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Office-based transperineal laser ablation for benign prostatic hyperplasia: functional outcomes and predictors of clinical improvement

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Introduction Transperineal laser ablation (TPLA) is an ultrasound-guided, office-based procedure for the treatment of benign prostatic hyperplasia (BPH). This study evaluates short-term functional outcomes following TPLA and identifies predictors of clinical improvement.

Material and methods This cohort included men undergoing TPLA between January 1, 2025, and February 1, 2026, using a transperineal interstitial laser system (EchoLaser, Elesta SpA). Minimum follow-up was six months. Variables included age, body mass index (BMI), prostate-specific antigen (PSA), PSA density, testosterone, prostate volume, International Prostate Symptom Score (IPSS), peak urinary flow rate (Q_{max}), and post-void residual (PVR). Intraoperative variables included ablation time and energy delivered. Pre- and post- treatement differences were assessed using the Wilcoxon signed rank test. Spearman correlation analysis evaluated predictors of improvement.

Results Thirty-five of forty men met the inclusion criteria. Mean prostate volume was 71.6 cm^3 (range 29.8–196). Mean IPSS improved from 23.5 to 10.6 ($p < 0.001$). Q_{max} increased from 7.2 to 18.4 ml/s ($p = 0.007$). PVR decreased from 396.8 to 70.6 ml ($p < 0.001$). Comorbidities included urinary tract infection or urosepsis history, hypertension, diabetes, hypercholesterolemia, and anticoagulation use. Postoperative complications included three patients with urinary retention requiring catheterization and one patient with urosepsis requiring hospitalization. Greater improvement correlated with higher baseline IPSS and PVR ($p < 0.001$).

Conclusions Office-based TPLA produced significant short term functional improvement. Functional gains were comparable to those achieved with hospital based surgical interventions. Prospective, multicenter, randomized studies are warranted to further evaluate long term durability.

Key Words: benign prostatic hyperplasia ‹› transperineal laser ablation ‹› image-guided surgery ‹› minimally invasive therapy ‹› office-based urology

INTRODUCTION

Benign prostatic hyperplasia (BPH) is a highly prevalent condition among aging men and represents a major cause of lower urinary tract symptoms (LUTS) worldwide [1, 2]. Current American Urological Association (AUA) and European Association of Urology (EAU) guidelines recommend initial management with medical therapy for symptomatic patients [3, 4]. However, a significant proportion of men experience persistent or progressive symptoms and ultimately require procedural intervention. Traditional hospital-based procedures such as transurethral resection of the prostate (TURP) remain highly effective, but require anesthesia, operating room resources, and may necessitate temporary discontinuation of anticoagulation, which can increase risk in elderly patients and those with significant comorbidities [5–7]. Although newer minimally invasive surgical therapies have aimed to reduce morbidity, many still require specialized facilities or anesthesia support [8, 9].

Interstitial laser therapies offer a potential alternative by enabling treatment in an office-based setting under local anesthesia. Transperineal laser ablation (TPLA) is an ultrasound-guided, percutaneous approach that has demonstrated favorable safety and functional outcomes in early feasibility, systematic review, and pooled analyses [10–12]. Importantly, TPLA may be performed without discontinuation of anticoagulation and may be suitable for patients with comorbid conditions who are poor candidates for traditional surgery. Emerging comparative data suggest that functional outcomes are similar to those achieved with hospital-based procedures [13].

Despite increasing clinical adoption, data describing real-world office-based outcomes remain limited. The present study evaluates early outcomes following office-based TPLA and explores baseline and intraoperative factors associated with symptom improvement in a cohort of rural and suburban men, with the aim of further defining its safety, feasibility, and effectiveness compared with established hospital-based therapies.

MATERIAL AND METHODS

Following approval by the Western Institutional Review Board (IRB), we conducted a retrospective review of consecutive male patients who underwent transperineal laser ablation (TPLA) for symptomatic benign prostatic hyperplasia (BPH) between January 1 and September 6, 2025. Patients were followed postoperatively at approximately 3, 6, and 12 months in accordance with standard clinical practice, with scheduling tailored to patient availability and clinical need. For study inclusion, a minimum of 6 months of follow-up was required to ensure consistent outcomes assessment. Outcomes were analyzed according to the intention-to-treat principle. Adult men with symptomatic benign prostatic hyperplasia (BPH) were considered eligible for transperineal laser ablation (TPLA) if they were appropriate candidates for either surgical or non-surgical management. Patients could be on active anticoagulation or temporarily holding therapy at the time of evaluation. Indications included obstructive lower urinary tract symptoms (LUTS), urinary retention (including catheter dependency), post-TURP gland regrowth with recurrent obstruction, and acute urinary retention with post-void residual <2,000 cc. Patients with treated urinary tract infection, sepsis, or catheter-associated urinary tract infection (CAUTI) were eligible following appropriate antimicrobial therapy and, when indicated, infectious disease consultation. Prostates up to 200 grams were included, also counting those with asymmetric lobe distribution or median lobe enlargement. In cases of urinary retention exceeding 1,200 cc, patients were counseled regarding the bladder neck-preserving design of TPLA and the potential need for subsequent bladder neck resection to facilitate voiding. All patients were required to be able to tolerate local anesthesia with a 1% lidocaine periprostatic block and the ability to lie in the dorsal lithotomy position with a Foley catheter placement for intraoperative guidance.

Preoperative evaluation included a comprehensive assessment of demographic, clinical, and laboratory parameters. Age, body mass index (BMI), serum prostate-specific antigen (PSA) and PSA density (PSAD), and total testosterone levels were recorded for all patients. Prostate volume was determined via transrectal ultrasound (TRUS). Functional and symptomatic assessment was performed using the International Prostate Symptom Score (IPSS), peak urinary flow rate (Q_{max}), and post-void residual (PVR), providing a standardized baseline of lower urinary tract symptom (LUTS) severity and objective urinary function [14]. Patients requiring anticoagulation did not have to stop their anticoagulation for this procedure.

All procedures were performed in an office-based setting under local anesthesia (1% lidocaine local anesthetic), enabling treatment of patients irrespective of surgical risk or comorbidities. The Echolaser X4 system (Elesta SpA, Florence, Italy), needles and laser fibers (Laser Thermal Therapy Kit, Elesta SpA, Florence, Italy) were employed for all interventions. Under real-time transrectal ultrasound guidance, optical fibers were inserted transperineally into the prostatic transition zone using a template-guided approach. Energy delivery was tailored according to individual prostate size and anatomy. Treatment simulation was performed, and fiber positioning was verified, using the Echolaser Smart Interface (ESI, Elesta SpA, Florence, Italy). The most common dispersal of fibers included 2 fibers for less than 50 grams and 4 fibers for over 50 grams in volume. Intraoperative parameters, including total ablation time and total energy delivered, both in Joules and Joules per cubic centimeter, were recorded to standardize procedural reporting.

The primary endpoints of the study were the changes in IPSS, Q_{max}, and PVR from baseline to postoperative follow-up. Secondary analyses explored associations between baseline clinical and procedural factors and the magnitude of functional improvements. Postoperative complications were recorded and graded according to the Clavien–Dindo classification system [15]. Continuous variables were summarized as mean ± standard deviation (SD) and median with interquartile range (IQR). Pre- and post-procedure comparisons were performed using the Wilcoxon signed-rank test, while correlations between baseline factors and outcome changes were assessed with Spearman's rank correlation coefficients. Statistical significance was defined as $p < 0.05$. All analyses were conducted using SPSS version 29 (IBM Corp., Armonk, NY, USA).

This methodology allows for standardized reporting of TPLA outcomes in a minimally invasive, office-based context and provides a robust framework for assessing the efficacy, safety, and procedural reproducibility of this technique in routine clinical practice.

Bioethical standards

The study was approved by the Western Institutional Review Board (IRB Tracking Number: 20210347). Informed consent was waived due to the retrospective design.

RESULTS

Baseline characteristics

Thirty-five of 40 patients (87.5%) met the inclusion criterion of at least 6 months of follow-up and were included in the primary analysis. The remaining five patients had undergone more recent procedures and had not yet reached the 6-month follow-up timepoint at the time of analysis. No patients were lost to follow-up. Mean follow-up was 9.56 months (range 6 to 13 months). Baseline characteristics are presented in Table 1. The mean age was 73.1 years. Mean prostate volume was 71.6 cm^3 (range 29.8–196). Our cohort included 35% patients dependent on urethral catheters on presentation. Comorbidity prevalence included hypertension (82.9%), hypercholesterolemia (65.7%), diabetes (37.1%), prior UTI/urosepsis (48.6%), and anticoagulation use (37.1%).

Nine patients (25.7%) had elevated prostate-specific antigen (PSA) levels preoperatively. Of these, five underwent prostate biopsy, with prostate cancer identified in five patients (14.3% of the cohort), including three with Grade Group 1 disease managed with active surveillance, one with Grade Group 4 disease, and one with metastatic disease.

Intraoperative findings

Intraoperative characteristics are presented in Table 2. Anatomic landmarks, measurements, and placement of the laser fiber on sagittal view can be seen in Figure 1. The sagittal view of the prostate gland demonstrates a median lobe; the placement of two laser fibers is depicted. A distance of 1.7 cm is optimal between the laser fiber and the bladder for bladder neck sparing. A distance of 1 cm is ideal between laser fibers and urethra, as visualized in the transverse view presented in Figure 2.

Functional outcomes

Preoperative and postoperative functional outcomes are summarized in Table 3. There was a clinically significant improvement in IPSS, Q_{max}, and PVR noted. Postoperative changes in functional parameters were graphed in Figure 3, as well as outcomes for individual patients. Predictors of improvement were greater ΔIPSS correlated significantly with higher baseline IPSS ($p < 0.001$). Greater ΔPVR

Table 1. *Baseline demographic and clinical characteristics (n = 35)*

Variable	Mean ± SD	Median (IQR)	Range	Normality (Shapiro–Wilk p)
Age (years)	73.09 ±9.55	72.0 (10.5)	50–94	0.905
BMI (kg/m²)	27.72 ±3.63	27.9 (4.5)	20.3–36.6	0.963
PSA (ng/ml)	5.48 ±12.46	2.65 (4.29)	0.24–74.0	<0.001
PSA density (ng/ml/cm³)	0.10 ±0.22	0.041 (0.043)	0.007–1.01	<0.001
Prostate volume (cm³)	71.55 ±40.88	60.0 (33.7)	29.8–196	<0.001
Testosterone (ng/dl)*	428.45 ±258.68	394.5 (130.3)	172–1419	<0.001

*Testosterone available in 20 patients.
Continuous variables are reported as mean ± standard deviation and median with interquartile range (IQR)
BMI – body mass index; PSA – prostate-specific antigen; PSAD – prostate-specific antigen density

correlated with higher baseline PVR (p <0.001). No significant correlations were observed with prostate volume, PSA, PSAD, testosterone, or total energy delivered.

No intraoperative complications occurred, and no patients experienced immediate procedure-related adverse events. Postoperative pain was minimal and managed with oral analgesics. Postoperative complications were limited and graded according to the Clavien–Dindo classification system. Three patients (8%) developed urinary retention requiring urethral catheterization (Clavien–Dindo grade I). One patient with severe baseline urinary retention (initial bladder volume >2,000 ml) demonstrated persistent incomplete emptying and underwent bladder neck resection to optimize voiding; this was performed electively in the context of pre-existing bladder dysfunction rather than as a direct procedural complication. Two additional patients elected to undergo bladder neck resection within 3–6 months to further improve urinary flow despite being catheter-free following TPLA, reflecting individualized management decisions based on underlying pathology. Notably, 35% of the entire cohort presented with urethral catheters preoperatively, and all patients were catheter-free by 6 months. One patient, who had a history of recurrent urinary tract infection and urosepsis, was from overseas and did not return for routine follow-up until 8 months post-procedure. They re-presented at 8 months with a urinary tract infection and bladder stone requiring intervention.

Table 2. Intraoperative characteristics during transperineal laser ablation (TPLA)

Variable	Mean ± SD	Median (IQR)	Range	Normality (p)
Ablation time (min) (n = 34)	12.42 ±3.68	13.5 (6.0)	4.4–18.0	0.055
Total energy (J) (n = 35)	11,458 ±5,237	11,396 (7,207)	3,612–24,052	0.014
Energy density (J/cm^3)	172.56 ±58.27	160.16 (52.87)	75.37–353.71	0.005

Variables include ablation time, total energy delivered, and energy density. Values are reported as mean ± standard deviation and median with interquartile range (IQR)

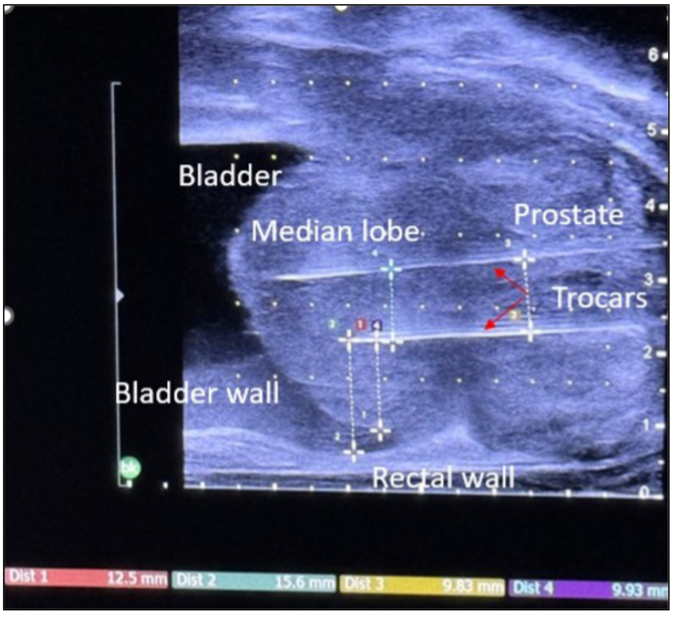

Figure 1. *Anatomic landmarks in sagittal view for transperineal laser ablation (TPLA). A median lobe is present in this patient. Two needles placed in parallel for optimal treatment of prostate and median lobe. Note that measurements from fiber tip to bladder wall and rectal wall are 15 mm. Laser fibers are inserted into needles and measurements are repeated for optimal fiber placement immediately before starting treatment.*

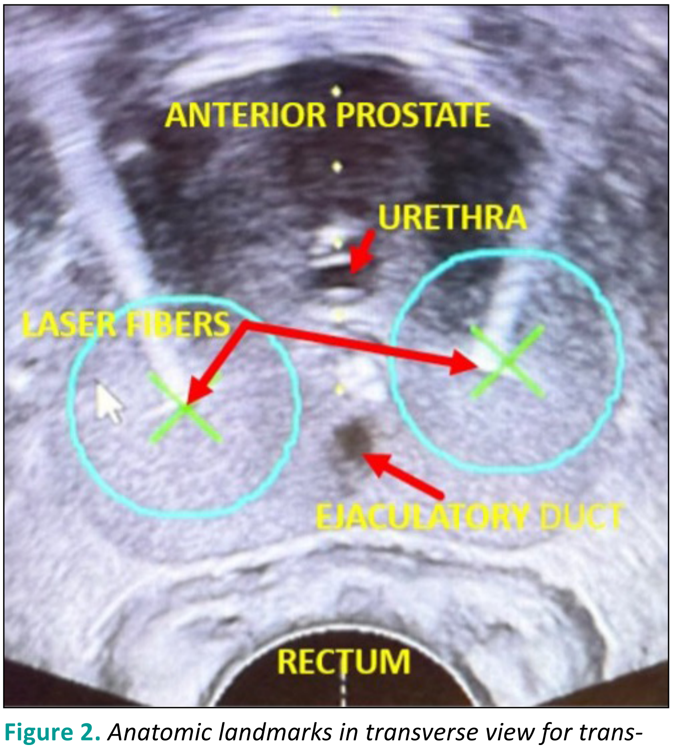

Figure 2. *Anatomic landmarks in transverse view for transperineal laser ablation (TPLA). The laser fiber's optimal distance from the urethra is 1.0 cm, clearly depicted in this view of key anatomic landmarks including urethra, ejaculatory duct, and rectum.*

Given the delayed presentation and underlying risk factors, this event was considered more reflective of baseline disease complexity rather than a direct postoperative complication.
One patient demonstrated persistent elevated post-void residuals of approximately 450 ml but did not require further intervention (grade I). Persistent asymptomatic bacteriuria was observed in 43% of patients on urine cultures at 6 months follow-up (grade I), and all cases resolved with subsequent management and follow-up.

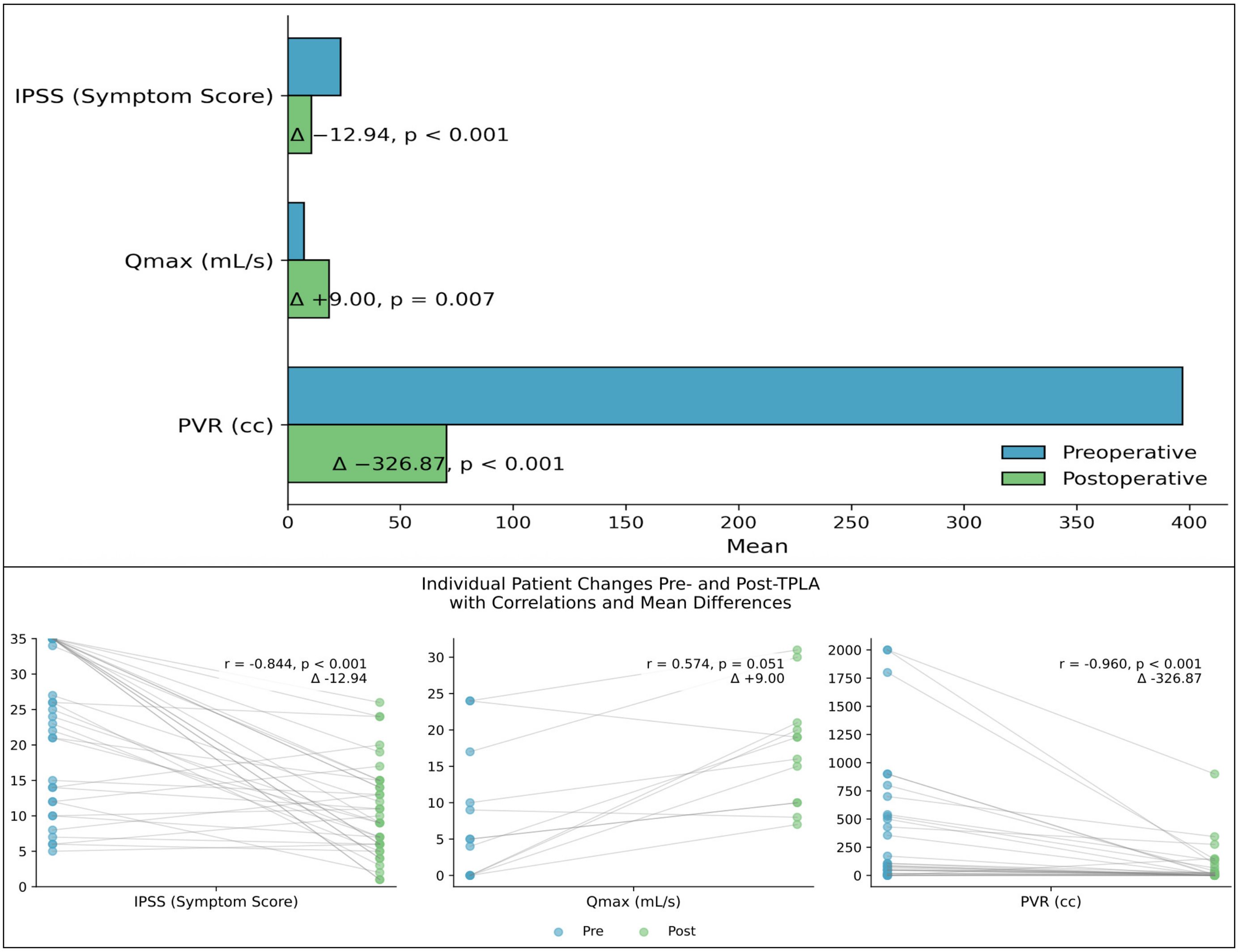

Figure 3. *Functional outcomes after transperineal laser ablation (TPLA). (Top) pre-and postoperative comparisons of International Prostate Symptom Score (IPSS), peak urinary flow rate (Q_{max}), and post-void residual (PVR) among men undergoing transperineal laser ablation (TPLA). Wilcoxon signed-rank test, (all p <0.01). (Bottom) Individual-level correlation analyses between IPSS, Q_{max}, and PVR, pre- and post-TPLA.*

Table 3. *Preoperative and postoperative functional outcomes*

Outcome	N	Preoperative mean ±SD (Median)	Postoperative mean ± SD (Median)	Δ Mean	Wilcoxon p	Effect size (rank biserial)
IPSS	35	23.51 ±11.14 (25)	10.57 ±6.62 (9)	−12.94	<0.001	0.849
PVR (cc)	32	396.82 ±569.01 (97.5)	70.59 ±172.54 (0)	−326.87	<0.001	0.906
Q_{max} (ml/s)	14	7.23 ±8.01 (5)	18.43 ±8.84 (17.5)	+9.00	0.007	0.897

Variables include preoperative and postoperative IPSS, PVR (cc), Qmax (ml/s). Values are reported as mean ± standard deviation and median

DISCUSSION

Benign prostatic hyperplasia (BPH) remains a prevalent urologic condition with significant morbidity, affecting up to 70% of men over 70 years and contributing to progressive lower urinary tract symptoms (LUTS) [1, 2, 16]. Beyond obstructive voiding symptoms, BPH pathophysiology encompasses epithelial and stromal hyperplasia with dynamic cellular remodeling and inflammatory signaling, as demonstrated in genomic analyses. Inflammatory signaling, androgen receptor modulation, and stromal–epithelial remodeling play central roles in progressive obstruction and symptom generation [17, 18]. Contemporary guidelines recommend tailoring intervention based on symptom severity, prostate morphology, sexual function preservation, and comorbidity burden [3, 4, 19].

Medical therapy remains first-line management for BPH; however, a significant proportion of patients eventually require procedural intervention due to refractory symptoms or medication intolerance [3, 4]. Traditional surgical approaches, including transurethral resection of the prostate (TURP) and holmium laser enucleation of the prostate (HoLEP), remain highly effective but carry notable limitations, such as anesthesia requirements, perioperative bleeding, common need for performance in a surgical facility, hospitalization, and potential sexual dysfunction [3–7, 19, 20].

In this context, minimally invasive surgical therapies (MISTs) such as EchoLaser transperineal laser ablation (TPLA) have emerged as outpatient alternatives that can be performed in an office-based setting, entirely under local anesthesia, including in patients considered poor candidates for conventional surgery [10, 21]. In this short-term retrospective cohort of forty patients treated in an office based setting with TPLA, we observed rapid and sustained functional improvement: median Q_{max} increased from 7.2 → 18.4 ml/s (Δ +9.0, $p = 0.007$), median post-void residual (PVR) decreased from 396.8 → 70.6 ml (Δ −326.9, $p < 0.001$), and median IPSS declined from 23.5 → 10.6 (Δ −12.9, $p < 0.001$). Notably, improvements were already substantial by 3 months and stabilized thereafter, consistent with prior pilot and multicenter studies [10, 21–24]. Although our sample size precludes formal inferential testing, the magnitude of change aligns with prior evidence: Tafuri et al. [10] reported mean IPSS reductions of 12–15 points and Q_{max} gains of 5–7 ml/s, while Alberti et al. [21] documented ≥50% IPSS improvement and 6–10 ml/s Q_{max} increases at 12 months, with low adverse event rates. Our cohort achieved outcomes at the upper range of these pooled estimates, suggesting that procedural optimization, patient selection, and operator expertise may further enhance efficacy. At 6 months, 100% of patients had discontinued medication use, and all recurrent urinary tract infections (UTIs) present at baseline had resolved. Four patients presented with acute kidney injury secondary to obstruction, requiring temporary catheterization; all subsequently recovered stable renal function.

A critical comparison with conventional TURP and other MISTs highlights both the strengths and limitations of TPLA. In randomized trials, TURP consistently yielded larger absolute Q_{max} gains (~13–14 ml/s) compared to TPLA (~7–9 ml/s), although TURP is associated with higher rates of ejaculatory dysfunction (up to 70%) and potential erectile complications [13, 25]. Bertolo et al. [25] demonstrated that 96.2% of patients preserved antegrade ejaculation with TPLA vs 28% with TURP, while Canat et al. [13] confirmed similar functional trade-offs: TURP maximized urinary flow but at the expense of sexual function. These findings underscore a recurrent theme in BPH management: maximal voiding improvement must be balanced against long-term sexual outcomes.

Comparisons with other MISTs further contextualize TPLA's role. Aquablation demonstrated five-year IPSS reductions of 15 points and Q_{max} gains of 10–12 ml/s, approaching TURP efficacy but requiring operative theater infrastructure and anesthesia [26, 27]. Prostatic urethral lift (PUL) produced modest Q_{max} improvement (~3–4 ml/s) but preserved sexual function with retreatment rates approaching 13% [28]. Rezūm water vapor therapy delivered intermediate efficacy (IPSS reduction 11–13 points, Q_{max} +4–5 ml/s) with transient irritative symptoms [29]. In this landscape, TPLA achieves functional outcomes superior to PUL and Rezūm in short-term Q_{max} gains and symptom relief, while maintaining a favorable safety and sexual function profile, albeit with slightly lower peak Q_{max} than TURP or Aquablation. Long-term comparative data further demonstrate that while TURP and HoLEP provide robust and durable improvements in urinary flow, minimally invasive options increasingly demonstrate comparable symptom reduction with improved safety and sexual function preservation profiles [5–7, 19, 20, 30]. Critically, TPLA can be delivered entirely in an office setting under local anesthesia, making it feasible for patients with high anesthetic risk or comorbidities who might not tolerate standard surgical interventions [9, 10]. Office-based procedures may also reduce perioperative cost burden, hospital utilization, and recovery time compared to inpatient surgical interventions [31–33].

Mechanistically, TPLA's transperineal image-guided approach enables precise ellipsoid thermoblation while minimizing urethral trauma and preserving neurovascular structures. Laganà et al. [22] similarly reported median Q_{max} improvement from 8 to 16 ml/s and IPSS reduction from 24 to 8 in 63 patients, mirroring our trajectory [33, 35, 36]. These studies observed that prostate volume reductions were statistically significant at early follow-up but plateaued or lost statistical significance at later intervals, likely reflecting tissue remodeling variability rather than clinical deterioration. Comparative randomized data further support TPLA's efficacy relative to convective water vapor therapy: Pacini et al. [23] reported equivalent IPSS reductions (~12–15 points) and Q_{max} gains (~6–8 ml/s) at 6 months, with TPLA producing earlier patient-reported symptom improvement.

Sexual function preservation has been reported as a defining attribute of TPLA in prior studies. Zucchi et al. demonstrated stable erectile and ejaculatory scores at 6 months compared with baseline, while longer-term follow-up by Patelli et al. (median 56.5 months) and Minafra et al. [39] (three years) confirmed sustained IPSS reduction (~13–16 points) and Q_{max} gains (~7–9 ml/s) with minimal retreatment [37, 38]. Long-term durability comparisons across modalities suggest retreatment rates after TURP and HoLEP remain low (<7–8% at 5 years), whereas certain MISTs demonstrate higher retreatment variability depending on gland size and patient selection [6, 8, 9, 30, 40]. In our cohort, no patient required BPH medication after 3 months, reinforcing TPLA's potential for durable symptom relief without adjunctive pharmacotherapy. Coupled with its office-based, local anesthesia delivery, these findings suggest that TPLA is particularly suitable for patients who are poor surgical candidates or prefer minimally invasive, ambulatory care. For elderly or comorbid patients with elevated anesthetic risk, guideline-supported risk stratification increasingly favors less invasive approaches that minimize systemic exposure and hospitalization [3, 4, 19].

The principal limitations include small sample size, retrospective design, and absence of a control arm, limiting statistical power and precluding definitive comparative inferences. Postoperative pain and sexual function outcomes were also not systematically assessed using standardized measures or questionnaires, representing another limitation of this study. Additionally, single-center expertise may amplify observed effect sizes, potentially overestimating reproducibility. Despite these limitations, the observed magnitude of functional improvement and alignment with prior prospective and randomized studies support external validity [10, 13, 21–25, 37–39]. TPLA has recently been incorporated into EAU guidelines, and ongoing randomized trials will further define its role in the management of BPH [19]. Future studies should prioritize multicenter, prospective, two-arm, randomized controlled designs with long-term follow-up and predefined sexual function endpoints to further clarify TPLA's comparative effectiveness.

From a technical perspective, the Echolaser TPLA platform requires ultrasound guidance for needle placement and supports the use of a stepper/stabilizer, as well as optional motorized arm assistance, features that not only enhance precision but also pave the way for further automation in the procedure. The Echolaser Smart Interface (ESI) played a critical role in simulating treatments, optimizing workflow, and ensuring accurate fiber placement while preserving surrounding anatomical structures.

CONCLUSIONS

In this short-term retrospective cohort, TPLA of the prostate demonstrated rapid, substantial, and durable improvements in urinary flow, post-void residual, symptom severity, and quality of life. While preservation of sexual function has been suggested in prior studies, this outcome was not formally assessed in our cohort. Its transperineal, image-guided, office-based design allows procedures to be performed under local anesthesia, making it feasible even for patients with significant comorbidities or those considered poor surgical candidates. Importantly, TPLA enables urologists in rural or resource-limited settings to deliver high-quality care without reliance on hospital-based operative infrastructure, bridging gaps in access to minimally invasive BPH management. Compared with contemporary MISTs, TPLA offers intermediate-to-high functional efficacy, superior preservation of ejaculatory function, and the potential for broad outpatient implementation. Prospective, multicenter randomized trials with extended follow-up, cost-effectiveness assessments, and standardized patient selection criteria are warranted to define TPLA's definitive role within contemporary BPH treatment algorithms.

CONFLICTS OF INTEREST

Victoria Vyonne Bird received a research grant from Rocamed Inc. The remaining authors declare no conflicts of interest.

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ETHICS APPROVAL STATEMENT

The study was approved by the Western Institutional Review Board (IRB Tracking Number: 20210347). Informed consent was waived due to the retrospective design.

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