BG Pulse Journal USA
ISSN:1947-2536 http://www.bgpulseusa.com/index.php/bg
BG PULSE JOURNAL

COMPLICATIONS AFTER SURGERY FOR BENIGN PROSTATIC HYPERPLASIA: A CONTEMPORARY REVIEW OF MECHANISMS, INCIDENCE, PREVENTION, AND MANAGEMENT

Mansurov Sardor Vali o'g'li
Asia International University, Bukhara, Uzbekistan

ABSTRACT

Background. Surgical therapy for benign prostatic hyperplasia (BPH) is among the most frequently performed urological operations worldwide. Although contemporary techniques have markedly improved safety, the spectrum of intra- and postoperative complications remains clinically important and procedure-dependent. **Objective.** To provide an advanced, evidence-based synthesis of complications encountered after surgery for BPH, with attention to incidence, pathophysiology, risk stratification, prevention, and management. **Methods.** Narrative review of randomized controlled trials, meta-analyses, and the 2023 American Urological Association (AUA) amendment and European Association of Urology (EAU) 2024 guidelines on the surgical management of lower urinary tract symptoms (LUTS) attributed to BPH, supplemented by systematic reviews published through 2025 indexed in PubMed and Scopus. **Results.** Overall complication rates after transurethral resection of the prostate (TURP) range from approximately 11–35%, with the majority being Clavien-Dindo grade I–II events. Hemorrhage, transurethral resection (TUR) syndrome, bladder neck contracture, urethral stricture, urinary incontinence, and sexual dysfunction remain the dominant categories. Enucleation techniques (HoLEP, ThuLEP) show non-inferior efficacy with lower transfusion rates; Aquablation and Rezum offer superior preservation of antegrade ejaculation; prostatic artery embolization (PAE) presents a distinct profile of post-embolization syndrome and access-site events. **Conclusions.** Procedure selection should integrate prostate volume, anatomical features, anticoagulation status, sexual function priorities, and surgeon expertise. Standardized reporting using the Clavien-Dindo classification facilitates objective comparison among techniques and supports informed counselling.

Keywords: *benign prostatic hyperplasia; TURP; HoLEP; Aquablation; Rezum; prostatic artery embolization; Clavien-Dindo; postoperative complications; bladder neck contracture; TUR syndrome.*

1. Introduction

Benign prostatic hyperplasia is a histopathological diagnosis defined by stromal and glandular hyperplasia of the transitional zone of the prostate. Clinically, it manifests through bladder outlet obstruction and storage-phase symptoms — together termed lower urinary tract symptoms — and represents the most common benign neoplastic process of the aging male. Prevalence is approximately 50% by the sixth decade and exceeds 80% beyond age 80, with surgical management indicated for patients refractory to or intolerant of pharmacotherapy, those with recurrent acute urinary retention, recurrent urinary tract infection, bladder calculi, refractory hematuria of prostatic origin, or progressive renal impairment due to bladder outlet obstruction.

Over the past three decades, the surgical armamentarium has diversified beyond monopolar transurethral resection of the prostate. Bipolar resection, holmium and thulium laser enucleation,

photoselective vaporization, robotic and open simple prostatectomy, prostatic urethral lift, convective water vapor therapy, prostatic artery embolization, and robotically-assisted water-jet ablation each have distinct safety and efficacy profiles. Consequently, the contemporary discussion of "complications after BPH surgery" must be procedure-specific and grounded in standardized reporting frameworks — most notably the Clavien-Dindo classification, which is endorsed by the European Association of Urology for the structured reporting of surgical adverse events.

This review consolidates current evidence on the incidence, mechanism, prevention, and management of complications following the major surgical modalities for BPH. Emphasis is placed on physiologically grounded explanations of mechanism, contemporary epidemiologic data, and clinically actionable strategies for the practising urologist and the advanced trainee.

2. Framework for Reporting Complications

2.1 The Clavien-Dindo Classification

The Clavien-Dindo classification grades complications according to the therapy required for their correction, rather than their subjective severity. Originally developed for general surgery and validated in urology, it permits objective comparison between centres and procedures.

Grade	Definition	Example
I	Any deviation from normal postoperative course not requiring pharmacological, surgical, endoscopic, or radiologic intervention; permitted regimens include antiemetics, antipyretics, analgesics, diuretics, electrolytes, physiotherapy.	Transient hematuria; bedside catheter exchange
II	Pharmacological therapy beyond grade I, including blood transfusion and parenteral nutrition.	UTI requiring antibiotics; single-unit transfusion
IIIa	Surgical, endoscopic, or radiologic intervention not under general anaesthesia.	Clot evacuation in cystoscopy suite under local
IIIb	Intervention under general anaesthesia.	Return to theatre for hemostasis
IVa	Life-threatening complication (including CNS); single-organ dysfunction requiring intermediate or intensive care.	Acute kidney injury requiring dialysis

Grade	Definition	Example
IVb	Multi-organ dysfunction.	Severe TUR syndrome with cardiopulmonary failure
V	Death of the patient.	Fatal cardiac event, septic shock

Across contemporary series, grades I–III constitute approximately 95–97% of all events after TURP; grades IV–V remain uncommon (<1–3%). This distribution provides a critical context: BPH surgery is intrinsically safe, but the absolute frequency of low-grade events is high enough to demand systematic prevention and counselling.

2.2 Temporal Classification

Complications are most usefully grouped by their temporal relationship to surgery, as this dictates the differential diagnosis and the therapeutic window:

- Intraoperative — events occurring during the procedure (hemorrhage, capsular perforation, ureteric orifice injury, anaesthetic-related events).
- Early postoperative (≤30 days) — TUR syndrome, postoperative bleeding and clot retention, urinary tract infection and sepsis, acute urinary retention, venous thromboembolism, cardiovascular events.
- Late postoperative (>30 days) — bladder neck contracture, urethral stricture, urinary incontinence, sexual dysfunction (retrograde ejaculation, erectile dysfunction), tissue regrowth requiring reoperation.

3. Intraoperative Complications

3.1 Hemorrhage

Intraoperative bleeding is inherent to all resective techniques and arises predominantly from the rich submucosal venous plexus and from arterial branches of the inferior vesical and prostatic arteries that supply the transitional zone. In monopolar TURP, severe bleeding requiring transfusion occurs in approximately 2–8% of cases, correlating with prostate volume (>80 mL), resection time, and prior urinary retention. Bipolar plasmakinetic resection (PKRP) reduces transfusion rates by approximately 50% through superior real-time hemostasis. Holmium laser enucleation (HoLEP) and thulium laser enucleation (ThuLEP) further reduce transfusion to under 1–2% because the laser simultaneously coagulates vessels at the energy delivery surface, and the enucleation plane is anatomic and largely avascular.

Clinical pearl. *Anticoagulant or antiplatelet therapy is a leading modifiable risk factor for major bleeding. The 2023 AUA amendment specifically identifies HoLEP, ThuLEP, and photoselective vaporization (PVP) as preferred options for patients who cannot safely discontinue anticoagulation. Aquablation also demonstrates favourable hemostatic profiles when combined with focal cautery of the bladder neck and 5–7 o'clock arteries.*

3.2 Capsular Perforation

Capsular perforation is the inadvertent breach of the surgical capsule of the prostate, exposing periprostatic venous sinuses to irrigation fluid and substantially increasing the risk of TUR syndrome. Incidence in contemporary monopolar TURP series is approximately 2–5%. Risk factors include large prostate volume, inexperience, deep resection at the bladder neck or apex, and inadequate visualization due to bleeding. Small perforations are typically managed conservatively with prolonged catheterization; large perforations with significant extravasation may require open or laparoscopic drainage and termination of the procedure.

3.3 Urethral and Ureteric Orifice Injury

Resection too close to the trigone risks injury to one or both ureteric orifices, with sequelae ranging from transient edema to ureteric stenosis and obstructive uropathy. Careful identification of the orifices at the outset of the procedure, particularly when resecting a median lobe, is mandatory. Iatrogenic urethral injury during instrument passage—false passage formation, sphincteric injury—is a recognized contributor to postoperative stricture disease, and is more common in patients with prior catheterization, urethral pathology, or limited operator experience.

3.4 Anaesthetic and Positioning Complications

Most BPH procedures are performed under spinal or general anaesthesia in the lithotomy position. Position-related events—well-recognized but uncommon—include lower-limb compartment syndrome, common peroneal and obturator neuropathy, and lumbosacral plexopathy. Time-dependent risk justifies limiting lithotomy duration and using padded supports. Cardiovascular instability during obturator nerve stimulation (when a lateral wall bladder lesion is co-resected) may be mitigated by bipolar energy or obturator nerve block.

4. Early Postoperative Complications (≤30 Days)

4.1 Transurethral Resection (TUR) Syndrome

TUR syndrome is a constellation of neurologic, cardiovascular, and metabolic disturbances caused by systemic absorption of irrigation fluid through open prostatic venous sinuses during monopolar resection, in which hypotonic, non-electrolyte solutions (most commonly 1.5% glycine) are used to avoid current dispersion. The resulting dilutional hyponatremia and, with glycine, direct neurotoxicity and ammonia generation produce a recognizable clinical picture.

Pathophysiology

Absorption rates can reach 20 mL/min when capsular perforation has occurred or when irrigation pressure exceeds venous pressure (>60 cm H_2O). Acute hyponatremia (serum Na^+ < 125 mmol/L) causes cerebral edema; glycine metabolism produces hyperammonemia contributing to encephalopathy; volume overload precipitates pulmonary edema and bradyarrhythmia.

Clinical features

Restlessness, nausea, headache, visual disturbance, hypertension followed by bradycardia and hypotension, confusion progressing to seizure and coma. Although classically appearing intraoperatively, presentation may be delayed several hours postoperatively, particularly under spinal anaesthesia where early symptoms are masked.

Incidence and prevention

In contemporary series, TUR syndrome occurs in approximately 0.5–2% of monopolar TURP cases. It is essentially eliminated by bipolar TURP, HoLEP, ThuLEP, PVP, and Aquablation, all of which use isotonic saline as the irrigation medium. Where monopolar TURP is performed, prevention rests on limiting resection time to under 60 minutes, maintaining low irrigation pressure (drip chamber ≤60 cm above the patient), promptly recognizing and managing capsular perforation, and monitoring serum sodium intraoperatively in high-risk cases.

Management

Immediate cessation of irrigation absorption (terminate or convert procedure), supportive cardiovascular management, and cautious correction of hyponatremia. Severe cases (Na^+ < 120 mmol/L with neurologic symptoms) warrant hypertonic 3% saline administered at a rate to raise serum sodium by no more than 8–10 mmol/L per 24 hours to avoid osmotic demyelination. Loop diuretics manage volume overload; mechanical ventilation may be required for severe pulmonary edema or seizure-related airway compromise.

4.2 Postoperative Hemorrhage and Clot Retention

Postoperative bleeding may be primary (within hours of surgery, typically arterial and from unsealed resection vessels), reactionary (12–24 hours, when vasoconstriction subsides), or secondary (5–14 days, due to eschar sloughing). Continuous bladder irrigation is used in the immediate postoperative period to prevent clot formation. Clot retention—presenting with suprapubic pain, catheter blockage, and bladder distension—occurs in approximately 5–10% of TURP cases and requires manual washout or, for refractory cases, return to theatre for cystoscopic evacuation and re-fulguration.

Secondary hemorrhage at 1–2 weeks is reported in 1–3% of patients and reflects sloughing of the resection eschar. Most episodes resolve with conservative management (increased oral hydration, temporary catheterization, tranexamic acid in selected cases), but persistent bleeding mandates cystoscopic evaluation.

4.3 Urinary Tract Infection and Urosepsis

Postoperative urinary tract infection is reported in 5–22% of patients undergoing TURP and in 11% or more after Aquablation in some series. Risk factors include preoperative bacteriuria,

prolonged catheterization, indwelling stents, diabetes mellitus, and immunosuppression. Urosepsis is a Clavien-Dindo grade IV event and remains a leading cause of postoperative mortality in BPH surgery, with reported rates of 0.3–1.5%.

Prevention. *Sterile preoperative urine culture is essential; bacteriuria should be treated with culture-directed antibiotics prior to surgery. Single-dose antimicrobial prophylaxis is standard, guided by local resistance patterns and recent EAU/AUA recommendations. Limiting postoperative catheter dwell time reduces ascending infection.*

4.4 Acute Urinary Retention After Catheter Removal

Approximately 4–9% of patients fail their initial trial without catheter, most commonly due to detrusor underactivity, prostatic edema, or residual tissue. Repeat catheterization for 5–7 days followed by a second voiding trial succeeds in the majority. Persistent retention warrants formal urodynamic evaluation and, where appropriate, additional resection.

4.5 Venous Thromboembolism

Symptomatic deep venous thrombosis and pulmonary embolism are uncommon (<1%) after endoscopic BPH surgery but are more frequent after open simple prostatectomy (1–3%). Mechanical prophylaxis with sequential compression devices is standard; pharmacological prophylaxis is individualized based on bleeding risk and patient-specific thrombotic risk factors.

4.6 Cardiac Events

Perioperative myocardial infarction and arrhythmia reflect the cardiovascular comorbidity profile of the BPH population (mean age in most series >65 years) rather than direct surgical injury. Optimization of cardiac status, careful fluid management, and avoidance of intraoperative volume overload remain the principal preventive strategies.

5. Late Postoperative Complications (>30 Days)

5.1 Bladder Neck Contracture

Bladder neck contracture is a fibrotic narrowing of the vesicourethral junction, typically presenting 3–12 months postoperatively with deteriorating urinary stream, recurrent retention, or rising post-void residual volume after an initially successful procedure. Incidence is approximately 1–4% after TURP, lower with enucleation techniques in some series, and unusually rare after Aquablation.

Pathogenesis involves excessive resection at the bladder neck, deep cauterization, urinary extravasation, postoperative infection, and individual fibroblastic predisposition. Management proceeds in a stepwise fashion: cold-knife or laser bladder neck incision (at 4 and 8 o'clock to avoid neurovascular bundles) is first-line; refractory contractures may require repeat incision with adjunctive intralesional steroid or mitomycin C, transurethral resection of scar tissue, or — rarely — open reconstruction.

5.2 Urethral Stricture

Urethral stricture occurs in 2–9% of patients after TURP and most commonly involves the bulbar urethra or the external meatus. Etiology is multifactorial: instrument size disproportionate to urethral caliber, prolonged catheterization, ischemic injury, and infection. Preventive strategies include the use of internal urethrotomy or perineal urethrostomy in tight urethras, generous lubrication, hydrophilic-coated instruments, and limiting resectoscope passage cycles. Treatment ranges from urethral dilation and direct visual internal urethrotomy for short, primary strictures to formal urethroplasty for recurrent or long-segment disease.

5.3 Urinary Incontinence

Stress urinary incontinence after BPH surgery typically results from injury to the external (rhabdosphincter) urinary sphincter and is reported in 0.5–2% of TURP cases and up to 5–10% in selected enucleation series during the learning curve. Urge or mixed incontinence often reflects pre-existing detrusor overactivity unmasked by relief of obstruction.

Most early postoperative incontinence resolves spontaneously within 3–6 months. Persistent stress incontinence beyond 12 months warrants urodynamic evaluation; treatment options include pelvic floor rehabilitation, male sling procedures, and artificial urinary sphincter implantation for severe cases. Storage symptoms unmasked by surgery respond to anticholinergics or beta-3 agonists once outlet obstruction has been confirmed relieved.

5.4 Sexual Dysfunction

Retrograde ejaculation

Retrograde ejaculation results from resection of the smooth muscle of the bladder neck, which normally closes during emission. It is the most common sexual side-effect of BPH surgery: 65–75% after TURP, similar after HoLEP and ThuLEP, lower after PVP and Aquablation, and substantially lower after prostatic urethral lift (PUL/UroLift) and Rezum, which preserve the bladder neck. Aquablation specifically aims for sub-trigonal preservation, and antegrade ejaculation has been preserved in over 99% of men in some contemporary series.

Erectile dysfunction

New-onset erectile dysfunction attributable to BPH surgery has been variably reported (3–20% in older studies). Contemporary controlled comparisons demonstrate that the absolute attributable risk over and above natural age-related decline is modest. Mechanisms include thermal injury to the cavernous nerves coursing lateral to the prostatic capsule and the neurovascular bundles, and changes in the periprostatic vasculature. Minimally invasive surgical therapies (PUL, Rezum, Aquablation) demonstrate the lowest incidence of de novo erectile dysfunction in comparative trials.

5.5 Reoperation and Tissue Regrowth

Long-term retreatment rates differ significantly by technique. After TURP, reoperation for residual or regrowth tissue is approximately 1–2% per year, cumulating to 12–15% at 8 years. Enucleation techniques (HoLEP, ThuLEP) remove tissue down to the surgical capsule and

demonstrate retreatment rates under 1% per year. Minimally invasive surgical therapies have higher retreatment rates: Rezum approximately 4–11% at 5 years, PUL approximately 10–14% at 5 years, and Aquablation approximately 3–4% at 4 years in published cohorts. PAE retreatment rates are higher still, in the range of 10–20% at medium-term follow-up, contributing to current AUA recommendations limiting its use to clinical trials.

6. Procedure-Specific Complication Profiles

The following synthesis summarizes contemporary complication estimates compiled from randomized controlled trials, systematic reviews, and large prospective cohorts published through 2025. Reported ranges reflect differences in operator experience, prostate volume, and definition of events.

Procedure	Transfusion	TUR Sd.	Stricture / BNC	Retrograde Ejac.	Incontinence	Retreatment
M-TURP	2–8%	0.5–2%	2–9% / 1–4%	65–75%	0.5–2%	≈1–2%/yr
B-TURP / PKRP	1–4%	≈0%	2–7% / 1–3%	60–70%	0.5–2%	≈1%/yr
HoLEP	<1–2%	≈0%	1–5% / 0.5–3%	60–75%	1–10% (transient)	<1%/yr
ThuLEP	<1–2%	≈0%	1–5% / 0.5–3%	60–75%	1–8% (transient)	<1%/yr
PVP (GreenLight)	<1–2%	≈0%	2–5% / 1–3%	35–55%	≤2%	≈1–2%/yr
Open / Robotic Simple Prostatectomy	5–15%	N/A	2–7% / 2–5%	70–90%	1–3%	<1%/yr
Aquablation	1–8%	≈0%	<1% / <1%	<10%	<1%	≈3–4% @ 4 yr
Rezum (water-vapor)	rare	0%	<1% / <1%	<5%	<1%	≈4–11% @ 5 yr

Procedure	Transfusion	TUR Sd.	Stricture / BNC	Retrograde Ejac.	Incontinence	Retreatment
PUL (UroLift)	rare	0%	<1% / <1%	0–5%	<1%	≈10–14% @ 5 yr
PAE	N/A	0%	<1% / <1%	<10%	rare	≈10–20% medium-term

Abbreviations: *M-TURP — monopolar TURP; B-TURP/PKRP — bipolar/plasmakinetic TURP; HoLEP — holmium laser enucleation of the prostate; ThuLEP — thulium laser enucleation; PVP — photoselective vaporization of the prostate; PUL — prostatic urethral lift; PAE — prostatic artery embolization; BNC — bladder neck contracture.*

6.1 Monopolar TURP

Monopolar TURP remains the historical benchmark and the most studied procedure for BPH. In well-conducted contemporary series the total complication rate is approximately 29–35%, with the overwhelming majority being Clavien-Dindo grades I–III. TUR syndrome and transfusion-requiring hemorrhage are the principal hazards unique to this technique.

6.2 Bipolar TURP

Bipolar resection uses isotonic saline irrigation and a return electrode at the resectoscope, eliminating TUR syndrome and reducing transfusion requirements. Long-term functional outcomes (IPSS, Qmax) and reoperation rates are comparable to those of monopolar TURP. Late complications (stricture, bladder neck contracture, sexual dysfunction) occur at similar rates.

6.3 Holmium and Thulium Laser Enucleation

HoLEP and ThuLEP achieve anatomical enucleation of the entire adenoma down to the surgical capsule, and are formally size-independent — making them the technique of choice for very large glands where simple prostatectomy was traditionally indicated. Transfusion rates and TUR syndrome incidence are negligible. The principal early complication is transient stress urinary incontinence, attributable to local sphincteric edema and reported in up to 10% during the learning curve, with resolution in the majority by 3 months. Bladder mucosal injury during morcellation is a procedure-specific intraoperative hazard requiring care with the morcellator device.

6.4 Photoselective Vaporization of the Prostate

PVP (GreenLight laser) vaporizes prostatic tissue using 532 nm wavelength laser energy preferentially absorbed by oxyhemoglobin. Hemostasis is excellent, transfusion rates are very low, and the procedure is suitable for anticoagulated patients. Tissue is not available for histopathological examination — a relative limitation when occult prostate cancer is a concern.

Mid- and long-term reoperation rates are slightly higher than after TURP in some comparative series.

6.5 Open and Robotic Simple Prostatectomy

Open transvesical (Freyer) or retropubic (Millin) simple prostatectomy is reserved for very large prostates (>80–100 mL) where enucleation expertise is unavailable. Robotic-assisted simple prostatectomy is an increasingly common alternative offering reduced blood loss and shorter hospital stay. Transfusion rates remain in the 5–15% range, venous thromboembolism is more frequent than after endoscopic procedures, and surgical-site complications (wound infection, dehiscence, prolonged urinary leak) are characteristic.

6.6 Aquablation

Aquablation is a robotically-controlled, heat-free water-jet resection performed under transrectal ultrasound guidance, with focal cautery applied at the bladder neck and 5–7 o'clock positions after resection. The technique demonstrates exceptional preservation of antegrade ejaculation, very low rates of stricture and bladder neck contracture, and applicability to large prostates up to 150 mL. The principal early complication is bleeding, with transfusion required in 1–8% of cases in pooled data and more frequent in larger glands. Most events are Clavien-Dindo grade I–II, and longer follow-up indicates retreatment in approximately 3–4% at four years.

6.7 Convective Water Vapor Therapy (Rezum)

Rezum delivers steam thermal energy to the transition zone, producing convective tissue necrosis with subsequent resorption over weeks to months. It is performed in the outpatient setting under local or light sedation. Sexual function is exceptionally well preserved. Complications are limited to transient dysuria, hematuria, and short-term urinary retention requiring temporary catheterization in 3–5% of patients. Mid-term retreatment rates are approximately 4–11% at five years.

6.8 Prostatic Urethral Lift (UroLift)

PUL mechanically retracts the lateral lobes of the prostate using permanent transprostatic implants, creating an anterior channel without thermal injury or resection. Sexual function, including ejaculation, is preserved. Complications are typically minor and self-limiting (dysuria, hematuria, transient retention). Reoperation rates are the highest among the minimally invasive surgical therapies, at approximately 10–14% at five years.

6.9 Prostatic Artery Embolization

PAE, performed by interventional radiologists, induces ischemic necrosis of prostatic tissue via super-selective embolization of the prostatic arteries. The procedure-specific complication profile includes the post-embolization syndrome (pelvic pain, dysuria, low-grade fever), groin hematoma, contrast-related events, and rare but characteristic non-target embolization to the bladder, rectum, or penis. The 2023 AUA guideline amendment recommends restricting PAE to

clinical trial contexts owing to unclear long-term benefit-risk balance and higher retreatment rates than competing techniques.

7. Risk Factors and Predictors of Complications

Identifying patients at elevated risk allows for procedure selection, perioperative optimization, and informed consent. Major predictors fall into patient-specific and procedure-specific domains:

Domain	Predictors
Patient	Advanced age, frailty, low BMI Cardiovascular and cerebrovascular comorbidity Diabetes mellitus, chronic kidney disease Anticoagulation or antiplatelet therapy Preoperative bacteriuria or indwelling catheter Pre-existing detrusor underactivity
Prostate	Volume >80 mL (bleeding, longer resection, TUR syndrome) Large median lobe (risk of ureteric orifice injury) Prior pelvic radiation or surgery (stricture, incontinence) Suspected malignancy (technique selection, tissue diagnosis)
Procedure	Resection time >60 min (TUR syndrome, hemorrhage) High irrigation pressure Capsular perforation Inexperience (especially during enucleation learning curve) Inadequate hemostasis prior to catheter placement

8. Prevention and Perioperative Optimization

Multiple strategies, applied systematically, reduce the incidence and severity of complications:

- **Procedure selection.** Match technique to prostate volume, anatomy, anticoagulation status, sexual function priorities, comorbidity profile, and patient preference. Enucleation or PVP are preferred when anticoagulation cannot safely be paused; minimally invasive surgical therapies are preferred when sexual function preservation is paramount and prostate volume is suitable.
- **Preoperative urine sterilization.** Culture-directed antibiotics for bacteriuria; single-dose perioperative prophylaxis informed by local antibiogram.
- **Anticoagulation management.** Multidisciplinary coordination to balance bleeding and thromboembolic risk; technique selection adjusted accordingly.
- **Irrigation discipline.** Maintain low irrigation pressure during monopolar TURP; use isotonic saline whenever bipolar, laser, or water-jet techniques are employed.
- **Resection time limitation.** Where monopolar TURP is performed, aim to complete resection within 60 minutes; consider staged or alternative technique for very large glands.

- **Position care.** Padded lithotomy supports, intermittent calf compression, and minimization of position time.
- **Venous thromboembolism prophylaxis.** Mechanical for all patients; pharmacological tailored to bleeding and thrombotic risk profile.
- **Catheter care and early removal.** Closed drainage, early removal where appropriate, structured trial-without-catheter protocols.
- **Structured follow-up.** Symptom score and uroflowmetry at 3, 6, and 12 months; prompt cystoscopic evaluation of any deterioration to detect stricture or contracture early.

9. Management of Established Complications

Once a complication is identified, structured management improves outcomes and limits sequelae. Key principles include:

- **Hemorrhage:** continuous bladder irrigation; cystoscopic re-fulguration for persistent bleeding; transfusion as indicated; tranexamic acid in selected cases; vascular embolization for refractory arterial bleeding.
- **TUR syndrome:** terminate irrigation absorption; supportive care; correction of hyponatremia with hypertonic saline limited to 8–10 mmol/L per 24 hours; ICU admission for grade IV events.
- **Urosepsis:** early goal-directed resuscitation; broad-spectrum antibiotics narrowed by culture; source control with adequate urinary drainage.
- **Clot retention:** manual bladder washout via large-bore catheter; cystoscopic evacuation under anaesthesia for refractory cases.
- **Bladder neck contracture:** stepwise endoscopic incision (4 and 8 o'clock), with consideration of intralesional steroid or mitomycin C for recurrence; rare open reconstruction.
- **Urethral stricture:** dilation or direct visual internal urethrotomy for short primary strictures; urethroplasty for recurrent or long-segment disease.
- **Stress incontinence:** pelvic floor rehabilitation initially; urodynamic confirmation; male sling for mild–moderate disease; artificial urinary sphincter for severe persistent incontinence.
- **Sexual dysfunction:** counsel preoperatively; PDE-5 inhibitors for erectile dysfunction; informed acceptance for retrograde ejaculation, which is often unbothersome to non-fertility-seeking patients.

10. Contemporary Evidence and Guideline Updates

The 2023 AUA guideline amendment, and EAU 2024 update, are concordant on several principles relevant to complications:

- HoLEP and ThuLEP are size-independent and preferred for very large prostates; both are recommended for patients on anticoagulation.
- PVP is a valid alternative for anticoagulated patients.
- Aquablation is offered for prostate volumes 30–80 mL, with emerging evidence supporting use in larger glands; the technique offers superior preservation of sexual function compared to TURP.
- PUL and Rezum are preferred when preservation of sexual function (especially antegrade ejaculation) is paramount and the prostate has appropriate anatomy.

• PAE is currently recommended only within clinical trials, owing to unclear benefit-risk balance and higher retreatment rates.

• Transurethral incision of the prostate (TUIP) remains an excellent option for small prostates (<30 mL) with low rates of retrograde ejaculation.

Systematic reviews published in 2025 confirm the safety profile of Aquablation, with most adverse events at Clavien-Dindo grade 1–2 and antegrade ejaculation preserved in over 99% of treated men in selected series. Comparative data continue to support the long-term efficacy of HoLEP, with non-inferior IPSS and Qmax outcomes versus TURP and consistently lower transfusion rates.

11. Conclusion

Surgery for benign prostatic hyperplasia is among the most effective procedures in urology, and the absolute risk of severe complications is low. Nonetheless, the breadth of available techniques — from monopolar TURP to robotic water-jet resection and convective steam therapy — produces distinct safety profiles that must be matched to patient anatomy, comorbidity, and priorities. Standardized reporting using the Clavien-Dindo classification, careful procedure selection, rigorous perioperative optimization, and structured follow-up together minimize complication burden and maximize patient-centred outcomes. The contemporary urologist must remain familiar with the mechanism, incidence, prevention, and management of complications across the entire surgical armamentarium, and counsel patients with technique-specific, evidence-based estimates rather than legacy figures derived predominantly from monopolar TURP cohorts.

References

1.CHRONIC PROSTATITIS: ETIOLOGY AND TREATMENT. (2025). International Journal of Medical Sciences, 5(12), 729-733. https://doi.org/10.55640/

2. COMPARISON OF SURGICAL TECHNIQUES FOR BENIGN PROSTATIC HYPERPLASIA: OUTCOMES AND INNOVATIONS. (2025). International Journal of Medical Sciences, 5(11), 551-554. https://doi.org/10.55640/

3. Mansurov Sardor Vali o'g'li. (2025). Neuro-Oncology in Transition: Molecular Classification and Emerging Therapies for Brain Tumors. International Journal of Integrative and Modern Medicine, 3(10), 233–237. Retrieved from https://medicaljournals.eu/index.php/IJIMM/article/view/2235

4. o'g'li, M. S. V. (2025). ESOPHAGEAL CANCER: EPIDEMIOLOGY, PATHOGENESIS, AND MODERN APPROACHES TO MANAGEMENT. International Journal of Cognitive Neuroscience and Psychology, 3(9), 59–64. Retrieved from https://medicaljournals.eu/index.php/IJCNP/article/view/2127

5. Mansurov Sardor Vali o'g'li. (2025). RECENT DEVELOPMENTS IN THE DIAGNOSIS AND TREATMENT OF HEPATITIS: A GLOBAL PERSPECTIVE. https://doi.org/10.5281/zenodo.15478708

6. Mansurov Sardor Vali o'g'li. (2025). URINARY BLADDER CANCER. https://doi.org/10.5281/zenodo.15227539

7. Mansurov Sardor Vali o'g'li. (2025). ACUTE KIDNEY INJURY: ETIOLOGY AND TREATMENT. https://doi.org/10.5281/zenodo.15070424

8. Mansurov Sardor Vali o'g'li. (2025). EPIDEMIOLOGY AND TREATMENT OF RENAL CELL CARCINOMA: IDENTIFYING KEY RISK FACTORS. https://doi.org/10.5281/zenodo.14909826

9. PROSTATE CANCER: PATHOLOGY AND TREATMENT. (2024). International Bulletin of Medical Sciences and Clinical Research, 4(11), 65-70. https://doi.org/10.37547/

10. Mansurov Sardor Vali o'g'li, KIDNEY CANCER: EPIDEMIOLOGY AND TREATMENT , EUROPEAN JOURNAL OF MODERN MEDICINE AND PRACTICE: Vol. 4 No. 11 (2024): European Journal of Modern Medicine and Practice

https://inovatus.es/index.php/ejmmp/article/view/4509

11. Mansurov Sardor Vali o'g'li, SQUAMOUS CELL CARCINOMA OF THE PENIS: EPIDEMIOLOGY AND TREATMENT , EUROPEAN JOURNAL OF MODERN MEDICINE AND PRACTICE: Vol. 4 No. 10 (2024): European Journal of Modern Medicine and Practice https://inovatus.es/index.php/ejmmp/article/view/4245

12. Valiyevich, M. S. . (2024). Specific Morphofunctional Characteristics of the Kidney Caused by Brain Damage in Various Emergency Situations. Research Journal of Trauma and Disability Studies, 3(4), 286–289. Retrieved from http://journals.academiczone.net/index.php/rjtds/article/view/2628

13.Bahromov Bekzod Shavkatovich. (2025). UROLITHIASIS: EPIDEMIOLOGY AND RISK FACTORS. https://doi.org/10.5281/zenodo.15070401

14.ANESTHESIOLOGICAL CARE AND INTENSIVE CARE OF GERONTOLOGICAL PATIENTS IN UROLOGY. (2025). International Journal of Medical Sciences, 5(02), 381-384. https://doi.org/10.55640/

15. SOME PROBLEMS OF UROLOGY IN NEPHROLOGY. (2024). International Journal of Medical Sciences, 4(12), 127-130. https://doi.org/10.55640/

16. PREVENTION OF INTRAOPERATIVE COMPLICATIONS OF ENDOVIDEOSURGICAL INTERVENTIONS IN UROLOGY. (2024). International Journal of Medical Sciences, 4(11), 292-295. https://doi.org/10.55640/

17. ПУТИ УЛУЧШЕНИЯ КАЧЕСТВА НЕОТЛОЖНОЙ ПОМОЩИ БОЛЬНЫМ УРЕТЕРОЛИТИАЗОМ. (2024). International Journal of Medical Sciences, 4(10), 135-138. https://doi.org/10.55640/

18. Bahromov Bekzod Shavkatovich. (2024). Urinary Tract Infection Gonorrhea. SCIENTIFIC JOURNAL OF APPLIED AND MEDICAL SCIENCES, 3(5), 515–517. Retrieved from https://sciencebox.uz/index.php/amaltibbiyot/article/view/10804

19. Shavkatovich B. B. . (2024). Urinary Tract Infections. Research Journal of Trauma and Disability Studies, 3(4), 249–251. Retrieved from https://journals.academiczone.net/index.php/rjtds/article/view/2602

20. Bahromov Bekzod Shavkatovich. (2025). PROSTATE CANCER: EPIDEMIOLOGY, RISK FACTORS, DIAGNOSIS. https://doi.org/10.5281/zenodo.15242564

21. URINARY STONE DISEASE: ETIOLOGY, PATHOGENESIS, AND TREATMENT. (2025). International Journal of Medical Sciences, 5(11), 456-458. https://doi.org/10.55640/

22. URINARY TRACT INFECTION (UTI): ETIOLOGY, PATHOGENESIS, DIAGNOSIS, AND TREATMENT. (2025). International Journal of Medical Sciences, 5(12), 735-738. https://doi.org/10.55640/

23. Bahromov Bekzod Shavkatovich. (2025). RISK FACTORS AND DIAGNOSIS OF KIDNEY STONE. https://doi.org/10.5281/zenodo.15515734

24. Shavkatovich, B. B. (2025). UROLITHIASIS: ETIOLOGY AND DIAGNOSTIC APPROACHES. International Journal of Cognitive Neuroscience and Psychology, 3(9), 39–43. Retrieved from https://medicaljournals.eu/index.php/IJCNP/article/view/2124

25. Bahromov Bekzod Shavkatovich. (2025). BENIGN PROSTATIC HYPERPLASIA (BPH). International Journal of Integrative and Modern Medicine, 3(10), 247–250. Retrieved from https://medicaljournals.eu/index.php/IJIMM/article/view/2238

26. ACUTE PROSTATITIS: ETIOLOGY, PATHOPHYSIOLOGY, CLINICAL PRESENTATION, DIAGNOSTIC APPROACH, AND CONTEMPORARY MANAGEMENT. (2026). Journal of Multidisciplinary Sciences and Innovations, 5(01), 806-812. https://doi.org/10.55640/

27. MODERN TREATMENT APPROACHES FOR URINARY STONE DISEASE (UROLITHIASIS). (2026). Journal of Multidisciplinary Sciences and Innovations, 5(01), 802-805. https://doi.org/10.55640/