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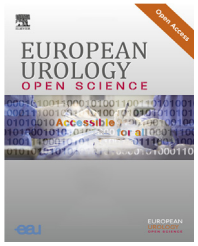

European Association of Urology

Prostate Cancer

Pelvic Lymph Node Dissection: A Comparison Among Extraperitoneal Single-port and Transperitoneal Multiport Radical Prostatectomy—A Single-center Experience

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Abstract

Background and objective: The role of pelvic lymph node dissection (PLND) for prostate cancer is still controversial. This study aims to compare the outcomes of PLND between extraperitoneal single-port (SP eRARP) and transperitoneal multiport (MP tRARP) robotic-assisted radical prostatectomy.
Methods: This was a retrospective analysis from our single-center database for patients who underwent SP eRARP or MP tRARP with PLND between 2015 and 2023. The primary endpoint was to analyze and compare specific data related to PLND between the two populations by the detection of pN+ patients, the total number of lymph nodes removed, and the number of positive lymph nodes removed. The secondary endpoints included comparing major complications, lymphoceles, and biochemical recurrence between the two cohorts of the study.
Key findings and limitations: A total of 293 patients were included, with 85 (29%) undergoing SP eRARP and 208 (71%) undergoing MP tRARP. SP eRARP showed significant differences in PLND extension from MP tRARP, while MP tRARP yielded more lymph nodes ($p < 0.001$). There were no differences in pN+ patient detection ($p = 0.7$) or the number of positive lymph nodes retrieved ($p = 0.6$). The rates of major complications ($p = 0.6$), lymphoceles ($p = 0.2$), and biochemical recurrence ($p = 0.9$) were similar between the two groups. Additionally, SP eRARP had shorter operative time ($p = 0.045$), hospital stay ($p < 0.001$), and less postoperative pain at discharge ($p = 0.03$). Limitations include a retrospective, single-center analysis.
Conclusions and clinical implications: Despite the SP approach in RARP resulting in fewer retrieved lymph nodes, outcomes were comparable with the MP approach

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regarding the detection of patients with positive lymph nodes and the number of positive nodes. Additionally, the SP approach led to lower pain levels and shorter hospital stays.

Patient summary: With this study, we demonstrate that pelvic lymph node dissection performed via the extraperitoneal approach during robotic-assisted radical prostatectomy with a single-port system provides comparable outcomes with the standard transperitoneal multiport approach in detecting patients with positive lymph nodes and retrieving positive nodes. In addition, it offers significantly reduced pain levels and shorter hospital stays.

1. Introduction

Pelvic lymph node dissection (PLND) is regarded as the most accurate method for nodal staging [1–3] and is recommended by the European Association of Urology (EAU) when the estimated lymph node metastasis risk exceeds 5% [4]. However, its oncological benefit remains uncertain [5]. Moreover, PLND can lead to specific complications, most commonly lymphocele formation [6].

During robot-assisted radical prostatectomy (RARP) performed by using the "traditional" DaVinci (Intuitive Surgical, Sunnyvale, CA, USA) multiarm platforms (ie, Xi and X), PLND is typically transperitoneal.

The advent of the DaVinci Single-Port (SP; Intuitive Surgical) robotic platform has sponsored the rediscovery of less common access routes, particularly the extraperitoneal one. The extraperitoneal approach leverages the unique benefits of this system, allowing surgery "regionalization". To note, some authors have postulated the spatial containment of surgical complications, such as lymphoceles [7].

While several experiences with the SP approach for RARP have widely been documented [8,9], a specific focus on the outcomes of PLND performed with the SP platform is lacking.

Given these premises, we aimed to analyze surgical and patient-related outcomes of extraperitoneal SP PLND and compare them with those of PLND performed using the traditional multiport (MP) transperitoneal approach.

2. Patients and methods

2.1. Patient selection

Study data were obtained from an institutional prospectively maintained database, based on digitized medical records of patients undergoing RARP for prostate cancer (PCa) between January 2015 and December 2023. The database was queried for data regarding all consecutive patients who underwent RARP with PLND using either MP or SP platforms over the study period. The search was limited to patients who underwent SP RARP performed via an extraperitoneal route (SP eRARP) and those who underwent MP RARP performed via a transperitoneal approach (MP tRARP). Two experienced robotic surgeons performed procedures both with SP and MP platforms.

The study followed the Declaration of Helsinki on ethical principles for medical research involving human individuals. Institutional review board approval was obtained (IRB: STUDY2017-0152). All patients provided written informed consent to include their data in the database and for their use in scientific research.

2.2. Study variables and outcomes

Variables of interest were prospectively collected, including demographic and clinical data, preoperative serum prostate-specific antigen (PSA) level, tumor characteristics, and predicted probabilities of lymph node involvement according to Memorial Sloan Kettering Cancer Center (MSKCC) [10] and Briganti 2012 [11]. PLND-related features were evaluated by collecting information on extension, tumor and lymph node pathology (histological type, pT, International Society of Urological Pathology [ISUP] grade, positive surgical margins [PSMs], and pN), lymph node yield (LNY), positive lymph nodes removed, ratio of positive lymph nodes to those totally removed, performance of peritoneal windows for the extraperitoneal approach, and presence of symptomatic lymphocele (defined as a discernible fluid accumulation, identified through abdominal ultrasound or computed tomography scan, necessitating hospitalization for treatment). Additionally, perioperative variables, including total in-room time (covering anesthesia and positioning time) and skin-to-skin time (from skin incision to wound closure), estimated blood loss (EBL), intra- and postoperative 90-d complications (graded by Clavien-Dindo classification [12] as any grade and "major" [Clavien-Dindo $\geq$3]), length of stay (LOS), postoperative pain (assessed by a visual analog scale at discharge), and opioid use 1 wk after surgery, were recorded. Oncological outcomes considered biochemical recurrence (BCR; defined as PSA >0.2 during follow-up) and postoperative radiotherapy and/or hormone therapy administration.

The study primary endpoint was to compare PLND-related features between SP eRARP and MP tRARP. The secondary endpoints were the rate of major complications, particularly the occurrence of lymphoceles, along with the rate of BCR between SP eRARP and MP tRARP.

2.3. Statistical analysis

A statistical analysis was conducted and reported following published guidelines [13]. The cohort was stratified into

two groups according to the type of surgical procedure (SP eRARP vs MP tRARP). Medians and interquartile ranges (IQRs) and frequencies and proportions were used to report continuous and categorical variables, respectively. A descriptive analysis was carried out using two-tailed Mann-Whitney U test for continuous variables and Fisher exact test for categorical variables. After adjusting for potential confounders (age at surgery, Charlson Comorbidity Index [CCI], preoperative PSA, ISUP, and robotic platform), a multivariable logistic regression model was used to predict the probability of detecting pN+ patients. Stata v17.0 software (StataCorp LLC, College Station, TX, USA) was used for the statistical analysis, with statistical significance set at $p < 0.05$.

3. Results

3.1. Baseline characteristics

A total of 293 patients underwent RARP with PLND over the study period and were included in the analysis. Of these patients, 85 (29%) underwent SP eRARP and 208 (71%) underwent MP tRARP. The median age was 64 yr (IQR 60–68) for SP eRARP and 62 yr (IQR 58–67) for MP tRARP ($p = 0.02$). In the SP eRARP group, a statistically significantly higher proportion of patients had an American Society of Anesthesiologists score of ≥3 (SP eRARP: 48% vs MP tRARP: 30%, $p = 0.004$) and a statistically significantly higher median (IQR) CCI (SP eRARP: 5 [4–6] vs MP tRARP: 4 [4–5], $p < 0.001$). No statistically significant difference emerged for preoperative median (IQR) PSA (SP eRARP: 10.8 [6.4–21.7] vs MP tRARP: 9.5 [5.7–17.8] ng/ml, $p = 0.2$). The median (IQR) follow-up was 12 (4–21) mo for SP eRARP and 8.5 (4–12) mo for MP tRARP, resulting in a statistically significant difference ($p = 0.01$). Baseline cohort features are outlined in Table 1.

3.2. PLND outcomes

A statistically significant difference was observed for the SP eRARP for the extension of PLND ($p < 0.001$). On the contrary, the median (IQR) LNY favored MP tRARP (SP eRARP 8 [5–12] vs MP tRARP 12 [8–19], $p < 0.001$). No statistically significant difference emerged for the rate patients with positive lymph nodes (SP eRARP: 17 [20%] vs MP tRARP: 32 [15%], $p = 0.7$), median (IQR) number of positive lymph nodes removed (SP eRARP: 1.5 [1–2] vs MP tRARP: 2 [1–2.5], $p = 0.6$), ratio between lymph nodes removed and positive nodes (SP eRARP: 5% vs MP tRARP: 3%, $p = 0.7$), and number of lymphoceles (SP eRARP: 5 [6%] vs MP tRARP: 6 [3%], $p = 0.2$).

Moreover, peritoneal windows were performed in 38 patients (45%) undergoing SP eRARP, with a similar incidence of lymphocele rate to that in patients without peritoneal windows (3 [8%] vs 2 [5%], $p = 0.6$; Table 2 and Fig. 1A).

According to the multivariable logistic regression analysis, only the oncological features (preoperative PSA and ISUP) of the included covariates emerged as significant predictors of pN+ detection (Supplementary Table 1).

Table 1 – Baseline features

	SP eRARP (85)	MP tRARP (208)	*p* value
Age at surgery (yr), median (IQR)	64 (60–68)	62 (58–67)	0.02
Race, *n* (%)			
Black	49 (58)	121 (58)	
Caucasian	17 (20)	47 (23)	0.6
Hispanic	16 (19)	34 (16)	
Asian	2 (2.5)	2 (1)	
Other/missing	1 (0.5)	4 (2)	
BMI (kg/m^2), median (IQR)	27.5 (24.4–32.8)	28.3 (25–31.8)	0.6
Preop Hb (g/l), median (IQR)	14.4 (13–15)	14.1 (13.2–15.3)	0.9
ASA, *n* (%)			
<3	44 (52)	146 (70)	**0.004**
≥3	41 (48)	62 (30)	
CCI, median (IQR)	5 (4–6)	4 (4–5)	**<0.001**
cT, *n* (%)			
cT1	69 (81)	132 (63)	
cT2	7 (8)	47 (23)	**0.004**
cT3	9 (11)	29 (14)	
cN, *n* (%)			
cNX	6 (7)	64 (31)	
cN0	74 (87)	138 (66)	**<0.001**
cN1	5 (6)	7 (3)	
cM, *n* (%)			
cMX	10 (12)	51 (24)	0.06
cM0	75 (88)	157 (76)	
Preoperative PSA (ng/ml), median (IQR)	10.8 (6.4–21.7)	9.5 (5.7–17.8)	0.2
ISUP, *n* (%)			0.3
1	–	9 (4)	
2	28 (34)	59 (29)	
3	27 (32)	65 (32)	
4	18 (22)	39 (19)	
5	10 (12)	34 (16)	
Nomograms, *n* (%)			
MSKCC ≥4	76 (97)	167 (91)	0.1
Briganti 2012 ≥ 5	56 (78)	137 (77)	1
Follow-up (mo), median (IQR)	12 (4–21)	8.5 (4–12)	**0.01**

ASA = American Society of Anesthesiologists score; BMI = body mass index; CCI = Charlson Comorbidity Index; Hb = hemoglobin; IQR = interquartile range; ISUP = International Society of Urological Pathology; MP tRARP = transperitoneal multiport radical prostatectomy with pelvic lymph node dissection; MSKCC = Memorial Sloan Kettering Cancer Center; PSA = prostate-specific antigen; SP eRARP = extraperitoneal single-port radical prostatectomy with pelvic lymph node dissection.

3.3. Surgical, postoperative, and oncological outcomes

A statistically significant difference favoring SP eRARP was found in the median (IQR) total in-room time (300 [255–338] min vs 326 [300–357] min, $p = 0.04$) compared with MP tRARP. No significant differences were observed in the median (IQR) skin-to-skin operative time (SP eRARP: 266 [232–296] min vs MP tRARP: 248 [217–286] min, $p = 0.1$), EBL (SP eRARP: 100 [50–200] ml vs MP tRARP: 100 [50–150] ml, $p = 0.6$), and intraoperative complication rates (SP eRARP: 1 [1%] vs MP tRARP: 2 [1%], $p = 1$) between the two groups.

In terms of postoperative outcomes, the median (IQR) LOS (SP eRARP: 14 [11–20] h vs MP tRARP: 45.7 [16–57] h, $p < 0.001$) and postoperative pain at discharge (SP eRARP: 0 [0–3] vs MP tRARP: 2.5 [0–4], $p = 0.03$) were statistically significantly lower after SP eRARP.

Oncological outcomes were comparable between the two groups: no statistically significant difference emerged

Table 2 – Pelvic lymph node dissection outcomes

	SP eRARP (85)	MP tRARP (208)	*p* value
PLND extension, *n* (%)			
Iliac obturators	4 (5)	118 (56.5)	
Iliac obturators and common iliacs	81 (95)	77 (37)	**<0.001**
Iliac obturators and presacrals	–	12 (6)	
Iliac obturators, presacrals and common iliacs	–	1 (0.5)	
pN, *n* (%)			
Nx	1 (1)	3 (1)	
N0	67 (79)	173 (84)	0.7
N+	17 (20)	32 (15)	
LNY (*n*)	875	2858	
Median (IQR)	8 (5–12)	12 (8–19)	**<0.001**
Positive lymph nodes removed, *n*	40	85	
Median (IQR)	1.5 (1–2)	2 (1–2.5)	0.6
RPLN/LNY (%)	5	3	0.7
Lymphocele, *n* (%)			
Yes	5 (6)	6 (3)	0.2
Peritoneal windows, *n* (%)			
Yes	38 (45)	–	
Lymphocele			0.6
With peritoneal windows	3 (8)		
Without peritoneal windows	2 (5)		

IQR = interquartile range; LNY = lymph node yield; MP tRARP = transperitoneal multiport radical prostatectomy with pelvic lymph node dissection; PLND = pelvic lymph node dissection; RPLN/LNY = ratio of positive lymph nodes to total removed; SP eRARP = extraperitoneal single-port radical prostatectomy with pelvic lymph node dissection.

for the rate of BCR (SP eRARP: 5 [6%] vs MP tRARP: 11 [5%], $p = 0.9$), postoperative radiotherapy (SP eRARP: 5 [6%] vs MP tRARP: 30 [14%], $p = 0.204$), and adjuvant hormone therapy (SP eRARP: 10 [12%] and MP tRARP: 35 [17%], $p = 1$). All outcomes are summarized in Table 3 and Figure1B and 1C.

4. Discussion

Although the extraperitoneal SP approach to RARP involved a relatively reduced LNY of PLND according to our analysis, it yielded comparable outcomes to the standard transperitoneal multiport approach in terms of patients with positive lymph nodes and number of positive nodes in this patient cohort. The SP approach exhibited significantly lower pain levels and shorter hospitalization durations.

To our knowledge, this is the first case series focusing mainly on PLND outcomes during SP eRARP.

With 20% nodal involvement and a median of 1.5 positive lymph nodes removed in the SP eRARP group, our detection rate exceeded that of Lenfant et al [14] in a single-center study comparing SP and MP RARP outcomes. This difference may result from our cohort's exclusive focus on PLND patients, potentially introducing a selection bias. However, despite the broader PLND conducted using the SP platform, MP tRARP demonstrated a significant advantage in terms of LNY. Nonetheless, surgeons may perceive varying degrees of lymph node removal compared with final histology findings, and total lymph node counts may differ among pathologists examining excised specimens [15], complicating direct comparisons of nodal yields across studies.

Even though the number of pN+ patients was similar between the two groups, our results revealed that a smaller number of lymph nodes were retrieved in the SP eRARP group than in the MP tRARP group. This outcome might compromise staging accuracy and potentially diminish oncological benefits. It is conceivable that retrieving a higher number of lymph nodes in the SP eRARP group could have identified more pN+ patients. Anyway, although there is consensus on enhancing staging accuracy by increasing LNY in RARP, the specific threshold accuracy remains undefined [15,16]. The therapeutic efficacy of PLND is still a topic

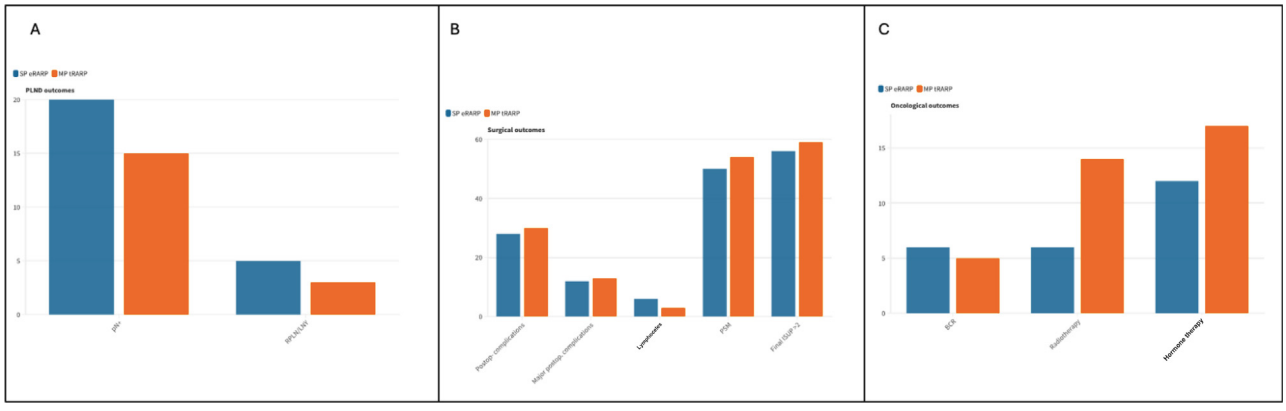

Fig. 1 – (A) Graphical representation comparing the rate of detection of patients with positive lymph nodes (pN+) and the ratio of positive lymph nodes to total nodes removed (RPLN/LNY) between extraperitoneal single-port robot-assisted radical prostatectomy and transperitoneal multiport robot-assisted radical prostatectomy. (B) Graphical representation comparing surgical outcomes, including the rates of overall and major postoperative complications, positive surgical margins (PSMs), and the population with intermediate-unfavorable- or high-risk prostate cancer at final histology (ISUP >2), between extraperitoneal single-port robot-assisted radical prostatectomy and transperitoneal multiport robot-assisted radical prostatectomy. (C) Graphical representation comparing oncological outcomes, including the rates of biochemical recurrence (BCR), radiotherapy, and hormone therapy between extraperitoneal single-port robot-assisted radical prostatectomy and transperitoneal multiport robot-assisted radical prostatectomy. ISUP = International Society of Urological Pathology; MP tRARP = transperitoneal multiport robot-assisted radical prostatectomy; PLND = pelvic lymph node dissection; SP eRARP = extraperitoneal single-port robot-assisted radical prostatectomy.

Table 3 – Surgical, postoperative, and oncological outcomes

	SP eRARP (85)	MP tRARP (208)	*p* value
Total in-room time (min), median (IQR)	300 (255–338)	326 (300–357)	**0.04**
Skin-to-skin time (min), median (IQR)	248 (217–286)	266 (232–296)	0.1
EBL (ml), median (IQR)	100 (50–200)	100 (50–150)	0.6
Intraoperative complications, *n* (%)			
Yes	1 (1)	2 (1)	1
Postoperative complications at 90 d, *n* (%)			
Yes	24 (28)	61 (30)	0.9
Major[a]	12 (12)	27 (13)	0.6
Histology, *n* (%)			
Acinar adenocarcinoma	83 (98)	203 (97.5)	
Squamous cell carcinoma	–	1 (0.5)	0.7
Ductal adenocarcinoma	–	2 (1)	
Other (mixed acinar/ductal)	2 (2)	2 (1)	
pT, *n* (%)			0.2
pT2	40 (47)	94 (45)	
pT3a	19 (22)	64 (31)	
pT3b	26 (31)	47 (23)	
pT4	–	3 (1)	
Final ISUP, *n* (%)			0.07
1	–	5 (2)	
2	37 (43)	80 (38)	
3	26 (31)	53 (26)	
4	13 (15)	23 (11)	
5	9 (11)	47 (23)	
PSM, *n* (%)			
Yes	42 (50)	112 (54)	0.6
Postoperative Hb (g/l), median (IQR)	13 (12.1–13.7)	13.3 (12.3–14.2)	0.2
LOS (h), median (IQR)	14 (11–20)	45.7 (16–57)	**<0.001**
Postoperative pain DD, VAS, median (IQR)	0 (0–3)	2.5 (0–4)	**0.03**
BCR, *n* (%)			
Yes	5 (6)	11 (5)	0.9
Missing	17 (20)	20 (10)	
Radiotherapy, *n* (%)			
Yes	5 (6)	30 (14)	0.2
Missing	17 (20)	20 (10)	
Hormone therapy, *n* (%)			
Yes	10 (12)	35 (17)	1
Missing	17 (20)	20 (10)	

BCR = biochemical recurrence; CD = Clavien-Dindo; DD = discharge day; EBL = estimated blood loss; Hb = hemoglobin; IQR = interquartile range; ISUP = International Society of Urological Pathology; LOS = length of stay; MP tRARP = transperitoneal multiport radical prostatectomy with pelvic lymph node dissection, PSM = positive surgical margin; SP eRARP = extraperitoneal single-port radical prostatectomy with pelvic lymph node dissection; VAS = visual analog scale.

[a] Cumulative CD ≥ 3.

of debate [5,17], and currently, latest studies failed to demonstrate that extended PLND significantly improves oncological outcomes [5,18–21].

The role of PLND during RARP and other surgeries such as cystectomy is currently under intense evaluation, questioning its necessity. Recent studies suggest performing unilateral PLND or reducing its extent overall. These studies indicate that despite retrieving fewer lymph nodes, it is possible to identify the same number of pN+ patients while minimizing morbidity [19,20].

Therefore, it can be inferred that even a limited LNY is sufficient for identifying the pN+ population without compromising oncological outcomes.

Both the EAU and the National Comprehensive Cancer Network guidelines recommend utilizing multivariable models and their associated cutoffs to reduce unnecessary ePLNDs and mitigate perioperative risks. However, despite this, about 70% of nodal dissections are considered "unnecessary" in pN0 patients [22], as observed in our study. This trend persists despite our high adherence rates to prediction nomograms, particularly the MSKCC nomogram, commonly used in our center. However, our adherence to the prediction nomograms may be influenced by the absence of multiparametric magnetic resonance imaging and targeted biopsy techniques, now considered the standard care procedures, which are still not routinely performed in our institution [22].

Despite a lower LNY, PLND during SP eRARP allowed for the excision of a similar number of positive lymph nodes with respect to the MP approach, with a comparable ratio of retrieved/positive nodes between the two groups.

We observed a high PSM rate, irrespective of the surgical approach. Despite groups similarities, our results exceed those reported in the current literature [23,24]. It is important to note that our study populations included only patients who underwent PLND, potentially introducing a bias toward higher ISUP and pT stages. Another possible explanation for these results is the significant representation of Black males in our cohort, a known risk factor for aggressive disease [25]. Indeed, as per the final histology report, >50% of patients in both groups harbored intermediate-unfavorable- or high-risk PCa (ISUP $\geq$3) and pT $\geq$3. Similar outcomes are reported in studies analyzing comparable cohorts [26,27].

Despite LNY favoring MP tRARP and our higher PSM rates, BCR results were similar between the study populations and aligned with literature reports [24]. Moreover, in our analysis, the median postoperative pain and LOS favored SP eRARP. In fact, the SP robot employs smaller tools and offers varied camera movements, either as a unit with instruments (relocation) or adjusted individually. This adaptability improves visualization and reduces the risk of instrument clashes, facilitating smooth operation even in confined spaces [26]. Anyway, this advantage should be attributed to both the SP platform and the adoption of an extraperitoneal approach, rather than solely to the SP platform [28]. Therefore, although SP eRARP may yield fewer lymph nodes, it should not be perceived as a platform compromise. Instead, it presents an advantage, facilitating comparable oncological outcomes, alongside the combined benefits of the platform and approach (such as reduced pain, improved cosmetic results, and shorter hospital stays). With increasing interest in outpatient RARP in contemporary urology, SP eRARP could enhance postoperative recovery, thereby improving patient care, cost management, and patient perception of the procedure [29–31]. In fact, the shorter LOS and reduced pain are of paramount importance in the USA, given its healthcare system based on insurance support. Furthermore, there is a significant issue related to opioid abuse among the population [32]. The SP platform and the extraperitoneal approach have shown lower pain levels, necessitating less opioid use [33]. Additionally, shorter hospital stays are well received by patients and their insurance providers [34,35].

Another concern with the extraperitoneal approach is the potential onset of a higher rate of symptomatic lymphoceles due to fluid collection in a confined anatomical space [29,36]. Peritoneal windows have been explored to facilitate lymphatic fluid drainage from the pelvis into the abdominal cavity, reducing the likelihood of symptomatic complications [37]. Our analysis found no statistically significant difference in symptomatic lymphocele rates among SP eRARP patients, irrespective of the performance of peritoneal windows. However, it is worth noting that our outcome had poor statistical significance due to the low number of events observed in the SP eRARP population; thus, it should be interpreted with caution. Moreover, a similar rate of symptomatic lymphoceles was observed in the present study, regardless of the surgical approach. The occurrence of lymphoceles after PLND for PCa ranges between 8.4% and 51% for both MP and SP procedures [38]. The follow-up protocol, including chosen imaging techniques, time intervals, and duration, influences this variation. Our study accounted for symptomatic lymphoceles only, possibly introducing a detection bias regarding their true incidence in our cohort. However, our results align with available literature, where symptomatic lymphoceles rate ranges from 2% to 8% [23,38,39].

In the present study, we highlighted some relevant differences between the SP and MP platforms. Total in-room time was shorter for SP eRARP, suggesting easier anesthesiology management of the patient. Indeed, possible advantages of an extraperitoneal approach can be related to the lower ventilatory pressures required [40], due to the avoidance of a steep Trendelenburg position and the lower CO_2 insufflation pressure [41]. This holds particular significance when considering baseline features of the two treatment groups. Patients who underwent SP eRARP were older, with a higher comorbidity burden, suggesting an increased risk from both an anesthesiological standpoint and perioperative complications [42]. Despite this, our study shows that a population with a potentially higher surgical risk was not a limiting factor for SP procedures, contrasting initial literature reports, underscoring the efficacy and safety of SP procedures, even in challenging patient populations [43,44].

We reported a higher rate of major complications than found in available literature [14,23]. Most complications (see Supplementary Table 2) in both groups were genitourinary, and additional severe complications occurred, such as deep vein thrombosis, pulmonary embolism, and sepsis, possibly linked to lymphocele formation [45]. It is important to note that our follow-up period was 90 d after surgery and included complications necessitating procedures under local anesthesia, such as drainage of leaks or cystoscopy-guided recatheterization. Instead, no gastrointestinal complications occurred among SP eRARP patients, further highlighting the advantages of the extraperitoneal approach, especially for patients with prior abdominal surgeries or chronic bowel disease. This approach is suggested to be related to quicker spontaneous bowel activity recovery and decreased operative pain by minimizing urine and blood contact with the intestines and avoiding bowel manipulation, potentially contributing to faster discharge [29,46]. Moreover, there is huge variability in how complications are classified and graded in the literature, despite efforts by the EAU Guidelines Panel to standardize reporting methods [47].

Our study is not devoid of limitations. First, its single-institution retrospective design carries inherent selection biases. In addition, the two treatment groups differed in terms of sample size, baseline characteristics, and year of surgery. No prior decisions were made on factors that could lead to the use of one platform over the other. Most of the MP tRARP procedures were performed at the beginning of our experience, before the SP robot was approved. From 2018 onward, the SP robot gradually replaced the MP robot, and in recent years, only eRARP procedures with the SP robot have been performed, based on surgeons' preference. As stated before, patients with a worse prognosis, in terms of both oncological and comorbidity baseline characteristics, were predominantly in the SP eRARP group, highlighting how the SP robot, when used via the extraperitoneal approach, could facilitate surgery even in more challenging patients.

We used a multivariable logistic regression model to predict the probability of detecting pN+ patients. The results indicated that pN+ detection is influenced by preoperative oncological features, such as preoperative PSA and ISUP, as expected. However, the type of robotic platform does not appear to influence pN+ detection.

Another important limitation is related to the extension of PLND, classified according to the current available American Urological Association guidelines [5]. While 56.5% of MP tRARP cases had an extended PLND (limited to iliac

obturator lymph nodes), 73% of SP eRARP cases involved a superextended PLND variant (including the removal of common iliac lymph nodes). Among all factors to consider are the surgeon's strategy and preferences, which may have changed during the study period. Moreover, there are certainly technical factors linked to the SP robot itself. The SP platform allows for work in more confined spaces. With only one trocar, it provides greater freedom of movement without the need for redocking [26]. However, the visible working space is limited and achieved primarily by the triangulation of the arms, which can lead to longer and more challenging procedures. Additionally, the smaller dimensions of the tools, compared with those of the MP robot, can make the process more laborious. As a result, the amount of specimen removed might be less, even if the extension was wider. Anyway, different PLND extensions may impact our results favoring SP eRARP: maintaining same PLND extension across both groups could have led to detecting a greater number of positive lymph nodes for MP tRARP. Additionally, we could not classify complications as PLND related, and some data, including PLND operative time, are unavailable, limiting a technical platform comparison. Moreover, in our institution, there is an outpatient protocol where eligible patients are discharged on the same day of surgery. It could be worthwhile to investigate whether our higher rates of complications could be linked to these rapid discharges and potentially mitigated with an inpatient protocol.

Despite limitations, we showed comparable efficiency and safety of PLND with the extraperitoneal approach and SP platform to those of transperitoneal MP procedures.

5. Conclusions

Despite the extraperitoneal SP approach to RARP involving a relatively reduced extension of LNY, it provided comparable outcomes to the standard transperitoneal multiport approach in terms of patients with positive lymph nodes and the number of positive nodes retrieved in this patient cohort, along with significantly lower pain levels and shorter hospitalization durations.

Author contributions: Greta Pettenuzzo had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Study concept and design: Crivellaro, Pettenuzzo.
Acquisition of data: Pettenuzzo, Sauer, Torres-Anguiano, Morgantini.
Analysis and interpretation of data: Pettenuzzo, Ditonno, Crivellaro.
Drafting of the manuscript: Pettenuzzo.
Critical revision of the manuscript for important intellectual content: Ditonno, Cannoletta, Pacini, Montorsi, Briganti, Bartoletti, Veccia, Bertolo, Antonelli, Crivellaro.
Statistical analysis: Ditonno, Pettenuzzo.
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Appendix A. Supplementary data

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References

[1] Briganti A, Blute ML, Eastham JH, et al. Pelvic lymph node dissection in prostate cancer. Eur Urol 2009;55:1251–65.
[2] García-Perdomo HA, Correa-Ochoa JJ, Contreras-García R, Daneshmand S. Effectiveness of extended pelvic lymphadenectomy in the survival of prostate cancer: A systematic review and meta-analysis. Cent Eur J Urol 2018;71:262–9.
[3] Bianco FJ, Scardino PT, Eastham JA. Radical prostatectomy: long-term cancer control and recovery of sexual and urinary function ("trifecta"). Urology 2005;66(5 Suppl):83–94.
[4] Mottet N, Bellmunt J, Bolla M, et al. EAU-ESTRO-SIOG guidelines on prostate cancer. Part 1: screening, diagnosis, and local treatment with curative intent. Eur Urol 2017;71:618–29.
[5] Fossati N, Willemse PPM, Van den Broeck T, et al. The benefits and harms of different extents of lymph node dissection during radical prostatectomy for prostate cancer: a systematic review. Eur Urol 2017;72:84–109.
[6] Motterle G, Morlacco A, Zanovello N, et al. Surgical strategies for lymphocele prevention in minimally invasive radical prostatectomy and lymph node dissection: a systematic review. J Endourol 2020;34:113–20.
[7] Ditonno F, Franco A, Licari LC, et al. Implementation of single-port robotic urologic surgery: experience at a large academic center. J Robot Surg 2024;18:119.
[8] Kaouk J, Garisto J, Bertolo R. Robotic urologic surgical interventions performed with the single port dedicated platform: first clinical investigation. Eur Urol 2019;75:684–91.
[9] Huang MM, Schwen ZR, Biles MJ, et al. A comparative analysis of surgical scar cosmesis based on operative approach for radical prostatectomy. J Endourol 2021;35:138–43.
[10] Memorial Sloan Kettering Cancer Center. Dynamic prostate cancer nomogram: coefficients. https://www.mskcc.org/nomograms/prostate/pre_op.
[11] Briganti A, Larcher A, Abdollah F, et al. Updated nomogram predicting lymph node invasion in patients with prostate cancer undergoing extended pelvic lymph node dissection: the essential importance of percentage of positive cores. Eur Urol 2012;61:480–7.
[12] Clavien PA, Barkun J, de Oliveira ML, et al. The Clavien-Dindo classification of surgical complications: five-year experience. Ann Surg 2009;250:187–96.
[13] Vickers AJ, Assel MJ, Sjoberg DD, et al. Guidelines for reporting of figures and tables for clinical research in urology. Eur Urol 2020;78:97–109.
[14] Lenfant L, Sawczyn G, Aminsharifi A, et al. Pure single-site robot-assisted radical prostatectomy using single-port versus multiport robotic radical prostatectomy: a single-institution comparative study. Eur Urol Focus 2021;7:964–72.
[15] Truesdale MD, Lee DJ, Cheetham PJ, Hruby GW, Turk AT, Badani KK. Assessment of lymph node yield after pelvic lymph node dissection in men with prostate cancer: a comparison between robot-assisted radical prostatectomy and open radical prostatectomy in the modern era. J Endourol 2010;24:1055–60.

[16] Briganti A, Chun FKH, Salonia A, et al. Critical assessment of ideal nodal yield at pelvic lymphadenectomy to accurately diagnose prostate cancer nodal metastasis in patients undergoing radical retropubic prostatectomy. Urology 2007;69:147–51.
[17] Abdollah F, Gandaglia G, Suardi N, et al. More extensive pelvic lymph node dissection improves survival in patients with node-positive prostate cancer. Eur Urol 2015;67:212–9.
[18] Preisser F, van den Bergh RCN, Gandaglia G, et al. Effect of extended pelvic lymph node dissection on oncologic outcomes in patients with D'Amico intermediate and high risk prostate cancer treated with radical prostatectomy: a multi-institutional study. J Urol 2020;203:338–43.
[19] Martini A, Wever L, Soeterik TFW, et al. Unilateral pelvic lymph node dissection in prostate cancer patients diagnosed in the era of magnetic resonance imaging-targeted biopsy: a study that challenges the dogma. J Urol 2023;210:117–27.
[20] von Deimling M, Furrer M, Mertens LS, et al. Impact of the extent of lymph node dissection on survival outcomes in clinically lymph node-positive bladder cancer. BJU Int 2024;133:341–50.
[21] Gschwend JE, Heck MM, Lehmann J, et al. Extended versus limited lymph node dissection in bladder cancer patients undergoing radical cystectomy: survival results from a prospective, randomized trial. Eur Urol 2019;75:604–11.
[22] Gandaglia G, Martini A, Ploussard G, et al. External validation of the 2019 Briganti nomogram for the identification of prostate cancer patients who should be considered for an extended pelvic lymph node dissection. Eur Urol 2020;78:138–42.
[23] Soputro NA, Chavali JS, Ferguson EL, et al. Complications of single-port robot-assisted radical prostatectomy: multi-institutional analysis from the Single-Port Advanced Research Consortium (SPARC). BJU Int 2024;134:54–62.
[24] Franco A, Ditonno F, Manfredi C, et al. Single port robot-assisted radical and simple prostatectomy: a systematic review and meta-analysis. Prostate Cancer Prostatic Dis. In press. https://doi.org/10.1038/s41391-024-00787-2.
[25] Lillard JW, Moses KA, Mahal BA, George DJ. Racial disparities in Black men with prostate cancer: a literature review. Cancer 2022;128:3787–95.
[26] Kaouk J, Valero R, Sawczyn G, Garisto J. Extraperitoneal single-port robot-assisted radical prostatectomy: initial experience and description of technique. BJU Int 2020;125:182–9.
[27] Beauval JB, Roumiguié M, Filleron T, et al. Biochemical recurrence-free survival and pathological outcomes after radical prostatectomy for high-risk prostate cancer. BMC Urol 2016;16:26.
[28] Bertolo R, Garisto J, Bove P, Mottrie A, Rocco B, EAU Robotic Urology Section (ERUS) Working Group on Science. Perioperative outcomes between single-port and "multi-port" robotic assisted radical prostatectomy: where do we stand? Urology 2021;155:138–43.
[29] Uy M, Cassim R, Kim J, Hoogenes J, Shayegan B, Matsumoto ED. Extraperitoneal versus transperitoneal approach for robot-assisted radical prostatectomy: a contemporary systematic review and meta-analysis. J Robot Surg 2022;16:257–64.
[30] Noël J, Moschovas MC, Sandri M, et al. Patient surgical satisfaction after da Vinci® single-port and multi-port robotic-assisted radical prostatectomy: propensity score-matched analysis. J Robot Surg 2022;16:473–81.
[31] Lenfant L, Sawczyn G, Kim S, Aminsharifi A, Kaouk J. Single-institution cost comparison: single-port versus multiport robotic prostatectomy. Eur Urol Focus 2021;7:532–6.
[32] Volkow ND, Blanco C. The changing opioid crisis: development, challenges and opportunities. Mol Psychiatry 2021;26:218–33.
[33] Sawczyn G, Lenfant L, Aminsharifi A, Kim S, Kaouk J. Predictive factors for opioid-free management after robotic radical prostatectomy: the value of the SP® robotic platform. Minerva Urol Nephrol 2021;73:591–9.
[34] Balasubramanian S, Ronstrom C, Shiang A, et al. Feasibility and safety of same-day discharge following single-port robotic-assisted laparoscopic prostatectomy. World J Urol 2022;41:35–41.
[35] Wilson CA, Aminsharifi A, Sawczyn G, et al. Outpatient extraperitoneal single-port robotic radical prostatectomy. Urology 2020;144:142–6.
[36] Danuser H, Di Pierro GB, Stucki P, Mattei A. Extended pelvic lymphadenectomy and various radical prostatectomy techniques: is pelvic drainage necessary? BJU Int 2013;111:963–9.
[37] Ditonno F, Manfredi C, Franco A, et al. Impact of peritoneal reconfiguration on lymphocele formation after robot-assisted radical prostatectomy with pelvic lymph node dissection: a systematic review and meta-analysis of randomized controlled trials. Prostate Cancer Prostatic Dis. In press. https://doi.org/10.1038/s41391-023-00744-5.
[38] Orvieto MA, Coelho RF, Chauhan S, Palmer KJ, Rocco B, Patel VR. Incidence of lymphoceles after robot-assisted pelvic lymph node dissection. BJU Int 2011;108:1185–90.
[39] Keskin MS, Argun ÖB, Öbek C, et al. The incidence and sequela of lymphocele formation after robot-assisted extended pelvic lymph node dissection. BJU Int 2016;118:127–31.
[40] Ragavan N, Dholakia K, Ramesh M, Stolzenburg JU. Extraperitoneal vs. transperitoneal robot-assisted laparoscopic radical prostatectomy-analysis of perioperative outcomes, a single surgeon's experience. J Robot Surg 2019;13:275–81.
[41] Hernandez-Meza G, Gainsburg DM. Anesthetic concerns for robotic-assisted laparoscopic radical prostatectomy: an update. Minerva Anestesiol 2023;89:812–23.
[42] Hall WH, Jani AB, Ryu JK, Narayan S, Vijayakumar S. The impact of age and comorbidity on survival outcomes and treatment patterns in prostate cancer. Prostate Cancer Prostatic Dis 2005;8:22–30.
[43] Il NT, Kang YJ, Shim JS, et al. Single-port vs multiport robot-assisted radical prostatectomy: a propensity score matching comparative study. J Endourol 2022;36:661–7.
[44] Covas Moschovas M, Bhat S, Rogers T, et al. Technical modifications necessary to implement the da Vinci single-port robotic system. Eur Urol 2020;78:415–23.
[45] Williams SK, Rabbani F. Complications of lymphadenectomy in urologic surgery. Urol Clin North Am 2011;38:507–18, vii.
[46] Pellegrino AA, Chen G, Morgantini L, Calvo RS, Crivellaro S. Simplifying retroperitoneal robotic single-port surgery: novel supine anterior retroperitoneal access. Eur Urol 2023;84:223–8.
[47] Mitropoulos D, Artibani W, Graefen M, Remzi M, Rouprêt M, Truss M. Reporting and grading of complications after urologic surgical procedures: an ad hoc EAU Guidelines Panel assessment and recommendations. Eur Urol 2012;61:341–9.