Research Square

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Impact of Prior Holmium Laser Enucleation of the Prostate on Outcomes After Robot-Assisted Radical Prostatectomy

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Abstract

Purpose

We evaluated the perioperative, oncologic, and continence outcomes of robot-assisted radical prostatectomy (RARP) in patients with and without prior holmium laser enucleation of the prostate (HoLEP).

Methods

We reviewed 419 RARP cases, including 27 patients with prior HoLEP, and performed 1:2 propensity score matching. Urinary continence was assessed longitudinally using pad counts at scheduled intervals, with 12-month continence as the primary endpoint. Secondary endpoints included perioperative outcomes and biochemical recurrence (BCR).

Results

Perioperative outcomes, pathological findings, and BCR-free survival were comparable between patients with and without prior HoLEP. At 12 months, functional continence (≤ 1 pad/day) was achieved in 100.0% of patients without prior HoLEP and in 85.2% of those with prior HoLEP ($p = 0.011$). Kaplan–Meier analysis demonstrated no significant difference in time to recovery (log-rank $p = 0.068$); however, a subset of patients with prior HoLEP experienced persistent incontinence beyond 12 months. Exploratory analyses implied an association between longer adjunctive transurethral coagulation time during HoLEP and worse functional continence.

Conclusions

Prior HoLEP did not compromise perioperative safety or oncologic outcomes after RARP; however, it was associated with a lower 12-month functional continence rate in a subset of patients. Post-enucleation anatomical changes should be considered during surgical planning and preoperative counseling.

Background

Holmium laser enucleation of the prostate (HoLEP) is an established surgical treatment for benign prostatic hyperplasia [1,2]. Given its widespread use, subsequent diagnosis of prostate cancer requiring definitive local therapy is not uncommon. Radical prostatectomy is a standard treatment option in this setting; however, anatomical alterations and energy-related tissue effects after HoLEP may complicate surgical dissection and potentially affect functional outcomes [3]. Previous studies have suggested impaired continence recovery after radical prostatectomy in patients with prior transurethral resection of the prostate (TURP) [4, 5]. In contrast, evidence regarding outcomes of radical prostatectomy after HoLEP remains limited and inconsistent [6,7]. We investigated the impact of prior HoLEP on urinary continence recovery after robot-assisted radical prostatectomy (RARP).

Methods

Study population

The Institutional Review Board of St. Luke's International University approved the study protocol. We retrospectively reviewed 1,276 patients who underwent RARP between 2011 and 2024. Patients who underwent salvage or cytoreductive surgery, received neoadjuvant or adjuvant therapy, or had < 12 months of follow-up were excluded.

Because RARP after HoLEP was performed by two expert surgeons, analyses were restricted to procedures performed by these surgeons (n = 419). Pad use was assessed at 1, 3, 6, 9, and 12 months postoperatively. The primary endpoint was urinary continence at 12 months after RARP. Secondary endpoints included perioperative outcomes and biochemical recurrence (BCR).

Surgical procedures

All HoLEP procedures were performed at our institution using a previously described anteroposterior enucleation technique [8, 9]. Enucleation and hemostasis were achieved using a holmium laser, with adjunctive bipolar transurethral coagulation (TUC) used selectively for hemostasis. Incidental prostate cancer detected in HoLEP specimens was generally managed with active surveillance. Patients with a high tumor burden or adverse Gleason grade underwent early treatment at the physician's discretion. During surveillance, prostate-specific antigen (PSA) levels were monitored, and biopsy was performed if PSA levels increased. RARP was considered when clinically significant cancer was confirmed.

RARP was performed using a conventional robotic approach regardless of prior HoLEP [10]. Nerve-sparing was attempted when oncologically appropriate, and pelvic lymph node dissection was considered in intermediate- or high-risk cases [11–13]. RARP after HoLEP requires specific technical considerations (Fig. 1). During bladder neck transection, post-enucleation changes may obscure the boundary between the bladder and the prostate. Because the prostatic lumen remains widely open, transection is initiated on the bladder side to avoid inadvertent incision into the prostate (Fig. 1a, b). The bladder neck is reconstructed before urethrovesical anastomosis. Lateral dissection may be complicated by thermal adhesions and collapse of the enucleation cavity; packing gauze into the cavity helps maintain the prostatic contour and facilitates dissection (Fig. 1c).

Definitions

Functional continence was defined as the use of ≤ 1 pad/day, and strict continence was defined as the use of 0 pads/day, consistent with prior studies [15]. BCR was defined as a PSA level of ≥ 0.2 ng/mL [15].

Statistical analysis

Propensity score matching (1:2) was performed with adjustment for age, body mass index (BMI), prostate volume at RARP, clinical T stage, biopsy Grade Group, and surgical period. Propensity scores

were estimated using logistic regression, and covariate balance was assessed using standardized mean differences (SMDs), with an absolute SMD < 0.1 indicating adequate balance.

PSA was excluded from the matching model because levels are typically reduced after transition-zone removal. Time to continence recovery and BCR-free survival were analyzed using the Kaplan–Meier method and compared using log-rank tests. Categorical variables were compared using Fisher's exact test, and continuous variables were compared using the Mann–Whitney U test. Statistical analyses were performed using R software (version 4.2.3; R Foundation for Statistical Computing, Vienna, Austria), and a two-sided p-value < 0.05 was considered statistically significant.

Results

Of 419 eligible patients, 392 had no history of HoLEP, and 27 had undergone HoLEP before RARP (Online Resource 1). Baseline characteristics were adjusted using propensity score matching based on age, BMI, prostate volume at RARP, clinical T stage, biopsy Grade Group, and surgical period (Table 1). Before matching, patients with prior HoLEP were older and more frequently underwent RARP during the later surgical period. Adequate covariate balance was achieved after matching (Online Resource 2). No patient reported pad use preoperatively.

Table 2 presents the perioperative and postoperative outcomes in the matched cohort. Operative time, estimated blood loss, nerve-sparing rate, complication rate, and pathological findings, including Grade Group, pathological T stage, and positive surgical margin, did not differ significantly between groups. In addition, BCR–free survival was comparable (log-rank p = 0.68; Online Resource 3). Grade 3 complications occurred in both groups and were not specific to patients with prior HoLEP (Online Resource 4). In the HoLEP group, two cases each of anastomotic leakage and stricture were observed.

For functional continence, 12-month recovery was achieved in 100% of patients without prior HoLEP and 85.2% of those with prior HoLEP (p = 0.011). Kaplan–Meier analysis demonstrated no significant difference in time to recovery (log-rank p = 0.068; Fig. 2a). Up to 6 months postoperatively, pad usage was similar; however, two patients with prior HoLEP continued to require 3 pads/day at 12 months (Online Resource 5). For strict continence, 12-month recovery rates were 72.2% in patients without prior HoLEP and 66.7% in those with prior HoLEP (p = 0.62), with no significant difference in time to recovery (log-rank p = 0.59; Fig. 2b).

In an exploratory analysis restricted to the HoLEP cohort, patients with persistent functional incontinence at 12 months tended to be older (76 vs 71 years, p = 0.08) and have longer bipolar TUC time during HoLEP (23 vs 10 min, p = 0.05; Table 3).

Discussion

In our study, prior HoLEP did not affect perioperative or oncologic outcomes after RARP but was associated with a lower 12-month functional continence rate, implying a potential adverse effect on

postoperative urinary recovery in a subset of patients.

Gellhaus and Abedali et al. [3, 14] reported matched analyses from the same institution across different periods. In their cohort of 27 patients with prior HoLEP, functional continence rates were 59% versus 81% ($p = 0.156$), and strict continence rates were 22% versus 74% ($p < 0.001$) in patients with and without prior HoLEP, implying worse outcomes, particularly for pad-free recovery. However, continence was not assessed at a uniform postoperative time point, and the cohort had a relatively high mean BMI (~ 28), both of which should be considered when interpreting these findings.

A European two-center matched study, including 43 patients with prior HoLEP, evaluated 12-month pad-free continence and reported rates of 65% versus 79% ($p = 0.09$) in patients with and without prior HoLEP [16]. Although the difference was not statistically significant, a trend toward inferior continence was observed in the HoLEP group. Interpretation is limited by the inclusion of open prostatectomy in nearly one-half of cases and by follow-up shorter than 12 months in approximately 30% of patients.

In our study, continence was assessed longitudinally using pad counts at 3-month intervals, with 12-month continence as the primary endpoint. When functional continence was defined as ≤ 1 pad/day, the 12-month recovery rate was 100.0% in patients without prior HoLEP and 85.2% in those with prior HoLEP. These findings indicate that patients with prior HoLEP were more likely to experience delayed or incomplete continence recovery. Notably, the 100% recovery rate observed in the matched non-HoLEP cohort was not attributable to the matching process. In the full unmatched cohort, 98% (384 of 392) of patients without prior HoLEP achieved functional continence within 12 months, demonstrating that continence recovery remained consistently high in the non-HoLEP population before and after matching.

Kaplan–Meier analysis demonstrated that approximately 80% of patients in both groups regained continence within 6 months; however, persistent incontinence beyond 12 months was observed in a subset of patients with prior HoLEP. Although time to recovery did not differ significantly on log-rank testing, the lower 12-month recovery rate in the HoLEP group implies that prior HoLEP may predispose certain patients to prolonged residual incontinence.

When strict continence was defined as the use of 0 pads/day, no statistically significant difference was observed between groups. Strict pad-free definitions may be influenced by patient behavior, such as the use of a “safety pad,” as well as by baseline bladder function or other nonsurgical factors. These influences may partly explain discrepancies with previous HoLEP–RARP studies [3, 14]. These findings imply that prior HoLEP does not necessarily preclude eventual continence recovery but may increase the likelihood of clinically meaningful persistent incontinence requiring the use of multiple pads.

Within the HoLEP cohort, longer bipolar TUC time was associated with worse 12-month functional continence in exploratory analyses. Bipolar electrocautery penetrates more deeply than holmium laser energy (holmium vs TUC, approximately 0.4 vs 2.4 mm), and prolonged coagulation may cause ischemic or structural damage to continence-related regions [17, 18]. In some patients, lateral dissection and nerve-sparing were performed relatively easily despite prior HoLEP (Fig. 1d). In contrast, in a patient who

required prolonged TUC, dense apical adhesions with obliteration of normal anatomic planes were observed (Fig. 1e). Blunt dissection was not feasible, necessitating sharp dissection with electrocautery, and the urethral wall showed focal thickening and whitish discoloration consistent with ischemic change (Fig. 1f). In such cases, preservation of continence-related periurethral structures may be technically challenging, potentially impairing postoperative functional recovery.

From a safety perspective, oncologic outcomes and most perioperative outcomes were comparable, consistent with prior studies [4, 5, 7]. Anastomotic leakage and stricture occurred in a small number of patients with prior HoLEP. Although these complications are not unique to post-HoLEP prostatectomy, potential periurethral ischemia or tissue fragility warrants meticulous urethral handling and careful anastomotic reconstruction.

Our study has several limitations. This was a retrospective, single-center analysis, and all procedures were performed by experienced surgeons, which may limit generalizability. The number of patients with prior HoLEP was relatively small, and analyses of HoLEP-related predictors were exploratory.

Conclusion

RARP is a reasonable definitive treatment option for prostate cancer diagnosed after HoLEP. Although prior HoLEP did not appear to compromise perioperative safety or oncologic outcomes, a subset of patients experienced prolonged or severe postoperative urinary incontinence. Surgeons should be aware of post-HoLEP anatomic changes and counsel patients regarding the potential risk of delayed continence recovery.

Abbreviations

BCR, Biochemical recurrence

BMI, Body mass index

HoLEP, Holmium laser enucleation of the prostate

PSA, Prostate-specific antigen

PSM, Propensity score matching

RARP, Robot-assisted radical prostatectomy

SMD, Standardized mean difference

TUC, Transurethral coagulation

TURP, Transurethral resection of the prostate

Declarations

Funding

The authors did not receive support from any organization for the submitted work.

Competing Interests

The authors have no relevant financial or non-financial interests to disclose.

Ethics Approval

This retrospective chart review study involving human participants was in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. The Human Investigation Committee (IRB) of St Luke's International University approved this study (Research number: 23-R152).

Consent to Participate

This retrospective study was conducted using an opt-out approach approved by the institutional review board. Formal written informed consent was waived due to the retrospective nature of the study.

Data Availability

The data supporting the findings of this study are not publicly available due to privacy or ethical restrictions but are available from the corresponding author upon reasonable request.

Authors' contribution

Nishino T: Project development, Data collection, Data management, Data analysis, Manuscript writing

Shimbo M: Project development, Data collection, Data management, Manuscript editing

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Endo F: Project development, Data collection, Data management, Manuscript editing

All authors reviewed and approved the final version of the manuscript.

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Tables

Table 1. Preoperative clinical characteristics of patients undergoing RARP, stratified by prior HoLEP status, before and after propensity score matching

		Unmatched				Matched			
		Overall	No HoLEP	HoLEP	|SMD|	Overall	No HoLEP	HoLEP	|SMD|
		(n = 419)	(n = 392)	(n = 27)		(n = 81)	(n = 54)	(n = 27)	
		median (IQR)				median (IQR)			
Age (years)		68 (63, 73)	67 (63, 72)	73 (71, 76)	1.49	73 (70, 77)	74 (69, 78)	73 (71, 76)	0.08
BMI (kg/m^2)		23.7 (22.0, 25.6)	23.7 (22.0, 25.3)	23.9 (21.2, 26.0)	0.07	23.8 (21.4, 25.8)	23.8 (21.7, 25.3)	23.9 (21.2, 26.0)	0.00
PSA at RARP (ng/mL)		6.23 (4.80, 9.10)	6.24 (4.86, 9.30)	5.90 (4.45, 7.76)	0.64	6.29 (4.60, 8.74)	6.50 (4.70, 10.9)	5.90 (4.45, 7.76)	0.97
PV at RARP (mL)		28 (23, 37)	29 (23, 37)	25 (21, 32)	0.12	25 (22, 35)	25 (22, 35)	25 (21, 32)	0.09
Surgical case order †		705 (362, 1022)	675 (349, 1003)	986 (756, 1100)	0.79	984 (739, 1125)	981 (711, 1126)	986 (756, 1100)	0.04
Follow-up period from RARP (month)		57 (28, 87)	59 (28, 89)	44 (24, 73)	0.26	50 (28, 70)	50 (29, 65)	44 (24, 73)	0.01
		n (%)				n (%)			
Biopsy GG	1–2	213 (50.8)	208 (53.1)	5 (18.5)	0.35	16 (19.8)	11 (20.4)	5 (18.5)	0.02
	3	76 (18.1)	67 (17.1)	9 (33.3)	0.16	26 (32.1)	17 (31.5)	9 (33.3)	0.02
	4–5	130 (31.0)	117 (29.8)	13 (48.1)	0.18	39 (48.1)	26 (48.1)	13 (48.1)	0.00
Clinical T stage	T1	68 (16.2)	63 (16.1)	5 (18.5)	0.02	13 (16.0)	8 (14.8)	5 (18.5)	0.04
	T2	308 (73.5)	289 (73.7)	19 (70.4)	0.03	58 (71.6)	39 (72.2)	19 (70.4)	0.02
	T3	43 (10.3)	40 (10.2)	3 (11.1)	0.01	10 (12.3)	7 (13.0)	3 (11.1)	0.02
Clinical N1	1	2 (0.5)	2 (0.5)	0 (0.0)	0.01	0 (0.0)	0 (0.0)	0 (0.0)	0.00

SMDs are used to assess covariate balance. |SMD| < 0.1 indicates adequate balance. PSA was not included in the matching model by design; residual imbalance remains.

† Surgical case order indicates the chronological order of RARP at our institution (1 = first case)

BMI, body mass index; GG, Grade Group; HoLEP, holmium laser enucleation of the prostate; PSA, prostate-specific antigen; PV, prostate volume; RARP, robot-assisted radical prostatectomy; SMD, standardized mean difference

Table 2. Perioperative and postoperative outcomes of patients undergoing RARP in the propensity score–matched cohort, stratified by prior HoLEP status

		Overall	No HoLEP	HoLEP	
		(n = 81)	(n = 54)	(n = 27)	
				median (IQR)	p-value
Operation time (min)		272 (222, 309)	267 (228, 308)	272 (217, 312)	0.78
Estimated blood loss (mL)		100 (50, 200)	140 (50, 200)	100 (50, 213)	0.66
				n (%)	
Nerve sparing	None	26 (32.1)	15 (27.8)	11 (40.7)	0.50
	Unilateral	35 (43.2)	24 (44.4)	11 (40.7)	
	Bilateral	20 (24.7)	15 (27.8)	5 (18.5)	
Lymph node dissection	1	69 (85.2)	45 (83.3)	24 (88.9)	0.74
Pathological GG	1–2	39 (48.1)	25 (46.3)	14 (51.9)	0.80
	3	31 (38.3)	22 (40.7)	9 (33.3)	
	4–5	11 (13.6)	7 (13.0)	4 (14.8)	
Pathological T stage	pT2	58 (71.6)	36 (66.7)	22 (81.5)	0.45
	pT3a	14 (17.3)	11 (20.4)	3 (11.1)	
	pT3b	9 (11.1)	7 (13.0)	2 (7.4)	
Pathological N1		7 (8.6)	5 (9.3)	2 (7.4)	1.00
Positive surgical margin	1	12 (14.8)	9 (16.7)	3 (11.1)	0.74
BCR	1	21 (25.9)	15 (27.8)	6 (22.2)	0.79
CRPC	1	2 (2.5)	1 (1.9)	1 (3.7)	1.00
Leakage of vesicourethral anastomosis	1	3 (3.7)	1 (1.9)	2 (7.4)	0.26
Clavien-Dindo complications	0	58 (71.6)	42 (77.8)	16 (59.3)	0.24
	1–2	21 (25.9)	11 (20.4)	10 (37.0)	
	3	2 (2.5)	1 (1.9)	1 (3.7)	
Functional continence at 1 year		77 (95.1)	54 (100.0)	23 (85.2)	0.011
Strict continence at 1 year		57 (70.4)	39 (72.2)	18 (66.7)	0.62

BCR, biochemical recurrence; CRPC, castration-resistant prostate cancer; GG, Grade Group; HoLEP, holmium laser enucleation of the prostate; IQR, interquartile range; RARP, robot-assisted radical prostatectomy

Table 3. Clinical and HoLEP-related characteristics among patients with prior HoLEP, stratified by 12-month functional continence status (≤ 1 pad/day) after RARP

	Continence	Incontinence	p-value
	n = 23	n = 4	
		median (IQR)	
Age (years)	71 (70, 76)	76 (73, 80)	0.080
BMI (kg/m^2)	23.9 (21.2, 25.9)	24.8 (22.9, 26.6)	0.53
PV at RARP (mL)	25 (21, 32)	23 (17, 29)	0.45
Enucleation volume (g)	34 (20, 43)	25 (20, 30)	0.32
Total energy (kJ)	125 (110, 154)	110 (87, 141)	0.57
Enucleation time (min)	33 (26, 43)	33 (20, 48)	0.93
Coagulation time (min)	16 (7, 20)	10 (4, 16)	0.28
TUC, n (%)	5 (25.0)	2 (50.0)	0.69
TUC time (min)	10 (8, 19)	23 (23, 24)	0.053
Interval from HoLEP to RARP (months)	46 (23, 78)	36 (29, 46)	0.44

BMI, body mass index; HoLEP, holmium laser enucleation of the prostate; IQR, interquartile range; PV, prostate volume; RARP, robot-assisted radical prostatectomy; TUC, transurethral coagulation

Figures

Fig. 1.

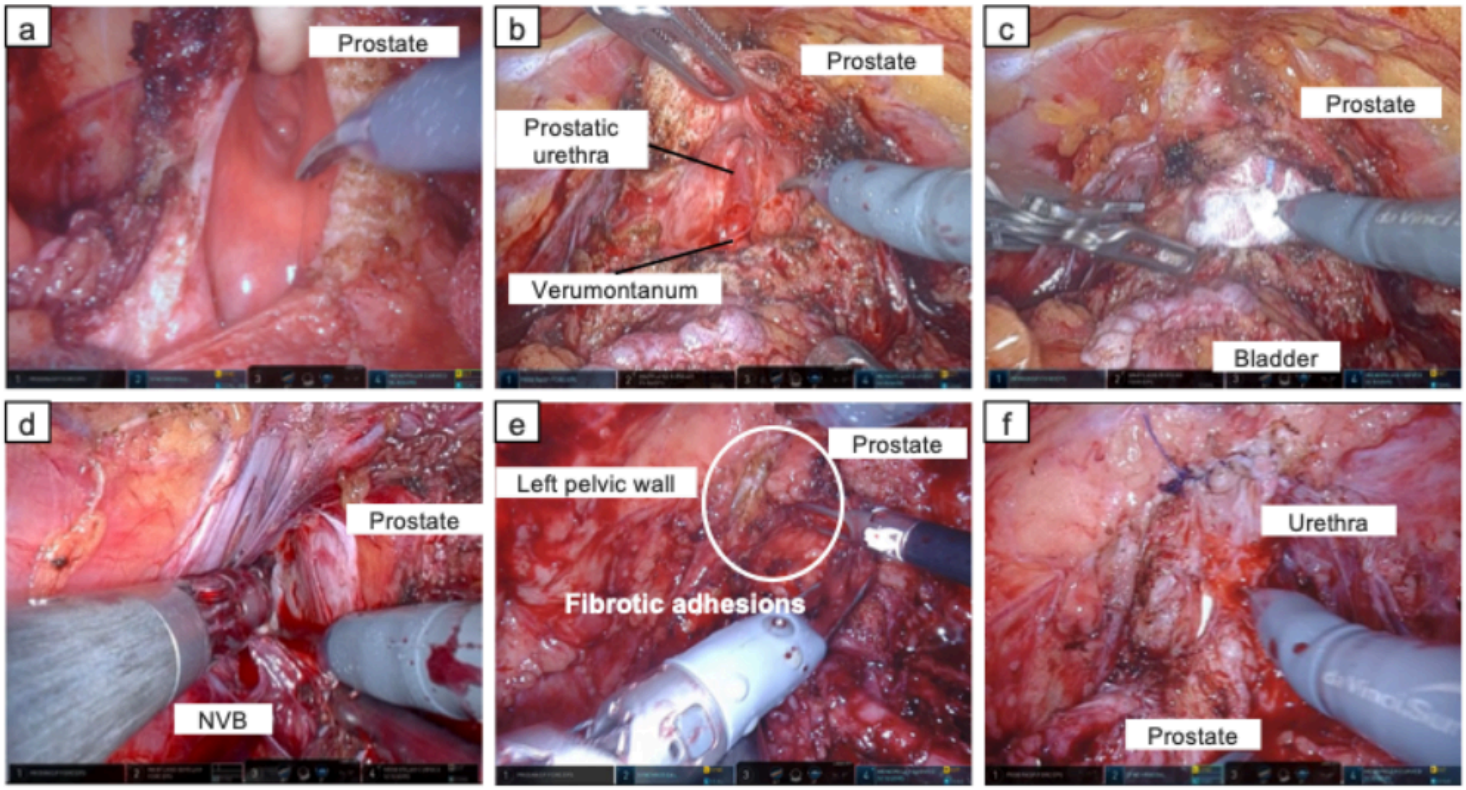


Figure 1

Intraoperative findings during RARP after prior HoLEP

(a–b) Anatomical characteristics after HoLEP. (a) Following adenoma enucleation, the prostatic lumen remains widely open, increasing the risk of inadvertent prostatic incision during dissection. Transection is therefore initiated from the bladder side with careful attention to the enlarged cavity. (b) The enucleation cavity is widely exposed, with the verumontanum clearly identifiable

(c) Surgical tip for lateral dissection. After HoLEP, the enucleation cavity may collapse, producing a concave prostate and challenging lateral dissection. Packing gauze into the cavity maintains prostatic contour and facilitates stable dissection

(d) A case minimally affected by prior HoLEP. Enucleated tissue weight was 48 g, total laser energy was 166 kJ, with no adjunctive TUC. Post-RARP, pad-free continence was achieved at 1 month. Intraoperatively, the dissection plane was clearly identified and smoothly developed along the nerve-sparing layer

(e–f) A case strongly affected by prior HoLEP. Enucleated tissue weight was 30 g, total laser energy was 125 kJ, and adjunctive TUC was performed for 22 minutes. After RARP, the patient continued to use three pads/day at 12 months. (e) Dense adhesions extended from the lateral aspect to the prostatic apex, obscuring the dissection plane and precluding blunt dissection, necessitating sharp electrocautery

dissection. (f) The dorsal venous complex, prostatic apex, and urethra were fused, producing an indistinct anatomical boundary. Adequate prostate traction was required, and sharp dissection was performed along an estimated plane. The urethral wall showed thickening with focal whitish discoloration, implying ischemic changes

HoLEP, holmium laser enucleation of the prostate; RARP, robot-assisted radical prostatectomy; TUC, transurethral coagulation

Fig. 2.

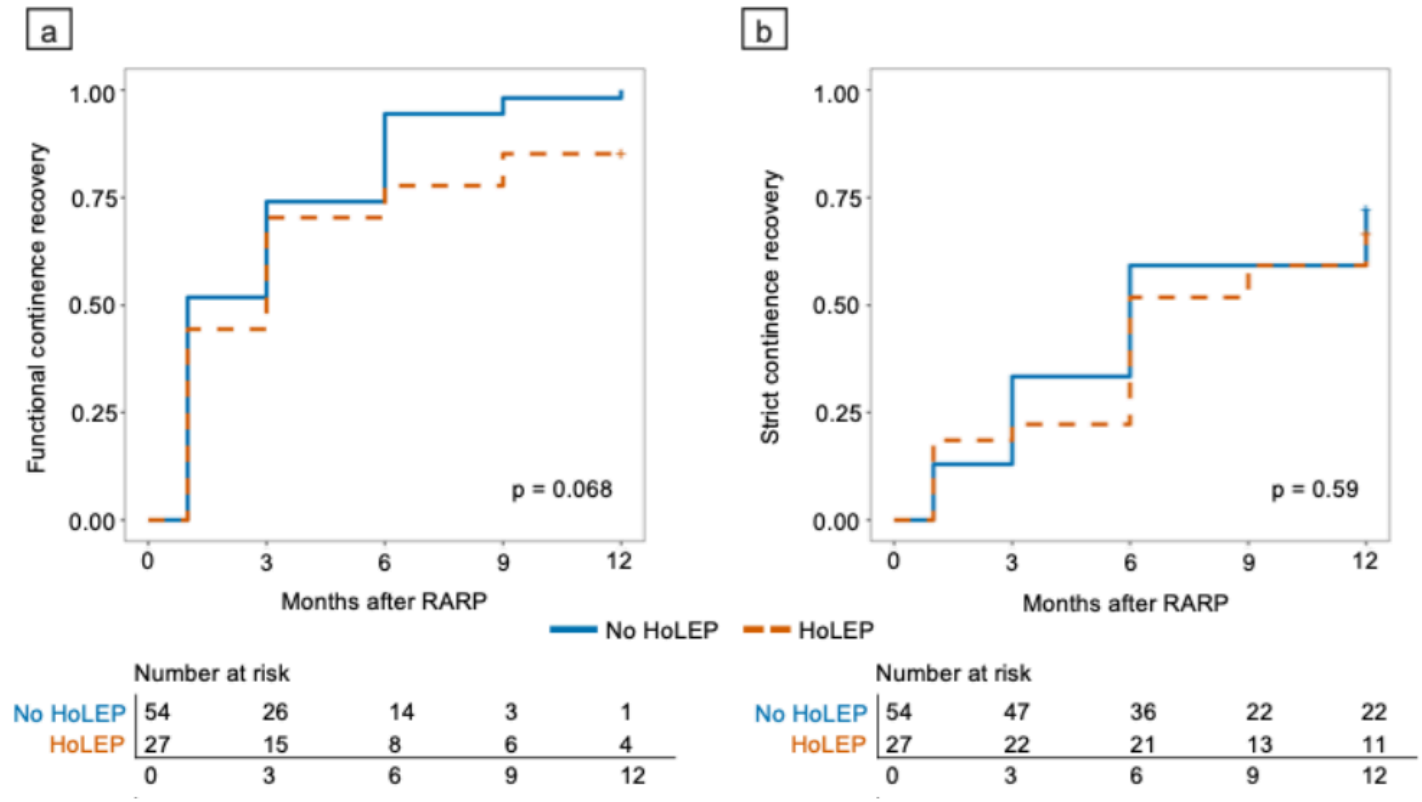


Figure 2

Kaplan–Meier curves showing time to continence recovery stratified by prior HoLEP status: (a) functional continence recovery and (b) strict continence recovery. The solid line represents patients without prior HoLEP, and the dashed line represents patients with prior HoLEP. Functional continence recovery appeared to plateau after approximately 6 months postoperatively in patients with prior HoLEP; however, no statistically significant differences were observed between groups for either definition (log-rank test: p = 0.068 for functional continence and p = 0.59 for strict continence)

HoLEP, holmium laser enucleation of the prostate; RARP, robot-assisted radical prostatectomy

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

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