The effect of peritoneal opening on outcomes of extraperitoneal laparoscopic radical prostatectomy: An analysis of 255 cases

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ABSTRACT

Introduction: This study aimed to investigate the impact of peritoneal patency during extraperitoneal laparoscopic radical prostatectomy (eLRP) on perioperative and postoperative outcomes.

Methods: Between May 2018 and March 2025, 255 patients who underwent eLRP were retrospectively evaluated. Patients without peritoneal opening were classified as group 1 (n=223), while those with peritoneal opening were classified as group 2 (n=32). Demographic data, operative time, complication rates, and complication grades based on the Clavien-Dindo classification were analyzed. Logistic regression analysis was performed to identify associated risk factors.

Results: A history of abdominal surgery was significantly more common in group 2 ($p<0.001$), and the mean operative time was also significantly longer in this group ($p<0.001$). Although the overall complication rate was higher in group 2 (37.5% vs. 24.2%), the difference was not statistically significant ($p=0.131$). Multivariate analysis revealed that a history of abdominal surgery, operative time >180 minutes, and estimated blood loss >150 ml were significantly associated with postoperative complications; however, peritoneal opening was not identified as an independent risk factor ($p=0.113$).

KEY MESSAGES

- Intraoperative peritoneal opening occurred in 12.5% of patients undergoing extraperitoneal laparoscopic radical prostatectomy (eLRP).
- Peritoneal opening was significantly associated with longer operative times and a history of prior abdominal surgery.
- Although complication rates were numerically higher in patients with peritoneal opening, the difference was not statistically significant.
- Multivariate analysis identified operative time >180 minutes, blood loss >150 ml, and abdominal surgery history as independent predictors of complications, but not peritoneal opening itself.
- Peritoneal opening appears to be a manageable intraoperative event and does not compromise the overall safety of the extraperitoneal approach when performed by experienced surgeons.

Conclusions: Although peritoneal opening may introduce technical challenges that compromise the advantages of the extraperitoneal approach, it does not significantly affect postoperative complication rates. With sufficient surgical experience, it appears to be a manageable intraoperative event.

INTRODUCTION

Radical prostatectomy (RP) is one of the primary curative treatment options for localized prostate cancer (PCa). Today, RP can be performed with three different surgical approaches: open (ORP), laparoscopic (LRP) and robot-assisted (RARP).[1]

Laparoscopic techniques, with increasing surgical experience, offer successful results both oncologically and functionally and offer advantages such as less postoperative pain, lower blood loss, shorter hospital stay and better cosmetic results. LRP was first described in 1997 by Schuessler et al.[2]. The extraperitoneal (EP) approach used in this method was developed as an alternative to the transperitoneal (TP) approach because it provides direct access to the bladder and prostate region without affecting bowel movements, reduces intraperitoneal complications and accelerates the healing process.[3]

However, involuntary peritoneal opening may occur during trocar insertion or dissection during RP via the EP route. This may cause distortion of the surgical field vision by displacement of intra-abdominal organs into the EP field, affecting the pressure balance and making the operation technically difficult. It is also thought to be associated with adverse outcomes such as increased pain in the postoperative period, prolonged drain and catheter duration, gastrointestinal complications and increased length of hospital stay.[4]

In this study, we evaluated the effects of intraoperative peritoneal opening on the surgical process and postoperative outcomes in patients undergoing extraperitoneal laparoscopic radical prostatectomy (eLRP). Specifically, we aimed to assess whether peritoneal opening influenced operative time, estimated blood loss, length of hospital stay, catheter and drain duration, and the incidence and severity of postoperative complications according to the Clavien-Dindo classification.

METHODS

This study was approved by the Ethics Committee of Kayseri City Hospital (Decision No: 444, Date: 13.05.2025). The requirement for informed consent was waived due to the retrospective nature of the study.

This retrospective cohort study included 302 patients who underwent eLRP for PCa in our clinic between May 2018 and March 2025. Forty-seven patients with inadequate medical records or inaccessible follow-up data were excluded. The remaining 255 patients were divided into two groups: those with preserved peritoneal integrity during the operation (Group 1, n = 223) and those with peritoneal dehiscence (Group 2, n = 32). A patient selection flow diagram summarizing inclusion and exclusion is provided in Figure 1.

Age, body mass index (BMI), comorbidities [hypertension (HT), diabetes mellitus (DM), coronary artery disease (CAD), chronic obstructive pulmonary disease (COPD), hyperlipidemia (HL)], prostate volume, prostate specific antigen (PSA) level, digital rectal examination findings, biopsy International Society of Urologic Pathology (ISUP) grades and history of previous abdominal surgery were recorded preoperatively. Perioperative operative time and estimated blood loss (EBL), postoperative drain duration, hospital stay, catheter duration, complication development, pathology ISUP grade and surgical margin positivity

were evaluated. Postoperative complications were retrospectively evaluated by 2 board certified urologists according to the Clavien-Dindo classification system.[5]

Surgical technique

The operations were performed by three surgeons, each contributing approximately 35–40%, 30–35%, and 25–30% of the cases, respectively. The distribution of patients between the two groups was similar across surgeons. All surgeons had extensive laparoscopic experience, each performing more than 100 laparoscopic procedures annually, thus minimizing variability related to surgical expertise. The procedure was performed under general anesthesia. The extraperitoneal space was accessed using an approximately 2 cm incision in the umbilical region and a 12 mm camera port was placed in this area. Two 10 mm working ports were placed inferiolateral to the camera port and one 5 mm working port was placed medial to the right crista iliaca anterior superior. After opening the retzius cavity, the endopelvic fascia was dissected, the Santorini vein plexus was ligated and the prostate apex was mobilized. The prostate was separated from the rectum with a Foley catheter. After controlling the vascular structures with bipolar cautery and clips, the bladder neck was incised, the prostate was removed and the urethra-bladder anastomosis was completed laparoscopically. The surgical goal was to minimize bleeding and complications.[6]

Statistical analysis

Statistical analyses were performed using SPSS (Statistical Package for the Social Sciences) v20.0 (Chicago, IL). Continuous variables were expressed as mean ± standard deviation (or median) and categorical variables were expressed as number and percentage (%). The compatibility of continuous variables with normal distribution was evaluated by Kolmogorov-Smirnov test. Mann-Whitney U test was used for group comparisons for non-normally distributed variables; Chi-square or Fisher's Exact test was used for categorical variables. Logistic regression analysis was used to determine the risk factors associated with peritoneal opening and postoperative complications. Continuous variables were divided into binary groups according to median values and included in the model. $p < 0.05$ was considered statistically significant.

RESULTS

Demographic and clinical characteristics

Of a total of 255 patients, 32 (12.5%) had intraoperative peritoneal dehiscence (Group 2), while peritoneal integrity was preserved in 223 (87.5%) patients (Group 1). There was no significant difference between the two groups in terms of age, body mass index (BMI), comorbidities (HT, DM, CAD, COPD, HL), prostate volume, PSA levels, digital rectal examination findings and preoperative ISUP grades ($p > 0.05$ for all variables).

However, history of abdominal surgery was significantly more frequent in Group 2 (26/32 [81.2%] vs. 72/223 [32.3%], $p < 0.001$). In addition, operative time was longer in Group 2 (205.3 ± 31.7 min vs. 175.5 ± 30.7 min, $p < 0.001$). There were no statistical differences in other perioperative and postoperative parameters (EBL, drain time, catheterization time, hospital stay, postoperative ISUP and surgical margin positivity). The results are given in Table-1.

Risk factors associated with peritoneal opening

In the analysis of risk factors associated with peritoneal opening, only history of abdominal surgery was found to be a significant variable (OR: 9.088, 95% CI: 3.582-23.057, $p < 0.001$).

No statistically significant association was found between age, BMI, prostate volume, PSA, DRE findings and comorbidities and peritoneal opening (all $p > 0.05$). (Table-2)

Postoperative complications and risk factors

Overall, postoperative complications were seen in 66 patients (25.9%). This rate was 24.2% (54/223) in Group 1 and 37.5% (12/32) in Group 2; however, this difference was not statistically significant ($p = 0.131$).

According to the Clavien-Dindo classification:

- Group 1: Grade 1 (10.8%), Grade 2 (7.6%), Grade 3a (2.7%), Grade 3b (2.2%) and Grade 4 (0.9%, n = 2; pulmonary embolism).
- Group 2: Grade 1 (12.5%), Grade 2 (12.5%), Grade 3a (6.3%), Grade 3b (6.3%). Grade 4 and 5 complications were not observed.

The most common complications were prolonged lymphatic drainage (defined as drain output >50 ml/day persisting beyond 7 days postoperatively; n = 14), blood transfusion (n = 10), acute urinary retention (n = 4), and ileus (n = 2) in Group 1; and blood transfusion (n = 3), lymphocele drainage (n = 2), and ileus (n = 2) in Group 2. There was no difference in the severity of complications between the groups according to Clavien-Dindo classification ($p = 0.262$).

In multivariate logistic regression analysis for complication risk factors, the following variables were found to be independent risk factors:

- History of abdominal surgery: OR: 2.073, 95% CI: 1.148-3.743, $p = 0.016$
- Operative time >180 min: OR: 2.391, 95% CI: 1.32-4.334, $p = 0.004$
- EBL >150 ml: OR: 2.238, 95% CI: 1.24-4.039, $p = 0.007$

Peritoneal opening was not found to be an independent risk factor for postoperative complications ($p = 0.113$). (Table-3)

DISCUSSION

Herein, we tried to examine the effects of peritoneal patency during eLRP on perioperative and postoperative outcomes. Our findings show that peritoneal patency significantly prolonged the operation time and history of abdominal surgery contributed significantly to this. However, peritoneal opening did not significantly increase postoperative complication rates. These results present a picture that both overlaps with the data in the literature and offers unique contributions in some aspects.

The fact that peritoneal patency prolongs the operation time is consistent with studies in the literature that similarly draw attention to the technical difficulties of the EP approach. For instance, Rodriguez et al. reported that the surgical learning curve significantly influenced operative time and surgical margin positivity in their 2010 study involving 400 eLRP cases.[7] In this study, the consistent involvement of three experienced surgeons minimized operator-related variability, enabling an isolated evaluation of peritoneal opening as a risk factor.

A study by Srinualnad and Udompunturak in Thailand, which included 96 patients, reported that eLRP resulted in longer operative times, reduced blood loss, and oncologic outcomes comparable to those of ORP.[8] Similarly, our findings indicated that while peritoneal opening added technical challenges to the eLRP procedure, it had no significant effect on key postoperative outcomes, including surgical margin status, pathological results, and hospital stay.

Many comparative studies have reported that the extraperitoneal approach is advantageous over the transperitoneal approach. In a meta-analysis by Purnomo et al. [9], EP-RP was shown to be associated with shorter operative time and lower complication rates. Similarly, De Hong et al. reported that eLRP provided shorter hospital stay and faster bowel

function recovery.[10] However, in this paper intraoperative technical difficulties, such as peritoneal opening, stood out as a factor that may overshadow these advantages. A history of abdominal surgery was identified as the most significant independent predictor of peritoneal opening. This highlights an important consideration for clinical practice: increased intraoperative caution is warranted in patients with previous abdominal procedures.

In terms of functional outcomes, a recent study published in 2025 compared EP-RARP with transvesical RARP and reported that functional recovery rates were similar, but drainage time was longer in the EP approach.[11] Our findings indicate that there was no significant difference in parameters such as drain or catheter duration due to peritoneal opening. This suggests that surgical experience may stabilize outcomes despite technical difficulties.

In a 2018 large series study, it was reported that most of the complications after RARP were at the Clavien-Dindo Grade I-II level and major complications remained below 1%.[12] Similarly, in the present study, Grade IV complications were seen in only 2 (0.9%) patients and no mortality was observed. In addition, in the case of peritoneal opening, ileus was seen in 2 patients as a complication, and although the rate was slightly higher than in the group without peritoneal opening, no significant difference was found in terms of general complications. According to the results of our study, a history of abdominal surgery, prolonged operation time, and increased estimated bleeding were independent risk factors for increased postoperative complications, while peritoneal opening was not found to be a risk factor for complications. These data suggest that eLRP remains within acceptable limits in terms of patient safety and has an acceptable effect on bowel function.

These results suggest that the extraperitoneal approach retains its overall safety but requires caution in certain risk groups.

Limitations of the Study

This study has some limitations. Firstly, the retrospective design of the study brings methodologic limitations such as selection bias and lack of information. Secondly, the relatively low number of patients with peritoneal dehiscence may limit the significance of some associations in statistical analyses. Furthermore, although the fact that all surgeries were performed by three experienced surgeons may reduce the effects of surgical skill, it may limit the generalizability of the results across different surgeons and centers. Finally, functional outcomes (such as duration of urinary incontinence, erectile function) were not evaluated in detail in the study, which makes it difficult to determine the effects of peritoneal patency on long-term quality of life.

CONCLUSIONS

Preservation of peritoneal integrity, one of the most important advantages of the extraperitoneal approach, may be compromised in some cases. Our study reveals that peritoneal opening increases the operation time and previous abdominal surgeries contribute to this situation. However, the lack of a significant difference in complication rate and severity suggests that this can be managed with surgical experience. The effects of this condition on functional outcomes (continence, erectile function) should also be evaluated in future studies.

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FIGURES AND TABLES

Figure 1. Patient selection flow diagram.

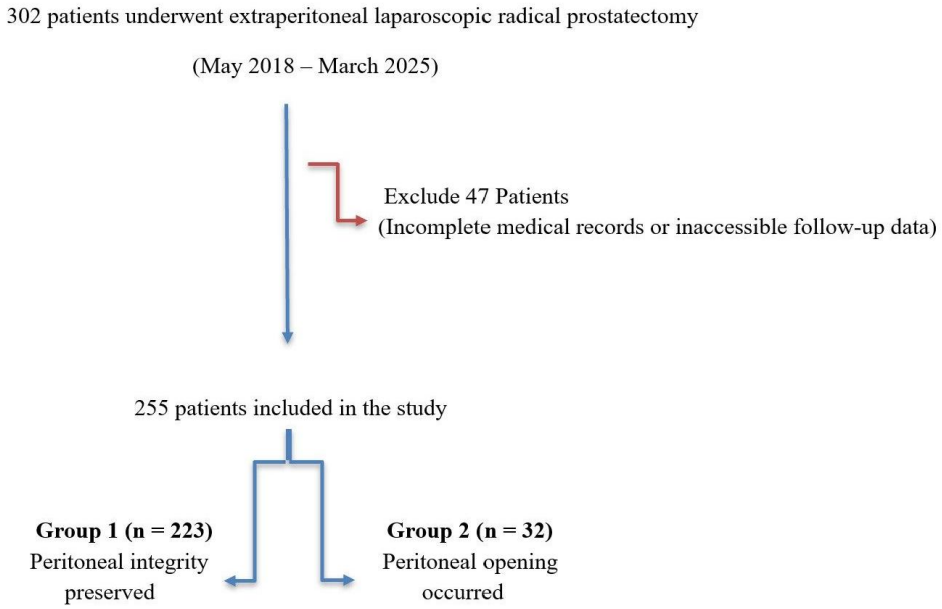

Table 1. Comparison of demographic, preoperative, perioperative, and postoperative data between patient groups with and without peritoneal opening

	Group 1 (n=223)	Group 2 (n=32)	Total (n=255)	p
Age (years)	65.1±6.5 (66)	65.8±6.7 (67)	65.2±6.5 (66)	0.685
BMI (kg/m^2)	27.4±3 (26.8)	27.6±3.2 (27.2)	27.4±3 (26.9)	0.575
Comorbidities				
HT	84 (37.7%)	12 (37.5%)	96 (37.6%)	1.000
DM	47 (21.1%)	7 (21.9%)	54 (21.2%)	1.000
COPD	9 (4%)	1 (3.1%)	10 (3.9%)	1.000
CAD	17 (7.6%)	1 (3.1%)	18 (7.1%)	0.485
HL	4 (1.8%)	1 (3.1%)	5 (2%)	0.491
Prostate volume (ml)	51.5±23.8 (48)	56.5±22.8 (52)	52.1±23.7 (48.5)	0.13
PSA (ng/ml)	10.1±7.2 (8)	10.2±8.8 (7.4)	10.1 7.4 (8)	0.65
Finding of DRE	123 (55.2%)	18 (56.2%)	141 (55.3%)	1.000
Preoperative (biopsy)				0.959
ISUP	132 (59.2 %)	22 (68.8%)	154 (60.4%)	
Grade 1	42 (18.8%)	5 (15.6%)	47 (18.4%)	
Grade 2	27 (12.1%)	3 (9.4%)	30 (11.8%)	
Grade 3	16 (7.2%)	2 (6.2%)	18 (7.1%)	

Grade 4 Grade 5	6 (2.7%)	0	6 (2.4%)	
Abdominal operation history	72 (32.3%)	26 (81.2%)	98 (38.4%)	0.000*
Operative time (minutes)	175.5±30.7 (180)	205.3±31.7 (205)	179.3±32.3 (180)	0.000*
Estimated blood loss (ml)	181±102.9 (150)	186.7±116.9 (175)	181.7±104.5 (150)	0.941
Drainage time (day)	4.4±1 (4)	4.5±0.9 (4)	4.4±1 (4)	0.411
Length of hospital stay (day)	6.4±1.7 (6)	6.5±1.7 (6)	6.4±1.7 (6)	0.612
Catheterization time (day)	19.1±2.4 (20)	19.7±1.8 (20)	19.2±2.3 (20)	0.39
Presence of post-operative complications	54 (24.2%)	12 (37.5%)	66 (25.9%)	0.131
Modified Clavien-Dindo classification grade				0.262
Grade 1	24 (10.8%)	4 (12.5%)	28 (11%)	
Grade 2	17 (7.6%)	4 (12.5%)	21 (8.2%)	
Grade 3	11 (4.9%)	4 (12.5%)	15 (5.8%)	
Grade 4	2 (0.9%)	0	2 (0.8%)	
Grade 5	0	0	0	
Postoperative ISUP				0.603
Grade 1	93 (41.7%)	15 (46.9%)	108 (42.4%)	
Grade 2	70 (31.4%)	7 (21.9%)	77 (30.2%)	
Grade 3	26 (11.7%)	5 (15.6%)	31 (12.2%)	
Grade 4	18 (8.1%)	4 (12.5%)	22 (8.6%)	
Grade 5	16 (7.2%)	1 (3.1%)	17 (6.7%)	
Surgical margin positivity	86 (38.6%)	12 (37.5%)	98 (38.4%)	1.000

Group 1: Patients without peritoneal opening; Group 2: Patients with peritoneal opening. Quantitative variables are presented as mean ± standard deviation (median), and qualitative variables are presented as n (%). *Statistically significant differences. BMI: body mass index; CAD: coronary artery disease; COPD: chronic obstructive pulmonary disease; DM: Diabetes Mellitus; DRE: digital rectal examination; HL: hyperlipidemia; HT: hypertension; ISUP: International Society of Urologic Pathology; PSA: prostate-specific antigen.

Table 2. Results of univariate logistic regression analysis for peritoneal opening's risk factors			
	OR	**95% CI**	**p**
Age (>66 years)	1.423	0.670–3.02	0.359
BMI (>26.9 kg/m^2)	1.489	0.701–3.163	0.301
Comorbidities			
HT	0.993	0.462–2.134	0.985
DM	1.049	0.427–2.573	0.918
COPD	0.767	0.094–6.264	0.804
CAD	0.391	0.05–3.042	0.37
HL	1.766	0.19–16.32	0.62
Prostate volume (>48 ml)	1.791	0.836–3.84	0.134
PSA (>8 ng/ml)	0.591	0.318–1.503	0.352
Finding of DRE	1.045	0.495–2.205	0.907
Abdominal operation history	9.088	3.582–23.057	0.000*

*Statistically significant differences. BMI: body mass index; CAD: coronary artery disease; CI: confidence interval; COPD: chronic obstructive pulmonary disease; DM: diabetes mellitus; DRE: digital rectal examination; HL: hyperlipidemia; HT: hypertension; PSA: prostate-specific antigen; OR: odds ratio.

Table 3. Results of logistic regression analysis for risk factors of postoperative complications						
	Univariate analysis			**Multivariate analysis**		
	OR	**95% CI**	**p**	**OR**	**95% CI**	**p**
Age (>66 years)	1.071	0.611-1.877	0.811			
BMI (>26.9 kg/m^2)	1.449	0.821-2.555	0.2			
Comorbidities						
HT	0.929	0.519-1.66	0.803			
DM	1.272	0.653-2.475	0.479			
COPD	1.238	0.311-4.934	0.762			
CAD	1.475	0.53-4.102	0.456			
HL	0.712	0.078-6.482	0.763			
Prostate volume (>48 ml)	1.389	0.79-2.442	0.253			
PSA (>8 ng/ml)	1.115	0.635-1.957	0.705			
Finding of DRE	1.133	0.643-1.996	0.665			
Preoperative ISUP	1.002	0.771-1.303	0.987			
Abdominal operation history	2.258	1.277-3.994	0.005*	2.073	1.148-3.743	0.016*

Operative time (>180 minutes)	2.461	1.386-4.368	0.002*	2.391	1.32-4.334	0.004*
Estimated blood loss (>150 ml)	2.205	1.248-3.898	0.007*	2.238	1.24-4.039	0.007*
Peritoneal opening	1.878	0.862-4.09	0.113			

*Statistically significant differences. BMI: body mass index; CAD: coronary artery disease; CI: confidence interval; COPD: chronic obstructive pulmonary disease; DM: diabetes mellitus; DRE: digital rectal examination; HL: hyperlipidemia; HT: hypertension; ISUP: International Society of Urologic Pathology; PSA: prostate-specific antigen; OR: odds ratio.