coagulation, and the total volume collected was determined. 5 mL of samples were extracted and analyzed at 540 nm using cyanide methaemoglobin spectrophotometry after a thorough mixing process. Blood loss was calculated using established formulas: (1) hemoglobin concentration in the irrigation fluid (g/L) = absorbance of the fluid × 367.7, and (2) bleeding volume (mL) = [hemoglobin concentration in the irrigation fluid (g/L) × rinse volume (mL)] / preoperative hemoglobin concentration (g/L) (13).

Postoperative hemoglobin, hematocrit, serum sodium, potassium, and creatinine levels were measured, and the percentage changes in hemoglobin and hematocrit from the preoperative values were calculated. The total volume of irrigation fluid, blood transfusion requirement, and the duration of hospitalization were recorded for all patients. Operative vision clarity was assessed by the operating surgeon and graded as excellent, good, or poor.

The primary outcomes were intraoperative and early postoperative adverse events, including hypertension, early lower urinary tract symptoms (LUTS), urinary tract infection (UTI), arrhythmia, incontinence, and urinary retention. The secondary outcomes, assessed at the postoperative follow-up,

comprised prostate volume (measured by TRUS), serum PSA, Qmax, PVRV, IPSS, QoL score, retrograde ejaculation, and the need for re-operation.

***Statistical Analysis***

Statistical analysis was conducted by SPSS version 27 (IBM Corp., Armonk, NY, USA). Continuous data were described as mean ± standard deviation or median (interquartile range) according to the normality of the distribution. Categorical data were expressed as frequencies and percentages. Between-group comparisons were performed utilizing the independent-samples t-test or the Mann–Whitney U test for continuous data and the chi-square test or Fisher's exact test for categorical data, as appropriate. A two-tailed p-value < 0.05 was considered statistically significant.

# Results

**Table 1** demonstrates the baseline demographic, clinical, and laboratory characteristics of the study groups (n = 40 per group). Age, BMI, prostate volume, and PVRV were similar among the TURP + epinephrine group and the TURP-only group, as were the proportions of patients with hydroureteronephrosis and preoperative catheterization. Preoperative hemoglobin, hematocrit, serum sodium, potassium, creatinine, PSA, IPSS and QoL scores were also similar among studied groups. Qmax showed a borderline, insignificant difference among the groups.

**Table 2** illustrates the operative data and postoperative hematological outcomes. The epinephrine group had a significantly shorter resection time ($p < 0.001$) and a greater weight of resected tissue ($p < 0.001$) than the control group. Postoperatively, the epinephrine group maintained significantly higher hemoglobin and hematocrit levels ($p < 0.001$, and 0.002 respectively), and the percentage declines in hemoglobin and hematocrit ($p < 0.001$ for both) were significantly smaller. Postoperative serum sodium, potassium, and creatinine levels did not differ between the groups, indicating the absence of clinically relevant electrolyte disturbance or renal function deterioration.

**Table 3** presents the perioperative bleeding parameters and early postoperative outcomes. Patients receiving intraprostatic epinephrine required a significantly reduced volume of irrigation fluid ($p = 0.007$), and the hemoglobin concentration in the irrigation fluid was significantly lower ($p = 0.032$), reflecting reduced blood loss into the irrigant. Median perioperative bleeding was also significantly lower in the epinephrine group ($p < 0.001$). No case (0%) in the epinephrine group needed a blood transfusion, compared with 5 cases (12.5%) in the control group ($p = 0.021$). Operative vision clarity was significantly better in the epinephrine group, with 97.5% of cases rated as excellent or good compared with 85% in the control group ($p = 0.048$). Hospital stay was statistically shorter with epinephrine ($p = 0.004$), although the absolute difference was small.

**Table 4** presents the primary safety outcomes and secondary functional outcomes. Hypertension and arrhythmia each occurred in 2 patients (5%) in the epinephrine group and in none of the control patients, with insignificant difference among groups ($p = 0.494$ for both), and continuous cardiac monitoring

remained stable throughout all procedures. Early LUTS occurred less frequently in the epinephrine group (5% vs. 20%), although this difference did not reach statistical significance ($p = 0.087$), the rates of UTI, incontinence, and urinary retention were comparable between the groups. At follow-up, the epinephrine group had a significantly smaller residual prostate volume ($p < 0.001$) and a decreased PVRV ($p = 0.015$), consistent with the more complete resection, whereas PSA, Qmax, IPSS, QoL, retrograde ejaculation, and re-operation rates were similar between the groups.

# Discussion

The present randomized controlled trial demonstrates that intraprostatic epinephrine injection during bipolar TURP significantly decreases perioperative hemorrhage, eliminates blood transfusion requirement, improves operative vision clarity, and shortens resection time in cases with large-volume prostates (80–100 g). The intervention was further correlated with a small hospitalization and a smaller residual prostate volume at follow-up, without a statistically significant elevation in early complications. These results extend the existing body of evidence supporting intraprostatic epinephrine as a safe, effective, and low-cost hemostatic adjunct in endoscopic prostate surgery.

The primary finding of our study is the substantial reduction in perioperative blood loss achieved with intraprostatic epinephrine. The epinephrine group demonstrated a significantly lower hemoglobin concentration in the irrigation fluid, smaller percentage declines in hemoglobin and hematocrit, and lower median perioperative blood loss than the control group. These results are aligned with Lira-Dale et al. (14) who revealed a reduction in mean blood loss from 336.6 mL to 127.5 mL ($p < 0.001$) with intraprostatic epinephrine during TURP. Similarly, Zohaib et al. (12) documented significant reductions in blood loss and transfusion requirements with intraprostatic epinephrine injection.

The mechanism underlying this effect is the potent vasoconstrictive action of epinephrine on the prostatic vasculature. Epinephrine activates alpha-1 adrenergic receptors in smooth vascular muscle, causing constriction of arterioles and venules within the prostatic parenchyma and thereby reducing blood flow to the surgical field during and immediately after tissue resection (14). The five-minute interval between injection and cauterization allows sufficient time for the vasoconstrictive effect to be established, and the subsequent bipolar cauterization provides definitive hemostasis at the injection sites.

Our findings are further supported by recent investigations of other hemostatic strategies. Stenmark et al. (15) demonstrated that intraprostatic injection of mepivacaine–adrenaline significantly decreased blood loss during TURP compared with the conventional technique, and Diab et al. (16) reported similar benefits with intraprostatic tranexamic acid injection during monopolar TURP.

The clinically most important result of the current research is the complete avoidance of blood transfusion in the epinephrine group (0% vs. 12.5%, $p = 0.021$). This result aligns with Zohaib et al. (12), who similarly reported a 0% transfusion rate in their epinephrine group compared with 30% in controls.

Avoiding transfusion has direct implications for patient safety, healthcare resource utilization, and cost, particularly in settings where blood products are scarce.

The relationship between prostate size and transfusion risk is well established. Reich et al. (17) demonstrated a transfusion rate of 2.9% overall, increasing to 9.5% when the resected tissue weight exceeded 60 g. More recently, a multicenter analysis by Schulte-Baukloh et al. (4) demonstrated transfusion rates exceeding 29% for resection weights above 100 g. The present study population, with a mean prostate volume of approximately 90 mL and a mean resected tissue weight of 71–82 g, therefore, represents a high-risk population in which transfusion prevention is of particular value. That simple, inexpensive intervention eliminated the transfusion requirement in this population is a clinically important result.

Our findings contrast with those of Rohith et al. (18), who investigated low-dose intravenous epinephrine infusion rather than intraprostatic injection and found no significant reduction in intraoperative blood loss (67.9 vs. 75.1 mL, $p = 0.086$). This distinction underscores the importance of the route of administration: intraprostatic injection achieves high local tissue concentrations with minimal systemic absorption, whereas intravenous infusion produces lower local concentrations and greater systemic exposure. The local route therefore appears to be superior for hemostatic purposes.

The improved operative vision clarity observed in the epinephrine group (97.5% vs. 85% rated excellent or good, $p = 0.048$) is an important secondary benefit with direct implications for surgical precision and safety. Improved visualization enables more accurate tissue resection, better identification of the surgical plane, and a reduced risk of capsular perforation, and it likely contributed to the more complete adenoma removal reflected in the greater resected tissue weight and the smaller residual prostate volume at follow-up. This effect can be explained by the reduced turbidity of the irrigation fluid when bleeding is controlled, together with decreased oozing from the residual tissue under vasoconstriction. Our data extends this principle to endoscopic prostate surgery, where visualization challenges are particularly pronounced in large, highly vascular glands.

The significantly shorter resection time in the epinephrine group (50.9 vs. 77.6 minutes, $p < 0.001$) likely reflects the improved visualization and more efficient tissue resection enabled by the hemostatic effect. Better visualization reduces the time spent on repeated coagulation and irrigation to clear the field, allowing the surgeon to focus on tissue removal. The combination of a shorter resection time with a greater resected tissue weight (81.6 vs. 71.4 g, $p < 0.001$) further supports the interpretation of improved surgical efficiency rather than a more limited resection.

These findings are particularly relevant given the established relationship between operative time and complication risk. Schulte-Baukloh et al. (4) identified an operative time exceeding 82.5 minutes as a cutoff for severe complications (Clavien–Dindo ≥ IIIb). In our research, the mean resection time in the control group (77.6 minutes) approached this threshold, whereas the epinephrine group remained well below it (50.9 minutes). The 26.7-minute reduction achieved with epinephrine may therefore contribute meaningfully to complication prevention, agreed with Teng et al. (19),  systematic review that identified

prolonged operative duration as a significant risk factor for bleeding complications following transurethral BPH procedures.

Our findings contrast with those of Lira-Dale et al. (14) and Rohith et al. (18), who detected insignificant difference in resection time with epinephrine administration. This discrepancy may be explained by differences in prostate size, as our study specifically included larger glands in which visualization challenges are more pronounced, and by differences in surgical technique (bipolar vs. monopolar TURP).

Hospital stay was statistically small in the epinephrine group ($p = 0.004$), while the absolute difference was small, with a median of one day in both groups. This finding likely reflects the smoother early recovery associated with reduced bleeding and the absence of transfusion rather than a major change in postoperative management.

The safety profile of intraprostatic epinephrine in our study was favorable. Cardiovascular events were infrequent: hypertension and arrhythmia each occurred in 2 patients (5%) in the epinephrine group and in none of the control patients, with insignificant difference among the studied groups ($p = 0.494$ for both), and continuous cardiac monitoring remained stable throughout all procedures. The epinephrine dose (200 mcg in 20 mL saline) was conservative, balancing hemostatic efficacy against systemic safety. Lira-Dale et al. (14) reported one case of intraoperative hypertensive crisis (7.7%) in their epinephrine group using a higher concentration. The low event rate in our study may reflect the lower concentration used, the five-minute observation period before resection, and the exclusion of patients with cardiovascular comorbidities. These results maintain intraprostatic epinephrine safety when appropriate patient selection and dosing protocols are followed.

Early postoperative complication rates were low and similar in the groups. Early LUTS occurred less frequently in the epinephrine group (5% vs. 20%), although this difference did not reach statistical significance ($p = 0.087$), and the rates of UTI, incontinence, and urinary retention were similar between the groups. The trend toward fewer early LUTS in the epinephrine group is consistent with the more complete resection achieved in these patients.

At follow-up, the epinephrine group had a significantly limited residual prostate volume (7.6 vs. 16.9 mL, $p < 0.001$) and a lower post-void residual volume ($p = 0.015$), while PSA, Qmax, IPSS, and quality of life were similar among the groups. This pattern indicates that the more extensive resection performed under better visualization translated into more complete adenoma removal without compromising functional recovery. Retrograde ejaculation (25% vs. 27.5%) and re-operation (7.5% vs. 15%) did not differ significantly among the groups, although the research was not motorized to identify differences in these infrequent events.

Intraprostatic epinephrine offers several practical advantages over other pharmacological strategies for reducing TURP-related bleeding: an immediate onset of action without pretreatment, minimal systemic absorption, very low cost, and ease of administration. The medication is universally available, and the technique requires no specialized equipment beyond a standard endoscopic injection needle. In

resource-limited settings where tranexamic acid or advanced hemostatic technologies may be unavailable, intraprostatic epinephrine represents a particularly valuable option (20).

The findings of this study carry several clinical implications. First, intraprostatic epinephrine injection should be considered as a routine adjunct in bipolar TURP for large-volume prostates (>80 g), where the bleeding risk is highest, the intervention is simple and inexpensive, and it eliminated the transfusion requirement in this cohort without adding measurable risk. Second, improved visualization and a shorter operative time may be particularly valuable in training settings, where procedures performed by residents often take longer and carry higher complication rates. Third, in healthcare systems with limited blood bank resources, the avoidance of transfusion provides both clinical and economic benefits, as the cost of epinephrine is negligible compared with the costs of blood products, prolonged hospitalization, and the management of transfusion-related complications.

*Limitations*

Numerous limitations of this research should be recognized. First, the research was performed at a single center, which may decrease the generalizability of the results to settings with different surgical expertise and patient populations. Second, although the sample size was sufficient for the primary outcomes, the research was not powered to detect small differences in infrequent events, such as individual complications or re-operation. Third, we excluded patients with cardiovascular comorbidities, which limits conclusions about safety in this higher-risk population. Finally, the follow-up period was restricted, and longer-term results, such as urethral stricture and late symptom recurrence, remain unknown. Future studies should examine whether the benefits of intraprostatic epinephrine are sustained over extended follow-up.

## Conclusions

Intraprostatic epinephrine injection during bipolar TURP significantly decreased perioperative blood loss, eliminates blood transfusion requirement, improves operative vision, and shortens resection time while allowing more complete resection of large prostates, without a significant increase in cardiovascular events. As a simple, inexpensive, and universally available adjunct, it should be considered for routine use in bipolar TURP for large-volume prostates.

## Declarations

**Financial support and sponsorship:** Nil

**Conflict of Interest:** Nil

# Author Contribution

M.A.A. and S.A.M. contributed to the study conception and design. A.A.S.E. and S.E.M.E. contributed to data collection. A.A.S.E. contributed to data analysis and interpretation and drafted the manuscript. M.A.A., S.A.M., S.E.M.E., and A.A.E.A.F. critically revised the manuscript. All authors reviewed and approved the final manuscript and agree to be accountable for all aspects of the work.

# Data Availability

The datasets generated and/or analysed during the current study are available from the corresponding author on reasonable request.

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# Tables

**Table 1: Baseline demographic, clinical, and laboratory characteristics of the study groups**

| | TURP + Epinephrine group (n =40) | TURP only group (n =40) | *p*-value |
|---|---|---|---|
| Age (years) | 66.9 ± 8.3 | 64.5 ± 5.8 | 0.184 |
| BMI (kg/m$^2$) | 27.2 ± 5.2 | 25.9 ± 4.7 | 0.298 |
| Preoperative clinical data | | | |
| Prostate volume (mL) | 89.9 ± 6 | 89.3 ± 6.3 | 0.652 |
| PVRV (mL) | 181.5 ± 69.7 | 194.1 ± 72.2 | 0.431 |
| IPSS score | 22 (20 - 24) | 22 (21 - 25) | 0.192 |
| Qmax (mL/s) | 5.2 ± 2.6 | 6.6 ± 3.8 | 0.053 |
| Hydroureteronephrosis | 7 (17.5%) | 9 (22.5%) | 0.781 |
| Catheterized | 7 (17.5%) | 7 (17.5%) | 1.000 |
| Preoperative laboratory data | | | |
| Hb (g/dL) | 13.4 ± 0.8 | 13 ± 1.4 | 0.115 |
| Hct (%) | 42.6 ± 6 | 40.8 ± 4.4 | 0.129 |
| Na (mEq/L) | 140 ± 3.2 | 139.5 ± 3.4 | 0.343 |
| K (mEq/L) | 4.1 ± 0.45 | 4.32 ± 0.44 | 0.087 |
| Sr. Cr. (mg/dL) | 1.13 ± 0.2 | 1.14 ± 0.21 | 0.880 |
| PSA (ng/mL) | 3 (2 - 4) | 2 (2 - 3) | 0.680 |
| QoL | 5 (4 - 6) | 5 (5 - 6) | 0.257 |

Data is presented as mean ± SD, median (IQR), or n (%). IQR: Interquartile range, SD: Standard deviation.

BMI: Body mass index, Hb: Hemoglobin, Hct: Hematocrit, IPSS: International Prostate Symptom Score, PSA: Prostate specific antigen, PVRV: Post-void residual volume, Qmax: Maximum urine flow rate, QoL: Quality of life, TURP: Transurethral resection of the prostate.

**Table 2: Operative and perioperative data in the study groups**

| | TURP + Epinephrine group (n =40) | TURP only group (n =40) | *p*-value |
|---|---|---|---|
| Operative data | | | |
| Resection time | 50.9 ± 4.6 | 77.6 ± 3.6 | <0.001* |
| Resected tissue weight | 81.6 ± 6.1 | 71.4 ± 6.8 | <0.001* |
| Postoperative Data | | | |
| Hb (g/dL) | 12.1 ± 0.88 | 11.1 ± 1.3 | <0.001* |
| Percentage of ΔHb (%) | 9.5 ± 3.2 | 13.8 ± 3.1 | <0.001* |
| Hct (%) | 39.4 ± 5.6 | 35.8 ± 4 | 0.002* |
| Percentage of ΔHct (%) | 7.5 ± 1.9 | 12.3 ± 4.3 | <0.001* |
| Na (mEq/L) | 140.7 ± 2.7 | 140.5 ± 2.9 | 0.812 |
| K (mEq/L) | 4.1 ± 0.39 | 4.2 ± 0.36 | 0.252 |
| Sr. Cr. (mg/dL) | 1.1 ± 0.17 | 1.12 ± 0.18 | 0.509 |

Data is presented as mean ± SD, median (IQR), or n (%). IQR: Interquartile range, SD: Standard deviation.

Hb: Hemoglobin, Hct: Hematocrit, TURP: Transurethral resection of the prostate, *Statistically significant as p value <0.05.

**Table 3: Postoperative outcomes of the study groups**

| | TURP + Epinephrine group (n =40) | TURP only group (n =40) | *p*-value |
|---|---|---|---|
| Hematological outcomes | | | |
| Volume of irrigation fluid | 18.7 ±8.5 | 23.6 ± 8.7 | **0.007*** |
| Hb concentration in irrigation | 0.63 ± 0.39 | 0.9 ± 0.54 | **0.032*** |
| Need for blood transfusion | 0 (0%) | 5 (12.5%) | **0.021*** |
| Perioperative bleeding | 87.5 (61 - 124) | 132.5 (82.5 - 164) | **<0.001*** |
| Clarity of operative vision | | | |
| Excellent/Good | 39 (97.5%) | 34 (85.0%) | **0.048*** |
| Poor | 1 (2.5%) | 6 (15%) | |
| Hospital stay (days) | 1 (1 - 1) | 1 (1 - 2) | **0.004*** |

Data is presented as median (IQR) or n (%). IQR: Interquartile range.

TURP: Transurethral resection of the prostate, *Statistically significant as p value <0.05.

**Table 4: Primary and secondary outcomes in the study groups**

| | TURP + Epinephrine group (n =40) | TURP only group (n =40) | *p*-value |
|---|---|---|---|
| Primary outcomes | | | |
| Hypertension | 2 (5%) | 0 (0%) | 0.494 |
| Arrythmia | 2 (5%) | 0 (0%) | 0.494 |
| Early LUTS | 2 (5%) | 8 (20%) | 0.087 |
| UTI | 2 (5%) | 4 (10%) | 0.675 |
| Incontinence | 2 (5%) | 3 (7.5%) | 1.000 |
| Urine retention | 3 (7.5%) | 4 (10%) | 1.000 |
| Secondary outcomes | | | |
| Prostate volume (mL) | 7.6 ± 1.75 | 16.9 ± 1.8 | **<0.001*** |
| PSA (ng/mL) | 1.59 ± 0.08 | 1.57 ± 0.07 | 0.196 |
| Qmax (mL/s) | 20.05 ± 4.56 | 19.7 ± 5.96 | 0.117 |
| PVRV (ml) | 24 (21 - 29) | 28 (25 - 30) | **0.015*** |
| IPSS score | 9 (7 - 12) | 11 (8 - 15) | 0.051 |
| QoL | 1 (0 - 2) | 1 (0 - 2) | 0.396 |
| Retrograde ejaculation | 10 (25%) | 11 (27.5%) | 0.799 |
| Re-operation | 3 (7.5%) | 6 (15%) | 0.481 |

Data is presented as median (IQR) or n (%). IQR: Interquartile range.

IPSS: International Prostate Symptom Score, LUTS: Lower urinary tract symptoms, PSA: Prostate specific antigen, PVRV: Post-void residual volume, TURP: Transurethral resection of the prostate, Qol: Quality of life, UTI: Urinary tract infection, *Statistically significant as p value <0.05.