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TRANSURETHRAL RESECTION OF THE PROSTATE IN THE MODERN ERA: ADVANCED PATHOPHYSIOLOGY, SURGICAL OPTIMIZATION, OUTCOMES, AND COMPARATIVE EFFECTIVENESS

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Abstract: Transurethral resection of the prostate (TURP) remains a benchmark surgical intervention for benign prostatic hyperplasia (BPH) despite the rapid evolution of laser-based and minimally invasive technologies. This advanced review critically evaluates TURP within contemporary urological practice, integrating molecular pathophysiology, patient selection algorithms, surgical optimization strategies, perioperative risk modeling, functional outcomes, complication profiles, long-term durability, cost-effectiveness, and comparative effectiveness data. Evidence from randomized controlled trials and meta-analyses confirms that TURP provides substantial and durable improvements in lower urinary tract symptoms (LUTS) and urinary flow parameters, particularly in prostates between 30–80 mL. While associated with perioperative bleeding risk and ejaculatory dysfunction, refinements such as bipolar energy systems have significantly enhanced safety. TURP continues to represent a reference standard for BPH surgery and remains integral to urological training and global health systems.

Molecular and Cellular Pathophysiology of BPH

BPH is characterized by hyperplastic expansion of stromal and epithelial components within the transition zone. The pathogenesis involves:

Androgen-dependent signaling via dihydrotestosterone (DHT)

Dysregulation of growth factors (FGF, TGF-β)

Chronic prostatic inflammation

Stromal–epithelial interactions

Age-related hormonal shifts (increased estrogen-to-androgen ratio)

Chronic inflammation contributes to tissue remodeling and fibromuscular proliferation. Elevated cytokines such as IL-6 and TNF-α promote cellular proliferation and extracellular matrix deposition, exacerbating static obstruction.

Dynamic obstruction arises from increased smooth muscle tone mediated by α1-adrenergic receptors. Persistent obstruction induces detrusor hypertrophy, collagen deposition, and eventual bladder decompensation.

TURP directly removes the static obstructive component, restoring luminal patency and reducing detrusor workload.

Indication Stratification and Patient Selection

Advanced patient selection requires multidimensional evaluation:

Clinical Severity Assessment

IPSS ≥ 20

Qmax < 10–12 mL/s

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Post-void residual > 100 mL

Absolute Surgical Indications

Recurrent acute urinary retention

Recurrent UTIs

Bladder stones

Renal insufficiency secondary to obstruction

Persistent hematuria due to BPH

Risk Stratification Tools

ASA physical status classification

Charlson comorbidity index

Anticoagulation status

Urodynamic confirmation of obstruction

Patients with impaired detrusor contractility require careful evaluation, as postoperative improvement may be limited.

Energy Modalities: Monopolar vs Bipolar TURP

Monopolar TURP

Requires non-conductive irrigation (glycine, mannitol)

Risk of TUR syndrome

Established long-term data

Bipolar TURP

Saline irrigation

Reduced hyponatremia risk

Lower transfusion rates

Comparable functional outcomes

Meta-analyses demonstrate significantly lower incidence of TUR syndrome and reduced blood loss with bipolar systems.

Operative Optimization Strategies

Advanced surgical refinement includes:

En bloc resection techniques

Apical tissue preservation to reduce incontinence

Low-pressure irrigation systems

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Early hemostatic control

Real-time fluid absorption monitoring

Enhanced recovery after surgery (ERAS) protocols further improve outcomes.

Functional Outcomes: Evidence Synthesis

Symptom Relief

Meta-analyses report:

Mean IPSS reduction: 15–20 points

Sustained relief up to 10–15 years

Uroflowmetry

Qmax improvement: +10–15 mL/s

Significant reduction in post-void residual volume

Durability

Retreatment rate: 10–15% at 10 years

Comparable durability to open prostatectomy for medium-sized glands

Perioperative Morbidity

Hemorrhage

Hemoglobin drop: 1–2 g/dL

Transfusion rate: 2–7%

Reduced with bipolar systems

TUR Syndrome

Incidence:

<1% in modern practice

Primarily with prolonged monopolar resections

Mechanism:

Hypotonic fluid absorption → dilutional hyponatremia → cerebral edema

Prevention:

Limit operative time (<60–90 min)

Use bipolar saline systems

Sexual and Reproductive Outcomes

Retrograde Ejaculation

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Occurs in 65–75%

Due to bladder neck resection

Does not impair erectile function

Erectile Function

Largely preserved

Some studies show mild improvement due to LUTS relief

Emerging ejaculation-sparing TURP techniques attempt to preserve supramontanal tissue.

Late Complications

Urethral stricture: 2–9%

Bladder neck contracture: 1–5%

Persistent LUTS: 5–10%

Risk factors:

Large resection cavity

Infection

Prolonged catheterization

Comparative Effectiveness

TURP vs HoLEP

Similar IPSS and Qmax outcomes

HoLEP superior for large prostates

HoLEP lower retreatment rate

TURP shorter learning curve

TURP vs Open Prostatectomy

Less invasive

Shorter recovery

Higher retreatment rate for very large glands

TURP vs Minimally Invasive Therapies (UroLift, Rezūm)

Greater symptom improvement

Higher sexual side effects

Better long-term durability

Economic and Global Health Considerations

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TURP remains:

Cost-effective

Widely available

Feasible in low-resource settings

Laser systems require significant capital investment and maintenance.

Cost-utility analyses demonstrate favorable cost per quality-adjusted life year (QALY) for TURP in medium-sized prostates.

Training and Learning Curve

Competency achieved after 30–50 supervised cases

Core component of urology residency training

Simulation-based training improves outcomes

Special Populations

Anticoagulated Patients

Higher bleeding risk

Consider bipolar TURP

Temporary anticoagulation interruption when feasible

Elderly Patients

Safe with spinal anesthesia

Careful fluid management required

Large Prostates (>80 g)

Increased complication risk

Consider HoLEP or open surgery

Limitations of Current Evidence

Heterogeneity of surgical expertise

Variation in prostate size inclusion criteria

Limited long-term RCTs beyond 10 years

Future Directions

Ejaculation-preserving modifications

Integration of real-time intraoperative imaging

Robotic-assisted endoscopic resection

AI-based surgical outcome prediction

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Conclusion

Transurethral resection of the prostate remains a highly effective and durable surgical treatment for BPH in appropriately selected patients. Modern refinements, particularly bipolar energy systems, have significantly improved safety. While laser-based technologies expand options for large prostates, TURP continues to serve as a benchmark procedure with predictable outcomes, strong evidence support, and global accessibility. Its role in urological practice remains fundamental.

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