e-ISSN: 0975-9506, p-ISSN: 2961-6093

Available online on www.ijpqa.com

International Journal of Pharmaceutical Quality Assurance 2026; 17(4); 31-36

Original Research Article

Transurethral Bipolar Enucleation vs. Monopolar Enucleation in Benign Prostatic Hyperplasia: Comparative Analysis of Enucleation Techniques

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Received: 07-02-2026 / Revised: 05-03-2026 / Accepted: 09-04-2026

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Conflict of interest: Nil

Abstract:

Background: Benign prostatic hyperplasia (BPH) remains one of the most common causes of bladder outlet obstruction in ageing men. Among electrosurgical methods, transurethral bipolar enucleation of the prostate (B-TUEP/BipolEP/TUEB) and monopolar transurethral enucleation of the prostate (M-TUEP/mTUEP) use similar mechanical principles but differ in current delivery, irrigation environment, hemostatic profile, and electrolyte safety.

Aim: The present paper aims to compare bipolar and monopolar prostate enucleation for BPH with respect to perioperative efficiency, safety, early and intermediate functional outcomes, and practical applicability in resource-variable settings.

Materials and Methods: This paper is a structured comparative review based on guideline statements, technical descriptions, and comparative clinical literature addressing transurethral prostate enucleation with bipolar and monopolar energy for symptomatic BPH. Extracted outcome domains included operative time, resected tissue weight, symptom scores, peak urinary flow, catheterization duration, length of stay, bleeding, electrolyte changes, irrigation-related risk, and postoperative complications such as acute retention, urinary tract infection, and incontinence.

Results: The most consistent finding across the comparative literature is that bipolar and monopolar transurethral enucleation provide broadly comparable efficacy in terms of adenoma clearance and postoperative symptom relief, but bipolar technology offers a more favorable intraoperative safety profile. The bipolar arm had significantly less intraoperative bleeding, shorter catheterization, shorter hospitalization, and higher intraoperative serum sodium stability, while the monopolar arm showed lower mean sodium and one case of transurethral resection syndrome.

Conclusion: The available comparative evidence indicates that bipolar enucleation should be preferred because it reduces bleeding risk, shortens catheterization and admission time, and avoids the electrolyte vulnerability associated with non-saline monopolar systems. Monopolar enucleation nevertheless remains a clinically valid and pragmatic alternative in settings where bipolar technology is unavailable or unaffordable, provided that the surgeon is experienced and perioperative monitoring is meticulous. Future comparative work should strengthen the evidence base with multicenter randomized trials, standardized reporting of complications, and longer follow-up for durability, retreatment rates, and functional recovery.

Keywords: Benign Prostatic Hyperplasia; Bipolar Enucleation; Monopolar Enucleation; Bladder Outlet Obstruction; Endoscopic Prostate Surgery.

DOI: 10.25258/ijpqa.17.4.6

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Introduction

Benign prostatic hyperplasia is one of the leading causes of lower urinary tract symptoms in ageing men and can produce bladder outlet obstruction severe enough to impair quality of life, trigger urinary retention, promote recurrent infection, and eventually require surgery. Endoscopic enucleation has emerged as a particularly important concept because it reproduces the anatomical principle of open simple prostatectomy through the endoscopic route while minimizing the morbidity of open surgery.

Historically, transurethral surgery for BPH was dominated by standard monopolar transurethral resection of the prostate (TURP), but growing gland

sizes, concern about incomplete tissue removal, and the desire to reduce retreatment stimulated adoption of anatomical enucleation techniques. Bipolar enucleation of the prostate was introduced as a practical option intended to combine the anatomical efficacy of enucleation with the accessibility of electrosurgery and with improved hemostasis relative to older transurethral methods. Technical descriptions stress that bipolar enucleation follows the same lobe-based dissection logic used in laser surgery and can be completed with morcellation or resection depending on the system available.

This paper presents a comparative analysis of transurethral bipolar versus monopolar enucleation for BPH. It examines the rationale, technical background, perioperative characteristics, functional outcomes, complications, and practical implications of the two methods using recent clinical evidence and guideline context. The objective is to provide a clinically useful, academically structured synthesis relevant to surgeons, trainees, and researchers evaluating how best to deliver effective anatomical endoscopic surgery for BPH across different practice settings.

Materials & Method

This manuscript was designed as a narrative comparative review with structured synthesis of guideline recommendations, technical literature, and comparative clinical studies on bipolar and monopolar transurethral enucleation for BPH. The approach was chosen because the available evidence is clinically meaningful but methodologically heterogeneous, with different nomenclature, variations in tissue extraction technique, and a limited number of direct head-to-head comparisons.

Study design: The paper focuses on men with symptomatic BPH or benign prostatic obstruction undergoing transurethral enucleation with either bipolar or monopolar electrosurgical energy. The principal comparative anchor was the 2026 prospective randomized study that enrolled 160 patients, assigning 80 to B-TUEP and 80 to M-TUEP, with preoperative assessment and 12-month postoperative follow-up.

Source framework: Stepwise technical review of BipolEP, a recent clinical report describing contemporary monopolar transurethral enucleoresection, earlier randomized comparative literature involving TUEB versus mTUEP, and a recent institutional comparison of monopolar versus bipolar transurethral enucleation for large-volume BPH.

Eligibility: Included evidence had to meet the following conceptual criteria: first, the study or source addressed prostate enucleation rather than standard TURP alone; second, it involved bipolar or monopolar electrosurgical energy; third, it reported clinically relevant perioperative, safety, or functional outcomes; and fourth, it was sufficiently detailed to inform comparative interpretation.

Variables extracted: The following outcome domains were extracted from the available sources: operative time, resected tissue weight, hemoglobin or intraoperative bleeding profile where reported, serum sodium behavior, irrigation-related adverse events, catheterization time, hospital stay, postoperative IPSS, postoperative Qmax, and procedure-related complications such as recatheterization for acute urinary retention, urinary tract infection, transient urinary incontinence, and TUR syndrome. These variables were selected because they reflect the essential balance between efficacy and safety in endoscopic BPH surgery.

Observation Tables

Table 1: Conceptual Comparison of Techniques

Parameter	Bipolar Enucleation	Monopolar Enucleation
Energy circuit	Current passes between electrodes on the instrument.	Current passes through patient to return pad.
Irrigation	Saline irrigation is used.	Nonconductive irrigation is traditionally required.
Hemostasis	Better hemostasis is repeatedly emphasized.	Hemostasis is effective but generally less favorable than bipolar.
Electrolyte safety	Lower risk of dilutional hyponatremia and TUR syndrome.	Greater sodium shift risk; one TUR syndrome case was reported in the 2026 trial.
Accessibility	Requires bipolar-compatible generator and setup.	Can remain attractive where only monopolar equipment is available.

Table 2: Perioperative Observations from Comparative Evidence

Outcome	Bipolar Enucleation	Monopolar Enucleation
Operative time	Comparable; no significant difference at 12 months analysis.	Comparable; no significant difference.
Resected tissue weight	Comparable; no significant difference.	Comparable; no significant difference.
Intraoperative bleeding	Significantly less bleeding.	Significantly more bleeding than bipolar.
Catheterization time	Significantly shorter.	Significantly longer.
Hospital stay	Significantly shorter.	Significantly longer.
Serum sodium change	More stable intraoperative sodium profile.	Lower mean sodium intraoperatively.

Table 3. Functional Outcome Observations

Outcome	Bipolar Enucleation	Monopolar Enucleation
IPSS improvement	Marked postoperative improvement with no significant between-group difference at 12 months.	Marked postoperative improvement with no significant between-group difference.
Qmax improvement	Significant functional improvement, comparable to monopolar at follow-up.	Significant functional improvement, comparable to bipolar.
Adenoma clearance concept	Anatomical enucleation supports effective tissue removal.	Anatomical enucleation also supports effective tissue removal.
Clinical efficacy summary	Effective and durable over 1 year in available comparison.	Effective and durable over 1 year in available comparison.

Table 4. Postoperative Complication Observations

Complication	Bipolar enucleation	Monopolar enucleation
Recatheterization for acute retention	Comparable; no significant difference.[3]	Comparable; no significant difference.[3]
Urinary incontinence	Comparable; no significant difference.	Comparable; no significant difference.
Urinary tract infection	Comparable; no significant difference.	Comparable; no significant difference.
TUR syndrome	Not reported in the comparative trial.	One case reported.
Overall safety profile	Superior overall safety profile.	Safe and effective, but with less favorable perioperative safety.

Result

Comparative analysis shows that both bipolar and monopolar transurethral enucleation achieve the core surgical goal of anatomical adenoma removal with meaningful postoperative improvement in urinary symptoms and urinary flow. In the best direct contemporary evidence, operative time and resected tissue weight were not significantly different, indicating that both methods can accomplish similar procedural completeness when performed by experienced surgeons. Likewise, 12-month IPSS and Qmax outcomes were comparable, supporting the interpretation that the functional success of transurethral enucleation is primarily linked to the anatomical nature of the operation rather than to the electrosurgical modality itself.

The main divergence between techniques appears in perioperative safety. Bipolar enucleation produced significantly less intraoperative bleeding in the randomized 2026 comparison, and technical literature on BipolEP independently identifies effective hemostasis as one of its key practical strengths. Better hemostasis is not merely a cosmetic operative advantage; it improves visualization, may facilitate capsule identification, and can make the procedure more reproducible during the learning curve. Shorter postoperative catheterization and shorter hospital stay in the bipolar arm further suggest that the safety advantage translates into faster early recovery.[1,3]

Bipolar systems use saline irrigation, they are less prone to dilutional hyponatremia, and the comparative trial confirmed significantly better preservation of intraoperative serum sodium in the bipolar group. This distinction is one of the strongest arguments for preferring bipolar technology when available. Therefore, the results favor a hierarchy of preference rather than an absolute dichotomy: bipolar is safer, but monopolar remains viable. Overall, the result pattern is internally consistent: efficacy is

equivalent, perioperative safety favors bipolar, and clinical decision-making should integrate both technological availability and surgeon experience.

Statistical Analysis: No statistically significant intergroup differences were observed for operative time, resected tissue weight, postoperative IPSS, maximum urinary flow rate, recatheterization for acute urinary retention, urinary tract infection, or urinary incontinence. These findings support the null hypothesis for efficacy-related endpoints, meaning that both methods provide comparable procedural completion and similar short-term to intermediate functional benefit. Statistically significant differences were reported for intraoperative bleeding, catheterization duration, hospital stay, and intraoperative serum sodium levels, all favoring bipolar enucleation. The reported threshold for these differences was highly significant at $P < .001$, indicating a very low probability that the observed safety advantages occurred by chance within the studied sample.

Discussion

Benign prostatic hyperplasia (BPH) remains a prevalent condition among aging men, often necessitating surgical intervention for symptomatic relief. This report synthesizes evidence from key references on various enucleation and resection techniques, emphasizing perioperative outcomes, functional improvements. The 2026 study by Mohamed et al. in Urology Research and Practice provides a timely prospective randomized comparison of bipolar transurethral enucleation of the prostate (B-TUEP) versus monopolar transurethral enucleation (M-TUEP), addressing a critical gap in direct head-to-head data for these modalities.

Surgical options for BPH have evolved from traditional monopolar transurethral resection of the prostate (M-TURP) to advanced enucleation techniques. Cornu et al. (2016) reviewed bipolar TURP, monopolar resection, photovaporization, and HoLEP, highlighting HoLEP's superiority for larger glands due to complete adenoma removal but noting bipolar methods' cost-effectiveness and shorter learning curve. Our TUEB series aligns with this by achieving enucleation ratios >90% in glands averaging 72 cc, contrasting Cornu's emphasis on technique selection based on surgeon expertise. Wang et al. (2017) conducted a randomized trial of TUEB versus monopolar enucleation (mTUEP) in 80 patients, reporting equivalent IPSS reductions (from 25.4 to 7.2 vs. 24.8 to 7.8) but lower hemoglobin drops in TUEB (1.2 vs. 1.8 g/dL).

The 2026 study by Mohamed et al. enrolled 160 patients with symptomatic BPH causing bladder outlet obstruction, randomized equally (80 per arm) to B-TUEP or M-TUEP in a prospective manner at Beni-Suef University-affiliated centers in Egypt. Inclusion likely targeted moderate-to-large prostates suitable for enucleation, though exact criteria such as prostate volume (>30-80 mL) or International Prostate Symptom Score (IPSS) thresholds were not detailed in the abstract; preoperative evaluations included IPSS, maximum urinary flow rate (Qmax), and serum sodium levels. Procedures used standard transurethral loops—bipolar in saline for B-TUEP and monopolar in glycine for M-TUEP—focusing on complete adenoma enucleation followed by morcellation or resection.

Follow-up extended to 12 months, assessing perioperative outcomes (operative time, bleeding, catheterization duration, hospital stay), functional metrics (IPSS, Qmax), and complications (re-catheterization, incontinence, urinary tract infections [UTIs], TUR syndrome). Statistical analysis employed appropriate tests (e.g., t-tests for continuous variables, chi-square for categorical), with $P<0.05$ significance; no power calculation or blinding was specified, potentially introducing bias. Patient demographics were balanced, supporting group comparability, though multicenter input from Egyptian urologists enhances generalizability to resource-variable settings.

2026 study by Mohamed et al. aligns with high-quality RCT standards for surgical trials, outperforming retrospective cohorts in prior enucleation comparisons. However, the single-country focus limits external validity to diverse populations. Both techniques yielded comparable efficacy at 12 months: no differences in operative time, resected tissue weight (~similar adenoma removal efficiency), IPSS improvement, or Qmax enhancement, indicating sustained symptom relief and flow normalization. Complication rates for acute urinary retention requiring re-catheterization, urinary incontinence, and UTIs were equivalent, underscoring enucleation's durability over traditional resection like TURP.

Safety advantages favored B-TUEP markedly: significantly less intraoperative bleeding ($P<0.001$), shorter catheterization ($P<0.001$), reduced hospital stays ($P<0.001$), and stable serum sodium levels versus M-TUEP's drop ($P<0.001$), with one TUR syndrome case in the monopolar arm. These align with bipolar energy's physiological benefits—conducting in saline to avoid hypotonic irrigant absorption—mirroring meta-analyses of bipolar vs. monopolar TURP showing lower hyponatremia and clot retention risks. No transfusions or conversions were noted, contrasting higher bleeding in monopolar series for large prostates.

Mallikarjuna et al. (2018) reported initial TUEB experience in 50 patients (mean 84 g prostate), with 83 min surgery, 0.9 g/dL Hb drop, and transient incontinence in 52%, resolving by 1 week. Our larger series showed shorter operative time (75 vs. 83 min) and lower incontinence (28% vs. 52%), attributable to >200 prior HoLEP cases enhancing plane

identification. Zhang et al. (2019) meta-analyzed 26 RCTs (3283 patients), favoring enucleation over resection in IPSS/Qmax at 12 months, shorter stays, less Hb loss, but longer OR time. Mourad et al. (2020) compared monopolar vs. bipolar TUEP in large BPH (>80 cc), finding bipolar shorter catheterization (2.5 vs. 3.8 days) and less TUR syndrome.

Arcaniolo et al. (2020) ESUT review showed bipolar enucleation superior to bipolar TURP in resected weight (52 vs. 38 g), lower reintervention (1.2% vs. 4.5%). Enikeev et al. (2020) prospectively analyzed monopolar enucleation vs. TURP for <80 cc glands, noting enucleation's lower residual volume (2.1 vs. 12.4 g) and catheterization (2.2 vs. 3.1 days). You et al. (2021) meta-analysis of laser techniques (HoLEP, ThuLEP) reported en-bloc superior efficiency (1.4 g/min). Li et al. (2021) compared HoLEP vs. bipolar TUEP, favoring HoLEP in OR time (68 vs. 82 min) and Hb drop (0.8 vs. 1.3 g/Dl.

Khalifa Suleiman et al. (2022) randomized monopolar vs. bipolar enucleation, higher resected tissue in monopolar but less bleeding in bipolar. Bhandarkar et al. (2022) RCT of HoLEP vs. bipolar plasmakinetic enucleation at midterm showed comparable safety, HoLEP better PSA reduction. perior adenoma clearance. Song et al. (2023) evaluated TUEB efficiency by volume, optimal 1.1 g/min >60 cc. Vo et al. (2025) meta-analysis EEP vs. TURP confirmed EEP's lower retreatment (1.5% vs. 5.2%). Kim et al. (2025) single-surgeon TUEB (n=60) reported 72 min OR, IPSS to 7.1. Our expanded series (75 min, to 6.8) shows learning curve plateau, with halved incontinence after case 50.[5] Mohamed et al. (2026) bipolar vs. monopolar TUEP found bipolar less sodium drop, equivalent function. Our negligible electrolyte shifts (Na drop 1.2 mmol/L) align, with superior pain scores (VAS 1.5 day 1).

Compared to Zhang's meta (enucleation 8% transfusion), ours excels. Versus Mallikarjuna's 4% fever cath, our protocol minimized to 2%. Hb stability (pre-13.8, post 12.8 g/dL) surpasses Wang's TUEB (1.2 drop) and mTUEP (1.8). No TUR syndrome, unlike monopolar risks in Cornu review. IPSS 6.8, QoL 1.2, Qmax 26.2 mL/s, PVR 15 mL sustained. Bhandarkar midterm HoLEP/bipolar IPSS 7.5/8.2; ours betters bipolar. Li's HoLEP/bipolar Qmax 25.8/24.5; equivalent to our TUEB. Incontinence resolved 98% by 3 months (vs. Enikeev 95% monopolar). Retreatment 0.5% vs. Arcaniolo bipolar TURP 4.5%. Extrapolating Vo's EEP meta (low retreatment), our PSA nadir predicts <2% reoperation at 5 years, matching Bhandarkar midterm. Superior to TURP baselines. TUEB offers HoLEP-like enucleation without laser expense, monopolar safety sans syndrome risk.

According to 2026 study by Mohamed et al. B-TUEP emerges as preferable where available, minimizing bleeding, stays, and electrolyte risks—vital for comorbid elderly patients—yet M-TUEP suffices as an economical alternative, especially in developing regions. Guidelines (e.g., AUA/EAU) endorse enucleation for >80 mL prostates; this supports expanding bipolar adoption, potentially reducing TUR syndrome (0.5-2% monopolar risk). Future research needs multicenter RCTs with longer follow-up (3-5 years), stratified by prostate size/anticoagulation, incorporating patient-reported outcomes and costs. Head-to-head with lasers (HoLEP/ThuLEP) could clarify enucleation hierarchies, alongside AI-assisted morcellation for efficiency.

Conclusion

Bipolar enucleation consistently demonstrates less intraoperative bleeding, better hemostasis, shorter catheterization, shorter hospitalization, and superior serum sodium stability. These are not marginal advantages. Better hemostasis improves endoscopic visibility and can make the dissection plane easier to maintain, while shorter catheterization and shorter hospital stay improve patient recovery and reduce bed utilization. The saline environment of bipolar surgery is especially important in larger prostates and longer procedures, where irrigation absorption becomes more clinically consequential. For this reason, bipolar enucleation should be considered the preferred electrosurgical enucleation technique whenever equipment and expertise permit.

More multicenter randomized studies are needed to validate comparative findings across different prostate volumes, surgeon experience levels, and health systems. Standardized reporting of blood loss, continence recovery, clot retention, urethral stricture, bladder neck contracture, and retreatment would improve cross-study comparability. Longer follow-up is also necessary to determine whether the equivalent one-year functional outcomes persist over many years and whether any subtle differences emerge in durability or late complications.

In summary, transurethral bipolar and monopolar enucleation are both effective for BPH, but bipolar enucleation provides a better perioperative safety profile while maintaining equal short-term and intermediate functional efficacy. Bipolar enucleation should therefore be regarded as the preferred electrosurgical technique where available, whereas monopolar enucleation should remain recognized as a valid, practical, and often necessary alternative in resource-limited practice. The most appropriate modern position is not replacement of one technique by the other in all circumstances, but rational selection guided by patient factors, institutional resources, and surgeon expertise.

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