EUROPEAN UROLOGY 61 (2012) 350–355

available at www.sciencedirect.com
journal homepage: www.europeanurology.com

European Association of Urology

Surgery in Motion

Robotic and Laparoscopic High Extended Pelvic Lymph Node Dissection During Radical Cystectomy: Technique and Outcomes

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Article info

Article history:
Accepted September 9, 2011
Published online ahead of print on October 20, 2011

Keywords:
Robotics
Laparoscopy
Pelvic lymph node dissection
Bladder cancer

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Abstract

Background: With the increasing use of laparoscopic and robotic radical cystectomy (RC), there are perceived concerns about the adequacy of lymph node dissection (LND).
Objective: Describe the robotic and laparoscopic technique and the short-term outcomes of high extended pelvic LND (PLND) up to the inferior mesenteric artery (IMA) during RC.
Design, setting, and participants: From January 2007 through September 2009, we performed high extended PLND with proximal extent up to the IMA ($n = 10$) or aortic bifurcation ($n = 5$) in 15 patients undergoing robotic RC ($n = 4$) or laparoscopic RC ($n = 11$) at two institutions.
Surgical procedure: We performed robotic extended PLND with the proximal extent up to the IMA or aortic bifurcation. The LND was performed starting from the right external iliac, obturator, internal iliac, common iliac, preaortic and para-aortic, precaval, and presacral and then proceeding to the left side. The accompanying video highlights our detailed technique.
Measurements: Median age was 69 yr, body mass index was 26, and American Society of Anesthesiologists class ≥ 3 was present in 40% of patients. All urinary diversions, including orthotopic neobladder ($n = 5$) and ileal conduit ($n = 10$), were performed extracorporeally.
Results and limitations: All 15 procedures were technically successful without need for conversion to open surgery. Median operative time was 6.7 h, estimated blood loss was 500 ml, and three patients (21%) required blood transfusion. Median nodal yield in the entire cohort was 31 (range: 15–78). The IMA group had more nodes retrieved (median: 42.5) compared with the aortic bifurcation group (median: 20.5). Histopathology confirmed nodal metastases in four patients (27%), including three patients in the IMA group and one patient in the aortic bifurcation group. Perioperative complications were recorded in six cases (40%). During a median follow-up of 13 mo, no patient developed local or systemic recurrence. Limitations of the study include its retrospective design and small cohort of patients.
Conclusions: High extended PLND during laparoscopic or robotic RC is technically feasible. Longer survival data in a larger cohort of patients are necessary to determine the proper place for robotic and laparoscopic surgery in patients undergoing RC for high-risk bladder cancer.

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0302-2838/$ – see back matter © 2011 Published by Elsevier B.V. on behalf of European Association of Urology. doi:10.1016/j.eururo.2011.09.011

1. Introduction

Radical cystectomy (RC) with pelvic lymph node dissection (PLND) is the standard of care for patients with muscle-invasive bladder cancer (BCa) and noninvasive high-grade tumors and carcinoma in situ (CIS) who fail transurethral resection and appropriate intravesical therapy. There is a growing body of evidence from various retrospective series that lymph node clearance at the time of RC may have prognostic and therapeutic significance [1–8].

Recently, laparoscopic and robotic RC has been explored as a minimally invasive alternative to open surgery with the potential advantages of decreased blood loss, reduced morbidity, improved convalescence, and earlier initiation of adjuvant therapies [9–13]. A major perceived question is whether laparoscopic and robotic techniques can achieve an adequate lymph node clearance comparable to open surgery. We report our detailed technique of laparoscopic and robotic high extended lymph node dissection (LND) during RC for patients with BCa.

2. Methods and patients

Laparoscopic RC (LRC) ($n = 11$) or robot-assisted RC ($n = 4$) with high extended LND was performed for 15 patients with BCa at two institutions. All data were entered prospectively into an institutional review board–approved database and queried retrospectively.

All procedures were performed under general anesthesia with the patient in a steep Trendelenburg tilt. The procedures were performed using six trocars, as shown in Figure 1. The primary camera port was positioned at least 5 cm cephalad to the umbilicus, and the right and left working ports were positioned at the level of the umbilicus. This relatively slightly higher position of the camera and working trocars facilitates dissection of the proximal template of the high extended node, cephalad to the common iliac vessels.

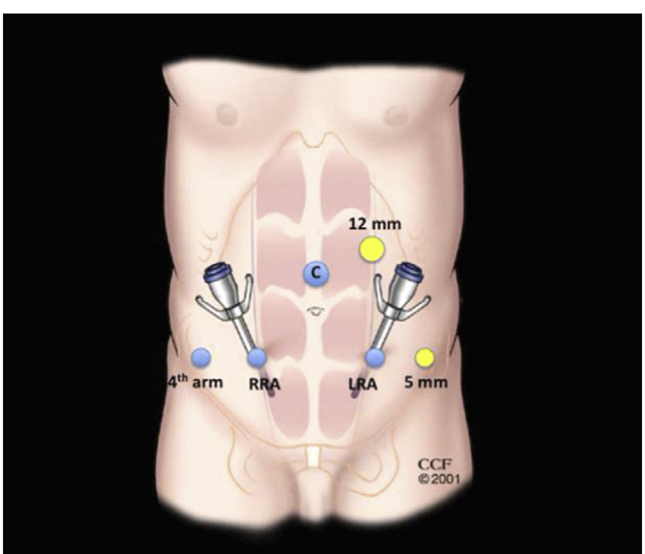

Fig. 1 – Port placement for robot-assisted radical cystectomy. Note that the camera port (C) and the robotic working ports (RRA and LRA) are positioned somewhat higher than usual. This placement facilitates the procedure as the dissection approaches the aortic bifurcation and higher.

The laparoscopic and robotic technique in radical cystoprostatectomy in the male and anterior exenteration in the female has been described [9,10,12]. We focus only on the lymphadenectomy (LND) technique. Although we have historically performed the RC first, followed by the LND, recently we have also carried out the LND first, followed by the cystectomy. In our opinion, there is no major advantage to performing the LND before or after the cystectomy.

For this study, we defined the high extended LND template as extending proximally up to the inferior mesenteric artery (IMA). We have modified the template of dissection during laparoscopic and robotic RC based on patient age, associated comorbidities, and clinical stage. In patients without significant comorbidity, especially with high clinical stage (T2 or greater), the extent of LND was either the aortic bifurcation or the IMA. However, our minimum proximal extent was the common iliac artery where the ureter crosses. In all 15 patients, the other boundaries of the extended template included the lymph node of Cloquet distally, the genitofemoral nerve laterally, and the perivesical tissue medially. Thus, the high extended pelvic template excised the external iliac, obturator, presciatic, hypogastric, common iliac, and presacral group of lymph nodes in all cases, with skeletonization of all of the previously mentioned anatomic structures bilaterally. In patients for whom the proximal template was extended up to the IMA, the preaortic, precaval, paracaval, and interaortocaval nodes distal to the IMA take-off were routinely included.

LND is initiated on the right distal external iliac vessels (Fig. 2). Using the right external iliac artery as a landmark, the lymphoareolar tissue lateral to it is dissected off the psoas muscle to identify the genitofemoral nerve that forms the lateral boundary of the template. The packet is longitudinally divided anterior to the artery using the split-and-roll technique. After delivering the packet posterior to the artery, a similar split-and-roll technique is done for the tissue surrounding the external iliac vein. Skeletonization of the entire length of the external iliac vessels up to the pubic bone completes this part of the LND, and the lymphatic packet is placed in an Endocatch I bag (Covidien, Mansfield, MA, USA).

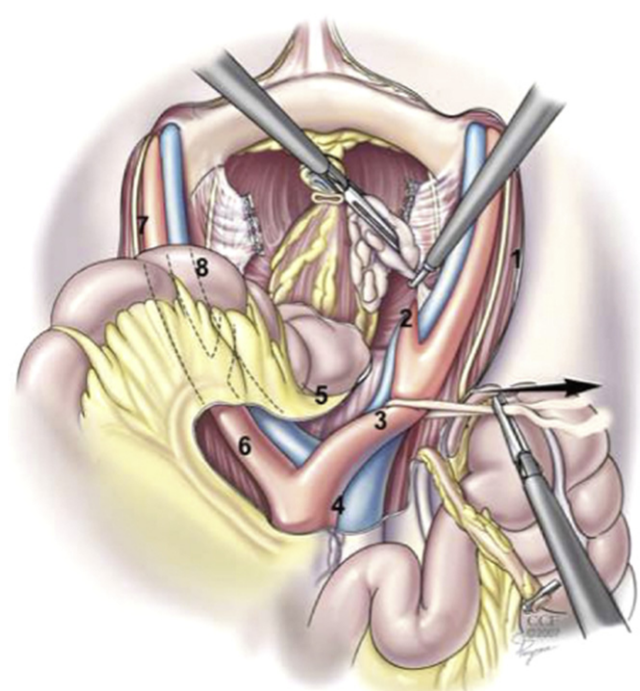

Fig. 2 – Order of high extended pelvic lymph node dissection up to the inferior mesenteric artery: (1) right external iliac, (2) right internal iliac/obturator, (3) right common iliac, (4) preparacaval and preparaaortic, (5) presacral (PS), (6) left common iliac, (7) left external iliac, and (8) left internal iliac/obturator.

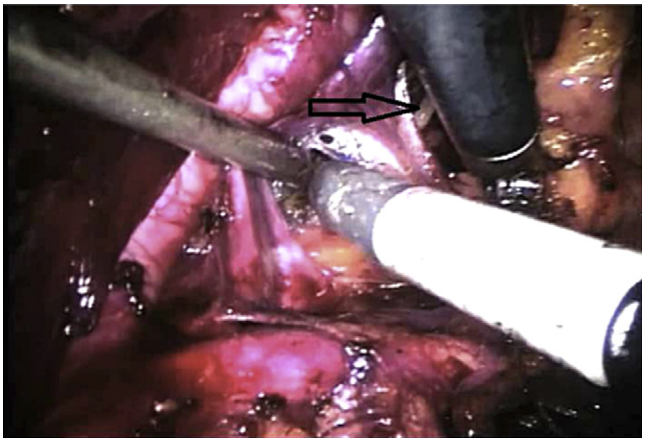

Fig. 3 – Dissection of the obturator packet showing the obturator nerve (arrow).

At this time, the common iliac artery and vein are also skeletonized, and the nodal packet is sent off separately. Dissection of the distal obturator lymphoareolar packet in the obturator fossa is performed posterior to the external iliac vein. Care is taken to identify the obturator nerve prior to disconnecting the packet proximally and distally (Fig. 3). Branches of the obturator vessels, typically coursing posterior to the nerve, can cause troublesome oozing and must be carefully controlled with electrocautery or clips, taking care not to damage the obturator nerve. The proximal obturator nodes and the presciatic nodes are better accessed from the lateral aspect of the external iliac vessels after completely mobilizing these vessels medially from the lateral pelvic sidewall. Such extensive medial mobilization of the iliac vessels exposes the triangle of Marcille, provides direct exposure of the entire intrapelvic course of the obturator nerve, and allows complete lymphatic clearance of the triangle of Marcille, an important area. Dissection now proceeds along the common iliac artery toward the aortic bifurcation. Care must be taken not to damage the ureter even though already mobilized and divided, as it may lie close to the iliac bifurcation (Fig. 4).

Cephalad dissection is performed in an ascending manner along the inferior vena cava up to the vicinity of the inferior mesenteric vein, removing the tissue along the anterior and right lateral aspect of the cava. At this point, dissection is performed across the interaortocaval region to skeletonize the aorta, until the IMA take-off is visualized. Descending dissection of the lymphaticoareolar tissue along the interaortocaval, preaortic, and left lateral aspect of the aorta is performed. During this dissection, the left ureter, which lies close to the left lateral aspect of the aorta, should be carefully preserved. Upon reaching the aortic bifurcation, dissection proceeds along the left common iliac artery, thereby lifting the root of the sigmoid mesocolon off these vessels, the sacral promontory, and the pelvic floor. Commonly, the entire left common iliac dissection, up to its bifurcation, is performed from the right side of the sigmoid mesocolon. Mobilization of the root of the descending mesocolon in this manner creates an easy path for subsequent retroperitoneal rerouting of the left ureter to the right side. Once the aortic bifurcation has been clearly identified, the presacral lymph node packet is dissected. Care is taken to clearly identify the left common iliac vein that courses just deep to the left superior boundary of this packet. There are often small venous tributaries that drain into the distal inferior vena cava and the anteroinferior aspect of the left common iliac vein that need to be carefully controlled to avoid troublesome bleeding.

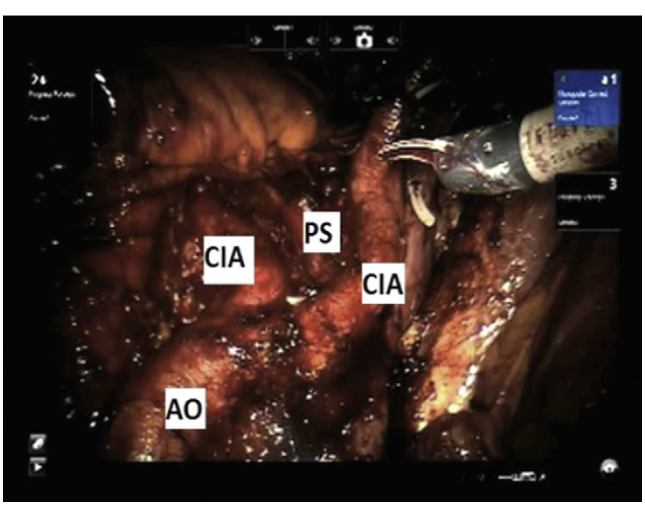

Fig. 4 – Completed high extended pelvic lymph node dissection. The distal aorta, common iliac arteries (CIAs), and presacral (PS) regions are completely dissected off lymphatic tissue.

The sigmoid colon is now retracted to the right side, and left PLND is performed in similar fashion to the right side. Individual packets are placed in two specimen retrieval bags as the PLND progresses. To minimize chances for local spillage and seeding, care is taken not to cut into any enlarged lymph nodes or extract nodal tissue directly through a port site without entrapping it in a retrieval bag.

Urinary diversion is created intracorporeally or extracorporeally according to surgeon preference. Postoperative follow-up and oncologic surveillance are performed in a standard manner.

3. Results

Demographic and tumor data are detailed in Table 1. Median patient age was 69 yr, and median body mass index was 26. American Society of Anesthesiologists class $\geq$3 was present in six patients (40%). Radical cystoprostatectomy was performed for 14 men, and anterior exenteration was performed for 1 woman.

All 15 procedures (laparoscopic: 11; robot-assisted: 4) were technically successful without need for open conversion. Intraoperative data are summarized in Table 2. Median total operating time was 400 min, and median estimated blood loss was 500 ml. Perioperative complications occurred in six patients (40%) and included ureteral stricture ($n = 1$, Clavien 3b), ureteral leak requiring percutaneous nephrostomy drainage ($n = 1$, Clavien 3a), lymphocele requiring percutaneous drainage ($n = 1$, Clavien 3a), bowel obstruction that responded to conservative treatment ($n = 1$, Clavien 2), myocardial infarction ($n = 1$, Clavien 4a), and deep vein thrombosis ($n = 1$, Clavien 4a). Median hospital stay was 6 d. Median lymph node yield in the entire cohort was 31 (range: 15–78), in patients undergoing LND up to the IMA was 42.5 (range: 16–78), and in patients undergoing dissection up to the aortic bifurcation was 20.5 (range: 15–26). Overall, positive nodes were identified in four cases (27%), including three patients in the IMA group and one patient in the aortic bifurcation group (Table 3). Primary tumor pathologic stage was CIS, Ta, T1, T2, T3, and T4 in 13%, 7%, 0%, 33%, 20%, and 27% cases, respectively. Positive soft tissue margin for cancer occurred in one

Table 1 – Demographic data

No. of patients	15
Age, yr*	68, *69* (49–82)
No. of males (%)	14 (93)
BMI*	27, *26.4* (24–34)
ASA class, *n* (%)	
1	1 (7)
2	8 (53)
3	6 (40)
Type of urinary diversion, *n* (%)	
Neobladder	5 (33)
Ileal conduit	10 (67)
Surgical technique, *n* (%)	
Laparoscopic	11 (75)
Robotic	4 (25)
Proximal extent of node dissection, *n* (%)	
IMA	10 (67)
Aortic bifurcation	5 (33)
Operative time, min*	380, *400* (240–720)
Estimated blood loss, ml	642, *500* (150–1250)
No. of blood transfusions (%)	3 (33)
Hospital stay, d*	7, *6* (5–18)
Time to ambulation, d*	2.2, *2* (2–3)
Time to PO intake, d	4.5, *4* (3–5)
Complications, *n* (%)	6 (40)
Ureteral stricture	1
Ureteral leak requiring percutaneous nephrostomy	1
Abdominal fluid collection requiring drainage	1
Bowel obstruction requiring readmission	1
Myocardial infarction	1
Deep vein thrombosis	1

BMI = body mass index; ASA = American Society of Anesthesiologists; IMA = inferior mesenteric artery; PO = by mouth.
* Data reported as mean, *median* (range).

Table 2 – Pathologic data

Pathologic stage, *n* (%)	
CIS	2 (13)
Ta	7%
T1	0 (0)
T2	5 (33)
T3	3 (20)
T4	4 (27)
Lymph nodes retrieved*	36, *26* (15–78)
IMA, mean (range)	42.5 (16–78)
Aortic bifurcation, mean (range)	20.5 (15–26)
Positive lymph nodes, *n* (%)	4 (27)
IMA group	3
Aortic bifurcation	1
Transitional cell carcinoma, *n* (%)	15 (100)
High grade, *n* (%)	14 (93)
Lymphovascular invasion, *n* (%)	7 (46)
Multifocal disease, *n* (%)	7 (46)
Prostate cancer, *n* (%)	7 (50)
No. of positive margins	3
CIS	2 (bladder, ureter)
Follow-up, mo*	16, *17.5* (2–32)
No recurrence	0

CIS = carcinoma in situ; IMA = inferior mesenteric artery.
* Data reported as mean, *median* (range).

patient with a T4 bladder tumor; two patients had CIS at the ureteral margin. Over a median follow-up of 17 mo (range: 2–32 mo), no local or systemic recurrences have been found.

4. Discussion

Invasive urothelial carcinoma of the bladder is a potentially lethal disease with lymph node metastasis present in 14–33% of patients undergoing RC [1–8]. Presence of lymph node metastasis remains a significant adverse prognosticator, with recurrence-free survival at 5 and 10 yr of 35% and 34%, respectively [1]. Data from multiple institutions suggest that the extent of LND and the number of positive lymph nodes influence survival [4,7]. The therapeutic value of LND is further reaffirmed by a study of Herr and Donat, who reported 84 patients undergoing open RC and extended PLND in the setting of grossly palpable lymphadenopathy [5]. Patients receiving neoadjuvant or adjuvant chemotherapy were excluded to eliminate the confounding influence of chemotherapy on survival. Disease-free survival at 10 yr was 24%, and median survival for patients with recurrence was 19 mo. Despite considerable data confirming the prognostic and therapeutic value of PLND, there is no clear

Table 3 – Pelvic lymphadenectomy for bladder cancer: review of literature

Reference	Approach	Extent of PLND	Nodal yield	Positive nodes, %
Poulsen et al., 1998 [4]	Open (*n* = 67)	Bifurcation of common ileac vessels	Median (range): 14 (5-30)	22
	Open (*n* = 124)	Aortic bifurcation	Median (range): 25 (9-67)	28
Stein et al., 2003 [1]	Open (*n* = 1054)	Inferior mesenteric artery	Median (range): 30 (1-96)	23
Leissner et al., 2004 [3]	Open (*n* = 290)	Inferior mesenteric artery	Mean ± SD: 43.1 ± 16.1	28
Vazina, 2004	Open (*n* = 158)	At or above aortic bifurcation	Median (range): 25 (2-80)	24
Abdel-Latif, 2004	Open (*n* = 418)	Distal common iliac artery	Mean ± SD: 17.9 ± 6.7	26
Fleischmann, 2005	Open (*n* = 507)	Crossing of the ureters with the common iliac artery	Median (range): 22 (10-43)	24
Cheng, 2006	Open (*n* = 120)	Bifurcation of common iliac vessels	Median (range): 8 (1-49)	32
Haber, 2007	Laparoscopic (*n* = 26)	Changing	Median (range): 14 (2-24)	17
Guru, 2008	Robotic (*n* = 67)	Aortic bifurcation	Mean (range): 18 (6-43)	29
Pruthi, 2008	Robotic (*n* = 28)	Bifurcation of the common iliac	Median (range): 18 (8-33)	na
	Robotic (*n* = 22)	vessels Including the common iliac vessels	Median (range): 28 (12-39)	
Janetschek, 2009	Laparoscopic (*n* = 10)	Aortic bifurcation	Median (range): 26.5 (19-35)	10
Schumacher, 2009	Robotic (*n* = 21)	Changing	Median (range): 29.5 (14-52)	na
Hellenthal, 2010	Robotic (*n* = 527)	na	Median (range): 17 (0-68)	20

PLND = pelvic lymph node dissection; SD = standard deviation; na = not applicable.

consensus on the cephalad extent of the LND template, even during open surgery. Various large-volume tertiary care centers treating BCa use the common iliac, aortic bifurcation, or IMA origin as the proximal extent of LND. We have tailored the proximal extent of dissection based on age, presence of comorbidities, indication (palliative vs curative intent), and clinical T and N stages. However, the minimum proximal extent for all our cases is the common iliac vessels at the site of ureteral crossing. In this study, we have only included patients for whom the proximal extent was the aortic bifurcation or the IMA, with the choice between the two being guided by surgeon preference and institutional practice patterns. We feel that this triage is justified, as the optimum proximal extent of dissection is largely unidentified. As such, a retrospective comparative study evaluating this question is currently under way at our institution.

The inconsistency of the LND template during open RC is well documented in large population-based studies. Konety et al. studied the Surveillance, Epidemiology and End Results public files for RC between 1992 and 1999 and found that no lymph nodes were submitted for pathologic evaluation in 99%, 85%, 61%, and 55% of cystectomies performed for CIS/stage I, stage II, stage III, and stage IV disease, respectively [14]. Additionally, in the same data set, a lymph node count >14 was obtained in only 0.2%, 3.2%, 9.2%, and 8.2% of patients with CIS/stage I, stage II, stage III, and stage IV disease, respectively. Thus, the extent of LND and lymph node clearance varies widely and seems to depend largely on individual surgeon preference and varying institutional practice patterns.

Robotic and laparoscopic RC is being increasingly used for treatment of invasive BCa [9–13]. Despite this growing use, there remain valid concerns regarding the feasibility of minimally invasive techniques for achieving adequate nodal clearance. We initially reported our experience with extended pelvic LND during LRC for 11 patients with the proximal extent of the dissection up to the proximal common iliac vessels and the aortic bifurcation [10]. Compared with the limited node dissection, the extended template provided a higher node yield (3 vs 22). Woods et al. reported their experience with 27 patients undergoing robot-assisted RC and extended PLND up to the aortic bifurcation [15]. Urinary diversions were performed extracorporeally in all procedures. Mean total operative time was 400 min, estimated blood loss was 277 ml, and complications occurred in 33% cases. Total nodal yield was 12.3 (range: 7–20). More recently, Pruthi et al. performed robot-assisted LRC in 100 patients with BCa [16]. While the authors reserved extended PLND (the cephalad extent is the common iliac artery) for high-risk disease initially in their experience, they now perform it routinely in all cases. Mean lymph node yield was 19 (range: 8–40), and they reported no difference between the first and last 50 cases (18.9 and 19.3 nodes, respectively; $p = 0.773$). To investigate the correlation of nodal yield on surgeon and surgical volume, the International Robotic Cystectomy Consortium reported a retrospective multi-institutional study on 527 patients undergoing robotic RC between 2003 and 2009 at 15 different centers [17]. Overall, 83% patients underwent some type of LND to retrieve a median of 17 nodes (range: 0–68); the lymph node yield was >20 in 43% of the cases. The performance of LND correlated with tumor stage, institution volume, and surgeon volume. Interestingly, by the individual surgeon's 20th case, patients were five times more likely to undergo LND compared with the first 10 cases. However, only 8 of the 22 surgeons in this study had performed >20 cases. The authors concluded that the decision to perform a nodal dissection during RC is ultimately dependent on the individual surgeon's preference and that skills were developed over time with repetition.

In this report we present the technical feasibility of extending the proximal extent of the LND to include the distal aorta up to the origin of the IMA. The primary reason for proximally extending the PLND template was to conform to existing standard practice at our institution during open RC. Although our series is relatively small, it is the first to demonstrate the consistent feasibility of achieving adequate clearance up to the highest proximal extent (IMA) using robotic and laparoscopic techniques. The median nodal yield with the extended template up to the IMA was 42.5 (range: 16–78), with three patients having nodes positive for cancer. This finding compares favorably with other large series of open RC and PLND and satisfies the recommended minimum of 25 lymph nodes needed for an adequate dissection [18] (Table 3). This is evidence that it is possible to perform an adequate lymph node template dissection robotically that is comparable to the most robust open surgical series.

In this paper we merely seek to demonstrate that, similar to open surgical techniques, a high extended template dissection up to the IMA can be consistently achieved by robotic and laparoscopic techniques. We fully recognize that controversy currently exists in regard to what represents adequate cephalad extent of LND (up to the aortic bifurcation or up to the IMA) during RC; our paper does not address this important issue. Lymph node count has been the typically used surrogate for assessing adequacy of lymph node clearance during RC. It is well known that various factors other than extent of lymph node clearance may influence lymph node count, such as method of submission (separate vs single packet) and method of counting nodes [19,20]. This is highlighted by the fact that there is significant variation in reported lymph node counts between centers with high-volume data that use similar templates of PLND. In fact, even in the present series, the lymph node counts between the two institutions were significantly different despite use of the same anatomic template. Ultimately, survival data will determine the completeness and resultant oncologic efficacy of laparoscopic and robotic approaches in treating invasive BCa.

Several technical caveats for robotic and laparoscopic PLND merit consideration. The camera port should be placed 2–3 cm superior to the umbilicus, and the working ports should also be somewhat higher than is typical during laparoscopic/robotic radical prostatectomy; this placement facilitates proximal dissection in the distal aortic and IMA locations. It is our subjective feeling that robotic technology, with the increased freedom of movement inherent to the EndoWrist, significantly facilitates LND. Additionally, as the dissection proceeds cephalad past the aortic bifurcation, the ergonomic advantages of the robotic approach become even more obvious; the surgeon's hands continue to be in a neutral position, compared with the awkward position in the laparoscopic approach, in which the instruments are almost vertical. The robotic technology also provides superior angles of dissection to retrieve lymphoareolar tissue from difficult-to-reach areas, possibly leading to a more complete dissection.

5. Conclusions

We report on the initial series of patients undergoing high extended PLND up to the IMA using robotic and laparoscopic techniques. Compared with pure laparoscopic techniques, the robotic approach seems to facilitate a more precise clearance, especially as the dissection proceeds cephalad along the aorta. In the future, long-term survival studies will be necessary to confirm the oncologic efficacy of robotic and laparoscopic RC in the treatment of invasive BCa.

Author contributions: Mihir M. Desai 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: Desai, Gill.
Acquisition of data: Berger, Brandina, Simmons, Zehnder.
Analysis and interpretation of data: Berger, Zehnder.
Drafting of the manuscript: Desai.
Critical revision of the manuscript for important intellectual content: Skinner, Aron, Gill.
Statistical analysis: Berger.
Obtaining funding: None.
Administrative, technical, or material support: None.
Supervision: Gill.
Other (specify): None.

Financial disclosures: I certify that all conflicts of interest, including specific financial interests and relationships and affiliations relevant to the subject matter or materials discussed in the manuscript (eg, employment/affiliation, grants or funding, consultancies, honoraria, stock ownership or options, expert testimony, royalties, or patents filed, received, or pending), are the following: None.

Funding/Support and role of the sponsor: None.

Appendix A. Supplementary data

The Surgery in Motion video accompanying this article can be found in the online version at doi:10.1016/j.eururo.2011.09.011 and via www.europeanurology.com.

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