GMR
The Original

CORRELATION BETWEEN INTRAVESICAL PROSTATIC PROTRUSION (IPP) AND POSTOPERATIVE OUTCOMES IN PATIENTS WITH BENIGN PROSTATIC HYPERPLASIA

Muhammad Owais Ramzan[1]*, Atif Javed[2], Muhammad Farjad[3], Quratulain Badar[4], Muhammad Numair Tariq[5], Nazim Din Soomro[6], Muhammad Waqas Arshad[7], Shafeullah Ahadi[8]

[1]M.S Postgraduate Resident, Department of Urology, Dr Ziauddin University Hospital, Karachi Pakistan
[2]Associate Professor, Department of Urology, Dr Ziauddin University Hospital, Karachi Pakistan
[3]Consultant Urology, Department of Urology, Dr Ziauddin University Hospital, Karachi Pakistan
[4]Assistant Professor/Consultant Radiation Oncologist, Department of Oncology, Dr Ziauddin University Hospital, Karachi Pakistan
[5]Consultant Urologist, Department of Urology, Al Shafi hospital, Sahiwal, Pakistan
[6]Postgraduate Resident, Department of Urology, Dr Ziauddin University Hospital, Karachi Pakistan
[7]Registrar, Department of Urology, Dr Ziauddin University Hospital, Karachi Pakistan
[8]PGR MS, Department of Urology, Dr Ziauddin University Hospital, Karachi Pakistan
***Correspondence Author:** Muhammad Owais Ramzan, Email: owaisramzan104@gmail.com

ABSTRACT

Background: Intravesical prostatic protrusion (IPP) is increasingly recognized as a predictor of surgical outcomes in benign prostatic hyperplasia (BPH), but data correlating IPP with multiple postoperative parameters after transurethral resection of the prostate (TURP) remain limited, particularly in South Asian populations.

Objective: To evaluate the correlation between pre-operative IPP diameter and three-month postoperative IPSS, Q-Max, PVR, and prostate volume in men undergoing TURP for BPH.

Methods: A single-center longitudinal study included 110 adult male patients undergoing TURP, stratified into significant (>5 mm, n=55) and non-significant (<5 mm, n=55) IPP groups based on transabdominal ultrasonography. Shapiro–Wilk testing confirmed non-normal distribution for most continuous variables. Spearman rank correlation was used to assess associations between IPP and postoperative outcomes, with further post-stratification analysis across age.

Results: IPP showed a significant moderate negative correlation with postoperative IPSS ($p<0.001$), a significant moderate positive correlation with Q-Max ($p<0.001$) and a significant low negative correlation with PVR ($\rho = -0.444$, $p<0.001$). No significant correlation existed between IPP and prostate volume ($p=0.069$). These correlations remained consistent across all stratified subgroups, with the strongest Q-Max correlation observed in patients aged 50–59 years ($p<0.001$).

Conclusion: IPP is an independent, reproducible predictor of favorable functional outcomes following TURP, supporting its routine incorporation into pre-operative assessment for BPH surgical planning.

KEYWORDS: Benign prostatic hyperplasia; Intravesical prostatic protrusion; Transurethral resection of the prostate; International Prostate Symptom Score; Maximum urinary flow rate; post-void residual urine.

INTRODUCTION

Benign prostatic hyperplasia (BPH) is a common condition characterized by non-cancerous enlargement of the prostate gland due to unregulated hyperplastic growth of the epithelial and fibromuscular tissues of the transition zone (TZ) and periurethral area. (1). In young adults, this transition zone comprises approximately 5–10% of the prostate gland and surrounds the proximal prostatic urethra, comprising the primary site of BPH (2). Lower urinary tract symptoms (LUTS) are common clinical manifestations of BPH (3). LUTS are characterized by urgency, nocturia, frequency, dysuria, impaired bladder emptying, difficulty initiating micturition, and a weak or intermittent urinary stream. The development of LUTS is strongly correlated with the presence of BPH in older men (3, 4).

BPH is the leading cause of Bladder outlet obstruction (BOO) in males over 50 years (5). Treatment strategies range from conservative management and medical therapy to minimally invasive procedures and surgical interventions. Recent advances have introduced potassium titanyl phosphate (KTP) laser photoselective vaporization and holmium laser enucleation of the prostate (HoLEP) as effective surgical options for LUTS secondary to BPH. Despite these developments, transurethral resection of the prostate (TURP) remains the reference standard for surgical management and is extensively utilized in many developing countries (6, 7).

Numerous factors including age, lower urinary tract symptom severity, prostate volume, bladder outlet obstruction, and detrusor overactivity significantly predicts the outcomes of surgical management for BPH (8). Intravesical prostatic protrusion (IPP) is an anatomical manifestation of BPH characterized by protrusion of the enlarged prostate into the bladder lumen, resulting in a "ball-valve" type of BOO that interferes with normal bladder neck function during voiding (9, 10).

Previous literature has shown that IPP is significantly associated with storage related LUTS, which may arise from bladder neck and trigonal irritation. Thus, IPP serves as an independent predictor of postoperative outcomes after Transurethral Resection of the Prostate in patients with BPH (11, 12). IPP caused by median lobe enlargement is more resistant to detrusor contraction than lateral lobe compression due to disruption of prostatic fascial support and greater radial pressure, making it a reliable predictor of terminal dribbling and IPSS severity (13, 14). Bladder hypertrophy and afferent hypersensitivity further aggravate storage symptoms (15).

Anatomical factors such as IPP are increasingly emphasized in evaluating LUTS severity and guiding treatment decisions such as prostatic artery embolization, although patient selection remains a challenge (16, 17). IPP has been shown to reliably predict the bladder obstruction index (BOOI) on pressure-flow studies, and ultrasound-based IPP measurement outperforms total prostate volume (TPV) and other non-invasive markers in diagnosing BO, attributed to its noninvasive, inexpensive, and reproducible nature without ionizing radiation.

Despite this body of evidence, data correlating IPP with postoperative outcomes in a local Pakistani population are underexplored. Therefore, this study focuses on evaluating the association of IPP with symptom severity and postoperative outcomes in patients undergoing transurethral resection of the prostate (TURP). The findings of this study support the integration of IPP with conventional preoperative parameters to improve the prediction of surgical outcomes in patients with BPH.

METHODOLOGY

A single-center longitudinal study was conducted at the Department of Urology, Dr. Ziauddin Hospital, North Nazimabad Campus, Karachi, after obtaining ethical approval (10590625ORURO, dated July 23, 2025). The duration of study was I year from July 2025 to June 2026. The sample size of 110 participants was calculated using a two-tailed significance level of 5%, 80% statistical power, and an anticipated Pearson correlation coefficient of 0.264 from a previous study (18). A non-probability consecutive sampling technique was used to recruit the participants. Patients who were >50 years of age, had clinically diagnosed benign prostatic hyperplasia (BPH) with transurethral resection of the prostate (TURP) surgery following medical therapy or due to BPH-related complications were included, whereas patients had previously undergone prostate surgery, prostate cancer, had neurogenic bladder, severe urethral stricture, and incomplete records, or who were not willing to undergo a 3-month follow-up were excluded.

Following ethical approval and informed consent, the following baseline demographic, clinical, laboratory and ultrasonographic parameters were recorded: PSA, IPSS, prostate volume, maximum urinary flow rate (Qmax), post-void residual urine (PVR) and intravesical prostatic protrusion (IPP). IPP was assessed by transabdominal ultrasonography, and classified as being significant (>5 mm) or not (IPP < 5 mm). All patients had a standardized TURP performed by highly experienced surgeons and the patients were evaluated for outcomes, such as IPSS, Qmax, PVR, after 3 months. Data were collected using a semi-structured questionnaire and analyzed using SPSS version 23. The Shapiro–Wilk test assessed normality, descriptive statistics were used to summarize the data, and Spearman's correlation coefficient evaluated the association between IPP and postoperative outcomes. A p-value <0.05 was considered statistically significant.

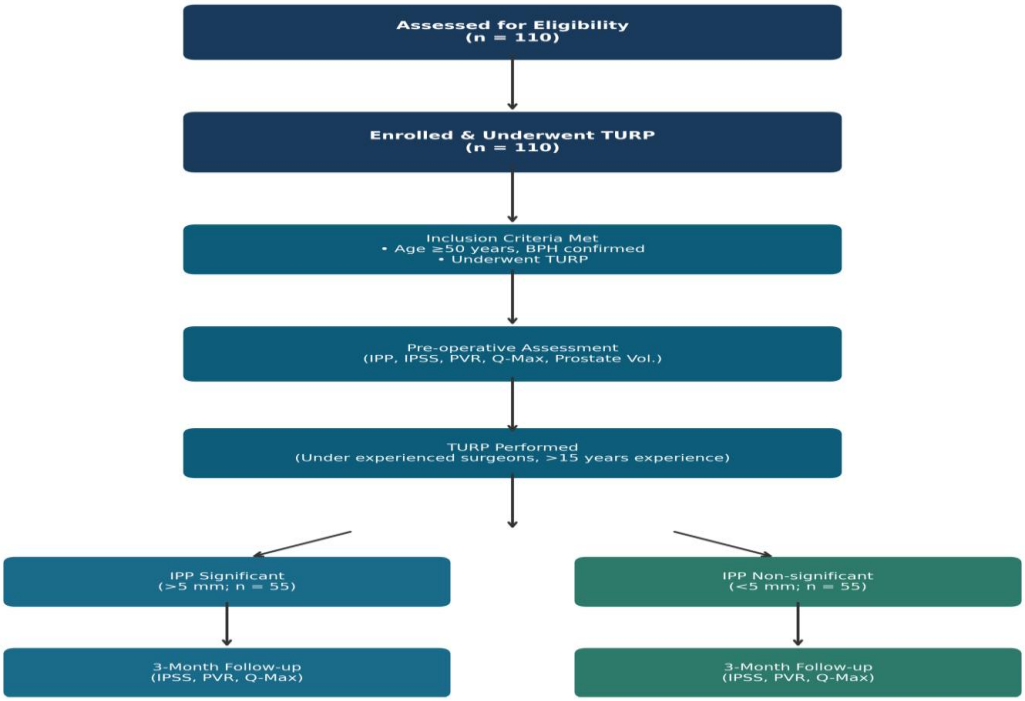


Figure 1 Study flow diagram showing patient enrollment, IPP-based stratification, and three-month postoperative outcome assessment following TURP

RESULTS

A total of 110 adult male patients demonstrated that the mean age of the cohort was 64.71 ± 7.63 years. The majority of patients resided in urban areas (n = 108, 98.2%) and belonged to a middle socioeconomic class (n = 102, 92.7%). Most patients had a graduation-level education (n = 88, 80.0%). Based on transabdominal ultrasonography, 55 patients (50.0%) had significant IPP (>5 mm) and 55 patients (50.0%) had non-significant IPP (<5 mm). IPP diameter ranged from 3.0 to 8.0 mm across the cohort. The complete baseline characteristics are presented in **Table 1**.

Table 1 Baseline Characteristics of the Study Population (N = 110)

Variable	Category / Value	
Demographics		
Age (years)		64.71 ± 7.63
50–59 years n (%)		23 (20.9)
60–69 years n (%)		58 (52.7)
≥70 years n (%)		29 (26.4)
Gender n (%)	Male	110 (100)
Residential Status n (%)	Urban	108 (98.2)
	Rural	2 (1.8)
Socioeconomic Status n (%)	Middle	102 (92.7)
	Upper	8 (7.3)
Education Level n (%)	Secondary	16 (14.5)
	Graduation	88 (80.0)
	Post-graduation	6 (5.5)
PRE-OPERATIVE CLINICAL VARIABLES		
IPP Grade n (%)	Significant (>5 mm)	55 (50.0)
	Non-significant (<5 mm)	55 (50.0)
IPP Diameter (mm) Median (IQR)		5.20 (4.00–6.50)
Prostate Volume (mL) Median (IQR)		52.50 (45.00–60.00)
Pre-op IPSS Score Median (IQR)		29.00 (27.00–30.00)
Pre-op PVR (mL) Median (IQR)		94.00 (80.00–117.00)
Pre-op Q-Max (mL/sec) Median (IQR)		9.50 (6.00–10.00)
POST-OPERATIVE OUTCOMES (3-MONTH)		
Post-op IPSS Score Median (IQR)		5.00 (4.00–6.00)
Post-op PVR (mL) Median (IQR)		5.00 (0.00–10.00)
Post-op Q-Max (mL/sec) Median (IQR)		16.00 (15.00–18.00)

Table 2 shows the stratified Spearman correlation analysis between intravesical prostatic protrusion (IPP) and postoperative outcomes. Across all age groups, IPP demonstrated a significant negative correlation with postoperative IPSS ($\rho = -0.495$ to -0.645; $p \leq 0.006$) and PVR ($\rho = -0.415$ to -0.574; $p \leq 0.013$), while a significant positive correlation was observed with postoperative Q-Max ($\rho = +0.637$ to $+0.759$; $p < 0.001$). Significant correlations were observed across all age subgroups, with the strongest correlation between IPP and Q-Max observed in patients aged 50–59 years ($\rho = +0.759$, $p < 0.001$).

Table 2 Post-Stratification Spearman Correlation between IPP Diameter and Postoperative Outcomes

Stratification Variable	Subgroup	n	Outcome	Spearman ρ	p-value
Age Group	50–59 years	23	Post-op IPSS	−0.572	0.004
			Post-op Q-Max	+0.759	< 0.001
			Post-op PVR	−0.574	0.004
	60–69 years	58	Post-op IPSS	−0.645	< 0.001
			Post-op Q-Max	+0.637	< 0.001
			Post-op PVR	−0.415	0.001
	≥70 years	29	Post-op IPSS	−0.495	0.006
			Post-op Q-Max	+0.693	< 0.001
			Post-op PVR	−0.453	0.013

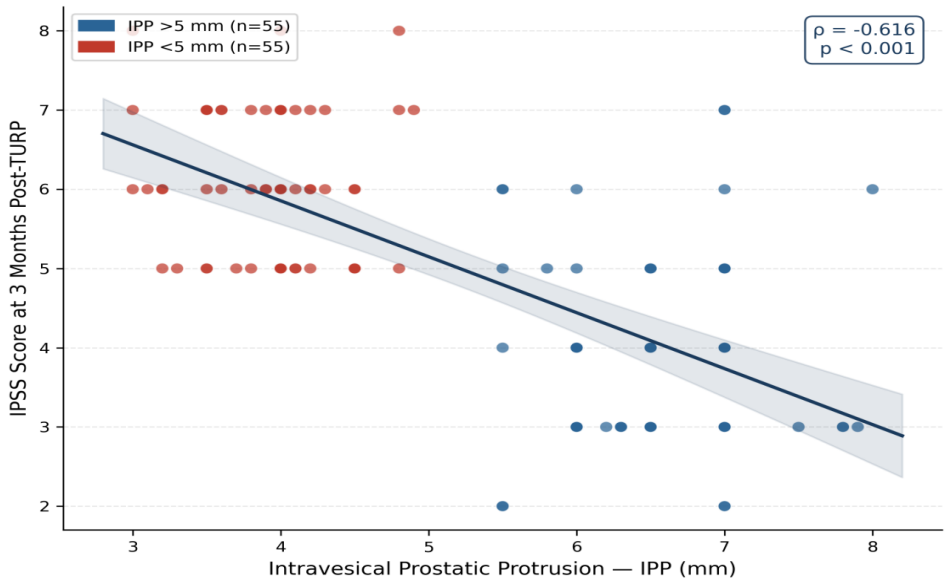


Figure 2 Scatter plot demonstrating a significant negative correlation between intravesical prostatic protrusion (IPP) and IPSS score at 3 months post-TURP, stratified by IPP ≤5 mm (red) and IPP >5 mm (blue) (ρ = −0.616, p < 0.001)

The **Figure 2** demonstrates a significant moderate-to-strong negative correlation between IPP and post-TURP urinary symptom scores (ρ = −0.616, p < 0.001). Patients with IPP >5 mm (n = 55) showed a progressive decline in IPSS scores with increasing IPP, suggesting better symptomatic outcomes after TURP in those with greater preoperative protrusion. In contrast, patients with IPP ≤5 mm (n = 55) clustered at higher post-operative IPSS scores (5–7), indicating relatively poorer symptomatic relief. These findings suggest that IPP may serve as a useful preoperative predictor of TURP outcomes, with larger IPP associated with greater post-operative symptomatic improvement.

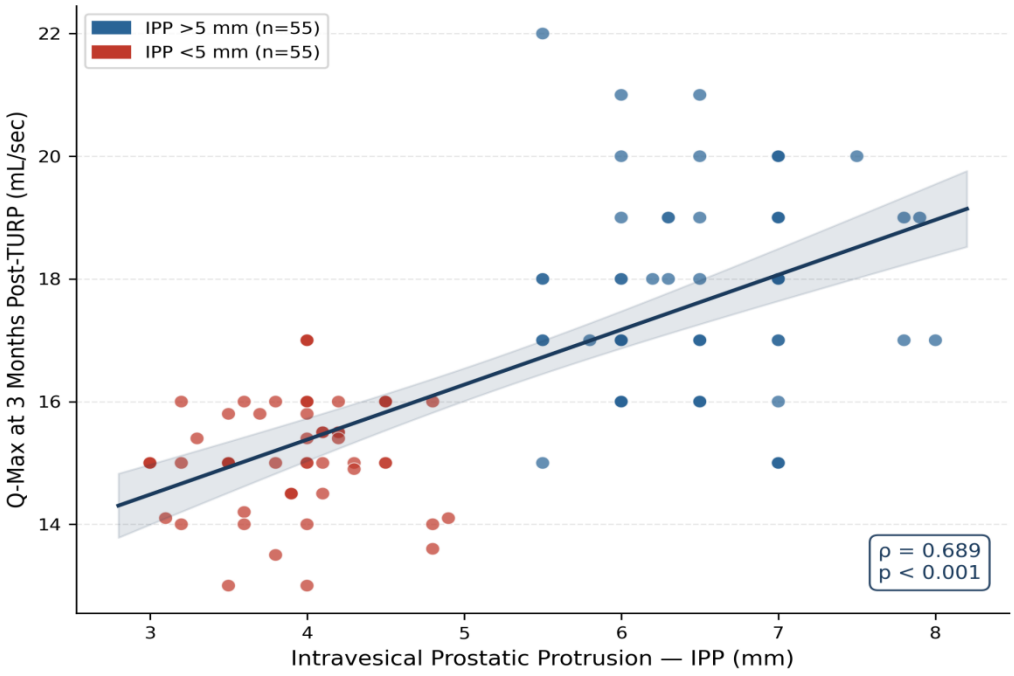


Figure 3 Scatter plot demonstrating a significant positive correlation between intravesical prostatic protrusion (IPP) and Q-Max at 3 months post-TURP, stratified by IPP ≤5 mm (red) and IPP >5 mm (blue) (ρ = 0.689, p < 0.001)

The figure 3 reveals a significant moderate-to-strong positive correlation between IPP and post-TURP Q-Max (ρ = 0.689, p < 0.001). Patients with IPP >5 mm (n = 55) demonstrated progressively higher Q-Max values with increasing IPP, clustering predominantly between 16–22 mL/sec, indicating superior functional urinary outcomes following TURP. Conversely, patients with IPP ≤5 mm (n = 55) showed consistently lower Q-Max values (13–17 mL/sec) with minimal variation across IPP measurements. These findings suggest that greater

preoperative IPP predicts significantly better post-TURP urinary flow improvement, reinforcing IPP as a clinically valuable preoperative predictor of functional surgical outcomes.

DISCUSSION

This study demonstrates that IPP diameter correlates significantly with three-month post-TURP outcomes in men with BPH, showing moderate negative correlation with IPSS ($\rho = -0.616$), moderate positive correlation with Q-Max ($\rho = +0.689$), and low negative correlation with PVR ($\rho = -0.444$), while remaining independent of total prostate volume. These results significantly support IPP's usefulness as a predictive, reliable, and anatomically specific tool for surgical benefit, and largely corroborate earlier studies investigating the relationship of IPP to surgical benefit within different clinical scenarios for BPH management (12, 19).

This is consistent with recent studies that have shown that IPP is a separate predictive variable in outcome models for TURP. IPP was also found to be an independent predictor of surgical effectiveness in a prediction-model study conducted in 2025, in addition to IPSS voiding or storage ratio and PVR ratio, with a high discriminative accuracy (AUC 0.894) (12). Likewise, another study showed that the more severe the protrusion, the worse the baseline urological outcomes and the higher the risk for acute urinary retention and adverse events, beyond symptom scoring, indicating that the protrusion is clinically relevant (17).

The particularly strong Q-Max correlation observed in our cohort supports the mechanistic hypothesis that IPP reflects a dominant mechanical, ball-valve-type obstruction that is directly and substantially relieved by prostatic tissue resection. This is consistent with a 2022 Iranian study that reported higher IPP grades were associated with greater impairment in urinary flow rate and a progressive increase in surgical intervention rates, rising from 4.0% in Grade I to 36.4% in Grade III (20). Together, these results indicate that IPP is a unique anatomical mechanism of BOO that cannot be explained by prostate volume or PSA, which is in line with the not statistically significant correlation between prostate volume and IPP that we found ($p = 0.069$).

The weaker correlation between IPP and postoperative PVR likely reflects the multifactorial nature of residual urine, which depends on both bladder outlet obstruction and detrusor contractility. This is consistent with findings from a nomogram study of 356 TURP patients, where detrusor function and voiding-efficiency parameters provided additional predictive value beyond IPP alone (21). Similarly, an evaluation of trial-without-catheter outcomes in men with acute urinary retention found that IPP predicted successful voiding trials with high positive predictive value, but reinforced that detrusor underactivity remained a confounding variable in a subset of non-responders (22). Overall, the results indicate that PVR improvement is more physiologically variable than symptom score or flow-rate improvements, despite its significant relationship with IPP.

Stratified analysis by age revealed that IPP was significantly correlated with postoperative outcomes across all age groups, with the strongest correlation between IPP and Q-Max observed in younger patients (50–59 years). This indicates that younger males with severe IPP might have a larger functional gain with surgery at an earlier age, as has been previously noted by others with better flow-rate and symptom improvement after surgery in younger patients (11, 23). Our findings in surgically high-risk patients (including patients with cardiac comorbidities) reflect the potential for generalizability of IPP as a prognostic marker across a variety of surgical risk profiles (24).

IPP has proven to be a useful, non-invasive, complementary diagnostic tool in the assessment of BPH-related BOO, with a lower need for invasive urodynamic testing (25). The results show that there is a significant prognostic value to simply evaluating the IPP preoperatively in the direction of symptom relief, urinary flow and bladder emptying after TURP.

The study has the following limitations: single center design, ethnicity diversity, no pressure-flow validation of urodynamics and short-term follow-up. However, bigger multicenter studies with longer follow-up and urodynamic correlation are required to improve the predictive models based on IPP.

CONCLUSION

In men with BPH, intravesical prostatic protrusion (IPP) is an easy, non-invasive ultrasonographic predictor of postoperative IPP. Greater IPP is independently associated with greater improvements in IPSS, Qmax and PVR, and predictive ability was consistent within all demographic subgroups. Using IPP assessment preoperatively in the clinical practice may therefore help in better counseling, surgical planning and identifying which patients are likely to have good results after TURP.

REFERENCES

1. Devlin CM, Simms MS, Maitland NJ. Benign prostatic hyperplasia - what do we know? *BJU international*. 2021;127(4):389-99.doi: 10.1111/bju.15229

2. Gaudiano C, Rustici A, Corcioni B, Ciccarese F, Bianchi L, Schiavina R, et al. PI-RADS version 2.1 for the evaluation of transition zone lesions: a practical guide for radiologists. *The British journal of radiology*. 2022;95(1131):20210916.doi: 10.1259/bjr.20210916

3. Elterman D, Aubé-Peterkin M, Evans H, Elmansy H, Meskawi M, Zorn KC, et al. UPDATE - Canadian Urological Association guideline: Male lower urinary tract symptoms/benign prostatic hyperplasia. *Canadian Urological Association journal = Journal de l'Association des urologues du Canada*. 2022;16(8):245-56.doi: 10.5489/cuaj.7906

4. Ng M, Leslie SW, Baradhi KM. Benign Prostatic Hyperplasia. StatPearls. Treasure Island (FL) ineligible companies. Disclosure: Stephen Leslie declares no relevant financial relationships with ineligible companies. Disclosure: Krishna Baradhi declares no relevant financial relationships with ineligible companies.: StatPearls Publishing
Copyright © 2026, StatPearls Publishing LLC.; 2026.
5. Gandhi J, Weissbart SJ, Kim AN, Joshi G, Kaplan SA, Khan SA. Clinical Considerations for Intravesical Prostatic Protrusion in the Evaluation and Management of Bladder Outlet Obstruction Secondary to Benign Prostatic Hyperplasia. *Current urology*. 2018;12(1):6-12.doi: 10.1159/000447224
6. Cadour F, Tradi F, Habert P, Scemama U, Vidal V, Jacquier A, et al. Prostatic artery embolization using three-dimensional cone-beam computed tomography. *Diagnostic and interventional imaging*. 2020;101(11):721-5.doi: 10.1016/j.diii.2020.05.002
7. Franco JVA, Tesolin P, Jung JH. Update on the management of benign prostatic hyperplasia and the role of minimally invasive procedures. *Prostate International*. 2023;11(1):1-7.https://doi.org/10.1016/j.prnil.2023.01.002
8. Lee A, Lee HJ, Lim KB, Huang HH, Ho H, Foo KT. Can intravesical prostatic protrusion predict bladder outlet obstruction even in men with good flow? *Asian journal of urology*. 2016;3(1):39-43.doi: 10.1016/j.ajur.2015.10.002
9. Chia SJ, Heng CT, Chan SP, Foo KT. Correlation of intravesical prostatic protrusion with bladder outlet obstruction. *BJU international*. 2003;91(4):371-4.doi: 10.1046/j.1464-410x.2003.04088.x
10. Galeti EH, Rasool M, Bharali MD. Intravesical prostatic protrusion and prostate volume in patients with acute urine retention. *International Surgery Journal*. 2022;9(2):356-61.https://doi.org/10.18203/2349-2902.isj20220323
11. Weng DF, Rui H, Zhou WM, Yuan XF, Li HB, Qin ZQ. [Predictive value of comprehensive preoperative evaluation for the outcome of TURP]. *Zhonghua nan ke xue = National journal of andrology*. 2021;27(11):1011-6
12. Yang J, Shi H, Zhan H, Wang H, Yang X, Liang Y, et al. A Preoperative Noninvasive Index Prediction Model for TURP Surgical Outcomes in Patients with Benign Prostatic Hyperplasia. *Journal of investigative surgery : the official journal of the Academy of Surgical Research*. 2025;38(1):2490536.doi: 10.1080/08941939.2025.2490536
13. Tsai CH, Lee WC, Shen YC, Wang HJ, Chuang YC. The role of intravesical prostatic protrusion in the evaluation of overactive bladder in male patients with LUTS. 2020;52(5):815-20.doi: 10.1007/s11255-019-02370-4
14. Sohrabi C, Mathew G, Maria N, Kerwan A, Franchi T, Agha RA. The SCARE 2023 guideline: updating consensus Surgical CAse REport (SCARE) guidelines. *International journal of surgery (London, England)*. 2023;109(5):1136-40.doi: 10.1097/js9.0000000000000373
15. Lee CL, Lee J, Park JM, Na HS, Shin JH, Na YG, et al. Sophisticated regulation of micturition: review of basic neurourology. 2021;17(5):295-307.doi: 10.12965/jer.2142594.297
16. Rahardjo H, Gemilang B. Correlation of Intravesical Prostatic Protrusion in Benign Prostate Hyperplasia and Residual Lower Urinary Tract Symptoms After Surgery: A Systematic Review. *Nephro-Urology Monthly*. 2021;13.doi: 10.5812/numonthly.113614
17. Al Rashed AA, Isa QM, Mahdi A, Ebrahim M, Abdulaziz K, Hasan O, et al. Clinical Outcomes of Intravesical Prostatic Protrusion in Patients With Benign Prostatic Hyperplasia. *Cureus*. 2024;16(1):e52541.doi: s10.7759/cureus.52541
18. Hamza B, Ahmed M, Bello A, Tolani M, Awaisu M, Lawal A, et al. Correlation of intravesical prostatic protrusion with severity of lower urinary symptoms among patients with benign prostatic hyperplasia. *African Journal of Urology*. 2021;27:1-7.doi: 10.1186/s12301-020-00102-0
19. Tan YG, Teo JS, Kuo TLC, Guo L, Shi L, Shutchaidat V, et al. A Systemic Review and Meta-analysis of Transabdominal Intravesical Prostatic Protrusion Assessment in Determining Bladder Outlet Obstruction and Unsuccessful Trial Without Catheter. *European urology focus*. 2022;8(4):1003-14.doi: 10.1016/j.euf.2021.09.016
20. Yahyazadeh S, Izadi S. Clinical Significance of Intravesical Prostatic Protrusion Index in Patients with Clinical Diagnosis of Benign Prostatic Hyperplasia2021.
21. Tian Y, Zhang H, Cao Y, Yang L, Luo G. The P.R.OS.T.A.T.E Nomogram for the Preoperative Prediction of Clinical Efficacy of Transurethral Resection of the Prostate in Benign Prostatic Hyperplasia Patients. 2022;17:845-55.doi: 10.2147/cia.s365282
22. Bansal A, Arora A. Predictors of successful trial without catheter following acute urinary retention in benign prostatic enlargement: A single centre, multivariate analysis. *Neurourology and Urodynamics*. 2017;36(7):1757-62.https://doi.org/10.1002/nau.23194
23. Yeni S, Demir A, Sabuncu H, Yildiz HE, Ortac H. Age-related differences in bladder function and sexual outcomes following bipolar transurethral resection of the prostate: a retrospective cohort study. *Therapeutic advances in urology*. 2026;18:17562872261451290.doi: 10.1177/17562872261451290

24. Mehmood Z, Abdullah MA, Sanan M, Fayyaz H, Ahmad U, Iftikhar A, et al. Outcomes of Transurethral Resection of the Prostate (TURP) in High-Risk Cardiac Patients Under Spinal Anesthesia. *Cureus*. 2025;17(8):e90137.doi: 10.7759/cureus.90137
25. Christensen VS, Skow M. Immediate or delayed trial without catheter in acute urinary retention in males: A systematic review. 2024;5(8):732-47.doi: 10.1002/bco2.369