REVIEW ARTICLE

Vol. 52 (2): e20250423, March - April, 2026
doi: 10.1590/S1677-5538.IBJU.2025.0423

Transperineal Laser Ablation for Treatment of Lower Urinary Tract Symptoms in Benign Prostate Enlargement: A Systematic Review and Meta-analysis

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ABSTRACT

Purpose: This is a systematic review and meta-analysis of the outcomes of transperineal prostate laser ablation (TPLA) in men with benign prostatic enlargement.

Materials and Methods: Pubmed, Embase, Scopus, and Cochrane Library databases were searched from inception to July 2024. Random-effects model was employed to compute mean differences for continuous endpoints. Heterogeneity was evaluated by prediction interval and I-squared statistics. Results were reported following the PRISMA guidelines.

Results: Seventeen studies involving 777 patients with mean age of 62 to 80 years were included. Over 12-month follow-up, TPLA decreased the International Prostate Symptom Score (MD -12.62; 95% CI -14.87 to -10.37; p<0.001; I2 = 90%), post-void residual (MD –73.24 mL; 95% CI –96.91 to –49.57; p<0.001; I2 = 89%), and prostate volume (MD -21.23 mL; 95% CI -32.65 to -9.81; p<0.001; I2 = 84%). TPLA increased the maximum urinary flow rate (MD 6.32 mL/s; 95% CI 4.69 to 7.95; p<0.001; I2 = 81%). Ejaculatory and erectile functions were not impacted. Compared to TURP, TPLA was associated with ejaculatory function preservation, shorter operating time and length of stay. Risk of bias for the non-randomized studies was moderate, and low for the randomized studies.

Conclusions: TPLA demonstrated favorable outcomes for BPE without a negative impact on sexual function. This minimally invasive treatment was found to have advantages over TURP, such as, ejaculatory function preservation, reduced operative time, and shorter hospital stay. Evidence for this MIST is emerging but remains predominantly retrospective with short follow-up, highlighting the need for further comparative prospective studies.

ARTICLE INFO

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Keywords:
Prostatic Hyperplasia; Transurethral Resection of Prostate; Laser Therapy

Submitted for publication:
August 01, 2025

Accepted after revision:
November 12, 2025

Published as Ahead of Print:
May 20, 2025

Data Availability
All data generated or analysed during this study are included in this published article

INTRODUCTION

Benign Prostatic Enlargement (BPE) frequently causes lower urinary tract symptoms (LUTS) in adult men, significantly affecting their quality of life (QoL) (1). If untreated, BPE can lead to serious complications such as acute urinary retention, hydronephrosis, and acute kidney injury (2).

International guidelines recommend lifestyle changes and pharmacological therapies as initial management for male LUTS (3). Surgical options may be indicated when pharmacotherapy fails or is not tolerated (4). However, these treatments often impact sexual function, particularly ejaculatory function, leading to poor adherence or discontinuation, mostly in young patients who want to preserve antegrade ejaculation (5). Therefore, improvements in minimally invasive and endoscopic methods for BPE have expanded therapeutic options, to minimize side effects and increase treatment efficacy (6).

Endoscopic laser treatments have made significant advances, proving to be effective, but still with significant adverse events and complications, such as retrograde ejaculation (7). Minimally invasive surgical therapies (MISTs) offer faster recovery and effective relief from LUTS with minimal side effects (8). Nevertheless, these newer methods generally have inferior functional results compared to traditional transurethral treatments (9).

In this context, transperineal laser ablation of the prostate (TPLA) has emerged as an alternative option that could maintain ejaculatory function in patients with BPE (10). Recent studies indicate promising perioperative and functional outcomes with TPLA in carefully selected patients with BPE/LUTS (11). This systematic review and meta-analysis aim to assess TPLA efficacy in treating BPE/LUTS and its influence on sexual function.

MATERIALS AND METHODS

Study Design

This systematic review and meta-analysis follow the Cochrane Collaboration recommendations and is reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement guideline (Table-S1) (12). The study protocol was registered on June 21st, 2024, in the PROSPERO database, under the identification number CRD42024556034.

Eligibility Criteria

Inclusion in this meta-analysis was restricted to studies that met the following eligibility criteria: (1) randomized controlled trials (RCTs) or nonrandomized cohorts; (2) transperineal laser ablation of the prostate in treating LUTS decurrent from BPE; and (3) enrollment of male patients older than 18 years with BPE. Additionally, studies were only included if they reported any clinical outcomes of interest, including primary outcome measures related to LUTS relief and side effects. Exclusion criteria were applied to studies with (1) potential overlapping populations; (2) unavailable full text; and (3) publications in non-English languages.

Search Strategy and Data Extraction

Two authors (I.Z. and M.P.) independently conducted searches on PubMed, Embase, and Cochrane Central Register of Controlled Trials from inception to June 2024, using specific search terms: 'benign prostatic enlargement', 'BPE', 'lower urinary tract symptoms', 'LUTS', 'transperineal laser ablation', and 'TPLA'. The complete and detailed search strategy is available in supplementary materials. Reference lists from all included studies were also manually searched for additional studies. Titles and abstracts of all electronic records were screened for potential eligibility. Subsequently, the articles regarded as eligible were retrieved as full texts. Then, any studies that did not report the outcomes of interest or fulfilled inclusion criteria were excluded. Three authors (I.Z., M.P., and M.G) independently extracted data following predefined search criteria and quality assessment. Disagreements were resolved through discussion with a fourth author (R.S.) and, when necessary, by consultation with the senior author (M.A.A).

Endpoints

Primary endpoints consisted of the International Prostatic Symptoms Score (IPSS) and objective parameters, such as the maximum urinary flow rate (Qmax), prostate volume (PV), and post-void residual (PVR). Secondary endpoints included ejaculatory and erectile function, evaluated by the Male Sexual Health Questionnaire - Ejaculatory Dysfunction (MSHQ-EjD) and the International Index of Erectile Function (IIEF-5); surgical aspects, comprised by operating time and length of stay; and quality of life reported by the IPSS Q8.

Quality Assessment

Randomized and nonrandomized studies were evaluated using the Cochrane Collaboration's risk-of-bias tools: RoB-2 (13) and ROBINS-I (14), respectively. Two independent authors (T.M. and M.G.) adhered to the Grading of Recommendations, Assessment, Development, and Evaluation (GRADE) handbook guidelines to assess the evidence's certainty level, utilizing categorizations ranging from high to very low (15). Publication bias was investigated by funnel-plot analysis of point estimates according to study weights (16).

Statistical Analysis

Data was synthesized using a random effects meta-analysis through a restricted maximum likelihood estimator. The random effects model was employed to account for potential clinical, methodological, and statistical heterogeneity since no assumption can be made that there would be no heterogeneity and that the intervention's true effect will be the same in the included studies (16, 17). Continuous endpoints were summarized using mean difference (MD). Additionally, a subgroup analysis was performed to compare outcomes between TPLA and TURP, the conventional standard therapy, from available randomized trials. Statistical significance was established by a 95% confidence interval (CI) and a p-value under 0.05. Evidence of heterogeneity was assessed with the Chi2 test, Tau and Tau2. To avoid misleading interpretation with a pre-determined threshold for I2 statistics, the extent of heterogeneity was evaluated by associating it with the prediction interval (PI) (18, 19). Additionally, a "leave-one-out" sensitivity analysis was performed to identify potential sources of heterogeneity. All statistical analyses were performed in R software version 4.4.1 (R Foundation for Statistical Computing) (20).

For outcome data presented in medians and interquartile ranges (IQRs), we used the most recent calculator to convert them into means and standard deviations (21). Additionally, for the study by Chen et al. (22), which reported outcomes using change scores rather than direct means and SDs, we employed an additional specialized calculator to facilitate the conversion, available at https://www.statstodo.com/CombineMeansSDs.php.

RESULTS

Study Selection and Baseline Characteristics

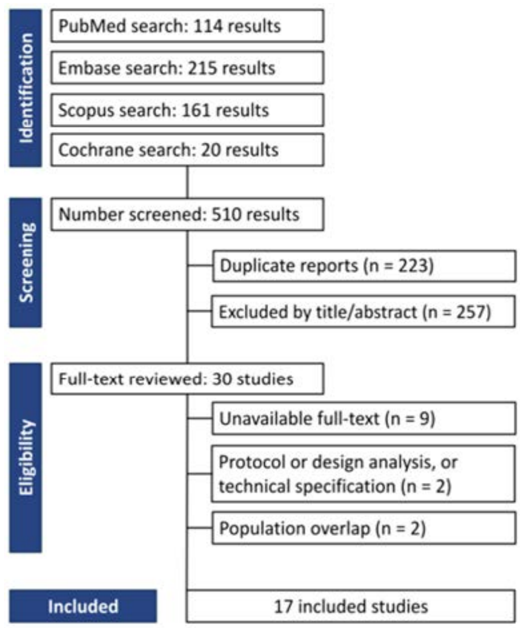
As reported in Figure-1, the initial search yielded 510 results. After excluding 223 duplicates, 257 articles were excluded based on title and abstract review. Subsequently, 30 articles were fully evaluated. In this comprehensive analysis, 9 articles were excluded due to full-text unavailability, 2 for protocol or design analysis and technical specification, and the last 2 excluded had overlapping populations. In this case, we selected the studies with the larger number of participants or the number of reported outcomes. Finally, 17 studies with 777 patients with BPE were included (22-38). These comprised 3 RCTs and 14 cohort studies, published from 2017 to 2024.

The baseline characteristics of the included studies are shown in Table-1.

Operative and Perioperative Aspects

All the patients were placed in lithotomy position. An 18Fr three-way vesical catheter was placed and continuous saline irrigation for urethral cooling was applied. The procedure was performed under transrectal ultrasound (TRUS) guidance. The use of a multi-channel needle applicator with a dedicated

Figure 1. PRISMA flow diagram of study screening and selection. Flow diagram illustrating the process of literature identification, screening, eligibility assessment, and inclusion. Of 510 records initially retrieved, 17 studies met the inclusion criteria and were analyzed in the meta-analysis.



Abbreviations: PRISMA – Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

software display grid overlapping the ultrasound images could also aid the procedure (23, 37). Local anesthesia was administered in 16 studies (22, 24-38), with concurrent conscious sedation or optimal sedation used in 13 studies (25-30, 32-38). One study performed standard spinal anesthesia (23).

TPLA was performed using EchoLaser (SoracteLite) and Asclepion. The diode laser generator with four independent channels, provided by Elesta, was employed for all procedures, except Chen et al. 2023 (22), where Asclepion Laser Technologies was provided. A 21G trocar needle was used to accommodate the 300-μm flat-tip optical fiber and a continuous mode with a wavelength of 1064 nm was employed. Lo Re, Sessa, De Rienzo, and Manenti (30, 31, 37, 38) initially set the power at a higher level (5 W, 4.5 W, and 5 W, respectively) and then reduced it after 1-2 minutes, while others used a fixed power setting of 3 W. The power deployed by Chen varied from 3 to 5 W (22).

The energy setting for the single fiber was 1800 J, except for Patelli and Sessa (34, 38), who reported settings ranging from 1200 to 1800 J. Up to three fibers per lobe were used with simultaneous laser emission, depending on prostate volume and surgeon preference. A second ablation cycle, called pull-back, was executed in larger prostates. This involved retracting the fiber 10 mm along its trajectory to deliver an additional 1200–1800J (22, 24, 26-29, 31-35, 37, 38).

Ten studies used antibiotic prophylaxis (26-29, 31, 33-35, 37, 38). At the end of the treatment, four studies utilized dexamethasone to reduce edema and inflammatory reactions, (6, 25, 27, 33) while two studies prescribed prednisone (31, 37). Chen et al. and Sessa et al. applied one dose of dexamethasone and methylprednisolone intravenously after treatment, respectively (22, 38). The mean procedural time ranged from 16 to 60.9 minutes (24, 25). Additionally, the mean length of stay ranged from 1.5 hours to 2.5

days (22, 24), while the catheterization period ranged from 4 to 22.8 days (23, 35).

Table-S2 summarizes the technical parameters of all selected studies.

Inclusion and Exclusion Criteria of the Included Studies

The inclusion and exclusion criteria differed between the studies. Eligible studies normally included patients over 18 years old with a PV ranging from 30 to 100 mL, measured by TRUS or magnetic resonance imaging (MRI), who were candidates for treatment with TPLA. The usual inclusion criteria also involved LUTS with an IPSS of 8 or more, a Qmax of 15 mL/s or less, or a PVR of 50 to 400 mL.

Ten studies reported the pharmacological treatments used for BPE (23, 26-31, 35, 37, 38). One study (31) focused exclusively on patients using combination therapy, while another did not describe the pharmacological treatment (35).

Common exclusion criteria included previous procedures on the urethra or prostate, prostate-specific agent levels higher than 4 ng/mL or suspected prostate cancer, a history of urethral stricture, neurological diseases, allergies to ultrasound contrast, underactive detrusor, bladder cancer, anterior prostatic abscess, acute or chronic prostatitis, active urinary tract infection, gland volume greater than 100 mL, bladder stones and active hematuria. Table-S3 provides a detailed list of these conditions. Some studies did not contraindicate the treatment for patients with a median lobe / intravesical prostatic protrusion (IPP) (27, 28, 33, 34, 37) or taking anticoagulants or antiplatelet agents (23, 25-27, 30, 33, 36-38). However, Minafra et al. (32) reported that a predictive factor for treatment failure in their cohort was the presence of the median lobe/IPP.

Functional Outcomes by Follow-up Time

In our pooled analysis, improvement in Qmax was observed after three months of treatment (MD 3.42 mL/s; 95% CI 2.44 to 4.40; p<0.001; I2 = 31%. Figure-2). Within six and twelve months, Qmax increased progressively (MD 5.02 mL/s; 95% CI: 3.80 to 6.24; p<0.001; I2 = 72%, and MD 6.32 mL/s; 95% CI 4.69 to 7.95; p<0.001; I2 = 81%. Figure-2). TPLA was associated with a significant decrease in IPSS as of one-month follow-up (1 month: MD −4.48; 95% CI −6.92 to −2.03; p<0.001; I2 = 41%. 3 months: MD −11.11; 95% CI −12.72 to −9.51; p<0.001; I2 = 66%. 6 months: MD −12.46; 95% CI −14.25 to −10.66; p<0.001; I2 = 82%; 12 months: MD −12.62; 95% CI −14.87 to −10.37; p<0.001; I2 = 90%. Figure-3; Figure S13 and S14). Reduction in prostate volume was observed within twelve months (MD −21.23 cm^3; 95% CI −32.65 to −9.81; p<0.001; I2 = 84%. Figure-S1). PVR also decreased over twelve months (3 months: MD −46.09 mL; 95% CI −65.66 to −26.51; p < 0.001; I2 = 62%. 6 months: MD −48.30 mL; 95% CI −60.53 to −36.07; p < 0.001; I2 = 57%. 12 months: MD −73.24 mL; 95% CI −96.91 to −49.57; p<0.001; I2 = 89%. Figure-S2). However, in the first month after the surgery, it had no statistically significant change (MD −28.78 mL; 95% CI −57.91 to 0.35; p = 0.053; I2 = 55%. Figure-S2). TPLA was associated with better quality of life by decreasing the IPSS Q8 score in six, twelve, and thirty-six months (MD −2.60; 95% CI −2.99 to −2.22; p < 0.001; I2 = 70%. MD −3.07; 95% CI −3.51 to −2.62; p < 0.001; I2 = 89%. MD -3.19; 95% CI -4.06 to -2.32; p < 0.001; I2 = 83%. Figure-S3).

Sexual Function by Follow-up Time

Eight studies analyzed ejaculatory dysfunction by MSHQ-EjD. At one-month follow-up, there was no statistically significant change (MD 1.91; 95% CI −0.29 to 4.10; p = 0.089; I2 = 62%. Figure-S4). After three and six months, there was a significant improvement in ejaculatory function (MD 2.01; 95% CI 0.71 to 3.31; p = 0.002; I2 = 32%, and MD 3.28; 95% CI 1.93 to 4.6; p < 0.001; I2 = 0%. Figure-S4). After twelve months, the ejaculatory function remained stable compared to baseline (MD 1.64; 95% CI −0.47 to 3.75; p = 0.127; I2 = 85%. Figure-S4). The IIEF-5 was performed in nine studies to evaluate erectile function. There was no significant statistical alteration in erectile function after the surgery during twelve months (MD 0.54; 95% CI −0.62 to 1.69; p = 0.363; I2 = 0%. Fugire-S5).

Comparative Analysis Studies (TPLA x TURP)

In our subgroup analysis of RCTs comparing TPLA against TURP, there was no significant difference in the treatment of LUTS, as assessed by the IPSS (MD 1.81; 95% CI −2.14 to 5.76; p = 0.369; I2 = 84%. Figure-4A). Additionally, TPLA was demonstrated to be more effective in preserving ejaculatory

Table 1. Baseline characteristics of the included studies. Summary of patient demographics, prostate volume, baseline functional parameters, and sexual function indices prior to intervention. Data are presented as mean ± standard deviation (SD) or median (interquartile range, IQR).

Study author/year	Time	N	Age [1] (years)	BMI [1] (kg/m²)	PV [1] (mL) (%)*	PSA [1] (ng/mL)	Qmax [1] (mL/min)	PVR [1] (mL)	IPSS [1]	IIEF-5 [1]	MSHQ-EjD3 [1]	IPSS-Q8 [1]
Bertolo, 2023	Baseline	51 (TPLA 26 / TURP 25)	63 (57-70.5)	NA	TPLA 49 (37–65) / TURP 55 (25–88)	TPLA 3.0 (1.1–4.0) / TURP 2.0 (1.2–2.2)	TPLA 10.2 (8.7–12.0) / TURP 10.0 (6.5–11.6)	TPLA 70 (20–100) / TURP 30 (20–70)	TPLA 24.0 (16.0–29.0) / TURP 20 (18.5–24.0)	TPLA 17.0 (15.0–21.0) / TURP 20.0 (16.0–20.5)	TPLA 29.0 (25.0–30.0) / TURP 29.0 (25.5–30.5)	TPLA 5 (3–5) / TURP 4 (3–5)
	1 month	NA	NA	NA	NA	NA	NA	NA	NA	18 (14–23) / 19 (18–23)	29.0 (25.0–30.0) / 20.0 (10.0–25.0)	NA
	6 months	NA	NA	NA	NA	NA	15.2 (13.5–18.3) / 26.0 (22.0–48.0)	0 (0–5) / 0 (0–20)	11 (8–15) / 8 (3–9)	NA	NA	2 (2–4) / 2 (1–2)
Cai, 2021	Baseline	20	73.9 ± 9.2	NA	70.8 ± 23.8	NA	8.5 ± 3.0	78.7 ± 58.8	22.7 ± 5.3	NA	NA	4.9 ± 1.7
	6 months	NA	NA	NA	54.7 ± 20.9	NA	15.2 ± 4.8	30.3 ± 34.2	9.1 ± 3.2	NA	NA	2.3 ± 1.3
Canat, 2023	Baseline	50 (TPLA 25 / TURP 25)	65.58 ± 6.59	TPLA 27.85 ± 2.12 / TURP 27.93 ± 2.27	TPLA 66.77 ± 25.28 / TURP 63.63 ± 21.10	TPLA 4.79 ± 4.63 / TURP 3.71 ± 3.26	TPLA 8.73 ± 3.77 / TURP 8.32 ± 3.54	TPLA 125 ± 68.50 / TURP 139.4 ± 58.73	TPLA 20.14 ± 6.02 / TURP 21.17 ± 4.33	TPLA 14.84 ± 3.93 / TURP 14.17 ± 4.09	TPLA 10.75 ± 2.42 / TURP 11.07 ± 1.87	TPLA 4.75 ± 0.75 / TURP 4.69 ± 0.75
	12 months	NA	NA	NA	TPLA 47.32 ± 13.59 / TURP NA	NA	TPLA 14.26 ± 3.73 / TURP 21.37 ± 6.04	TPLA 46.88 ± 32.40 / TURP 49.13 ± 31.54	TPLA 10.14 ± 3.21 / TURP 10.95 ± 4.33	TPLA 14.68 ± 3.92 / TURP 13.44 ± 4.53	TPLA 10.33 ± 2.31 / TURP 5.93±4.01	TPLA 1.50 ± 0.90 / TURP 1.31 ± 0.75
Chen, 2023	Baseline	51 (TPLA 25 / TURP 26)	69.27 ± 9.67	TPLA 24.38 ± 2.91 / TURP 23.18 ± 2.66	TPLA 60.48 ± 21.1 / TURP 65.19 ± 21.1	TPLA 3.63 ± 1.73 / TURP 3.32 ± 1.84	TPLA 77.14 ± 6.11 / TURP 75 ± 6.27	TPLA 92.5 ± 73,282.5 / TURP 104 ± 62,104	TPLA 23.14 ± 5.38 / TURP 21.40 ± 4.15	TPLA 9.86 ± 4.31 / TURP 10.12 ± 4.28	6.09 ± 3.84 / 6.41 ± 2.28	4.57 ± 0.65 / 4.25 ± 0.58
	3 months[2]				TPLA 73.27 ± 12.94* / TURP 68.59 ± 19.38*	TPLA 0.55 ± 2.02 / TURP -1.56 ± 0.63	TPLA 5.28 ± 4.24 / TURP 16.33 ± 9.82	TPLA -39 (-97,-35) / TURP -85 (-140,-25)	TPLA -14.17 ± 6.13 / TURP -13.19±5.86	TPLA -0.27 ± 1.56 / TURP 0.06 ± 0.93	TPLA 0.49 ± 1.08 / TURP -1.52 ± 0.67	TPLA -2.33 ± 0.89 / TURP -2.5 ± 0.97
Destefanis, 2023	Baseline	40	80 (72.5–84)	24 (22–27)	38 (30.5–73)	2.2 (0.8–3.8)	8 (5.5–10)	38 (30.5–73) cc	25 (19–30)	NA	NA	6 (5–6)
	3 months	NA	NA	NA	35 (26–49)	2.3 (1.7–2.7)	12.5 (9.5–14)	30 (0–60)	10.5 (7.5–13)	NA	NA	3 (0–4)
	6 months	NA	NA	NA	34 (28–49)	1.8 (0.9–8)	12 (10–13)	30 (0–60)	8 (6–11.5)	NA	NA	2 (0–4)
Frego, 2021	Baseline	22	61.9 (55–65.5)	27.16 (24.8–28.6)	65 (46.5–81)	2.24 (1.4–4.5)	9 (5–12.5)	60 (25–107.5)	22 (19.5–25.25)	NA	NA	4 (4–5)
	3 months	NA	NA	NA	46(28.4–69)	NA	12 (9–16.5)	39 (10–87.5)	8 (4.5–11)	22 (19.5–24)	NA	1 (0.5–2)
	6 months	NA	NA	NA	42.3 (39.5–59	NA	15 (11.5–20.5	40(16–63)	5(3–8.5)	23 (20.5–24)	NA	1(0–2)
	12 months	NA	NA	NA	41.5 (36.25–55)	NA	20.5 (14.25–23.75)	30 (5–50)	6(4.25–7)	21.5 (17.25–23.75)	NA	1 (1–2)
Kollenburg, 2024	Baseline	20	70.3 ± 7.3	NA	65.5 ± 23.0	5.0 ± 3.3	9.7 ± 3.5	61.8 ± 58.3	21.3 ± 5.2	35.4 ± 23.6	NA	4.9 ± 0.9
Frego, 2021	3 months	NA	NA	NA	NA	NA	12.8 ± 6.1	64.8 ± 70.4	12.8 ± 6.0	36.9 ± 24.8	NA	2.6 ± 1.7
Kollenburg, 2024	6 months	NA	NA	NA	NA	NA	12.1 ± 6.1	74.2 ± 87.4	11.7 ± 5.2	40.5 ± 23.3	NA	1.8 ± 1.0
Lagana, 2023	12 months	NA	NA	NA	63.2 ± 20.6	NA	14.9 ± 6.0	44.2 ± 55.8	10.9 ± 5.5	31.1 ± 24.4	NA	1.9 ± 1.1

Laganà 2023	Baseline	63	72.3 ± 10	30.2 ± 7.1	63.6 ± 29.7	4.82 ± 1.8	8.6 ± 3.5	124.8 ± 115.4	20.8 ± 7.4	NA	NA	4.7 ± 1.4
Manenti, 2021	3 months	NA	NA	NA	45.6 ± 21.8	NA	NA	43.6 ± 53.6	11.0 ± 6.6	NA	NA	1.5 ± 1.2
Pacella, 2019	12 months	NA	NA	NA	NA	2.89 ± 1.2	16.2 ± 4.3	40.6 ± 53.6	8.4 ± 5.9	NA	NA	1.2 ± 0.8
Lo Re, 2024	Baseline	100	66.5 (60–75)	25.9 (23.5–27.6)	50 (40–70)	NA	9.1 (6.9–12)	90 (50–150)	18 (15–23)	NA	6 (2–11)	4 (3–4)
Patelli, 2024	3 months	NA	NA	NA	NA	NA	11 (8.8–14.8)	45 (20–77,5)	10 (6–13)	NA	10 (5–13)	2 (1–3)
Polverino, 2023	6 months	NA	NA	NA	NA	NA	11 (8.5–16.0)	50 (20–90)	10 (5.7–14)	NA	11 (5–14)	2 (1–3)
Rienzo, 2021	12 months	NA	NA	NA	NA	NA	13 (8.5–16.9)	45 (1.2–87.5)	10 (5–16.5)	NA	9 (5–13)	2 (1–3)
Manenti, 2021	Baseline	44	72.1 ± 6.6	NA	102.42 ± 36.3	7.3 ± 1.8	7.6 ± 4.2	138.4 ± 40.8	18.5 ± 5.5	21 ± 4	4.9 ± 3.7	5.8 ± 1.4
	12 months	NA	NA	NA	48.12 ± 19.2	2.1 ± 0.8	16.2 ± 4.9	18.8 ± 8.5	6.2 ± 3.8	22 ± 3	7.7 ± 3.2	2.1 ± 1.1
Minafra, 2023	Baseline	21	63 (55–70)	NA	41.5 (40.0–54.3)	NA	8.8 (7.8–10.8)	70.0 (33–120)	18 (16–21)	17 (15–21)	4 (3–8)	4 (4–5)
	6 months	NA	NA	NA	NA	NA	13.9 (5.0–32.0)	14.0 (0–50)	6 (3–12)	18 (3–25)	9 (15–13)	2 (1–3)
	3 years	NA	NA	NA	35.0 (32.0–38.8)	NA	11.0 (9.0–12.8)	15.0 (0– 25)	12 (10–15)	17 (15–20)	11(7–21)	2 (1–2)
Pacella, 2019	Baseline	160	69.8 ± 9.6	NA	75.0 ± 32.4	NA	8.0 ± 3.8	89.5 ± 84.6	22.5 ± 5.1	NA	NA	4.5 ± 1.1
	6 months	NA	NA	NA	60.3 ± 24.5	NA	14.3 ± 3.9	27.2 ± 44.5	7.7 ± 3.3	NA	NA	1.8 ± 1.0
	12 months	83	NA	NA	58.8 ± 22.9	NA	15.0 ± 4.0	17.8 ± 51.0	7.0 ± 2.9	NA	NA	1.6 ± 0.9
Patelli, 2017	Baseline	18	71.7 ± 9.4	NA	69.8 ± 39.9	NA	7.6 ± 2.7	199.9 ± 147.3	21.9 ± 6.2	NA	NA	4.7 ± 0.6
	3 months	NA	NA	NA	54.8 ± 29.8	NA	13.3 ± 76.2	81.5 ± 97.8	10.7 ± 4.7	NA	NA	2.1 ± 1.2
Patelli, 2024	Baseline	40	65.1 ± 8.3	NA	66 (48.5–86.5)	NA	9.8 ± 6.2	108 (38–178)	23 (19–26)	NA	NA	5 (4–5)
	12 months	NA	NA	NA	46 (36–65)	NA	12.8 ± 7.4	13.5 (0–40.5)	5 (4–9)	NA	NA	1 (0–1)
	24 months	NA	NA	NA	48 (31–84)	NA	10.8 ± 6.9	23 (5–54)	5 (4–10)	NA	NA	1 (0–1)
	36 months	38	NA	NA	49.5 (31–79)	NA	10.4 ± 4.8	21 (5–49)	7 (3–10)	NA	NA	1 (0–2)
Polverino, 2023	Baseline	23	77 (68–84)	24.5 (22–27)	42 (39–70)	NA	NA	NA	NA	NA	NA	4 (3–5)
	12 months	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2 (1–3)
Rienzo, 2021	Baseline	21	62 (54–69)	27 (25–28)	40 (40–50)	2.0 ± 1.1	9.2 ± 3.4	81.8 ± 62.6	18.3 ± 3.9	17.8 ± 6.6	5.7 ± 4.5	4.1 ± 1.0
	1 months	NA	NA	NA	NA	3.0 ± 1.9	12.1 ± 6.4	37.4 ± 25.7	12.0 ± 5.6	17.4 ± 5.0	9.6 ± 4.1	2.4 ± 1,6
	3 months	NA	NA	NA	NA	1.7 ± 0.8	13.3 ± 6.7	18.7 ± 21.2	8.3 ± 3.8	17.7 ± 6.7	6.8 ± 3.5	1.4 ± 0.9
	6 months	NA	NA	NA	NA	1.7 ± 0.8	13.9 ± 6.2	14.0 ± 17.7	6.1 ± 2.6	18.3 ± 5.7	8.6 ± 3.1	1.7 ± 0.8
Sessa, 2022	Baseline	38	71.5 (63.5–79)	25 (22–29)	46 (38–71)	1.86 (0.56–2.76)	9.1 (8–11.5)	100 (70–150)	20 (16–25)	15 (7–24)	6 (2–10)	4 (3–5)
	1 month	NA	NA	NA	NA	NA	10.6 (9–13.6)	55 (32.5–97.5)	15 (12–20)	16 (8–21)	7 (6–10)	3 (2–4)
	3 months	NA	NA	NA	NA	NA	11 (9.4– 13.6)	50 (35–95)	11 (9–16)	18 (8–24)	8 (7–11)	1 (1–3)

NA, not available; BMI, body mass index; IIEF, International Index of Erectile Functions; IPSS, International Prostatic Symptoms Score; MSHQ-EJD, Male Sexual Health Questionnaire-Ejaculatory Dysfunction; PSA, prostate-specific antigen; PV, prostate volume; PVR, Post-Void Residual; Qmax, Maximum urinary flow; IPSS-Q8, International Prostatic Symptoms Score - question 8; TPLA, Transperineal Prostate laser ablation; TURP, transurethral resection of the prostate. [1] Mean (Standard Deviation) or median (IQR).
[2]Variation from the baseline to 3 months.

Figure 2. Forest plots of changes in Qmax at different follow-up intervals after TPLA. TPLA produced a consistent and statistically significant improvement in urinary flow over time, reflecting enhanced bladder emptying capacity.

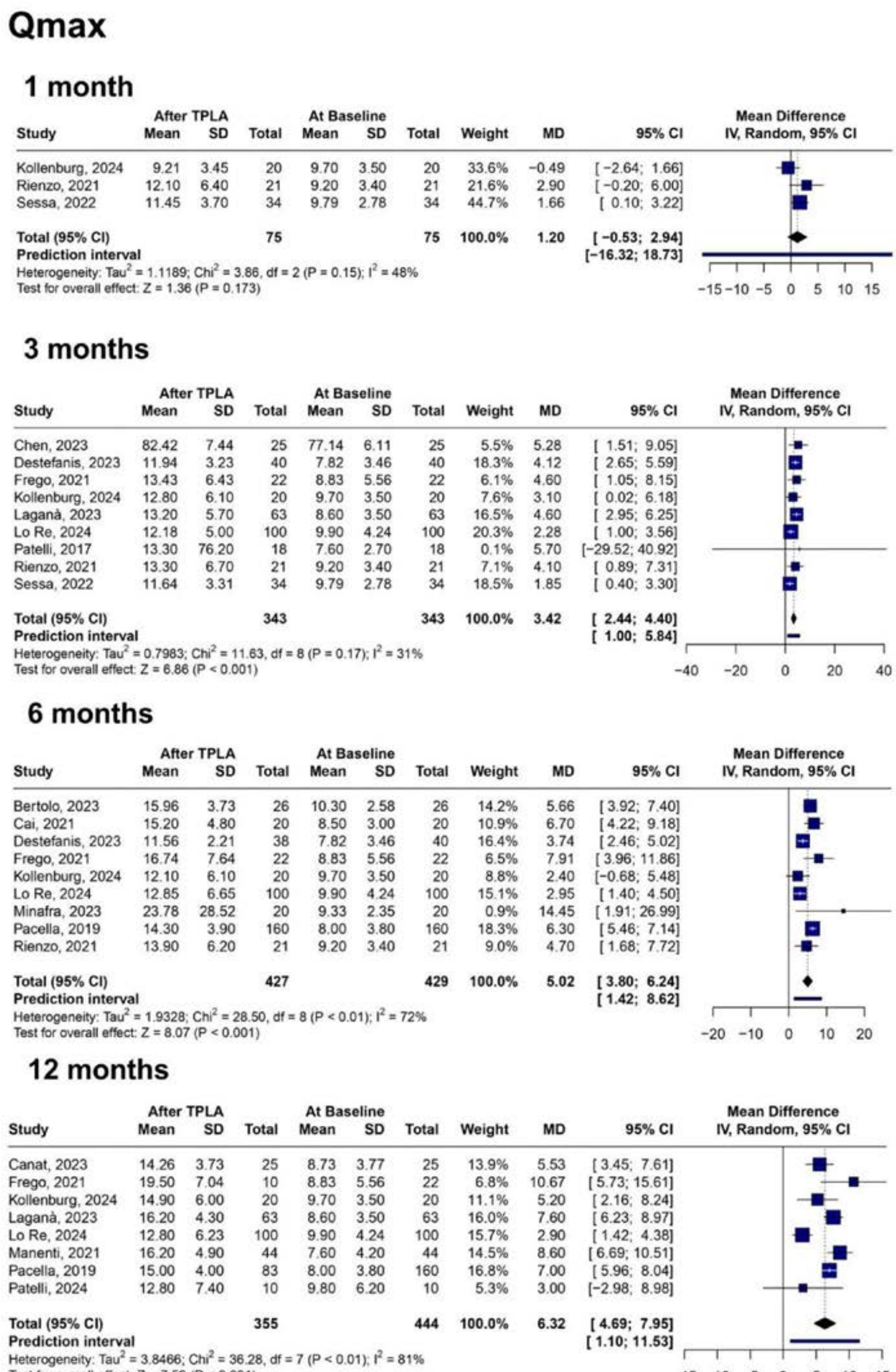
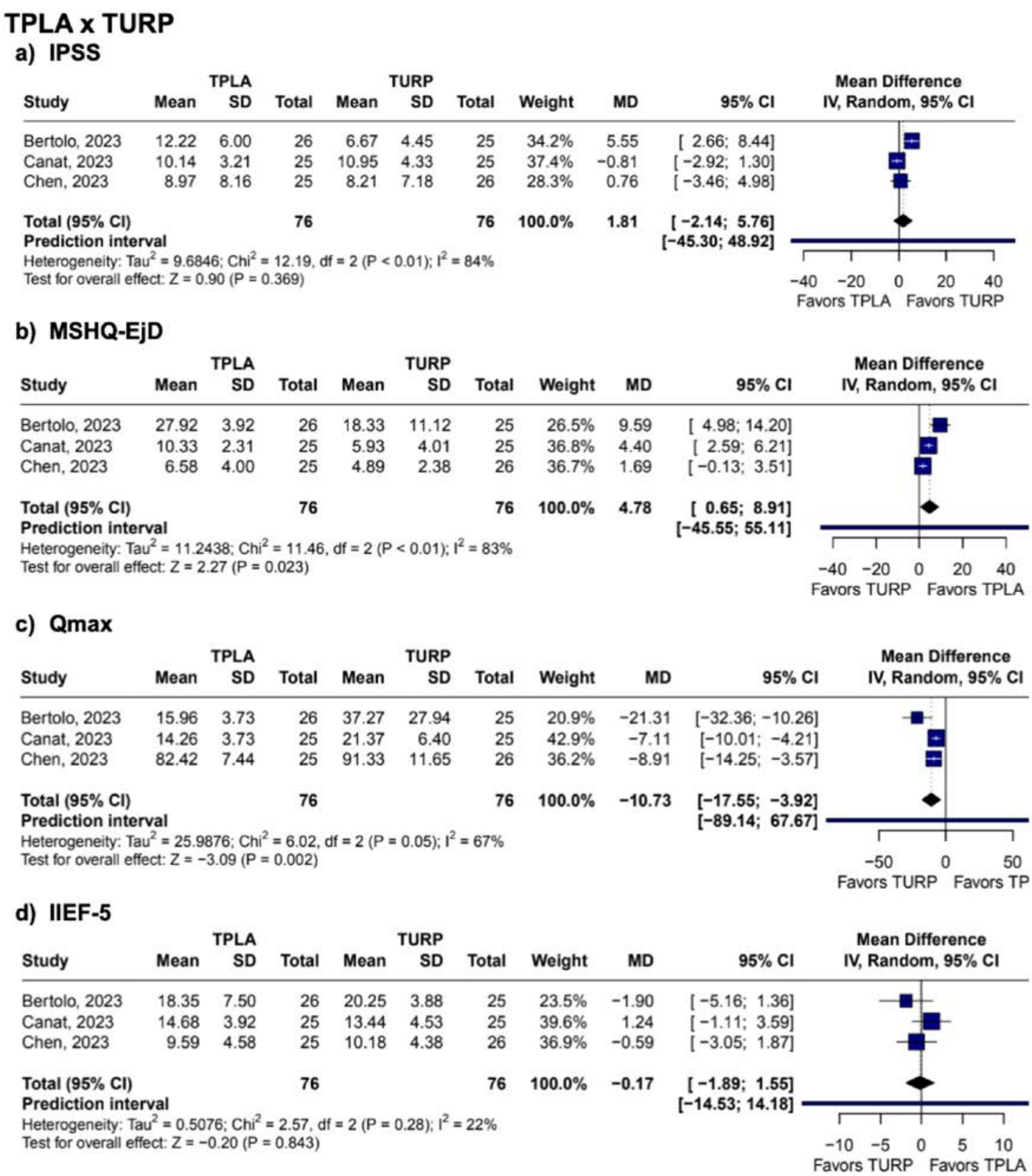
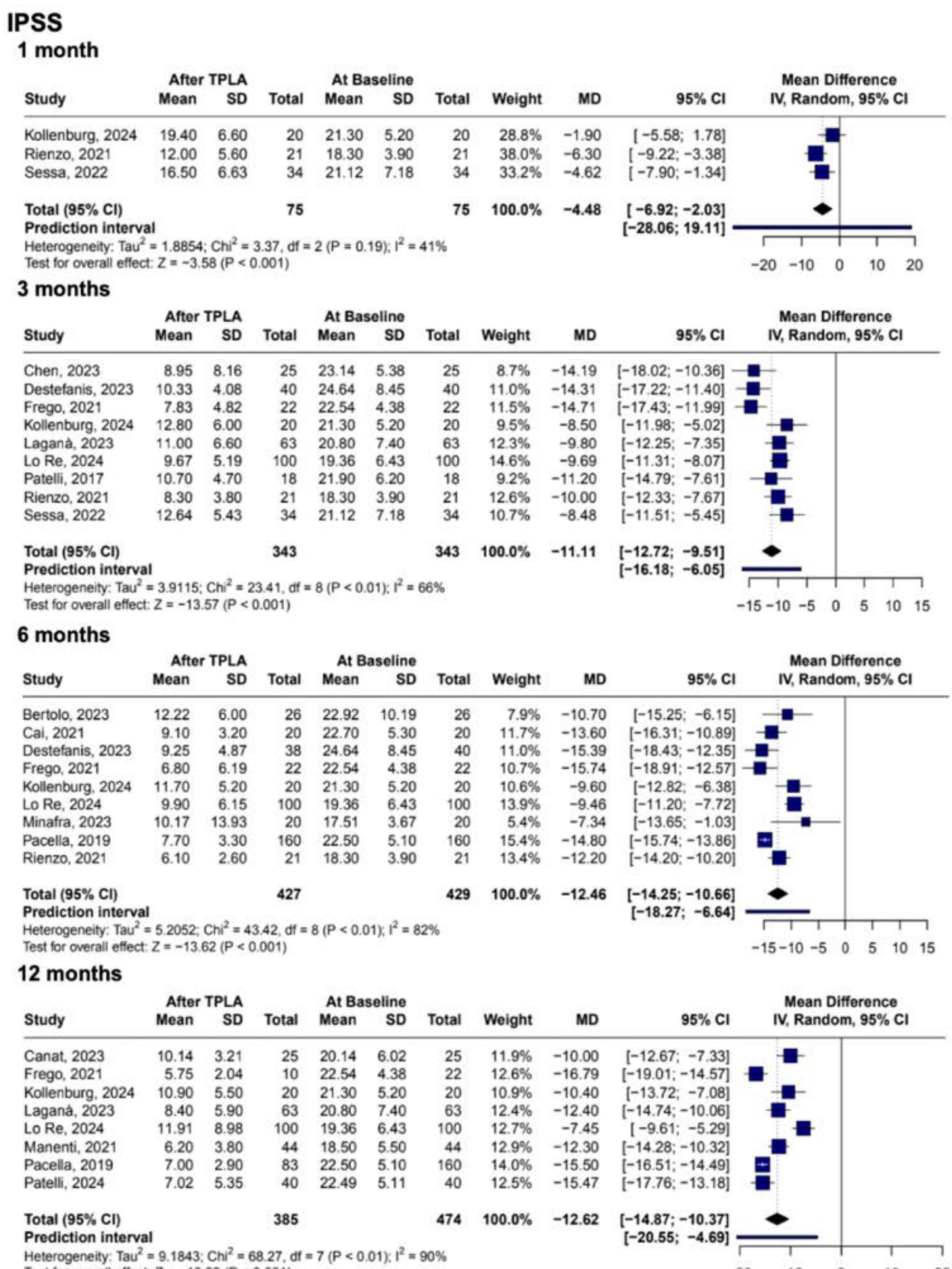


Figure 3. Forest plots of changes in IPSS at different follow-up intervals after TPLA. Pooled analysis demonstrates progressive and significant reduction in IPSS from baseline to 12 months, indicating sustained symptomatic relief in LUTS.



Abbreviations: IPSS – International Prostate Symptom Score; CI – Confidence Interval; MD – Mean Difference; LUTS – Lower Urinary Tract Symptoms; TPLA – Transperineal Prostate Laser Ablation.

Figure 4. Comparative forest plots between TPLA and transurethral resection of the prostate (TURP): (a) IPSS; (b) Ejaculatory function (MSHQ-EjD); (c) Maximum urinary flow rate (Qmax); (d) Erectile function (IIEF-5). There was no significant difference in LUTS relief (IPSS), and TPLA preserved ejaculatory function (MSHQ-EjD). TURP achieved greater improvement in urinary flow (Qmax), while erectile function (IIEF-5) remained comparable between techniques.



Abbreviations: TPLA – Transperineal Prostate Laser Ablation; TURP – Transurethral Resection of the Prostate; IPSS – International Prostate Symptom Score; MSHQ-EjD – Male Sexual Health Questionnaire for Ejaculatory Dysfunction; Qmax – Maximum Urinary Flow Rate; IIEF-5 – International Index of Erectile Function; CI – Confidence Interval; MD – Mean Difference.

function, as measured by the MSHQ-EjD (MD 4.78; 95% CI 0.65 to 8.91; p = 0.023; I2 = 83%. Figure-4B). Conversely, TURP was more effective in improving the Qmax (MD −10.73mL/s; 95% CI −17.55 to −3.92; p = 0.002; I2 = 67%. Figure-4C). IIEIF-5 did not differ and showed no statistically significant difference between the procedures (MD −0.17; 95% CI −1.89 to 1.55; p = 0.843; I2 = 22%. Figure-4D). TPLA presented lower operating time and length of stay compared to TURP (MD −43.46min; 95% CI −47.26 to −39.65; p < 0.001; I2 = 4%, and MD −0.54 days; 95% CI −0.73 to −0.35; p < 0.001; I2 = 0%. Figure-S6 A and B)

Leave-one-out analysis

To explore heterogeneity, a sensitivity analysis was performed to detect studies contributing to the I^2 value. In the Qmax and PVR outcomes at one month, after omitting the study by Kollenburg, a significant result was found, with heterogeneity reduced to zero. Additionally, omitting Kollenburg et from IPSS outcome at 1 month follow up, the heterogeneity reduced to zero. Still in the first month, regarding the IIEF outcome, after omitting Kollenburg, the heterogeneity resulted in zero, and regardless of the excluded study, no significance was observed. At 12 months of follow up, Canat et al. significantly contribute to the high heterogeneity in the MSHQ-EjD outcome. Excluding this study, TPLA demonstrated to significantly improve the ejaculatory function by 12 months (MD 2.75; CI 95% 1.63 to 3.86; I2 = 0%). The sensitivity analysis of the single arm outcomes by follow up is illustrated in Figures S7, S8, and S9. The leave-one-out sensitivity analysis of the RCTs did not identify a study for the possible source of heterogeneity for most of the outcomes. However, omitting Bertolo et al. of the Qmax analysis, the heterogeneity reduced to zero, and omitting Chen et al. from the PVR outcome, the heterogeneity, also, was zero, but the results in both outcomes were still the same. The sensitivity analysis of the RCTs is shown in Figure-S10.

Complications

Fourteen studies described the type and the number of complications (22-24, 26-34, 37, 38), and eight classified it according to the Clavien–Dindo system (26-30, 33, 36, 37). Sessa et al. (38) did not describe postoperative complications or sequelae in detail; nevertheless, they specified that no Clavien-Dindo grade ≥2 complications were experienced. Acute urinary retention, urinary tract infection, hematuria, and prostatic abscess were the most frequent complications. According to Chen et al. (22), TPLA had fewer complications than TURP (16% vs. 19.23%). Most of TPLA complications were Clavien-Dindo grade I and II. Table-S4 specifies all the reported complications.

Risk of Bias and Certainty of Evidence

The overall risk of bias for most of the non-randomized studies was moderate (Figure-S11), and low for the randomized studies (Figure-S12). The full GRADE assessment of the certainty of evidence is available in the supplementary materials (Table-S5).

DISCUSSION

The novel therapeutic options for BPE aim to treat non-neurogenic LUTS and avoid sexual side effects, which are a major source of dissatisfaction for men undergoing treatments for BPE. Therefore, the sexual side effects should be carefully considered, and the patient should be properly counseled before starting medical or surgical therapies. MISTs are becoming a new promise, especially with the concern of preserving sexual function and improving urodynamics parameters.

In this systematic review and meta-analysis of 17 studies and 777 patients, TPLA was assessed as a single-arm intervention and against the conventional TURP strategy. Our analysis demonstrated that TPLA was able to decrease IPSS and prostate volume from baseline while increasing the maximum urinary flow rate. Concerning the ejaculatory function, evaluated by the MSHQ-EjD, TPLA did not impose a negative effect. No changes were observed in the erectile function measured by the IIEF-5. In addition, TPLA was associated with a shorter operating time and length of stay than TURP. According to Chen et al., there was a minimum per-protocol hospitalization time in the TPLA group of up to 2.5 days. However, there was a benefit in terms of short hospital stays in the studies evaluating the new technology in general, as evidenced in the comparison of TPLA versus TURP in the RCTs (22).

A usual indication for the surgical treatment of BPE is moderate or severe voiding symptoms refractory to drug therapy. Although TURP has remained the gold standard due to its well-established technique and efficacy, it has been linked with numerous complications, (39) while MISTs are generally associated with fewer adverse events. (6) However, despite the American Urological Association (AUA) and European Association of Urology (EAU) guidelines on non-neurogenic male LUTS included MISTs as new therapeutic approaches for selected patients, the recommendations are still low to moderate in strength as they await more robust data (3).

Several trials have evaluated different MISTs interventions as alternatives to TURP, observing favorable outcomes (22, 23, 25). Recent data from a network meta-analysis of RCTs comparing new MISTs with standard surgical methods demonstrated similar symptom improvement profiles in the short and medium term, with less sexual dysfunction. However, the same data indicated that TURP provided greater benefits in increasing Qmax (40). Indeed, our comparative analysis revealed a 10-point difference in post-procedure Qmax favoring TURP. This could be explained by the extent of tissue removal and the immediate effect of TURP compared to the delayed prostatic volume response to TPLA (41). Nevertheless, TPLA has shown a 5-point reduction in Qmax in our analysis, consistent with what is expected from currently available therapies (42). It is worth noting that, while improvements in uroflowmetry parameters are important, patient-centered outcomes are as crucial since LUTS heavily impacts patients' QoL (43). As such, IPSS has been widely used as a symptom index for BPE and should be repeated after non-invasive and minimally invasive treatments (44). Our pooled analysis revealed an 11-point reduction in IPSS with TPLA treatment, along with no observable difference when compared to TURP, suggesting a similar patient-perceived treatment response.

In regard to sexual function, TPLA did not change erectile function from baseline, as evaluated with the IIEF-5 score (45), nor did it differ when compared to TURP. BPE procedures do not appear to impact erectile function, as stated in a comprehensive review of forty-five RCTs. However, there seems to be lesser risk of retrograde ejaculation with the new MISTs compared to TURP (46). In our pooled analysis, the ejaculatory function, assessed with the MSHQ-EjD form (47), did show a slight improvement from baseline, although we acknowledge that a 1.5-point change may not be clinically relevant. Nevertheless, when compared to TURP, the new treatment was able to preserve ejaculatory function, showing a clear benefit of the procedure. Although the advantages of TPLA over TURP, such as shorter operating time, and preservation of sexual function, are notable, TURP still is more effective in increasing Qmax and other parameters in terms of clinical significance.

Recent data demonstrated that prolonged surgical time may be a modifiable risk factor for complications due to an incidence likelihood of 14% for every additional 30 minutes of surgery, as reported by a meta-analysis of sixty-six studies (48). The impact of surgical time was further assessed by a 10-year analysis of patients undergoing TURP, which demonstrated a significant overall complication rate of 9%, and an increased complication risk as surgical time prolongs (49). In our pooled analysis, TPLA not only reduced operating time but also resulted in a slight decrease in hospitalization time compared to TURP, which could potentially improve safety outcomes and patient willingness to undergo the procedure (23). However, benefits are not limited to patient-related outcomes. Along with technological advancements, shortened operating time and faster recovery may allow these procedures to be performed in an office-based setting (50) and may represent a cost-effective alternative to current standard approaches (30).

This study has limitations. Nearly all included studies were single arm with no comparators, posing a significant limitation to the scope of our analysis. Only three RCTs were included in the analysis, which limited the robustness of the results and affected the certainty of evidence, since most of the included studies were non-randomized and had moderate risk of bias. Furthermore, current literature on TPLA is limited by the short follow-up period (≤ 12 months), unlike other procedures, which have long follow-up periods (51). This limits confidence in durability, retreatment rates, possible late complications, and long-term sexual/functional outcomes; consequently, we moderate the conclusiveness of our statements to reflect these limitations. Moreover, there was variability among procedure techniques. Significant variation in laser settings, procedural protocols, and follow-up durations across studies were noted. Differences in laser power settings, ablation time and a greater number of fibers potentially influence both the efficacy and safety of the procedure, with higher intensities yielding better results, but also increasing the risk of adverse effects. The minimum distance from bladder neck, urethral and between needles, also, had a few variations among studies. This technical and methodological heterogeneity contributes to variability between studies in terms of functional outcomes and complications. Future evidence syntheses should stratify results by key parameters (power/energy settings, fibers per lobe, total energy delivered, and energy density expressed in joules/mL of baseline prostate volume) and evaluate the device platform and perioperative protocols as additional moderators to identify technically optimized and patient-centered protocols, as well as clarify trade-offs between efficacy, ejaculation preservation, and complications. In addition, discrepancies in the duration of follow-up can lead to inconsistent assessments of long-term efficacy, as some benefits or complications may only emerge over time. To increase the clinical applicability of the results, future analyses should consider comparing studies with similar methodologies, grouping them based on key parameters to identify more consistent trends. This approach would provide clinicians with clearer, evidence-based insights to optimize laser treatments and minimize risks.

Although this new technology is being extensively researched, and many recent studies have been published, our study presents significant advances in terms of scope, methodological rigor, and analytical depth. First, among the reviews already published, ours included a larger number of patients (n=777) and studies (17), reflecting a broader and more up-to-date literature search. In addition, we conducted a complete quantitative meta-analysis with the application of random effects models, subgroup analysis (including direct comparisons between TPLA and TURP), assessment of the certainty of evidence via the GRADE approach, and leave-one-out sensitivity analysis to investigate sources of heterogeneity. Another relevant difference was the inclusion of functional data stratified by follow-up time (1, 3, 6, and 12 months), allowing a more detailed view of the clinical evolution of patients. Our work also stood out by presenting quality of life and sexual function data based on validated instruments (MSHQ-EjD and IIEF-5), which reinforces the clinical relevance of the findings. Finally, by strictly following the PRISMA guidelines and registering the protocol in PROSPERO, we ensured transparency and reproducibility. These characteristics consolidate our review as a more comprehensive, current, and methodologically robust contribution to the literature on TPLA in the treatment of LUTS secondary to BPE.

This review provides the most complete quantitative appraisal of TPLA for BPH, integrating symptoms, flow, perioperative, and sexual outcomes with consistent analytic standards (random-effects, sensitivity analyses, GRADE) and head-to-head context versus TURP when available. Beyond summarizing effects, it maps key technical drivers (power/energy, fibers-per-lobe, energy density) that may explain heterogeneity and offers a framework for future studies. These contributions enhance clinical interpretability—particularly around ejaculatory preservation and recovery—while highlighting evidence gaps (nonrandomized designs, short follow-up) that should shape the next generation of trials. Therefore, future randomized trials are advised to be performed in a multicentric fashion with a greater number of patients, comparing other treatment options to increase the generalizability of the findings. Nevertheless, observational studies often include a broader and more diverse population, and allow for a longer follow-up, thus, providing further insights into a real-world clinical setting.

CONCLUSION

TPLA demonstrated favorable outcomes for LUTS/BPE without a negative impact on sexual function. This minimally invasive treatment was found to have advantages over TURP, such as reduced operative time and shorter hospital stay. The evidence on this new MIST is emerging, but more comparative studies are required to understand the role of this technology, as this study consists mainly of retrospective studies. To date, this is the first meta-analysis to compare TURP and TPLA, and a substantial number of studies published in the literature have been included, although the available evidence is limited.

CONFLICT OF INTEREST

None declared.

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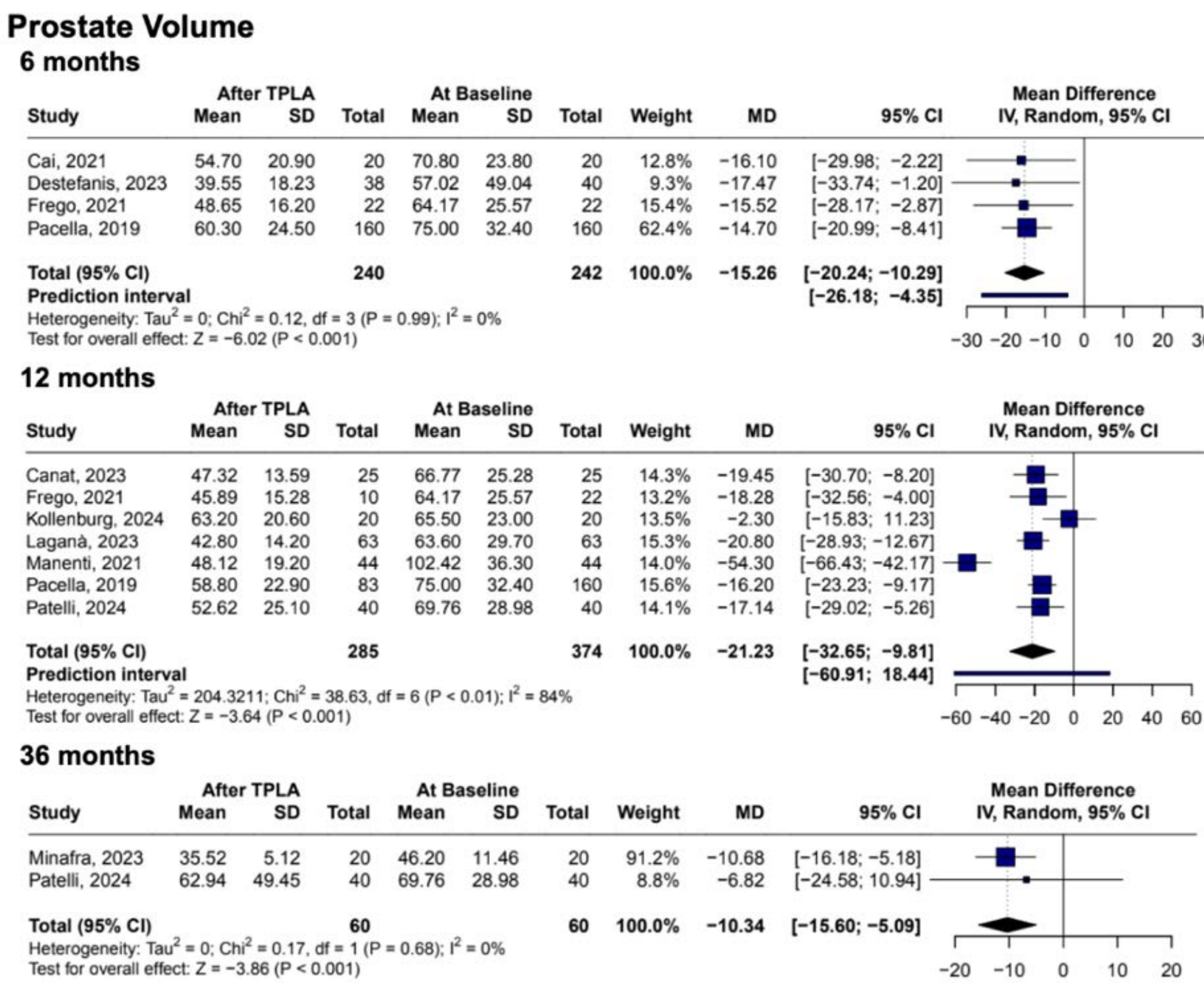
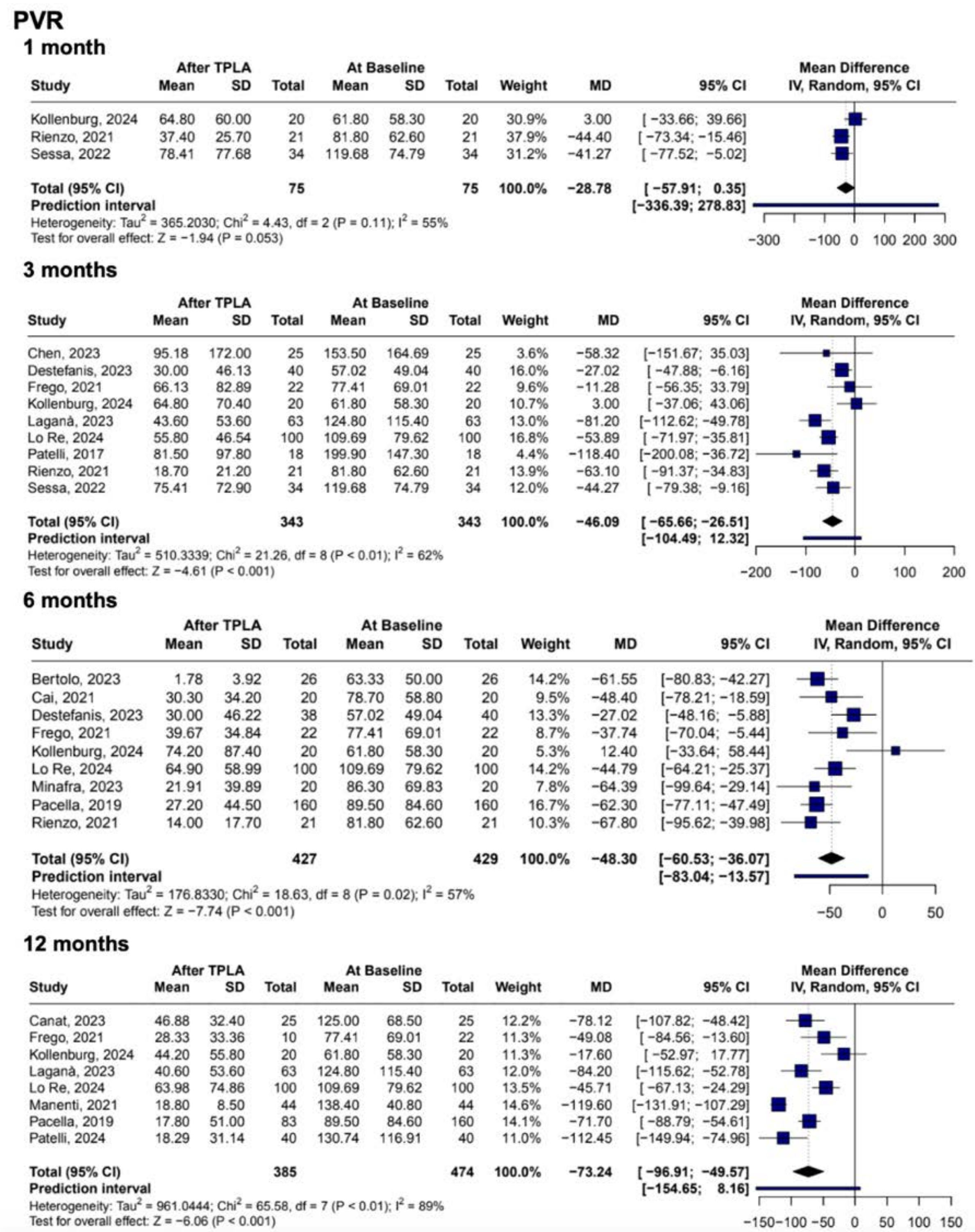
SUPPLEMENTARY MATERIAL

Figure S1. Changes in prostate volume at each follow-up period after TPLA. A progressive and statistically significant decrease in PV was observed up to 12 months, indicating sustained reduction in gland size.



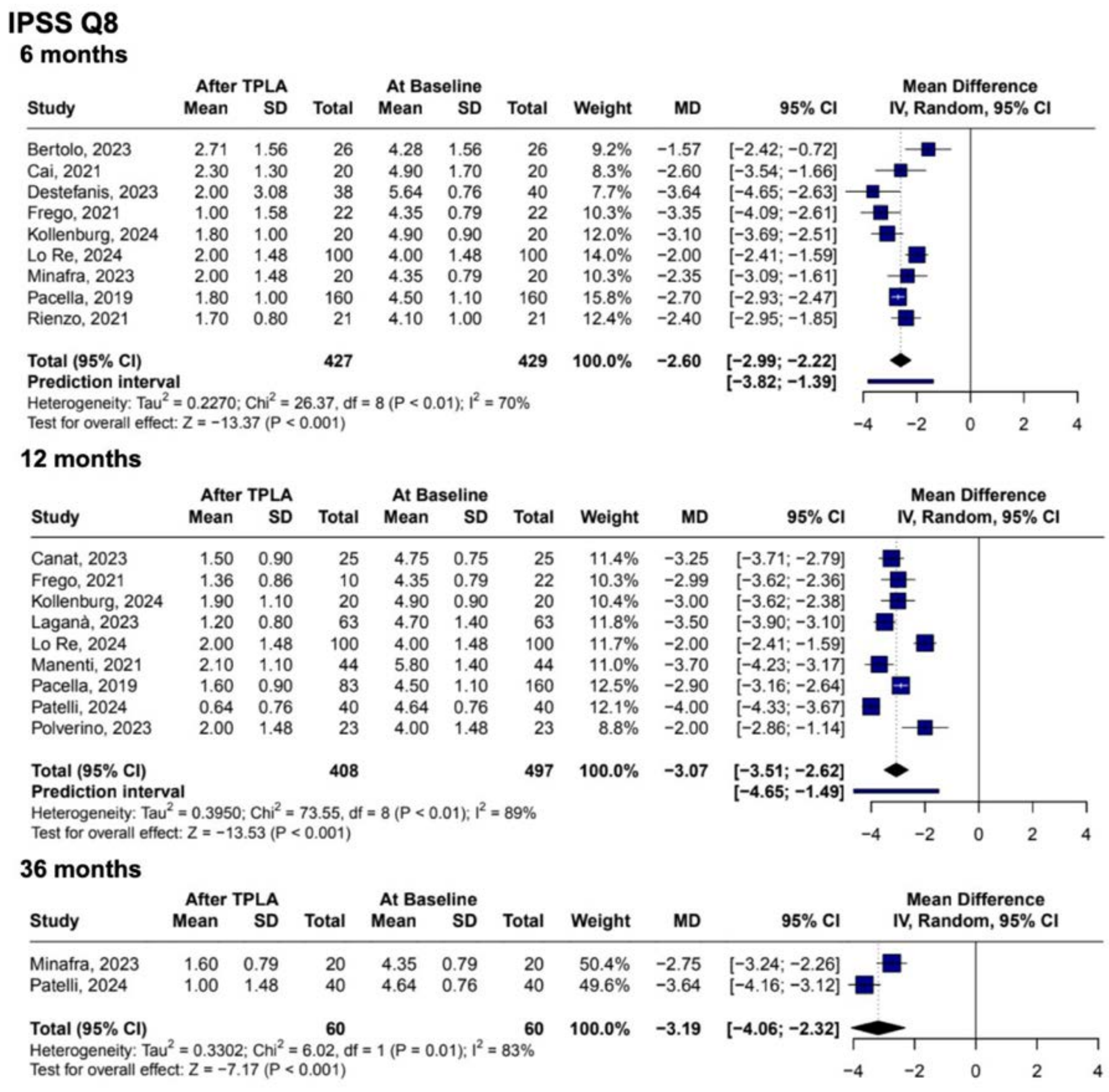
Abbreviations: PV – Prostate Volume; TPLA – Transperineal Prostate Laser Ablation; CI – Confidence Interval; MD – Mean Difference

Figure S2. Changes in post-void residual urine volume at each follow-up period. TPLA significantly reduced PVR from baseline at 3, 6, and 12 months, showing improved bladder emptying over time.



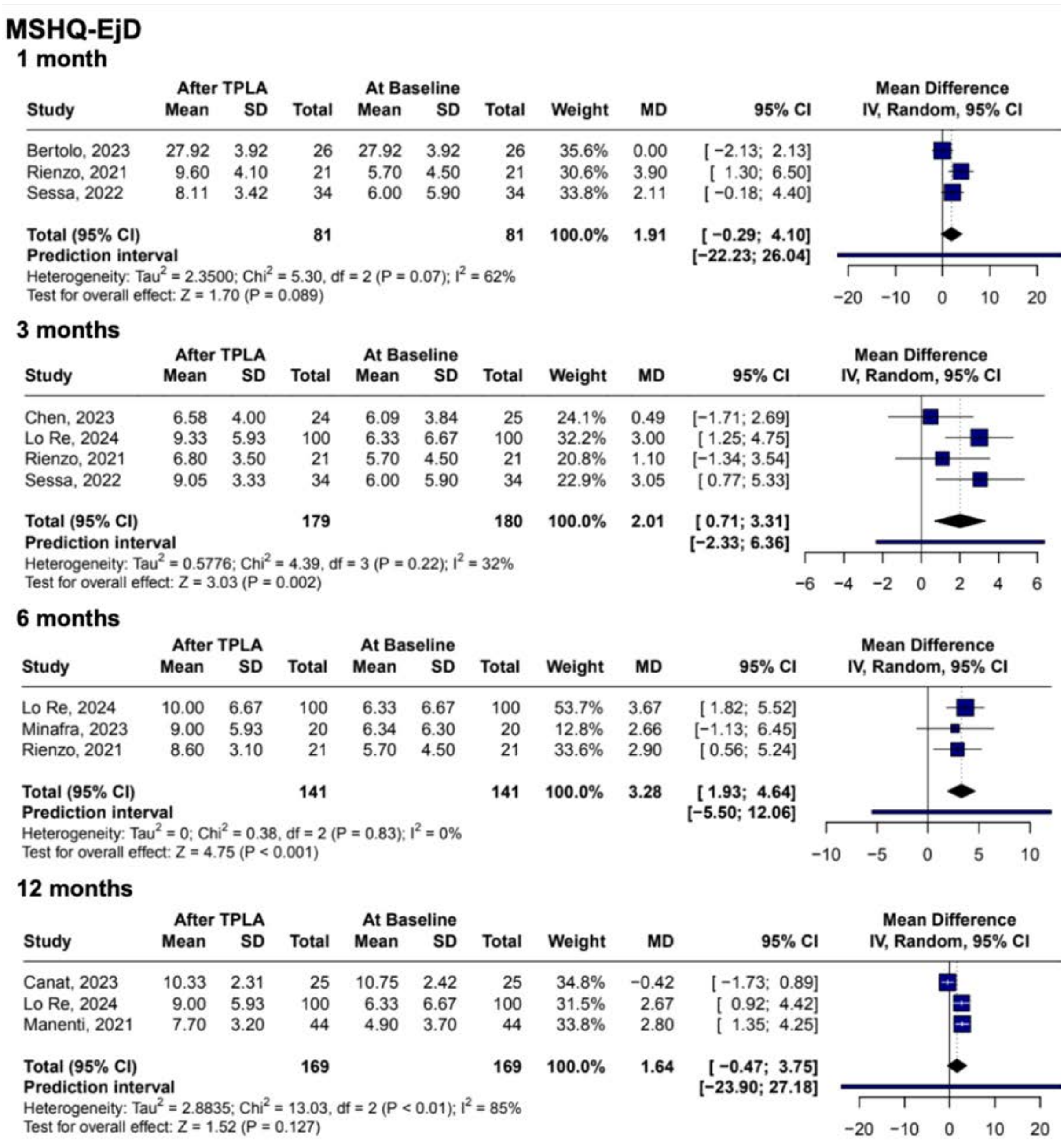
Abbreviations: PVR – Post-Void Residual; TPLA – Transperineal Prostate Laser Ablation; CI – Confidence Interval; MD – Mean Difference.

Figure S3. Changes in quality-of-life IPSS Question 8 following TPLA at each follow-up. The IPSS-Q8 domain, which assesses patients perceived quality of life, improved significantly across all follow-up intervals, reflecting symptom relief and better daily functioning.



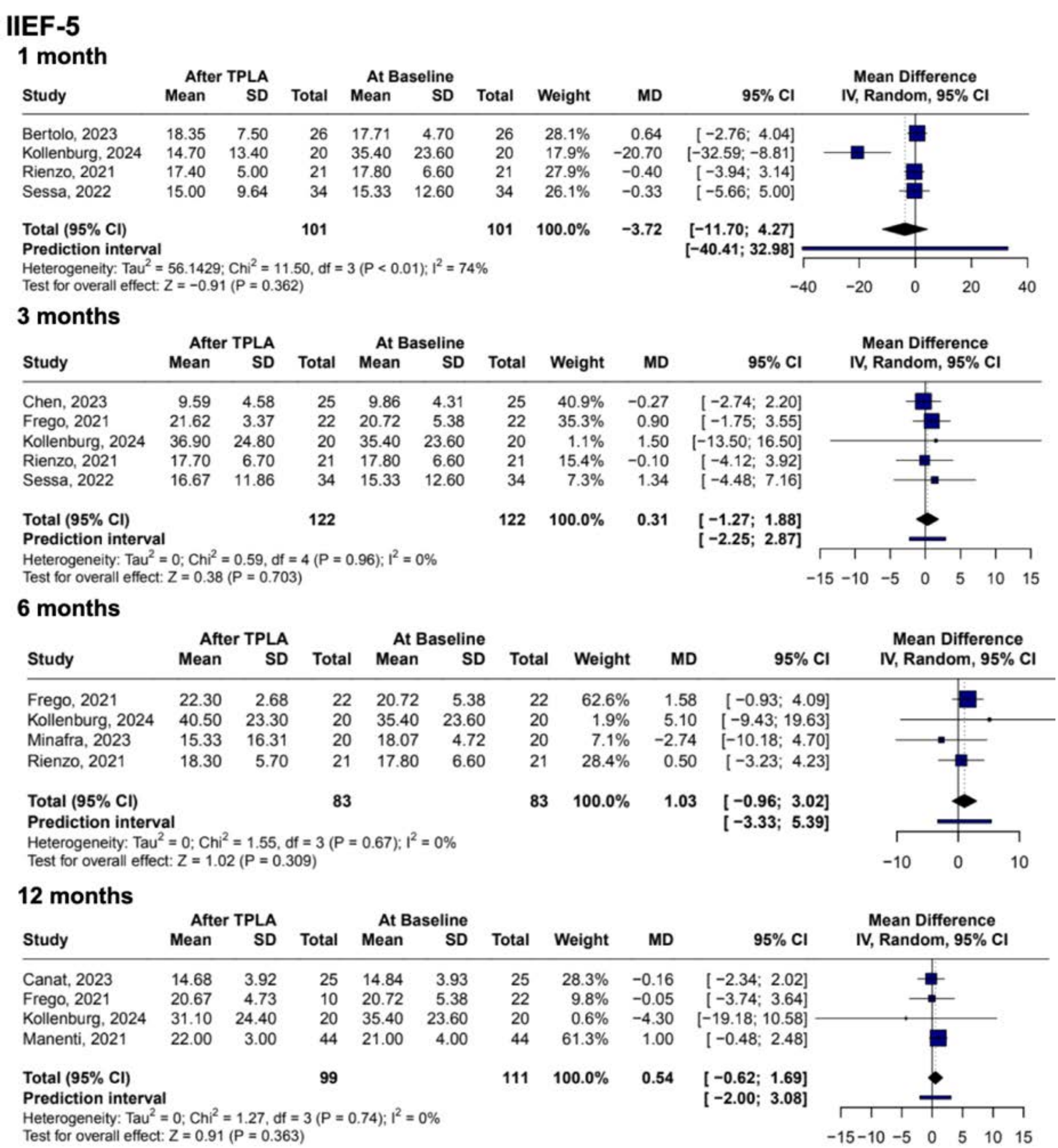
Abbreviations: IPSS – International Prostate Symptom Score; CI – Confidence Interval; MD – Mean Difference; TPLA – Transperineal Prostate Laser Ablation.

Figure S4. Changes in MSHQ-EjD after TPLA. Ejaculatory function showed mild improvement within 3-6 months after the procedure and remained stable thereafter, suggesting preservation of sexual function.



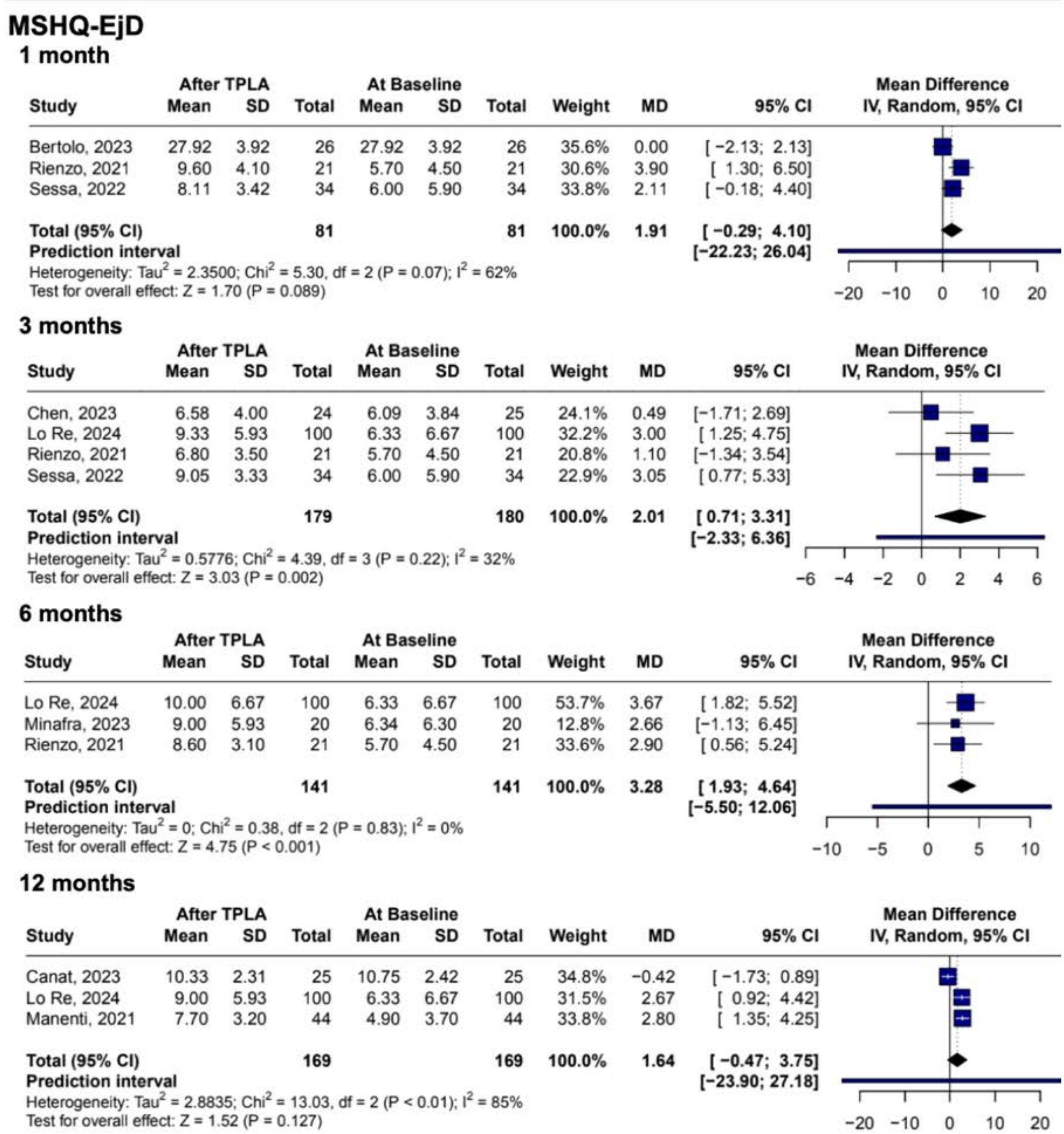
Abbreviations: MSHQ-EjD – Male Sexual Health Questionnaire for Ejaculatory Dysfunction; CI – Confidence Interval; MD – Mean Difference; TPLA – Transperineal Prostate Laser Ablation

Figure S5. Changes in IIEF-5 following TPLA. No significant differences were observed at any follow-up, indicating that TPLA does not adversely affect erectile function.



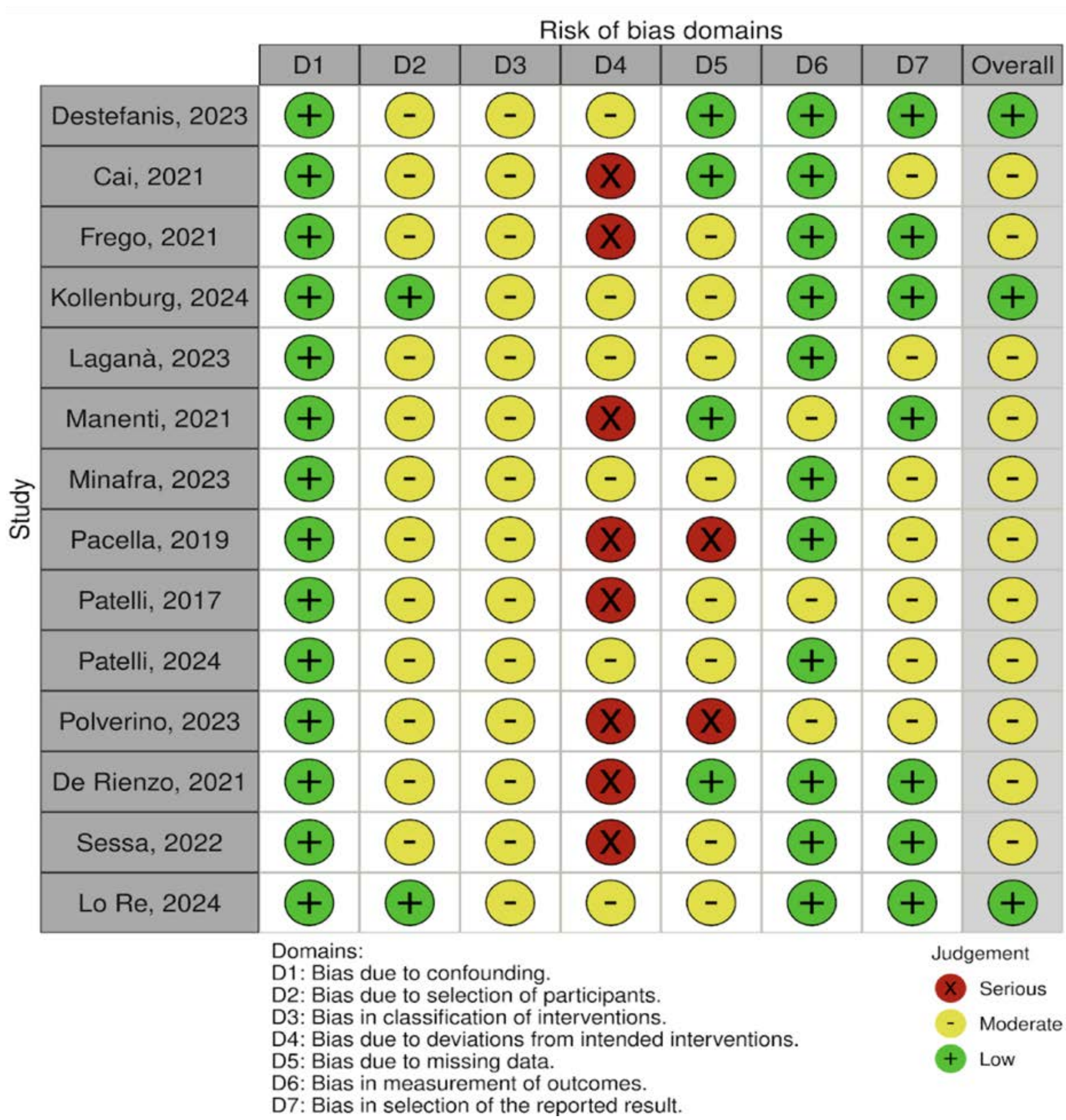
Abbreviations: IIEF-5 – International Index of Erectile Function; CI – Confidence Interval; MD – Mean Difference; TPLA – Transperineal Prostate Laser Ablation.

Figure S6. Comparative analysis between TPLA and TURP: (a) Operating time; (b) Length of hospital stay. Compared to TURP, TPLA demonstrated shorter operative times and reduced hospitalization periods, confirming the minimally invasive nature of the procedure.



Abbreviations: TPLA – Transperineal Prostate Laser Ablation; TURP – Transurethral Resection of the Prostate; CI – Confidence Interval; MD – Mean Difference.

Figure S7. Risk of bias assessment for non-randomized studies using the ROBINS-I tool. Most studies were classified as having moderate risk of bias, primarily due to non-randomized design and potential confounding.

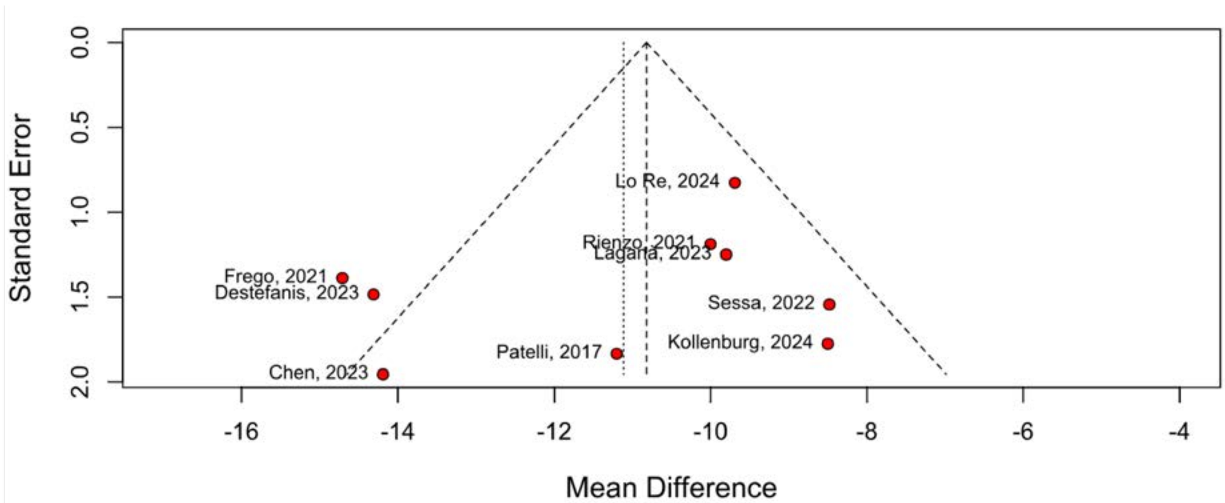


Abbreviations: ROBINS-I – Risk Of Bias In Non-randomized Studies of Interventions

Figure S8. Risk of bias assessment for randomized controlled trials using the RoB 2 tool. All included randomized trials demonstrated low risk of bias across major domains, supporting the robustness of comparative findings.

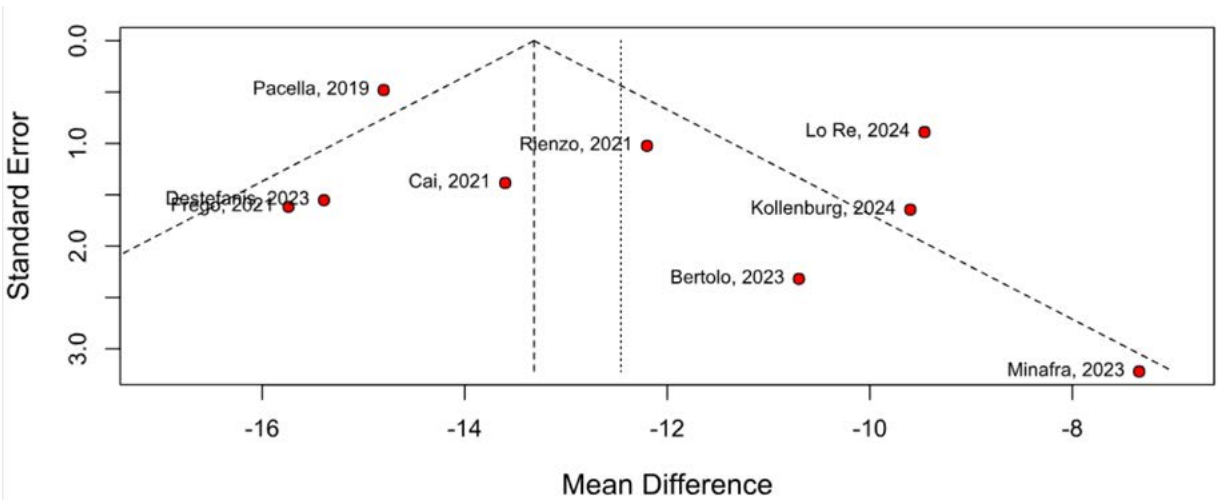
Abbreviations: RoB 2 – Revised Cochrane Risk of Bias tool for Randomized Trials.

Figure S9. Funnel plot for IPSS change at 3 months after TPLA. The scatter appears approximately symmetric around the pooled mean difference, with no prominent visual asymmetry. Given the limited number of studies at this time point, we cannot exclude small-study effects; observed dispersion is compatible with between-study heterogeneity in technique and follow-up.



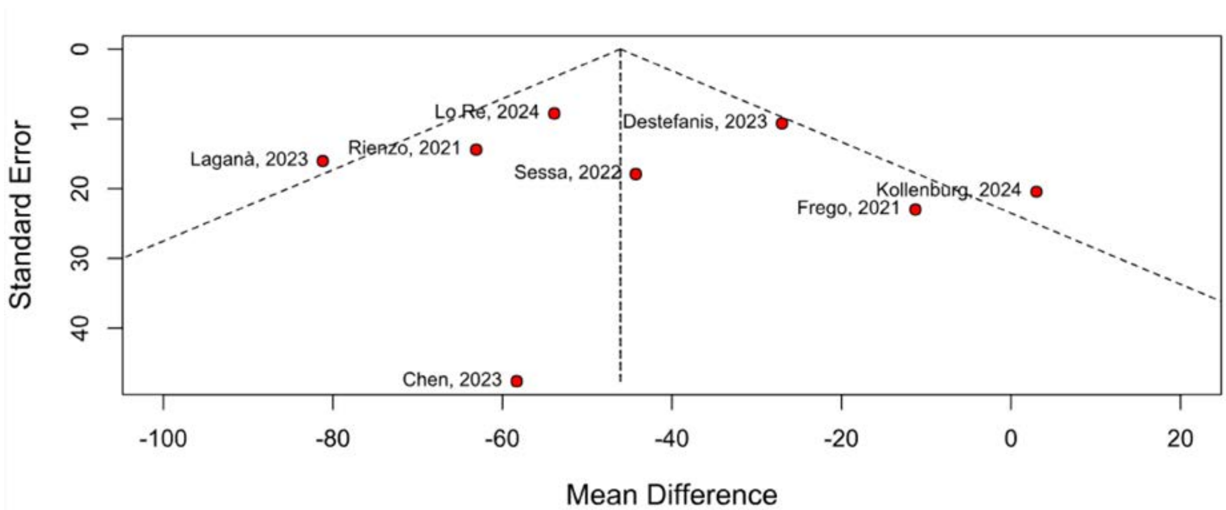
Abbreviations: TPLA – Transperineal Prostate Laser Ablation; IPSS – International Prostate Symptom Score; MD – Mean Difference; SE – Standard Error; CI – Confidence Interval.

Figure S10. Funnel plot for IPSS change at 6 months after TPLA. A broadly symmetric distribution is observed around the summary effect, without a clear directional pattern of small studies. The wider spread among less precise studies is expected and may reflect variability in power/energy settings and fibers-per-lobe across studies.



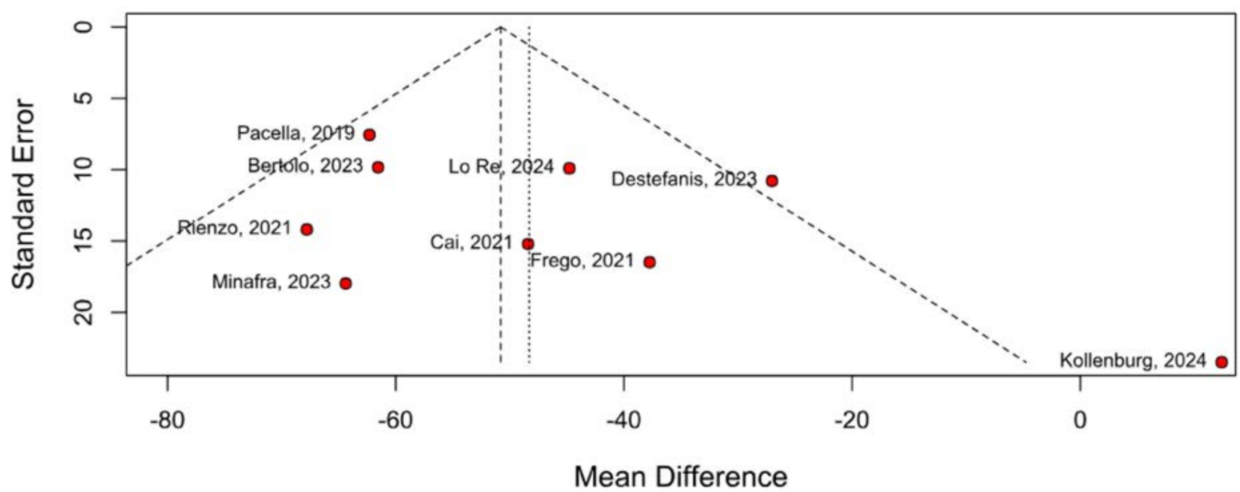
Abbreviations: TPLA – Transperineal Prostate Laser Ablation; IPSS – International Prostate Symptom Score; MD – Mean Difference; SE – Standard Error; CI – Confidence Interval.

Figure S11. Funnel plot for PVR change at 3 months after TPLA. No marked visual asymmetry is evident. The dispersion among smaller studies likely reflects clinical and technical heterogeneity (e.g., energy per fiber, inter-fiber spacing). Caution is warranted due to the limited number of contributing studies.



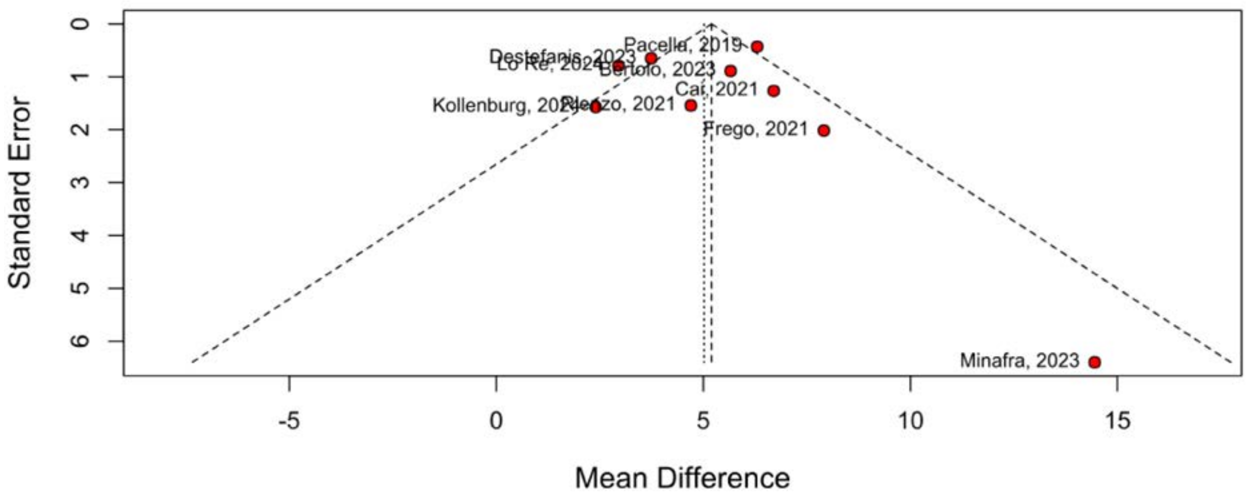
Abbreviations: PVR – Post-Void Residual; TPLA – Transperineal Prostate Laser Ablation; MD – Mean Difference; SE – Standard Error; CI – Confidence Interval.

Figure S12. Funnel plot for PVR change at 6 months after TPLA. The plot shows approximate symmetry around the pooled estimate with a typical funnel shape. Any subtle imbalance in the wings is insufficient to assert publication bias and may instead indicate heterogeneity of technique and perioperative protocols.



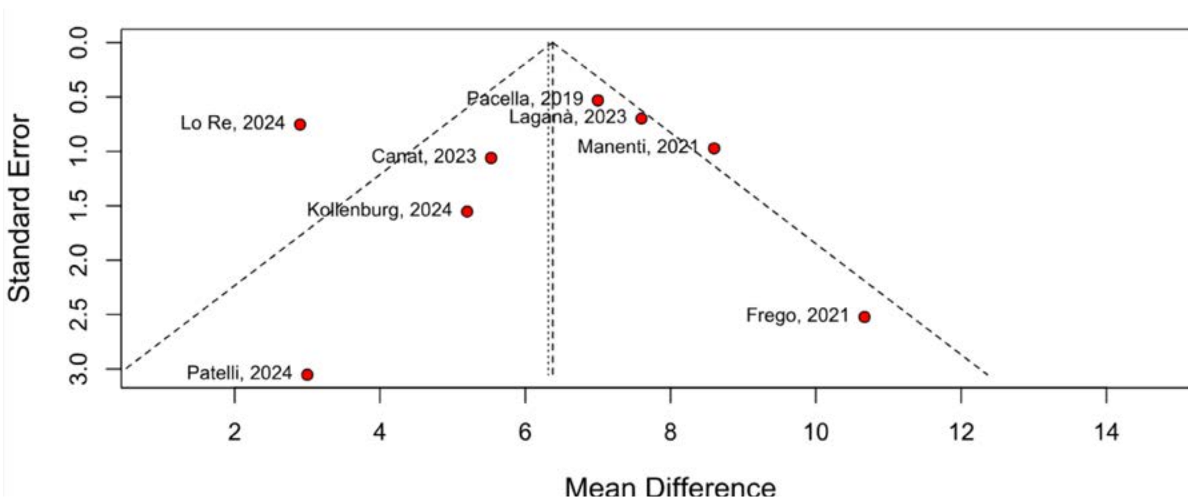
Abbreviations: PVR – Post-Void Residual; TPLA – Transperineal Prostate Laser Ablation; MD – Mean Difference; SE – Standard Error; CI – Confidence Interval.

Figure S13. Funnel plot for Qmax change at 6 months after TPLA. Visual inspection suggests near-symmetric scatter; however, a slightly broader spread among less precise studies is noted, consistent with methodological/technical variability. Small-study effects cannot be ruled out.



Abbreviations: Qmax – Maximum Urinary Flow Rate; TPLA – Transperineal Laser Ablation; MD – Mean Difference; SE – Standard Error; CI – Confidence Interval.

Figure S14. Funnel plot for Qmax changes 12 months after TPLA. The distribution is broadly symmetric with few studies near the base of the funnel, limiting the ability to detect asymmetry. Findings should be interpreted with caution given sample size and heterogeneity across techniques and follow-up schedules.



Abbreviations: Qmax – Maximum Urinary Flow Rate; TPLA – Transperineal Laser Ablation; MD – Mean Difference; SE – Standard Error; CI – Confidence Interval.

Table S1. PRISMA 2020 checklist of items for systematic reviews. Checklist of 27 items used to ensure transparency and completeness of reporting according to PRISMA 2020 guidelines.

Section and Topic	Item #	Checklist item	Location where item is reported
TITLE			
Title	1	Identify the report as a systematic review.	Page 01
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	Page 02
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	Page 03
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	Page 03
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	Page 04
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	Page 04
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	Page 04
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	Page 04
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	Page 05
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	Page 05
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	Page 05
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	Page 09
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	Page 05
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	Page 05
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	Page 05
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	Page 05
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	Page 05
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	Page 05
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	Page 05

Section and Topic	Item #	Checklist item	Location where item is reported
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	Page 09
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	Page 09
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	Page 06
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	Page 06
Study characteristics	17	Cite each included study and present its characteristics.	Page 06
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	Page 09
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	Page 07
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	Page 06
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	Page 06
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	Page 06
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	Page 07
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	Page 09
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	Page 09
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	Page 10
	23b	Discuss any limitations of the evidence included in the review.	Page 11
	23c	Discuss any limitations of the review processes used.	Page 11
	23d	Discuss implications of the results for practice, policy, and future research.	Page 11
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	Page 01
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	Page 04
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	Page 04
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	Page 12
Competing interests	26	Declare any competing interests of review authors.	Page 12
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	Page 05

From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71.

Abbreviations: PRISMA – Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

Table S2 Technical parameters and perioperative data of the included studies. Overview of procedural characteristics, including anesthesia type, laser settings, number of fibers, and perioperative management strategies.

Study author/ year	Anesthesia	Laser system	Power setting (W)	Energy setting	Number and type of needles	Minimum distance from bladder neck (mm)	Minimum distance from the urethra (mm)	Minimum distance between Needles (mm)	No of fibres	Procedure time (min)	Ablation time (min)	Hospitalization	Catheterization time (days)	Antibiotic prophylaxis	Therapy at discharge	Pre-Op BPH Therapy N (%)	Antiaggregant/ Anticoagulant therapy N (%)
Bertolo et al. (23), 2023	Standard spinal anesthesia	SoracteLite EchoLaser, Elesta	4.5 reduced to 3.5 after 1-2 min	1800 J/ fiber/firing	1 or 2 needles per lobe 21 G	15	8	10	1 each needle	TPLA 35 (30-55) / TURP 68 (60-95)	NA	TPLA 2 (2-3) days / TURP 3 (3-4) days	TPLA 4 (2-7) / TURP 3 (3-4)	NA	NA	23 (88.5) / 22 (88)	10 (38.5%) / 0
Cai et al. (24), 2021	Local anesthesia (2% lidocaine)	SoracteLite EchoLaser, Elesta	3	1800 J/ fiber/firing	1 needle per lobe 21 G	15	8	15	1 each needle	60.9 (10.8)	42.6 (9.9)	1.5 (0.5) hours	16.5 (4.2)	NA	NA	NA	NA
Canat et al. (25), 2023	Sedation (Midazolam) + Local anesthesia (2% lidocaine)	SoracteLite EchoLaser, Elesta	NA	1800 J/ fiber/firing	1 needle per lobe 1 more needle if PV >60 mL 21 G	15	8	NA	2 (2-2.5)[1]	16 (2.35)	NA	TPLA 0.67 ±0.49 days / TURP 1.27 ±0.46 days	TPLA 6.5 (1.02) / TURP 2.27 (0.46)	NA	Dexamethasone and non-steroidal anti-inflammatory	NA	9 (36%) / 0
Chen et al. (21), 2023	Local anesthesia (2% lidocaine)	Asclepion Laser Technologies GmbH	3-5	1800 J/ fiber/firing	1 needle per lobe 21 G	20	8	10	1 each needle	TPLA 60.1 (19.67) / TURP 111 (49.09)	TPLA 36 (16) / TURP 100.63 (48.51)	TPLA 2.5 (0.52) days / TURP 2.94 (0.57) days	TPLA 11.38 (2.81) / TURP 8.88 (2.22)	NA	Antibiotic therapy for 7 days.	NA	NA
Deste-fanis et al. (26), 2023	Optional sedation + Local anesthesia (lidocaine/ bupivacaine)	SoracteLite EchoLaser, Elesta	NA	NA	Multiple 21 G Chiba needles	NA	NA	NA	2 (2-2.5)[1]	42.5 (35-50)	17.5 (8.5-18.5)	NA	NA	According to preop urine culture	NA	a-blockers 12 (30%) 5-ARIs 4 (10%) Combined therapy 15 (37.5%)	22 (55%)
Frego et al. (27), 2021	Sedation (Midazolam) + Local anesthesia (2% lidocaine)	SoracteLite EchoLaser, Elesta	3	1800 Joule/ fiber/firing in 600 s	1 needle per lobe 1 more needle if PV 60 mL 21 G Chiba	15	10	10	1 each needle	NA	17.21 (10-18.8)	1 day	7	Levofloxacin 500 mg (1 day before and for 5 days after procedure)	Antibiotic for 5 days; Dexamethasone 8 mg and Ketoprofen 100 mg for 7 days	a-blockers 22 (100%); Combined therapy 6 (27.3%)	NA
Kollen-burg et al. (28), 2024	Optional sedation (Midazolam) + Local anesthesia (2% lidocaine)	SoracteLite EchoLaser, Elesta	3	1800 J/ fiber/firing	1 needle per lobe	15	8	NA	1 each needle	59 (14)	17.2 (6.3)	6.5 (5.0) hours	15.2 (3.5)	Ciprofloxacin 500 mg single dose	Dexamethasone 8 mg for 7 days	a-blockers 12 (60%); 5-ARIs 8 (40%) B3-agonist 1 (5)	NA
Laganà et al. (29), 2023	Sedation + Local anesthesia	SoracteLite EchoLaser, Elesta	3	1800 J/ fiber/firing	1-2 needles per lobe 21 G	15	8	10	NA	48.8 (14.3)	13 (1.95)	NA	14.9 (7.5)	2 g cephazolin IV (before the start of the procedure)	NA	a-blockers 27 (42.9%) 5-ARIs 6 (9.5%)	NA
Lo Re et al. (30), 2024	Sedation (Oral BZD*) + Local anesthesia (2% lidocaine)	SoracteLite EchoLaser, Elesta	5 reduced to 3.5 after 2 min	NA	1-2 needles 21 G	15	8	NA	2 (2-2)[1]	NA	NA	99% of patients were discharged within daily hospital stay.	7 (7-7)	NA	NA	a-blockers 60 (60%) 5-ARIs 4 (4%); Combined therapy 17 (17%)	24 (24%)
Manenti et al. (31), 2021	Local anesthesia with 2% lidocaine	SoracteLite EchoLase, Elesta	5 reduced to 3 after 2 min	1800 J/ fiber/firing	1 needle per lobe 1 more needle if PV >45 mL 21 G Chiba	15	10	8	1 each needle	28.2 (10.6)	NA	NA	NA	Levofloxacin 500 mg (1 h before and for 5 days after the procedure).	Antibiotic for 5 days; Acetaminophen 1000 mg if necessary; Prednisone 25 mg for 5 days with subsequent dose tapering; Alpha-blockers for 30 days	Combined therapy 44 (100%)	NA

Study author/ year	Anesthesia	Laser system	Power setting (W)	Energy setting	Number and type of needles	Minimum distance from bladder neck (mm)	Minimum distance from the urethra (mm)	Minimum distance between Needles (mm)	No of fibres	Procedure time (min)	Ablation time (min)	Hospitalization	Catheterization time (days)	Antibiotic prophylaxis	Therapy at discharge	Pre-Op BPH Therapy N (%)	Antiaggregant/ Anticoagulant therapy N (%)
Minafra et al. (32), 2023	Sedation + Local anesthesia (2% lidocaine)	SoracteLite EchoLase, Elesta	NA	NA	1-2 needles per lobe	15	8	NA	1 each needle	NA	NA	NA	NA	NA	NA	NA	NA
Pacella et al. (33), 2019	Sedation (Midazolam) + Local anesthesia (2% lidocaine)	SoracteLite EchoLase, Elesta	3	1800 J/ fiber/firing	1 needle per lobe 1 more needle if PV > 40 mL 21 G Chiba	15	8	8	1 each needle	44.1 (12.9)	23.4 (10.2)	1.8 (0.4) days	11.3 (11.5)	Ciprofloxacin 500 mg single dose	NA	NA	NA
Patelli et al. (34), 2017	Sedation (Midazolam) + Local anesthesia (2% lidocaine)	SoracteLite EchoLase, Elesta	3	1200-1800 J/fiber/ firing	1-2 needles per lobe 21 G Chiba	15	8	15	1 each needle	43.3 (8.7)	15.9 (3.9)	1.5 (0.4) days	17.3 (10.0)	Antibiotic therapy from the previous day and for a variable period	NA	NA	NA
Patelli et al. (35), 2024	Sedation (Midazolam) + Local anesthesia (2% lidocaine)	SoracteLite EchoLase, Elesta	3	NA	1 needle per lobe 21 G	NA	NA	NA	3.5[2]	43.4 (8.7)	17.3 (4.4)	NA	22.8 (10.9)	Levofloxacin (initiated the day before and 7 days after procedure)	NA	16 (100%)	NA
Polve-rino et al. (36), 2023	Sedation (Oral BZD[a]) + Local anesthesia (2% lidocaine)	SoracteLite EchoLase, Elesta	NA	NA	NA	NA	NA	NA	2 (2-2)[1]	NA	NA	1	7 (7-9)	NA	NA	NA	18 (78%)
Rienzo et al. (37), 2021	Sedation + Local anesthesia (2% lidocaine)	SoracteLite EchoLaser, Elesta	4.5 reduced to 3.5 after 1–2 min	1800 J/ fiber/firing	1 needle per lobe 1 more needle if PV > 55–60 mL 21 G Chiba	15	8	10	2.2 (0.5)[2]	36 (9.5)	NA	20.8 (3.6) hours	8.7 (2.5)	Oral cephalo-sporines or fluoroqui-nolones (1 h before and for 7 days after procedure)	Antibiotic for 5 days; prednisone 25 mg for 15 days with subsequent tapering of the dose; bromelain for 30 days; Alpha-blockers for 30 days	a-blockers 14 (66.7%) 10 5-ARI (47.6%) 8 combination therapy (38.1%)	NA
Sessa et al. (38), 2022	Sedation (Oral BZD solution) + Local anesthesia (2% lidocaine and lidocaine-prilocaine 5% cream)	SoracteLite EchoLase, Elesta	5 reduced to 3.5 after 2min	1400 J/ fiber/ firing [b]	1 needle per lobe 21 G Chiba	15	8	NA	2 (2-2)[1]	31.5 (28-37)	NA	6.4 (5.9-7.2) hours	7 (7-7)	2 g cephazolin IV (1h before the start of the procedure)	Antibiotic (cefixime 400 mg daily), for 7 days; Gastroprotective therapy (pantoprazole 20 mg daily) for 7 days; Ibuprofen 600 mg twice a day for 7 days	a-blockers 20 (52.6%) 6 5-ARI (15.8%) combination therapy 5 (10.5%).	11 (28.9%)

Values are presented in absolute numbers unless otherwise specified. 5-ARI, 5-alpha reductase inhibitor; BZD, benzodiazepine; G, Gauge; IV, intravenous; NA, Non available; PV, Prostate volume; TPLA, Transperineal laser ablation; TURP, transurethral resection of the prostate; W, Watt.

[1]median, fiber per patient.

[2] mean, fiber per patient.

[a] According to patients' preference.

[b] In the case of large prostates, additional laser energy was delivered up to 1800J per fiber.

Table S3. Inclusion and exclusion criteria of the included studies. Detailed eligibility criteria applied in each study, including design, recruitment period, patient characteristics, and follow-up duration.

Study author/year	Design	Recruitment period	Inclusion criteria	Exclusion criteria	Follow-up	N (TPLA/TURP)
Bertolo et al. (23), 2023	RCT (TPLA versus TURP); Open-label; Monocentric	Jan 2020-Sep 2021	Age 18-75 Normal ejaculatory function and presence of antegrade ejaculation before surgery IPSS ≥ 10 Qmax <15 mL/s PV <100mL Normal pre-operatory urine analysis	Previous prostate surgery, history of PCa or urethral stricture, Marion's disease, concomitant bladder stones, presence of median obstructive lobe, and neurological disorders*.	6 months	51 (26/25)
Cai et al. (24), 2021	Non comparative; Retrospective; Monocentric	June 2018-Jan 2020	Age >50 PV ≥ 30mL PVR 50-400 IPSS ≥12 Qmax <=15	Previous prostate, bladder neck, or urethral surgery, PSA >4 ng/mL, diagnosed PCa, severe urethral stricture, neurological disorders*, hypersensitivity to ultrasound contrast media.	6 months	20
Canat et al. (25), 2023	RCT (TPLA versus TURP); Monocentric	Nov 2021-Feb 2023	Age ≥ 50 IPSS >12 Qmax ≤ 15 mL/s TURP candidates	Urethral stricture, previous bladder or prostate surgery, bladder dysfunction, long-standing urethral catheters, PCa, neurological disorders*, and patients who had undergone rectal surgery.	15 months	50 (25/25)
Chen et al. (22), 2023	RCT (TPLA versus TURP); Open-label; Monocentric	Jun 2019-Dec 2021	Age >50 IPSS >8 PV 30-100mL Qmax ≤ 15 mL/s RUV ≥ 50 mL Failure with prior treatment or patients who were unsuitable for medical treatment as judged by the clinician	Urethral stenosis, previous prostate, bladder or urethral surgery, bladder calculi or tumor, PCa, PSA >4 ng/ml, neurological disorders*, post-rectal surgery or patients with anal atresia, severe coagulation disorders or infection	12 months	51 (25/26)
Destefanis et al. (26), 2023	Non comparative; Prospective; Monocentric	Oct 2020-June 2022	High hemorrhagic risk due to ongoing pharmacological therapy or due to pre-existent diseases ASA score > 3 Indwelling bladder catheter or intermittent catheterization IPSS > 8 Qmax < 15 ml/s	Clinical suspicion of hypo or non-contractile bladders, PVR >500mL, PCa, urethral stricture, PV <30mL, previous prostate, bladder or bladder neck surgery, neurological disorders* or cognitive impairment	6 months	40
Frego et al. (27), 2021	Non comparative; Prospective; Monocentric	July 2019-Jan 2020	Age ≥ 45 IPPS ≥ 8 PSA < 4 ng/mL, previous negative prostate biopsy, or negative DRE Qmax 15 mL/s PVR ≤ 150 mL PV 30–100 mL	Previous bladder neck, urethral or prostatic surgery, previous diagnosis of BCa or PCa, neurological disorders*, gross hematuria, active UTI	12 months	22
Kollenburg et al. (28), 2024	Non comparative; Prospective; Multicentric	NA	Age ≥ 45 IPSS ≥8 PSA < 4 ng/mL or PSA >4 ng/ml with previously negative prostate biopsy and negative DRE Qmax ≤ 15ml/s PVR ≤ 150mL PV 30-100mL	Prostate, bladder neck or urethral surgery, PCa or BCa, neurological disorders*, acute UTI or macroscopic hematuria	12 months	20
Lagana et al. (29), 2023	Non comparative; Prospective; Monocentric	Jan 2020-Jan 2022	Desire to spare antegrade ejaculation Intolerance of poorly compliant to medical therapy, with no indication for surgery.	Acute and chronic prostatitis, prior prostatic abscess, PV>85 mL, PSA>4.0 ng/mL without a negative MRI scan or negative biopsy for PCa	12 months	63
Lo Re et al. (30), 2024	Non comparative; Prospective; Monocentric	April 2021-July 2023	Age ≥ 45 IPPS ≥ 8 PV 30-100 mL Lack of efficacy, intolerance, or poor compliance to previous medical therapy or strong desire to preserve antegrade ejaculation or very high risk for standard surgery due to comorbidities	Clinical suspicion or previous PCa, neurologic disorders*, urethral strictures, bladder stones, large median lobe, previous prostatic surgery	Baseline, 3, 6, 12 months, last follow up	100
Manenti et al. (31), 2021	Non comparative; Prospective; Monocentric	May 2018-Feb 2020	Age > 50 IPPS ≥12 PV > 30 mL lack of efficacy, intolerance, or poor compliance to previous medical therapy	Urethral stricture, previous prostatic surgery, clinical or imaging findings suspicious for malignancy confirmed by biopsy, neurological disorders*, large median lobe, indwelling catheter, previous diagnosis of BCa or PCa	12 months	44

Study author/year	Design	Recruitment period	Inclusion criteria	Exclusion criteria	Follow-up	N (TPLA/TURP)
Minafra et al. (32), 2023	Non comparative; Retrospective; Monocentric	Sep 2018-Mar 2019	IPPS ≥ 12 Qmax ≤ 15 mL/s PV 30-100 mL (TRUS)	Previous treatment for BPO, history of bladder neck or urethral surgery, indwelling catheter or intermittent catheterization, bladder stones, detrusor acontractility or severely impaired contractility, urethral strictures, neurological disorders*, active UTI, macroscopic hematuria, history of clinical suspicion of PCa (elevated PSA without a negative prostate biopsy or negative DRE), history or clinical suspect of BCa.	3 years	21
Pacella et al. (33), 2019	Non comparative; Retrospective; Multicentric	NA	Age > 50 IPSS ≥ 12 PV > 30 mL (TRUS) Qmax < 15 mL/s PVR < 400 ml	Urethral stricture, previous prostatic surgery, neurological disorders*, previous diagnosis of PCa	12 months	160
Patelli et al. (34), 2017	Non comparative; Prospective; Monocentric	May 2014-May 2016	Age > 50 IPSS ≥ 13 PV > 30 mL (TRUS) Qmax ≥ 5 to ≤ 15 mL/s PVR ≥ 50 ml	Urethral stricture, previous prostate, bladder neck, or urethral surgery, PCa or PSA >4 ng/mL. neurological disorders*.	3 months	18
Patelli et al. (35), 2024	Non comparative; Prospective; Monocentric	May 2014-Sep 2018	Age > 50 IPSS ≥ 13 PV > 30 mL (TRUS) Qmax ≥ 5 to ≤ 5 mL/s PVR > 50 ml	Urethral stricture; PCa or suspected neoplastic disease; known neurological disorders*	36 months and last follow up	40
Polverino et al. (36), 2023	Non comparative; Prospective; Monocentric	April 2021-Feb 2023	ASA score ≥ 3 IPSS ≥ 8 PV 30-100 mL	NA	12 months	23
Rienzo et al. (37), 2021	Non comparative; Prospective; Monocentric	Sep 2018-Mar 2019	Age 40-90 IPSS ≥ 12 PV ≥ 100 mL lack of efficacy, intolerance, or poor compliance to previous medical therapy	Previous surgical treatment for BPH, indwelling catheter or intermittent catheterization, bladder stones, detrusor acontractility or hypocontractility (BCI < 50), urethral strictures, neurological disorders*, previous diagnosis of BCa of PCa	6 months	21
Sessa et al. (38), 2022	Non comparative; Prospective; Monocentric	April 2021-Feb 2022	Age ≥ 45 IPPS ≥ 12 PV 30-100 mL (TRUS) lack of efficacy,bintolerance, or poor compliance to previous medical therapy	Clinical suspicion or previous PCa, neurological disorders*, urethral strictures, bladder stones, indwelling catheter with severe detrusor hypo-contractility	1, 3 months and last follow up (4-12 months)	38

Values are presented in absolute numbers unless otherwise specified. ASA, American Society of Anesthesiologists; BCa, Bladder cancer; BCI, Bladder contractility index; BPH, Benign prostatic obstruction; BPO, Benign prostatic obstruction; Dec, December; DRE, Digital rectal examination; Feb: February; IPPS, International Prostatic Symptoms Score; Jan: January; Mar: March; Mo, Months; MRI, Magnetic resonance imaging; NA, Non available; Nov, November; Oct, October; PCa, Prostate cancer; PSA, Prostate-specific antigen; P, Prostate volume; PVR, Post-Void Residual; Qmax, Maximum urinary flow; RCT, Randomized controlled trials; RUV, Residual urine volume; Sep, September; TPLA, Transperineal laser ablation; TRUS, Transrectal ultrasonographic images; TURP, transurethral resection of the prostate; UTI, urinary tract infection.*neurological disorders: e.g., multiple sclerosis, Parkinson's disease, or known history of spinal cord injury.

Table S4. Reported postoperative complications and management strategies among included studies. Complication rates are stratified by Clavien-Dindo classification. Most complications were mild (Grade I-II) and included transient urinary retention, infection, and hematuria.

Study author/year	N	Type and number of complications		Management	Complication rate: N (%)		Clavien-Dindo: N (%)
Bertolo et al. (23), 2023	51	No complications		NA	0 (0)		NA
Cai et al. (24), 2021	20	Intraoperative urethral burn: 1 Transient urinary retention: 1		Bladder catheter for 25 days	2 (10)		NA
Canat et al. (25), 2023	50	TPLA No complications	TURP Urethral stenosis: 1	NAP	NA		NA
Chen et al. (22), 2023	51	TPLA Urinary retention: 1 Prostate abscess: 1 Overactive bladder: 1 Urinary infection: 1	TURP Electrolyte disturbance: 1 Urge-incontinence: 1 Hematuria: 1 Urinary infection: 1	Oral medications and supportive treatment	TPLA 4 (16)	TURP 5 (19.23)	NA
Destefanis et al. (26), 2023	40 (3 months) / 38 (6 months)	Catheter displacement or malfunction: 3 Urinary tract infection: 5 Hematuria: 1 Acute urinary retention: 13 Blood transfusion: 1 Acute heart failure: 3.			19 (47,5)		Grade I: 16 (40) Grade II: 9 (22.5) Grade III: 1 (2.5)
Frego et al. (27), 2021	22	Dysuria: 8 Acute urinary retention: 3 Urinary infection: 2		Antibiotics therapy	13 (59)		Grade I: 8 (36.3) Grade II: 5 (22.7)
Kollenburg et al. (28), 2024	20	Dysuria: 5 Urgency: 4 Haematuria: 3 Pain: 2 Frequency: 1 Urinary retention: 10 Urinary tract infection: 7		Conservative treatment and antibiotics			Grade I: Dysuria: 5 (25) Urgency: 4 (20) Haematuria: 3 (15) Pain: 2 (10) Frequency: 1 (5) Grade II: Urinary retention: 10 (50) Urinary tract infection: 7 (35)
Laganà et al. (29), 2023	63	Prostatic abscess: 2 Orchitis: 1		Abscess drainage Antibiotics	3 (4,8)		Grade II: 1 (1,6) Grade IIIa: 2 (3.2)
Lo Re et al. (30), 2024	100	Urinary infection: 2		Oral antibiotics	2 (2)		Grade II: 2 (2)
Manenti et al. (31), 2021	44	Urinary blockage and urinary clots: 5		Catheter reposition	5 (11,3)		NAP
Minafra et al. (32), 2023	21	No patient complained about the development of late-onset complications		NAP	NAP		NAP
Pacella et al. (33), 2019	160	Transient hematuria: 3 Acute urinary retention: 3 Orchitis: 1 Prostatic abscess: 1		None Bladder catheter for 15 days Antibiotic Antibiotic and percutaneous drainage	8 (5)		Grade I: 7 (4.3) Grade III: 1 (0.6)

Study author/year	N	Type and number of complications	Management	Complication rate: N (%)	Clavien-Dindo: N (%)
Patelli et al. (34), 2017	18	0	NAP	NAP	NAP
Patelli et al. (35), 2024	40	Prostatitis: 1 UTI: 1	NA	NA	NA
Polverino et al. (36), 2023	23	NA	NA	NA	Grade ≥2: 0 (0)
Rienzo et al. (37), 2021	21	Prostatic abscess: 1	Transperineal drainage and antibiotic	1 (4.7)	Grade III: 1 (4.7)
Sessa et al. (38), 2022	38	Acute urinary retention: 2	NA	NA	NA

NAP: not applicable; NA: not available

Table S5. GRADE assessment of the certainty of evidence across outcomes. Certainty of evidence graded according to GRADE domains (risk of bias, inconsistency, indirectness, imprecision, and publication bias). All main outcomes demonstrated high certainty.

Author(s): Iago Zang Pires, Marília Oberto da Silva Gobbo, Tanize Louize Milbradt, Renan Yuji Ura Sudo, Mable Pereira, Nilson Marquardt Filho, Márcio Augusto Averbeck.
Question: Transperineal Prostate Laser Ablation compared to Transurethral Resection of the Prostate for Benign Prostatic Enlargement

Certainty assessment							№ of patients		Effect		Certainty	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Transperineal Prostate Laser Ablation	Transurethral Resection of the Prostate	Relative (95% CI)	Absolute (95% CI)		
International Prostate Symptom Score changes (assessed with: points; Scale from: 0 to 35)												
3	Randomised trials	Not seri-ous	Not serious	Not serious	Not serious	None	76	76	-	Mean 1.81 Pontos more (2.14 fewer to 5.76 more)	⊕⊕⊕⊕ High	CRITICAL
Maximum urinary flow rate changes (assessed with: ml/s)												
3	Randomised trials	Not serious	Not serious	Not serious	Not serious	None	76	76	-	Mean 10.73 ml/s lower (17.55 lower to 3.92 lower)	⊕⊕⊕⊕ High	CRITICAL
Male Sexual Health Questionnaire for Ejaculatory Dysfunction changes (assessed with: points)												
3	Randomised trials	Not serious	Not serious	Not serious	Not serious	None	76	76	-	Mean 4.78 pontos higher (0.65 higher to 8.91 higher)	⊕⊕⊕⊕ High	CRITICAL
Simplified International Index of Erectile Function changes (assessed with: points)												
3	Randomised trials	Not seri-ous	Not serious	Not serious	Not serious	None	76	76	-	Mean 0.17 pontos lower (1.89 lower to 1.55 higher)	⊕⊕⊕⊕ High	CRITICAL

CI: confidence interval

Abbreviations: GRADE – Grading of Recommendations, Assessment, Development and Evaluation.