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REVIEW

Outcomes and safety of trans perineal laser ablation of the prostate: a systematic review

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Abstract

Objective Prostate trans-perineal laser ablation (TPLA) is a minimally invasive treatment for benign prostatic hyperplasia (BPH) that is gaining importance as an alternative to the standard of care, namely transurethral resection of the prostate (TURP). To evaluate the functional outcomes and rates of complication in BPH patients with LUTS who underwent TPLA.

Materials and methods We performed a scoping systematic review (PROSPERO id CRD42024612152) on PubMed/Medline, Embase, and the Cochrane Library in June 2025 according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) statement. Identified reports were reviewed according to the methodological index for non-randomized studies (MINORS).

Results Overall, 17 studies (13 prospective and four retrospective studies) involving 717 patients were analyzed. However, study heterogeneity and limited long-term data hinder a comprehensive and unbiased comparison with TURP. Prostate TPLA was associated with improvements at 12-month in LUTS (Δ of IPPS and QoL ranged from 40.7 to 72.7% and from 50 to 75%, respectively) as well as patient satisfaction, and uroflowmetry measures (Δ of Qmax and Post-voidal residuum ranged from 42.8 to 127.7% and from 28.4 to 86.4%). Moreover, ejaculatory functioning was preserved. Prostate TPLA-related complication rates were low, with most adverse effects classified as Clavien-Dindo grade II.

Conclusions Retrospective evidence widely suggests that prostate TPLA is a suitable option for BPH treatment. Future research, especially randomized controlled trials, are needed to confirm prostate TPLA efficacy over a period longer than the standard 12-month follow-up and assess its cost-effectiveness relative to TURP.

Keywords Prostate · Minimally invasive · Laser · LUTS

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Introduction

Benign prostatic hyperplasia (BPH) is a benign condition affecting 50–60% of males in their 60s, increasing with age [1, 2, 3, 4]. Due to the anatomy of the gland, it may affect the bladder and the urethra resulting in lower urinary tract symptoms (LUTS) [3]. Among these, the BPH patients may exhibit weak flow, prolonged voiding, and partial or complete urinary retention [3, 4, 5]. Moreover, they may also exhibit complications due to prostate enlargement such as urinary retention, recurrent urinary tract infections, bladder stones, renal dysfunction, and erectile dysfunction [6]. Therefore, LUTS may negatively impair the quality of life (QoL) of BPH patients, as well as their mental health status [4, 7, 8]. Historically, the first line treatment for BPH is represented by watchful waiting or drug therapy (single or in combination) [9]. Surgery may represent a choice when drug therapy fails to control symptoms or when adverse effects are not tolerated [10, 11]. Transurethral resection of the prostate (TURP) and suprapubic enucleation are the gold standard for the management of BPH [1, 2]. Unfortunately, TURP patients may exhibit complications, such as bleeding, urethral strictures, ejaculatory dysfunction, and persistent urinary symptoms [12]. Recently, a variety of minimally invasive techniques are emerging exhibiting similar or better outcomes than TURP with a significantly lower rates of complication [13, 14, 15]. Among those, trans-perineal laser ablation (TPLA) of the prostate is gaining importance during recent years [16, 17]. Specifically, prostate TPLA can be performed under local anesthesia and is associated with a shorter hospitalization time recovery, similarly to other minimally invasive techniques such as UroLift [16, 17, 18]. Although previous systematic reviews have explored TPLA in BPH patients [19, 20, 21, 22], an updated scoping review was warranted to summarize the current evidence, and to highlight methodological limitations. In consequence, we addressed this knowledge gap. Specifically, we performed a review to evaluate the functional outcomes and rates of complication in BPH patients with LUTS who underwent TPLA.

Materials and methods

We designed this study following the PRISMA-ScR (Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews) guidelines, given the exploratory nature of the analysis (Supplementary Table 1) [23]. The protocol was registered on PROSPERO (CRD42024612152).

Literature search

The search was performed in the Medline (US National Library of Medicine, Bethesda, MD, USA), Scopus (Elsevier, Amsterdam, The Netherlands), and Web of Science Core Collection (Thomson Reuters, Toronto, ON, Canada) databases up to June 2025. No chronological restrictions were applied. The following keywords were combined to capture relevant publications with a title/abstract search: (benign prostatic obstruction) OR (BPO) OR (benign prostatic hyperplasia) OR (BPH) OR (benign prostatic enlargement) OR (BPE) OR (lower urinary tract symptoms) OR (LUTS) AND (trans-perineal laser treatment) OR (trans-perineal ablation) OR (minimally invasive laser ablation). Reference lists in relevant articles were also screened for additional studies.

Selection criteria

Two authors (L.N. and F.D.B. a senior and a junior urologist resident, respectively) reviewed the records separately and individually selected relevant publications, with any discrepancies resolved by a third senior author (V.M.A. an associate Professor). An initial screening of titles and abstracts was performed to determine which papers could meet the inclusion criteria. Subsequently, the full-text articles underwent a more exhaustive assessment. The Population, Intervention, Comparison, Outcome, Study design (PICOS) criteria were used to assess the eligibility of studies, as previously done [24, 25]. PICOS criteria were set as follows: (P) Patients with benign prostatic hyperplasia; (I) Prostate TPLA; (C) "none or any surgical treatment for BPH"; (O) Safety, functional outcomes and complications; (S) Prospective, retrospective primary studies, case series, case reports, case-control, observational and comparative studies were included. Moreover, abstract, letters to the editor, editorial comments, systematic reviews and meta-analysis, narrative reviews and original articles without primary data were excluded. Ethical approval and patient consent were not required for the present study.

Data collection

The following data were extracted: author name, year of publication, study design, sample size, patient characteristics at baseline, such as age, prostate volume (PV), prostate-specific antigen (PSA), post-void residual volume (PVR), maximum flow rate (Qmax), International Prostate Symptom Score (IPSS), IPSS- quality of life (QoL), International Index of Erectile Function (IIEF-5) score. Moreover, the following perioperative characteristics were collected:

Antibiotic prophylaxis (yes or not, which class of antibiotics), operative time, length of in-hospital stays, therapy at discharge, catheterization time, complications rates and grade according to Clavien-Dindo classification.

Quality assessment

The evaluation of the level of evidence was performed according to Oxford Center for Evidence-Based Medicine 2011. The methodological index for non-randomized studies (MINORS) was used to assess the methodological quality of both comparative and non-comparative studies (Supplementary Table 2) [26]. The questionnaire includes 12 items: 8 items for non-comparative studies and an additional 4 items for comparative studies [26]. Each item is scored from 0 (not reported) to 2 (reported and adequate), with a maximum score of 16 for non-comparative and 24 for comparative studies [26]. Higher scores indicate better methodological quality [26]. Risk of bias was independently assessed by two paired investigators (L.N. and E.D.M.) for all the included studies version 2 Cochrane risk-of-bias tool for randomized trials (ROB-2) [27]. This instrument evaluates five key domains that may affect the internal validity of RCTs [27]. Specifically, it analyzes the bias arising from the randomization process, the deviations of intended interventions, missing outcome data, outcomes measurement, and from selection of the reported result [27]. Each domain could be rated as "low risk" or "high risk", depending on the amount of uncertainty and concerns present [27].

Results

The search strategy revealed a total of 98 results. Screening of the titles and abstracts revealed 70 papers eligible for inclusion. Further assessment of articles, based on full text, led to the exclusion of 54 papers. A total of 17 papers (13 prospective and 4 retrospective), involving a total of 717 patients (18–160) were included in the final analysis.

Patient' clinical profile

Study characteristics and patients' clinical profile were reported in Table 1. Overall median age ranged from 62 to 80 years old. PSA was reported in only eight studies. Of those, PSA ranged from 0.56 to 13.5 ng/mL. According to baseline characteristics of BPH patients: PV ranged from 30.5 to 130 ml, Qmax and PVR ranged in respectively from 4 to 15 mL/s and 0 to 400 ml. The IPSS scores and IPSS-QoL ranged from 12 to 35 points and from 3 to 6 scores. In three and in one studies, IPSS and IPSS-QoL were not reported, respectively. Only nine studies reported IIEF-5 scores that ranged from 0 to 26 points. Of the 17 studies, only two relied on a follow-up at 36-month, seven studies on a 12-month follow-up while nine studies on either 3-months or 6-months follow-up. The improvements in Qmax, PVR, IPSS and IPPS-QoL (Table 2) at 12-month of follow-up ranged in respectively from 42.8 to 127.7%, from 28.4 to 86.4%, from 40.7 to 72.7% and from 50 to 75%.

Perioperative characteristics

Perioperative characteristics were reported in Table 3. Of all the studies, nine studies reported an antibiotic prophylaxis. Within those, four studies described a prophylaxis with only fluoroquinolones, two studies with cephalosporines and two studies did not specify the antibiotic class. Ten studies reported the operative time (in minutes) that ranged from 31.5 to 59 min. Eight studies reported the length of in-hospital stay (in hours) that ranged from 2 to 6.5 h. Twelve studies reported the catheterization time (in days) that ranged from 4 to 15 days.

Complication rates

The number and complications grade according to Clavien-Dindo classification were reported in Table 4. Only 110 (15.3%) patients experienced complications after prostate TPLA. Clavien-Dindo grade II was the most experienced complication type ($n=54$ patients, 49.0%), followed by Clavien-Dindo grade I complications ($n=39$, 35.4%). Within complications, acute urinary retention (AUR) was the most reported complications ($n=39$, 35.4%), followed by urinary tract infections (UTIs, $n=24$, 21.8%), dysuria ($n=13$, 11.8%), and hematuria ($n=10$, 9.0%).

Discussion

Prostate TPLA technique showed promising advantages, namely better functional outcomes, over the standard of care for BPH management [13, 16, 18, 28]. Despite these advantages, the sources of prostate TPLA have not been comprehensively and recently analyzed in a scoping systematic fashion. We addressed this knowledge gap and made several noteworthy observations.

First, to the best of our knowledge only 17 studies from 2017 to 2024 were included in the final qualitative analysis. The studies were mainly prospective designed ($n=13$, 76.4%) and relied on small sample sizes (Table 1). Moreover, data were highly heterogeneous. Ten studies reported the outcomes in median and IQR while the remaining seven studies relied on mean ± SD. Overall, data concerning outcomes of interest, namely PV, PSA, Qmax, IPSS, QoL, PVR

Table 1 Detailed characteristics of 17 papers included in the systematic review

Author, years	Study type	Sample size	Age (median, IQR)	Prostate volume (median, IQR)	PSA (median, IQR)	Qmax (median, IQR)	PVR (median, IQR)	IPSS (median, IQR)	QoL (median, IQR)	IIEF5 (median, IQR)
Patelli, 2017	P	18	71.7 (51–89)	69.8 ± 39.9	N.A.	7.6 ± 2.7	199.9 ± 147.3	21.9 ± 6.2	4.7 ± 0.6	N.A.
Pacella, 2020	R	160	69.8 ± 9.6	75.0 ± 32.4	N.A.	8.0 ± 3.8	89.5 ± 84.6	22.5 ± 5.1	4.5 ± 1.1	N.A.
Frego, 2021	P	22	62 (55–65.5)	65 (46.5–81)	2.24 (1.4–4.5)	9 (5–12.5)	60 (25–107.5)	22 (19.5–25.25)	4 (4–5)	22 (16.5–24)
Cai, 2021	R	20	73.9 ± 9.2	70.8 ± 23.8	N.A.	8.5 ± 3.0	78.7 ± 58.8	22.7 ± 5.3	4.9 ± 1.7	N.A.
De Rienzo, 2021	P	21	62 (54–69)	40 (40–50)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Manenti, 2021	P	44	72.1 ± 6.6	102.42 ± 36.3	7.3 ± 1.8	7.6 ± 4.2	138.4 ± 40.8	18.5 ± 5.5	5.8 ± 1.4	21 ± 4
Sessa, 2022	R	30	72 (64–79)	42 (40–53)	1.64 (0.56–2.43)	9.5 (7.6–11.2)	100 (70–150)	21.5 (18.0– 27.8)	4.0 (4.0–5.0)	16.0 (7.5–23.5)
Cai, 2023	R	20	72.3 ± 9.0	70.7 ± 23.8	N.A.	8.3 (4–15)	82.8(0–200)	22.7(15–35)	5.0 (2–8)	N.A.
Laganà, 2023	P	63	72.3 ± 10.0	63.6 ± 29.7	4.82 ± 1.8	8.6 ± 3.5	124.8 ± 115.4	20.8 ± 7.4	4.7 ± 1.4	N.A.
van Kollenburg, 2023	P	20	70.3 (59–88)	65.5(31–117)	5.0 (0.9–13.5)	9.7(5–15)	61.8 (0–212)	21.3 (12–28)	4.9 (3–6)	35.4 ± 23.6
Minafra, 2023	P	20	63 (55– 70)	41.5 (40.0– 54.3)	N.A.	8.8 (7.8–10.8)	70 (33–120)	18 (16–21)	4 (4–5)	17 (15– 21)
Bertolo, 2023	RCT	51	63.0 (57.0–70.5)	49 (37–65)	3.0 (1.1–4.0)	10.2 (8.7–12.0)	70 (20–100)	24.0 (16.0–29.0)	5 (3–5)	17.0 (15.0–21.0)
Canat, 2023	RCT	25	65.58 ± 6.59	66.77 ± 25.28	4.79 ± 4.63	8.73 ± 3.77	125 ± 68.50	20.14 ± 6.02	4.75 ± 0.75	14.84 ± 3.93
Polverino, 2023	P	23	77 (68–84)	42 (39–70)	N.A.	N.A.	N.A.	N.A.	4 (3–5)	N.A.
Destefanis, 2023	P	40	80 (72.5–84)	38 (30.5–73)	2.2 (0.8–3.8)	8 (5.5–10)	50 (15–180)	25 (19–30)	6 (5–6)	0 (0–6)
Patelli, 2024	P	40	65.1 ± 8.3	66 (48.5–86.5)	N.A.	N.A.	108 (38–178)	N.A.	5 (4–5)	23 (19–26)
Lo Re, 2024	P	100	66.5 (60–75)	50 (40–70)	N.A.	9.1 (6.9–12)	90 (50–150)	18 (15–23)	4 (3–4)	N.A.

Mean ± Standard deviation was presented for all the papers that did not report the median (IQR)

The data reported were all preoperative

IIEF-5 International Index of Erectile Function, *IPSS* International Prostate Symptom Score, *IQR* interquartile range, *N.A.* not available, *P* prospective study, *PSA* prostate specific antigen, *PVR* post-void residual volume, *Qmax* maximum flow rate, *QoL* quality of life, *R* retrospective study, *RCT* randomized controlled trials

as well as IIEF-5 were lacking in the majority of the studies retrieved ($n=10$, 58.8%). Those limitations suggest a careful interpretation of the following evidence. Moreover, they do not allow us to perform a clinically meaningful quantitative synthesis of the current results.

Second, the populations analyzed were also highly heterogeneous in age and PV. Indeed, despite the vast majority of the sample size consisting of septuagenarians, Destefanis et al. relied on 40 octogenarians patients [29]. Conversely, three studies (Frego et al., De Rienzo et al., and Minafra et al.) relied on younger age (median: 61.9, 62, and 63 years) [13, 30, 31]. These differences in years may jeopardize the reliability of the technique in the general population [32]. Moreover, the PV has not been standardized neither in measurement nor in suitability for the procedure. Indeed, Destefanis et al. relied on 40 prostate glands with a median volume of 38 (30.5–73), measured with a trans-rectal ultrasonography [29]. Conversely, Manenti et al. relied on a population of men harboring a mean PV of 102.42 (SD: 36.3), measured at MRI [33]. These characteristics, different in statistic measurement, may also affect the reliability of the prostate TPLA in clinical practice. Additionally, no study reported a stratification according to PV. Therefore, TPLA may be differently effective according to PV, exerting different outcome improvements.

Third, despite the differences in the baseline characteristics, the studies enrolled BPH patients with a Qmax < 10 mL/min, IPPS ≥ 20 as well as QoL ≥ 4 [28, 30, 34, 35, 36, 37]. All these features characterized the severe LUTS condition. However, the follow-up period was different. Nine papers (52.9%) reported a follow-up of at least 12-month while only two (11.7%) reported a 36-month follow-up. Of the first group, three papers (33.3%) were focused on the improvements of symptoms at 3-, 6- and 12-month, comprehensively. Only two papers (11.7%) were focused on the improvement respectively at 3- and 12- months or

Table 2 Functional outcomes improvements at 12-months of follow-up

Author, years	Prostate volume	Qmax	PVR	IPSS	QoL
Pacella et al. 2020					
T0	75.0	8.0	89.5	22.5	4.5
T12	58.8	15.0	17.8	7.0	1.6
Δ%	**21.6**	**87.5**	**80.1**	**68.8**	**64.4**
Frego et al. 2021					
T0	65	9	60	22	4
T12	41.5	20.5	30	6	1
Δ%	**36.1**	**127.7**	**50**	**72.7**	**75**
Manenti et al. 2021					
T0	102.4	7.6	138.4	18.5	5.8
T12	48.1	16.2	18.8	6.2	2.1
Δ%	**53.0**	**113**	**86.4**	**66.4**	**63.7**
Laganà et al. 2023					
T0	63.6	8.6	124.8	20.8	4.7
T12	42.8	16.2	40.6	8.4	1.2
Δ%	**32.7**	**88.3**	**67.4**	**59.6**	**74.4**
van Kollenburg et al. 2023					
T0	65.5	9.7	61.8	21.3	4.9
T12	N.A.	14.9	44.2	10.9	1.9
Δ%	N.A.	**54.7**	**28.4**	**48.8**	**61.2**
Minafra et al. 2023*					
T0	41.5	8.8	70	18	4
T12	35.0	11.0	15	12	2
Δ%	**20.4**	**45.8**	**85.7**	**37.2**	**60**
Canat et al. 2023					
T0	66.7	8.73	125	20.14	4.75
T12	N.A.	14.26	46.8	10.1	1.5
Δ%	-	**63.3**	**62.5**	**40.7**	**68.4**
Patelli et al. 2024*					
T0	66	N.A.	108	23	5
T12	49.5	N.A.	21	7	1
Δ%	**25.0**	-	**87.5**	**74**	**80**
Lo Re et al. 2024					
T0	50	9.1	90	18	4
T12	N.A.	13	45	10	2
Δ%	-	**42.8**	**50**	**44.4**	**50**

The bold values are for statistically significant results

The improvements were calculated as Δ (%)

The data reported for Patelli et al. and Minafra et al. are based on Δ between T0 and 36-months of follow-up

IPSS International Prostate Symptom Score, *IQR* interquartile range, *N.A.* not available, *P* prospective study, *PSA* prostate specific antigen, *PVR* post-void residual volume, *Qmax* maximum flow rate, *QoL* quality of life, *R* retrospective study, *RCT* randomized controlled trials

6- and 12- months. It should be noted that the improvements at 12-month reported in the majority of papers is slightly similar between the different studies. For instance, van Kollemburg et al., within 20 patients from a multicenter study setting, reported an improvement at 12-month of Qmax (from 9.7 to 14.9, $p=0.01$), IPSS (from 21.3 to 10.9, $p<0.001$), as well as QoL (from 4.9 to 1.9, $p<0.001$) [37]. Moreover, Laganà et al. reported similar promising results at 12-month within 63 BPH patients [36]. Specifically, they recorded an improvement in IPSS (from 20.8 to 8.4, $p<0.001$), QoL (from 4.7 to 1.2, $p<0.001$), Qmax (from 8.6 to 16.2 mL/s, $p=0.01$), as well as in PVR (from 124.8 to 40.6 mL, $p=0.003$) [36]. Similarly, Manenti et al. and Patelli et al., reported at 12-month similar improvements when Qmax, IPSS, QoL as well as PVR were the endpoints of interest [28, 33]. Of the second group of paper that describe the 36-month of follow-up improvements, these relied only on small-sized patients' group of 20 (Minafra et al.) and 40 (Patelli et al.) BPH patients [33, 38]. Thus, the results achieved within those groups are smallest to be generalized. However, the above observation suggested that at least 12-month of follow-up are necessary to establish an effective response to prostate TPLA and to experience a clinically meaningful improvement in LUTS. Indeed, of the seven papers that presented 12-month results, the Δ of improvement in Qmax, PVR, IPSS as well as IPSS-QoL were mainly>30%, suggesting the effectiveness of the prostate TPLA. However, further perspectives as well as randomized controlled studies may enrich the sample size and may prolong the follow-up period to account for need of re-treatment. These observations may furnish an important element also in the preoperative counselling of the BPH patients.

Fourth, the ejaculatory function (EF) after TPLA was not mentioned within all the studies enrolled. Specifically, only four studies (23.5%) reported EF [18, 30, 33, 37]. Of those, two studies did not report the metric to evaluate the EF. For instance, van Kollenburg et al. reported a preserved antegrade ejaculation in 11 of 13 patients (85%) [37]. Similarly, Frego et al. observed a preserved EF in almost the total sample of prostate TPLA treated patients ($n=21$, 95.5%) [30]. Conversely, Manenti et al. and Bertolo et al. relied on Male Sexual Health Questionnaire - Ejaculatory Dysfunction (MSHQ-EjD) short form questionnaire [18, 33]. Similarly to previous authors, Manenti et al. as well as Bertolo et al. also observed an improvement in EF at 12-month from prostate TPLA [18, 33]. Despite the results consistency, a more in-depth analysis should be assessed to evaluate the EF determinants related to prostate TPLA in order to integrate this aspect in the preoperative counselling of the BPH patients.

Fifth, overall, 12 studies (70.5%) reported complications at prostate TPLA according to Clavien-Dindo classification (Table 3). Of the remaining five, no complications were recorded (Patelli et al., Polverino et al., Bertolo et al.) or were not available (Minafra et al., Canat et al.) [15, 17, 18, 28, 31]. Specifically, the Clavien-Dindo grade II complications were most common. Of those, urinary retention

Table 3 Perioperative characteristics reported in 17 papers included in the systematic review

Author, years	Antibiotic prophylaxis	Operative time (minutes)	Length of in-hospital stay (hours)	Therapy at discharge	Catheterization time (days)
Patelli, 2017	NOS	43.3 ± 8.7	N.A.	N.A.	17.3 ± 10.0
Pacella, 2020	Fluoroquinolones	44.0 ± 12.9	1.8 ± 0.4	N.A.	N.A.
Frego, 2021	Fluoroquinolones	N.A.	N.A.	NSAID	11.3 ± 11.5
Cai, 2021	N.A.	60.9 ± 10.8	42.6 ± 9.9	N.A.	16.5 ± 4.2
De Rienzo, 2021	Cephalosporines or fluoroquinolones	36.0 ± 9.5	20.8 ± 3.6	Antibiotic NOS, Corticosteroids, Bromelain, Alpha-blockers	8.7 ± 2.5
Manenti, 2021	Fluoroquinolones	31.5 (28–37)	6.4 (5.9–7.2)	Antibiotic NOS, Gastroprotectors, NSAID	7 (7–8)
Sessa, 2022	Cephalosporines	31.5 (28–37)	6.4 (5.9–7.2)	Antibiotic NOS, Gastroprotectors, NSAID	7 (7–8)
Cai, 2023	N.A.	N.A.	N.A.	N.A.	N.A.
Laganà, 2023	Cephalosporines	N.A.	N.A.	N.A.	14.9 ± 7.5
van Kollenburg, 2023	N.A.	59 (34–95)	6.5 (3–27)	N.A.	15.2 (10-20)
Minafra, 2023	N.A.	N.A.	N.A.	N.A.	N.A.
Bertolo, 2023	N.A.	35 (30–55)	2 (2–3)	N.A.	4 (2–7)
Canat, 2023	N.A.	N.A.	N.A.	N.A.	N.A.
Polverino, 2023	N.A.	N.A.	N.A.	N.A.	7 (7-9)
Destefanis, 2023	NOS	42.5 (35–50)	N.A.	N.A.	N.A.
Patelli, 2024	Fluoroquinolones	43.3 ± 8.7	**2 (N.A.)***	N.A.	22.8 ± 10.9
Lo Re, 2024	N.A.	N.A.	N.A.	N.A.	7 (7–7).

Mean ± Standard deviation was presented for all the papers that did not report the median (IQR)

N.A. not available, *NOS* not otherwise specified, *NSAID* non-steroidal anti-inflammatory drugs

*The length of in-hospital stay was expressed in days

requiring re-catheterization and UTIs were the most commonly reported complications in prostate TPLA treated patients. Conversely, among Clavien-Dindo grade III complications, it was only reported the prostatic abscess that required drainage. Overall, complication rates ranged between 1.9% and 2.3% for hematuria, 3.7% and 36.3% for dysuria, 1.9% and 19% for urinary retention, 0.6% and 9.1% for UTIs, and 0.6% and 4.8% for prostatic abscess formation. However, the Clavien-Dindo was also heterogeneous. For instance, Pacella et al. classified urinary retention as Clavien-Dindo grade I complication [34]. Conversely, for Destefanis et al. as well as Frego et al. urinary retention was classified as Clavien-Dindo grade II complication [29, 30]. Due to this heterogeneity in complications grading, the results should be carefully interpreted and cannot be directly compared. Moreover, according to Gauhar et al. the rates of complication after prostate enucleation with laser increased in parallel with PV [39, 40]. Unfortunately, the authors only analyzed PV≥than 80 mL thus a practical comparison with the current data also cannot be performed. Although most complications were Clavien-Dindo grade I or II, the clinical implications, especially of acute urinary retention or UTIs, may impact patient satisfaction and postoperative recovery. Moreover, the variability in how complications were classified across studies hinders a reliable estimate of real-world safety.

Sixth, three randomized controlled trials reported a comparison between prostate TPLA and standard of care for BPH treatment (TURP) [15, 18, 41]. Zhang et al. enrolled 114 from 16 participating centers worldwide [41]. Moreover, Bertolo et al. enrolled 51 patients within a single center trial over a period of one year (2020–2021) [18]. Finally, Canat et al. relied on 50 patients enrolled over a period of three years (2021–2023) [15]. The three RCTs showed comparable results in LUTS improvement between prostate TPLA and TURP at 12-month of follow-up [15, 18, 41]. However, prostate TPLA was more successful in avoiding EF impairment compared to the standard of care. Last but not the least, a small retrospective study (Cai et al.) compared the short-term efficacy of prostatic arterial embolization vs. TPLA of 40 patients enrolled in a single center over a period of four years (2018–2021) [42]. The two techniques showed a similar short-term efficacy (evaluated at 3- and 6-months), without the occurrence of serious complications. However, the study did not report 12-month outcomes and in consequence a direct comparison to other RCTs cannot be completed. Interestingly, RCTs on prostate TPLA vs. TURP are consistent in reporting prostate TPLA as an option to standard of care. Indeed, the indications for

Table 4 Number and complication grade according to Clavien-Dindo classification of 17 papers included in the systematic review

Authors	Complications	Clavien-Dindo Grade	Number	Total
Patelli, 2017	0	–	–	–
Pacella, 2020	Hematuria	I	3	8
	Orchitis	I	1	
	Acute urinary retention	II	3	
	Prostatic abscess	III	1	
Frego, 2021	Dysuria	I	8	13
	Acute urinary retention	II	3	
	Urinary tract infection	II	2	
Cai, 2021	Urethral burns	I	1	10
	Transient urinary retention	I	1	
De Rienzo, 2021	Prostatic abscess	III	1	1
Manenti, 2021	Prolonged hematuria	I	1	5
	Orchitis	II	3	
	Bilateral prostatic abscess	III	1	
Sessa, 2022	0	–	–	–
Cai, 2023	Hematuria	I	2	3
	Urethral burns	I	1	
Laganà, 2023	Orchitis	II	2	3
	Prostatic abscess	III	1	
van Kollenburg, 2023	Dysuria	I	5	32
	Urgency	I	4	
	Haematuria	I	3	
	Pain	I	2	
	Frequency	I	1	
	Urinary retention	II	10	
	Urinary tract infection	II	7	
Minafra, 2023	N.A.	N.A.	N.A.	N.A.
Bertolo, 2023	0	–	–	–
Lo Re, 2024	urinary tract infection	II	2	2
Canat, 2023	N.A.	N.A.	N.A.	N.A.
Polverino, 2023	0	–	–	–
Destefanis, 2023	Catheter displacement/ malfunction	I	3	33
	Urinary Tract Infection	II	5	
	Hematuria	I	1	
	Acute Urinary Retention	II	13	
	Blood transfusion	III	1	
	Heart Failure	II	3	
	Death	V	2	
	Multiple complications	V	5	
Patelli, 2024	Prostatitis	I	1	2
	Urinary tract infection	II	1	

N.A. not available

prostate TPLA are still narrowed, compared to TURP. For example, patients with bladder dysfunction, rectal surgery history, an oversized prostate with a prominent medial lobe or BPH with cystolith would not be appropriate for prostate TPLA. While TPLA appears to offer advantages in terms of reduced invasiveness and preservation of EF, the evidence supporting its long-term efficacy and cost-effectiveness remains limited. Furthermore, TURP held and continue to hold an advantage in BPH with high prostate volume. Thus, TPLA may be feasible for selected patients rather than as a universal alternative for BPH management.

Taken together, prostate TPLA represents an innovative minimally invasive technique for BPH that showed interesting results, namely lower IPSS and QoL scores, lower PVR, and higher Qmax at 12-month of follow-up. The relief of obstructive LUTS may also be paralleled by a preserved EF, underpowered in the current review due to the paucity of data. Indeed, similar metrics should be employed to assess the reliability of TPLA in BHP patients experiencing severe LUTS. However, the heterogeneity of the current results cannot allow a quantitative synthesis of the evidence. Furthermore, the overall quality of the included studies was mainly low-to-intermediate resulting in concerns about the robustness of the findings. Therefore, our synthesis should be interpreted cautiously, especially when comparing TPLA with established treatments, namely TURP. Future research should measure the outcomes of interest at a longer follow-up (over 12-month) to evaluate the risk of retreatment. They should also shed light on the cost-effectiveness of this procedure compared to TURP and enlightened furtherly the benefit of TPLA in EF preservation.

Conclusions

Prostate TPLA represents a novel minimally invasive treatment for BPH. It is associated with improvements in uroflowmetry parameters, obstructive LUTS. Moreover, prostate TPLA is associated with low rates of complications (mainly CD grade II and I). Future research, especially randomized controlled trials, are needed to confirm prostate TPLA efficacy over a period longer than the standard 12-month follow-up and assess its cost-effectiveness relative to TURP.

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Declarations

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