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FUNCTIONAL UROLOGY

Feasibility and safety of robot-assisted radical prostatectomy following laser enucleation of the prostate

Mehmet Yilmaz[1], Mustafa Karaaslan[2], Mehmet Emin Şirin[3], Halil Çağrı Aybal[4], Muhammed Emin Polat[5], Zeynep Akdagcik[6], Mustafa Yigit Ozdemir[7], Tuncay Toprak[8], Arkadiusz Miernik[9]

[1]Urology, MediClin Kraichgau-Klinik, Bad Rappenau, Germany
[2]Department of Urology, Bayindir Healthcare Group Kavaklidere Hospital, Ankara, Turkey
[3]Clinic of Urology, Private Inova Hospital, Aksaray, Turkey
[4]Clinic of Urology, Polatlı Duatepe State Hospital, Ankara, Turkey
[5]Department of Urology, University of Health Sciences, Ankara City Hospital, Turkey
[6]Department of Urology, University of Health Sciences, Abdurrahman Yurtaslan Oncology Training and Research Hospital, Ankara, Turkey
[7]Medical Faculty, Ankara University, Turkey
[8]Department of Urology, University of Health Sciences, Fatih Sultan Mehmet Training and Research Hospital, Istanbul, Turkey
[9]Faculty of Medicine, Department of Urology, University of Freiburg – Medical Centre, Germany

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Corresponding author
Mehmet Yilmaz
MediClin Kraichgau-Klinik, Urology
15 Fritz-Hagner-Promenade,
74906 Bad Rappenau, Germany
yilmazmehmet88@hotmail.com

Introduction The aim of this study was to systematically review the available evidence on the feasibility and safety of robot-assisted radical prostatectomy (RARP) in patients with prostate cancer following laser enucleation of the prostate (LEP).

Material and methods A systematic search was conducted using PubMed (MEDLINE) and Web of Science online databases until 31 July 2025 with the search terms (“HoLEP” OR “endoscopic enucleation” OR “laser enucleation of the prostate” OR “ThuLEP” OR “ThuFLEP” OR “EEP” OR “LEP”) AND (“robot assisted radical prostatectomy” OR “robotic assisted radical prostatectomy” OR “RARP”) by incorporating the PICO formula (population, intervention, comparison, outcome).

Results Three studies were identified. Continence rates and recovery times differed between patients with prior LEP and those who were LEP-naïve. In one study, postoperative incontinence rates were significantly different between the prior HoLEP and HoLEP-naïve groups (74.0% vs 22.0%, p <0.001), whereas in the other two studies there was no significant difference between groups. Erectile function was documented in 2 studies, which exhibited no statistically significant differences between the prior-LEP group and LEP-naïve group. Complication rates across the studies remained relatively low (7.0–9.0%). Biochemical recurrence and positive surgical margins between the previous LEP and LEP naïve groups were comparable.

Conclusions In patients undergoing RARP after LEP, complications are low and the oncological outcomes are promising, similar to patients who are LEP-naïve. It is essential for surgeons to counsel patients on the potential for prolonged recovery, particularly in regard to continence and sexual function.

Key Words: benign prostatic obstruction ‹› laser enucleation of the prostate ‹› prostate cancer ‹› robot-assisted radical prostatectomy

INTRODUCTION

Lower urinary tract symptoms (LUTS) due to benign prostatic obstruction (BPO) represent a significant health concern affecting the quality of life of men worldwide [1]. In recent years, a fundamental shift has occurred within the domain of urological surgery, precipitated by the emergence of laser technology, which has played a seminal role in the evolution of innovative surgical methodologies.

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Among these, laser enucleation of the prostate (LEP) has emerged as a leading modality for the management of BPO-related LUTS, gaining global acceptance and establishing itself as a preferred surgical option [1–3].

The widespread adoption of lasers in endourology, along with advances in energy delivery systems, has resulted in substantial advancements [1]. Several laser modalities have been developed for the purpose of BPO surgery. Holmium laser enucleation of the prostate (HoLEP) has been evidenced to yield surgical outcomes that are consistent with those of conventional procedures such as transurethral resection of the prostate (TURP) [1, 2]. Thulium laser enucleation of the prostate (ThuLEP) was first described by Hermann and has since become established as a BPO surgical treatment, representing an alternative to the HoLEP method [4]. The recent advent of the thulium fibre laser (TFL) has precipitated a paradigm shift in the domain of prostate enucleation, with TFL (ThuFLEP) emerging as a contender among the surgical methodologies employed in LEP [5, 6]. Evidence has also demonstrated that ThuFLEP can improve functional parameters [5, 7].

Prostate cancer (PCa) is the second most prevalent form of cancer among the male population, accounting for 15.0% of all cases of cancer diagnosed [8]. The presence of PCa can be incidentally detected during histopathological evaluation of specimens obtained from BPO procedures, including LEP, or during subsequent follow-up monitoring [9, 10].

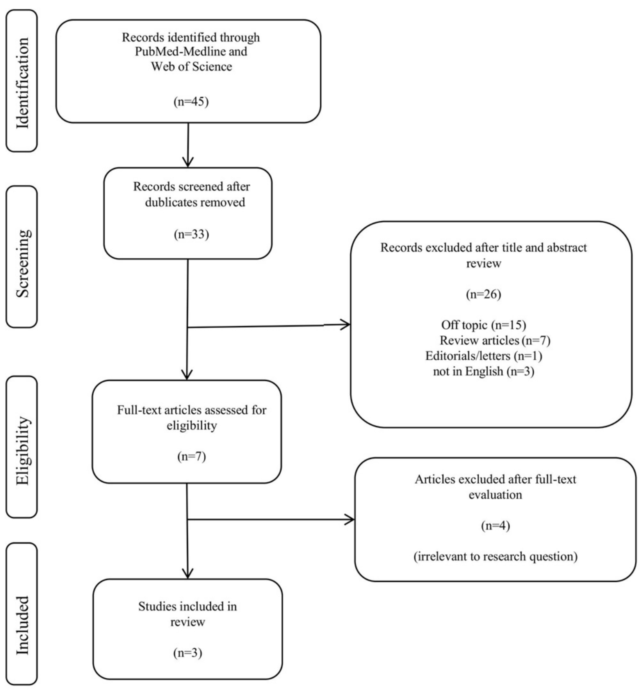

Figure 1. *Flow diagram of the selection process in the study.*

Advancements in technological capabilities have resulted in the widespread adoption of robot-assisted radical prostatectomy (RARP) as a prevalent minimally invasive procedure for the treatment of PCa [11, 12]. RARP has been established as the preferred surgical method due to its combination of safety and effectiveness, as well as its improved perioperative outcomes, decreased postoperative bleeding, reduced complications during surgery and in the postoperative period, and superior ergonomic features [13]. As LEP has become a common intervention for BPO, clinicians and researchers have had to address a new challenge: whether RARP remains an effective and safe treatment if PCa is detected in patients who have previously undergone LEP.

In the present study, we conducted a systematic review of the current evidence on the feasibility and safety of RARP in patients with PCa who had previously undergone LEP.

MATERIAL AND METHODS

Evidence acquisition

The protocol for this systematic review was registered on PROSPERO (CRD42024563819). This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guidelines [14].

Search strategy

A systematic search was performed in the online databases PubMed (MEDLINE) and the Web of Science up to 31 July 2025: The following search term combinations were employed: ("HoLEP" OR "endoscopic enucleation" OR "laser enucleation of the prostate" OR "ThuLEP" OR "ThuFLEP" OR "EEP" OR "LEP") AND (robot assisted radical prostatectomy" OR "robotic assisted radical prostatectomy" OR "RARP"). Subsequently, an exhaustive search was conducted on the complete texts of all articles deemed relevant, using the titles and abstracts of the selected articles. Furthermore, an overview of the reference lists of all relevant articles and reviews was conducted.

Eligibility criteria and data extraction

The PRISMA flowchart (Figure 1) provides a visual representation of the search process. The PICO approach was used in alignment with the recommendations stipulated within the PRISMA guidelines, with the objective of assessing the inclusion criteria. The PICO approach is characterised by 4 key elements: population (P), intervention (I), comparison (C), and outcomes (O) [15]. Therefore, we selected studies involving men who underwent LEP for BPO and were subsequently diagnosed with PCa (through pathological material or biopsy in follow-up) (P) and treated with RARP (I), single-arm or comparative studies (C) evaluating functional, oncological outcomes and complications (O).

Studies were excluded if they were not associated with PCa and RARP, or did not address objectives or outcomes related to mainly RARP after LEP, or studies where data on RARP after LEP are not available separately, or articles not written in English, conference/meeting abstracts, review articles, as well as case reports, editorials, letters, or author replies.

The selection of articles relevant to the subject of interest was conducted independently by two authors (M.K. and M.E.P.). Any discrepancies were resolved through discussion by a third reviewer (M.Y.).

The following details were recorded: authors and date of study, study design, patient numbers, age at RARP, time to RARP from LEP, serum total PSA (prostate specific antigen) at RARP, prostate volume (PV), Gleason score after LEP (pathological or biopsy), baseline erectile function (EF), baseline urinary continence (UC), total operation (TOT) and console time (CT), estimated blood loss (EBL), bladder neck repair, nerve sparing procedure, lymph node dissection, duration of hospital stay after RARP, time to catheter removal after RARP, postoperative UC (pad free-leak free) and EF (potent in the last follow-up), complications, pathological stage and Gleason scores (GS), the presence of extracapsular extension (ECE), lymphatic, vascular and perineural invasion, seminal vesicle invasion, positive surgical margins (PSM), biochemical recurrence (BCR) of postoperative pathological specimens.

Qualitative assessment of the studies

The employment of the National Institutes of Health (NIH) Quality Assessment Tool for observational cohort and cross-sectional studies enabled an assessment and rating to be made of the quality of the evidence presented in each of the selected studies. (https://www.nhlbi.nih.gov/health-topics/study-quality-assessment-tools). This instrument consists of an evaluation comprising 14 questions that address issues pertaining to the quality of the study. The following options are provided for each question: "yes", "no", "cannot be determined", "not applicable" or "not reported". Disagreements between the 2 authors were resolved through discussion. Quality ratings of poor (≤60.0%), fair/adequate (60.0–69.0%), good (70.0–79.0%), and strong (>80.0%) were assigned according to the criteria set out in other reviews [16, 17]. The quality score for each study was determined by dividing the total number of "yes" responses by the sum of all valid responses.

RESULTS

A comprehensive search of the databases identified a total of 45 studies. Following the evaluation of the study titles and abstracts, studies were excluded for various reasons. These included duplicate articles (n = 12), studies that did not meet the inclusion criteria or were unrelated to the topic of RARP after LEP and studies with objectives or outcomes that were not associated with robot-assisted radical prostatectomy after LEP (n = 15), review articles (n = 7), editorials/letters (n = 1), and studies not in English language (n = 3). Following the full-text evaluation, 4 additional articles were excluded as they did not address the specified topic. In total, 3 studies that met the inclusion criteria were deemed suitable for inclusion.

Study characteristics

The characteristics of the studies are shown in Table 1. Abedali et al. [18] evaluated 27 patients with a mean age of 69.6 (5.1) years and a mean prostate volume (PV) of 68.2 (55.6) ml. The median time from LEP to RARP was reported as 31 (71) months, and the mean preoperative PSA (prostate specific antigen) level was 5.78 (2.6) ng/ml.

In contrast, Banno et al. [19] included 25 patients with a mean age of 71 (5.7) years and a smaller mean PV of 34.4 (11.3) ml. The median interval between LEP and RARP was notably shorter at 141 (112–226) days, with a median preoperative PSA of 1.6 (0.5–2.7) ng/ml. Gellhaus et al. [20] reported a smaller cohort of 11 patients, with a mean age of 67.9 (4) years and a mean PV of 43.4 (17–134) ml. Across the three included studies, functional and oncological outcomes after RARP were also compared between patients with and without previous LEP.

In accordance with the NIH Quality Assessment Tool, all three of the studies were defined as being of good quality (Table 2).

Perioperative and postoperative outcomes

Perioperative and postoperative features and outcomes including complications of the studies are given in Table 3. Mean TOT varied significantly across studies, ranging from 145.2 (35.5) minutes in the study of Banno et al. [19] to 216.6 (18) minutes in the study of Gellhaus et al. [20]. CT was reported only by Banno et al. [19], with a mean of 120.6 (35.7) minutes. Moreover, RARPs with prior-HoLEP had significantly longer TOT and CT than those without prior-HoLEP (mean TOT: 145.2 min [SD: 35.5] vs 123.0 min [SD: 36.4], p = 0.004, and mean CT: 120.6 min [SD: 35.7] vs 96.2 min [SD: 33.3], p <0.001).

The incidence of vesicourethral anastomotic urine leakage on the 7^{th} postoperative day was found to be significantly higher in the prior-HoLEP group (12.0% vs 2.1%, p = 0.006) [19]. In the study by Banno et al. [19], bladder neck repair was performed in 76.0% of patients, whereas this rate was lower at 27.0% in the study by Gellhaus et al. [20].

Nerve-sparing procedures were performed to varying degrees. Bilateral nerve-sparing was more common in the study of Banno et al. [19] (52.0%), while Abedali et al. [18] reported only 11.0% of patients receiving bilateral nerve-sparing. Unilateral nerve-sparing was performed in 37.0% of cases in the study by Abedali et al. [18]

Functional outcomes were assessed in terms of UC and EF. UC, defined as being pad-free, was achieved in 22.0% of patients in the study by Abedali et al. [18] and in 27.0% of patients in the study by Gellhaus et al. [20]. In the study by Banno et al. [19], analysis of parameters affecting postoperative UC revealed that nerve-sparing intraoperative bladder neck repair and body mass index were independently associated with postoperative UC, whereas prior-HoLEP was not [20]. Continence rates and recovery times showed differences between the prior-HoLEP and HoLEP-naïve groups.

Table 1. *Baseline characteristics of the studies*

Author and year	Study design and type	No. of patients	Age at RARP mean ±SD or median (min–max) [years]	Prostate volume mean±SD or median (min-max) [g]	Time to RARP from LEP mean ±SD or median (min–max)	tPSA at RARP mean ±SD or median (min–max) [ng/ml]	Gleason score after LEP (pathological or biopsy) [n (%)]	Baseline erectile function [n (%)]	Baseline urinary continence [n (%)]
Abedali et al. (2019) [18]	Retrospective	27	69.6 (5.1)	68.2 (55.6) (resected)	31 (71) months	5.78 (2.6)	Gleason grade group (pathological) 1 : 3 (11) 2 : 14 (52) 3 : 2 (7) 4 : 4 (15) 5 : 1 (4)	7 (37)	23 (85)
Banno et al. (2023) [19]	Retrospective	25	71 (5.7)	34.4 (11.3)	141 (112–226) days	1.6 (0.5–2.7)	Gleason grade group 1 : 8 (32.0) 2 : 10 (40.0) 3 : 5 (20.0) 4 : 1 (4.0) 5 : 1 (4.0)	N/A	N/A
Gellhaus et al. (2015) [20]	Retrospective	11	67.9 (4)	43.4 (17–134)	4 (1–13) years	4.6 (2)	Gleason score (biopsy) 3 +3 : 1 (10) 3 +4 : 7 (70) 3 +5 : 1 (10) 4 +3 : 1 (10)	4 (40)	9 (82)

LEP – laser enucleation of the prostate; N/A – not applicable; PSA – prostate specific antigen; RARP – robot-assisted radical prostatectomy; SD – standard deviation

Table 2. *Quality assessments of the studies according to NIH Quality Assessment Tool*

Studies	Quality assessment criteria														Quality
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
Abedali et al. (2019) [18]	+	+	+	+	–	+	+	+	+	–	+	–	+	–	71.4% good
Banno et al. (2023) [19]	+	+	+	+	–	+	+	+	+	–	+	–	+	+	78.5% good
Gellhaus et al. (2015) [20]	+	+	+	+	–	+	+	+	+	–	+	–	+	–	71.4% good

In the studies by Abedali et al. [18] and Gellhaus et al. [20], continence recovery was achieved in a shorter median time in HoLEP-naïve patients compared to those with prior HoLEP. Additionally, in the study by Abedali et al. [18], strict continence, defined as being pad-free and leak-free, was achieved in 74.0% of HoLEP-naïve patients, whereas only 22.0% of patients with a history of HoLEP achieved this level of continence ($p < 0.001$). Similarly, Gellhaus et al. [20] reported strict continence rates of 64.0% in HoLEP-naïve patients compared to 27.0% in the prior-HoLEP group ($p = 0.071$). However, as noted by Banno et al. [19], long-term continence rates were comparable between the groups ($p = 0.06$).

The EF recovery was generally poor across the studies. In the study by Abedali et al. [18], only 11% (n = 3) of patients regained potency, while Gellhaus et al. [20] reported a slightly higher rate of 25% (n = 1). Banno et al. [19] did not report EF recovery. Potency outcomes were poorer in the prior-HoLEP group, with lower rates of EF recovery reported across studies. Gellhaus et al. [20] reported that only 25.0% of HoLEP patients retained potency at follow-up compared to 54.0% in non-HoLEP patients ($p = 0.576$), a finding consistent with the lower bilateral nerve-sparing rates in prior-HoLEP patients. Similarly, Abedali et al. [18] reported that in HoLEP- naïve patients, where a higher rate of bilateral

Table 3. *Perioperative and postoperative outcomes*

Author and year	Operation time mean ±SD or median (min–max) [min]	Console time mean ±SD or median (min–max) [min]	Estimated blood loss mean ±SD or median (min–max) [min]	Bladder neck repair [n (%)]	Nerve sparing [n (%)]	Lymph node dissection	Length of hospital stay after RARP mean ±SD or median (min–max) [min] days or hours	Time to catheter removal after RARP mean ±SD or median (min–max) [min] days or hours	Urinary continence (pad free, leak free) [n (%)]	Erectile function (potent at last follow-up) [n (%)]	Complications [n (%)]
Abedali et al. (2019) [18]	193.5 (43.4)	N/A	160 (93) ml	11 (39)	Uni: 10 (37) Bil: 3 (11)	89	1 (0) day	8.3 (2) days	6 (22)	3 (11)	2 (7)
Banno et al. (2023) [19]	145.2 (35.5)	120.6 (35.7)	70 (25–100) ml	19 (76)	Uni: 2 (8.0) Bil: 13 (52.0)	0 (0)	7.6 (1.3) days	8.1 (1.8) days	N/A	N/A	0 (0)
Gellhaus et al. (2015) [20]	216.6 (18)	N/A	209.1 (50–400) ml	3 (27)	Uni: 4 (36) Bil: 2 (18)	N/A	1 (1–1) days	7.7 (1.6)	3 (27)	1 (25)	1 (9)

LEP – laser enucleation of the prostate; N/A – not applicable; PSA – prostate specific antigen; RARP – robot-assisted radical prostatectomy; SD – standard deviation

Table 4. *Pathological and oncological findings after RARP*

Author and year	Pathological stage [n (%)]	Gleason score/ISUP grade [n (%)]	Extracapsular extension [n (%)]	Lymphatic invasion [n (%)]	Vascular invasion [n (%)]	Perineural invasion [n (%)]	Seminal vesicle invasion [n (%)]	Positive surgical margins [n (%)]	Biochemical recurrence [n (%)]
Abedali et al. (2019) [18]	N/A	1 : 4 (15) 2 : 13 (48) 3 : 6 (22) 4 : 0 (0) 5 : 3 (11)	13 (48)	2 (7)	4 (14)	N/A	4 (15)	6 (22)	2 (7)
Banno et al. (2023) [19]	T0 : 10 (40.0) T2 : 13 (52.0) T3 : 2 (8.0)	1 : 14 (56) 2 : 7 (28) 3 : 1 (4) 4 : 2 (8) 5 : 1 (4)	2 (8)	1 (4)	0 (0)	4 (16)	1 (4)	2 (8)	N/A
Gellhaus et al. (2015) [20]	N/A	≤6 : 3 (30) 3 +4 : 5 (50) 4 +3 : 2 (20)	2 (18)	0 (0)	2 (18)	N/A	0 (0)	2 (18)	0 (0)

ISUP – International Society of Urological Pathology; N/A – not applicable; RARP – robot-assisted radical prostatectomy; SD – standard deviation nerve-sparing was achieved, EF was higher at 29% (n = 7) compared to 11% (n = 3) in the prior-HoLEP group (p = 0.305).

Complications

Complication rates across the studies remained relatively low (Table 3). Abedali et al. [18] reported a lower complication rate of 7.4% (n = 2), consisting of non-urologic complications, including rectal bleeding and an infiltrated IV that caused a second-degree burn. Gellhaus et al. [20] reported a small anastomotic leak in a previous HoLEP patient, which was resolved by Foley catheter drainage for a further week. Banno et al. [19] did not report any significant complications.

Pathological and oncological findings after robot-assisted radical prostatectomy

The pathological outcomes, including pathological staging and ISUP (International Society of Urological Pathology) grades or Gleason score (GS), and oncological outcomes were reported with varying levels of detail across the studies, as presented in Table 4.

ECE was reported by Abedali et al. [18] in 48.0% (n =13) of patients, while Banno et al. [19] documented ECE in 8.0% (n = 2) of their cohort. Gellhaus et al. [20] found ECE in 18.0% (n = 2) of patients.

Lymphatic invasion was relatively rare across the studies. Abedali et al. [18] reported 7.0% (n = 2) of patients with lymphatic invasion, while Banno et al. [19] reported a lower rate of 4.0% (n = 1). Gellhaus et al. [20] did not report any lymphatic invasion. Vascular invasion was observed in 14.0% (n = 4) of patients in the study by Abedali et al. [18], compared to 18.0% (n = 2) in the study by Gellhaus et al. [20].

Across all three studies, PSM were reported to range from 8.0% to 22.0%, with statistically comparable findings observed between the groups.

Regarding BCR, all 3 studies found no significant differences between the prior-HoLEP and HoLEP- naïve groups. In the study by Abedali et al. [18], BCR was reported at 7.0% (n = 2) in both groups. Gellhaus et al. [20] reported no biochemical recurrence in the prior-HoLEP group, whereas a rate of 7.0% (n = 2) was observed in the non-HoLEP group. Banno et al. [19] evaluated predictors of BCR following RARP using univariate and multivariate analyses; accordingly, previous HoLEP was not a risk factor for biochemical recurrence after RARP.

DISCUSSION

In the present review study, the feasibility and safety of RARP after LEP were examined. Despite the paucity of studies evaluated in this review, the RARP procedure following LEP appears to be a feasible and reproducible option with comparable oncological results and low complication incidences. According to studies we reviewed, a previous LEP should not be considered a risk factor for BCR after RARP. Furthermore, PSM between the previous LEP and HoLEP naïve groups were comparable. Some studies in the literature have indicated that radical prostatectomy is an effective treatment for patients who have previously undergone transurethral prostate interventions [21–23].

Kretschmer et al. [24] reported their experience in patients undergoing radical prostatectomy (open or robotic, but separate data are not available) after HoLEP. They found that prior HoLEP had no significant effect on positive margin rate (PMR) (14.0% [HoLEP] vs 18.8% [no HoLEP], p = 0.06) or BCR-free survival (hazard ratio 0.74, 95% confidence interval [CI] 0.32–1.70, p = 0.4).

Regarding functional outcomes, previous LEP may adversely affect the recovery of continence after subsequent radical prostatectomy surgery. In one study included in our review, postoperative stress urinary incontinence (SUI) rates were significantly different between the prior-HoLEP and HOLEP naïve groups (74.0% vs 22.0%, p <0.001) [18], whereas in the other two studies there was no significant difference between the rates. Intrinsic injury to the sphincter and bladder neck during LEP and manipulation of pelvic floor and periurethral anatomy during RARP may affect patients' eventual continence potential. The ideal time to perform RARP following LEP is contingent, in part, on the degree of enhancement in continence that has been accomplished following LEP.

Regarding EF, it is imperative to acknowledge the difficulties related to functional recovery of erections in patients who have previously undergone LEP. This phenomenon can be attributed to the fact that potency levels may be diminished initially in these patients. Kretschmer et al. [24] found that 1-year urinary incontinence rates increased after radical prostatectomy in patients with prior-HoLEP and that prior-HoLEP had no significant effect (OR 0.87, 95% CI 0.74–1.01; p = 0.07). According to the study, previous HoLEP also did not prevent 1-year improvement in erectile function (OR 1.22, 95% CI 1.05–1.43; p = 0.01) [24].

We observed that the EF at the final follow-up was documented in only 2 studies [18, 20], which exhib-

ited no statistically significant differences between the prior LEP group and the LEP-naïve group.
The total duration of the procedure was found to be statistically significantly longer in the prior LEP cohort in the aggregate of the studies reviewed. This is related to the challenges encountered during RARP, which are attributable to the prior LEP procedure. It is imperative to acknowledge that certain difficulties may be encountered during RARP following LEP. The primary challenges encountered pertain to the posterior bladder neck and the apical dissection process. The potential presence of a thin capsule in the anterior prostate, resulting from prior laser enucleation, is a contributing factor. In such cases, it may be advisable to consider a more distal, anterior dissection route in order to avoid iatrogenic injury [20].
The identification of the bladder neck represents a further challenging step in the process. Furthermore, it is important to note that the position of the ureteral orifices may have been altered, given that the patients had previously undergone BPO [19]. It is imperative to acknowledge the potential implications of periprostatic inflammation for tissue changes during LEP, as this may result in intraoperative challenges during RARP. In patients in whom nerve preservation is considered, it should be remembered that the softer prostatic capsule and periprostatic fibrosis caused by enucleation may make it difficult to enter the correct surgical field [19].
This systematic review is not without limitations. Firstly, all studies included are retrospective, and the number of studies is small. This is due to the strict inclusion and exclusion criteria applied in this review, which was designed to evaluate the effectiveness of RARP only in patients who underwent LEP. As a result, studies on RARP after other transurethral procedures were completely excluded. Secondly, data heterogeneity is attributable to factors such as variations in follow-up periods, time interval between LEP and RARP, patient numbers, surgical experience and hospital case volumes, which resulted in potential bias. Thirdly, some studies did not provide data on functional outcomes (e.g. erectile recovery), which has further compounded the challenges in conducting a comprehensive analysis.

CONCLUSIONS

Prior LEP may be associated with longer operative times, vesicourethral leakage, and delays in continence recovery, though long-term continence rates are comparable. Despite these perioperative challenges, complication rates are low, and oncological outcomes remain unaffected.
These findings suggest that prior LEP presents technical and functional challenges in RARP but does not compromise oncological safety, reinforcing its viability in selected patients. It is essential for surgeons to counsel patients on the potential for prolonged recovery, particularly in regard to continence and sexual function. Furthermore, surgeons should consider optimising the timing of RARP to enhance outcomes.
The effectiveness and safety of RARP after LEP should be more clearly demonstrated in multicentre prospective studies involving more patients.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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ETHICS APPROVAL STATEMENT

The ethical approval was not required.

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