BJUI
BJU INTERNATIONAL

Lymph node dissection during robotic-assisted laparoscopic prostatectomy: comparison of lymph node yield and clinical outcomes when including common iliac nodes with standard template dissection

Darren J. Katz, David S. Yee, Guilherme Godoy, Lucas Nogueira, Kian Tai Chong and Jonathan A. Coleman

Department of Surgery (Urology Service), Memorial Sloan-Kettering Cancer Center, New York, NY, USA

Accepted for publication 11 September 2009

Study Type – Therapy (case series)
Level of Evidence 4

OBJECTIVE

To compare the perioperative outcomes of standard pelvic to full-template lymph node (LN) dissection (LND) during robotic-assisted laparoscopic prostatectomy (RALP).

PATIENTS AND METHODS

The study included 94 patients undergoing RALP with LND between January 2007 and August 2008, by one surgeon. In February 2008 the LND template was modified to include common iliac and medial hypogastric LNs. Clinical and pathological patient characteristics were analysed, including total number of retrieved and positive LNs in each area of dissection, operative duration and complications.

RESULTS

Of the 94 patients, 62 underwent standard LND (group 1) and 32 underwent full-template pelvic LND (group 2). The median (mean) number of LNs retrieved in groups 1 and 2 were 12 (13.3) and 17.5 (21.4), respectively. Of the five patients with positive LNs (5%), four were in group 2 (13%); two of these patients had positive LNs in the common iliac dissection, and for one of these patients it was the sole site of involvement. Deep venous thrombosis, pulmonary embolism or transient neuropraxia occurred in six patients (five in group 1 and one in group 2). The median additional operative time for resection of common and internal LNs was 25 min.

CONCLUSIONS

LN yield increased and additional sites of LN metastases were identified during full-template pelvic LND during RALP. This modification was not associated with an increased rate of complications. Derived benefits of including additional nodal dissection and the effect on staging accuracy remain to be determined.

KEYWORDS

prostate cancer, prostatic neoplasms, lymphadenectomy, lymph node, laparoscopic surgery

INTRODUCTION

Lymph node (LN) metastases are an important prognostic indicator in patients undergoing radical prostatectomy (RP) for clinically localized prostate cancer [1,2]. Proper surgical staging depends on the extent of dissection and the accurate determination of LN involvement [3,4]. Current preoperative staging techniques have a low sensitivity to micrometastatic tumour deposits in LNs [5–7]. LN dissection (LND) at the time of surgery offers the best means to detect the presence of nodal metastases. However, optimal nodal templates for patients with prostate cancer, patient selection, associated risks and long-term benefits have not been established.

Several templates for pelvic LND have been described, largely based on access to nodal basins using the retropubic approach [8]. The standard template for LND at our institution includes the external iliac, obturator, and lateral hypogastric LNs. Recent publications have reported that this template results in a higher LN yield and greater detection of LN metastases than a more limited dissection [5,9–11]. Transperitoneal minimally invasive surgical procedures allow access to more proximal nodal regions. Expanding the template of LN dissection to include more proximal nodal echelons would therefore be expected to increase LN yield and improve staging of LN metastases. Herein we describe our experience with full-template pelvic LND during robotic-assisted laparoscopic RP (RALP) and report the pathological and clinical outcomes with the technique compared with those obtained from standard-template dissection.

PATIENTS AND METHODS

Patients undergoing RALP with LND by one surgeon (J.C.) were included in the study. Patients were classified into two groups: group 1 included 62 men who had a standard LND (external, obturator, and lateral hypogastric packets to the common iliac bifurcation), and group 2 (full-template LND) included 32 men with additional dissection of more proximal nodes (standard plus medial hypogastric to aortic bifurcation, which

includes the common iliac nodal packet). As the expanded LND was initiated in February 2008, patients in group 1 had surgery earlier than patients in group 2. Institutional Review Board approval was obtained for the collection and analysis of necessary clinical data.

Clinical and pathological patient characteristics were evaluated, including the RP specimen, total LN count, and positive LN count with location. Perioperative outcomes were also assessed, including estimated blood loss, hospital stay, operative duration and complications. Charts, outpatient notes, nursing communications and correspondence with local physicians were reviewed retrospectively to determine all complications within 30 days of surgery; the minimum follow-up was 40 days. Complications were defined and graded according to an established five-grade modification of the Clavien system [12,13]. Complications related to LND were defined as symptomatic lymphoceles, deep venous thrombosis (DVT), pulmonary embolism, major vascular or ureteric injury, and sensory or motor neuropraxia. All patients were placed on a standardized perioperative-care pathway which included DVT prophylaxis (sequential compression stockings and low molecular weight heparin, i.e. 5000 IU dalteparin given subcutaneously, daily until discharge).

A transperitoneal laparoscopic approach was used with the patient in a steep Trendelenburg position with split-leg support. Procedures were performed using the DaVinci Surgical System (Intuitive Surgical, Sunnyvale, CA, USA) with either a three- or four-arm system. Ports were placed as follows: 12-mm camera and assistant ports were located supraumbilically and 2–4 cm cephalad to the left anterior superior iliac crest, respectively; two 8-mm robot ports were placed 2 cm below and 9 cm lateral to the camera port bilaterally; one 5-mm assistant port was placed 6 cm cephalad and 3 cm medial to the left lower quadrant 8-mm port; and the optional 8-mm port for the 4th arm was placed 2 cm cephalad to the right anterior superior iliac crest (Fig. 1).

The boundaries of standard LND were similar to those previously published [9]. Dissection respected the medial border of the external iliac artery, the lateral aspect of the hypogastric artery from the bifurcation of the

FIG. 1. Port placement for extended pelvic LND during RALP.

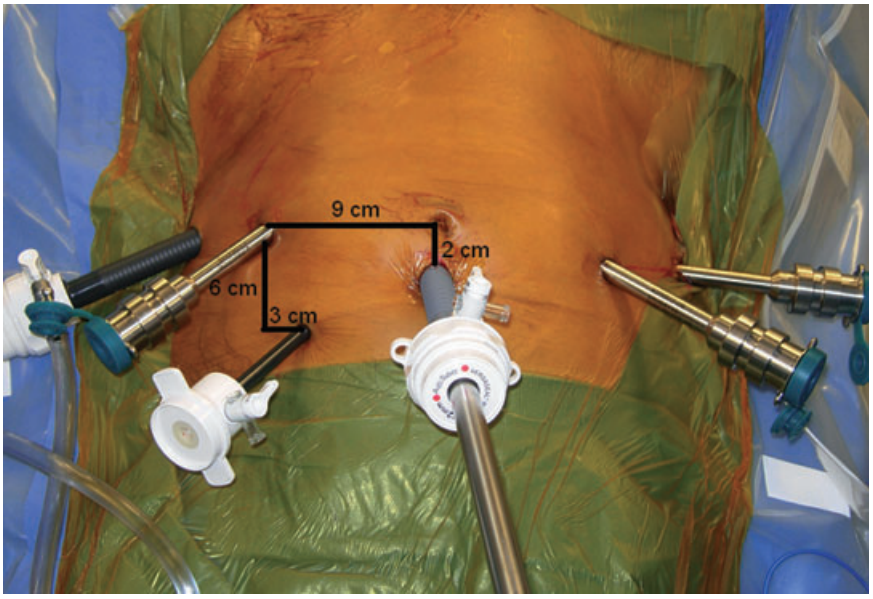
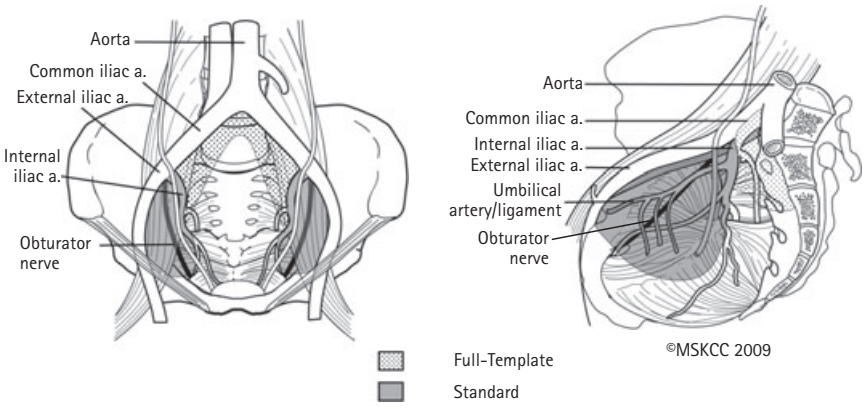


FIG. 2. Standard and full-template pelvic LND templates; the full-template pelvic LND also removed nodal tissue medial to the common iliac vessels from the aortic bifurcation proximally to the medial border of the hypogastric artery ending at the umbilical artery distally.



iliac vessels to the node of Cloquet. Dissection deep to the obturator nerve was carried out to the muscles of the pelvic side-wall. Nodal tissue obtained from this dissection was labelled as pelvic nodes. Full-template pelvic LND also removed nodal tissue medial to the common iliac vessels from the aortic bifurcation proximally to the medial border of the hypogastric artery ending at the umbilical artery distally (Fig. 2). Nodal tissue obtained from this additional dissection was labelled as 'common iliac nodes' and tagged with a locking clip. LN from the right and left sides were laparoscopically isolated within separate specimen bags before removal.

All specimens were processed routinely by the Department of Pathology. LN specimens were fixed in neutral buffered 4% formaldehyde for 24 h. The LNs were then located, counted manually, sectioned, and fixed in paraffin. Slides stained with haematoxylin and eosin were examined microscopically. The RP specimens were examined in a whole-mount fashion. Pathological variables included Gleason score, T stage, extracapsular extension, surgical margin status, and bladder neck invasion.

Continuous variables were compared using a nonparametric analysis (Mann–Whitney

TABLE 1 The clinical characteristics, pathological data and distribution of LNs dissected in groups 1 and 2

Median (IQR) or *n* (%) variable	Group 1	Group 2	*P*
No. of patients	62	32	
Age, years	59.6 (56.3–66.3)	60.4 (55.1–65.5)	0.7
PSA level, ng/mL	5.7 (4.4–8.2)	6.3 (4.9–8.1)	0.3
Body mass index, kg/m^2	28.2 (26.3–30.6)	28.1 (25.6–31.8)	0.9
Clinical stage			0.2
T1c/T2a	57 (91.9)	26 (81.3)	
≥T2b	5 (8.1)	6 (18.7)	
Biopsy Gleason score			0.8
≤6	28 (45.2)	13 (40.6)	
7	27 (43.5)	16 (50.0)	
≥8	7 (11.3)	3 (9.4)	
LN invasion, % by:			
Partin preop nomogram [14]	1 (0–3)	2 (0–6)	
Kattan preop nomogram [15]	2 (1–3)	2 (2–4)	
Pathological			
Pathological stage			0.6
pT2a/b	37 (59.7)	20 (62.5)	
pT3/pT4	25 (40.3)	12 (37.5)	
Gleason score			0.9
≤6	14 (22.6)	6 (18.8)	
7	43 (69.4)	24 (75.0)	
≥8	4 (6.5)	2 (6.3)	
Extracapsular extension	25 (40.3)	10 (31.3)	0.4
Seminal vesicle invasion	3 (4.8)	1 (3.1)	0.7
Positive surgical margins	10 (16.1)	4 (12.5)	0.6
Distribution of LNs dissected			
No. of retrieved nodes	12.0 (7.0–16.3)	17.5 (12.0–28.3)	0.001
No. of pelvic LNs	12.0 (7.0–16.3)	13.5 (8.3–20.0)	0.5
No. of LNs in the extended area	–	4.5 (2.0–9.6)	–
No. of patients with positive LNs	1 (1.6)	4 (12.5)	–

test), and categorical using either Pearson's chi-square or Fisher's exact test when appropriate. All statistical tests were two-sided (except for the analysis of the complications related to the LND), with significance set at $P < 0.05$.

RESULTS

The preoperative clinical characteristics of each group are shown in Table 1; 71% of patients had an American Society of Anesthesiologists (ASA) score of ≤2. There were no statistically significant differences between the groups; ≈90% of the patients had a biopsy Gleason score of ≤7 and most were clinical stage ≤ T2a. The probability of LN involvement was similar between the groups according to predictive modelling (Partin table and Kattan nomogram) [14,15]. Pathological data after RALP are also listed in Table 1, showing that few patients in either group had a Gleason score of ≥8, but ≈40% in each group were staged ≥pT3.

Table 1 also details the distribution of the dissected LNs. The median (mean) number of total LNs retrieved in groups 1 and 2 were 12 (13.3) and 17.5 (21.4), respectively, representing a 46% increase in the median number of total LNs retrieved with additional dissection ($P = 0.001$). Of the five patients with positive LNs (5%), four had a full-template dissection, with two of these patients having positive LNs in the common iliac region; in one of these patients the common iliac region was the sole site of involvement (Table 2).

In all, there were 33 complications in 25 separate patients in group 1 and 14 complications in 11 separate patients in group 2 occurring within 30 days after RALP (Table 3). Most complications were grade 1 (81%), but eight patients had grade ≥2 complications. Four patients had grade 2 complications, which included *Clostridium difficile* enteritis (infectious), urine leak (genitourinary), DVT and pulmonary embolism (thromboembolic). Another patient was admitted for intravenous hydration and pain management from unilateral ureteric obstruction secondary to vesico-urethral anastomosis oedema, as identified on CT. Four patients had grade 3 or 4 complications, including a myocardial infarction (cardiac) requiring placement of a coronary artery stent, incarcerated hernia into the umbilical port site requiring a laparotomy, compartment syndrome requiring decompression, and a bowel serosal injury recognized and repaired during RALP. No lymphoceles presented clinically and there were no vascular injuries or deaths.

The EBL, total operative duration and length of stay were similar between the groups. The median (interquartile range, IQR) follow-up was 229 (131–164) and 47 (40–70) days in groups 1 and 2, respectively. The median (IQR) time for the standard LND was 47 (42–51) min and that for the full-template dissection was 72 (66–86) min.

DISCUSSION

For patients with prostate cancer, LN metastases are associated with worse cancer-specific survival than for patients with no involved LNs [2]. Evidence suggests that the more LNs that are removed the greater the chance of detecting nodal metastases [5,9–11]. However, the number of LNs that should be removed to be considered an adequate dissection is unknown. Briganti *et al.* [16] suggested that at least 10 LNs should be assessed to accurately stage a patient. Barth *et al.* [17] found that the rate of metastatic nodal involvement was twice as high when ≥13 LNs were examined compared with lower LN yields. One anatomical study estimated that ≈20 LNs should be removed for adequate staging [18].

Our study confirms that significantly more LNs are retrieved by extending the LND template to the bifurcation of the aorta than with standard LND. Furthermore, we found that this common iliac region might be a primary 'landing site' of prostate cancer even in the absence of positive LNs distally. We showed that a full-template dissection

increased the median LN yield from 12 to 17.5, and the mean LN yield from 13 to 21 nodes. This is a significant increase of 46% (median) and 60% (mean) in the number of total LNs retrieved. The number of pelvic LNs extracted from areas that are dissected using either a standard or a more extended template was relatively constant, showing that the increase in the number of LNs was due to additional areas being included in the dissection.

Given a uniform LND template, many factors could influence the number of LNs removed. In addition to individual variation in patient anatomy, the method by which a specimen is submitted for pathological examination and how it is analysed by pathology has been shown to influence the total LN count [18–21]. Institutional differences in nodal labelling and processing can make it difficult to compare results. In the present study pelvic nodal packets (obturator, lateral hypogastric, and external iliac) were submitted as one sample for each side, minimizing operative tissue handling. LN yields in the present series were comparable to LN yields in other published series from our institution, in which the specimens were submitted and analysed similarly. During a standard dissection of 104 patients undergoing a purely laparoscopic RP, the median LN count was 14 [9]. For the open approach, the median LN count was 12 (unpublished data). With similar anatomical boundaries for the LND during radical cystectomy, a series from our institution showed a median increase of six extra LNs when the common iliac region was included in the template [22]. In this cystectomy series, the median LN yield in the standard dissection area was 12.

In the present study, all but one patient with positive LNs had a full template dissection, despite a similar probability of LN involvement between the groups (Table 1). In a recent article, Touijer *et al.* [9] reported a significant increase in LN count and positive LN detection with standard vs limited dissection in patients with comparable cancer characteristics. The limitations of the present study preclude the ability to assess the statistical significance of this difference between the groups; however, the finding that an extended dissection resulting in the removal of more LNs and an increase in percentage of patients with positive LNs has been substantiated by several studies [5,10,11].

TABLE 2 Location and predicted risk of positive LNs

Patient	Group	Positive LN location	Probability of LN invasion, %		Follow-up, months	Status
			Partin	Kattan		
1	1	Pelvic	9	11	12	BCR
2	2	Pelvic	10	14	7	BCR
3	2	Pelvic	2	2	8	NED
4	2	Pelvic/Common	11	4	6	BCR
5	2	Common	3	2	4	NED

Pelvic, within borders of standard template; Common, within borders of additional LND template; BCR, biochemical recurrence by serum PSA; NED, no evidence of disease.

TABLE 3 LND-associated complications and perioperative data

Factor, median (IQR) or *n*	Group 1	Group 2	*P*
Estimated blood loss, mL	250 (200–400)	300 (150–400)	0.8
Total operative time, min	306.5 (273.0–330.3)	298.0 (282.0–330.0)	0.9
Length of stay, days	2.0 (1.0–2.0)	2.0 (2.0–2.8)	0.3
Follow-up, days	229 (131–367)	47 (40–95)	
Complications*			
All	33	14	0.6
Gastrointestinal	2	1	
Infectious	5	5	
Wound	3	1	
Genitourinary	9	6	
Cardiac	2	0	
Pulmonary	0	0	
Bleeding	2	0	
Thromboembolic	2	0	
Neurological	3	1	
Miscellaneous	3	0	
Surgical	2	0	
LND-related	5	1	0.5
DVT	2	0	
Pulmonary embolism	1	0	
Lymphocele	0	0	
Neuropraxia	2	1	
Major vascular injury	0	0	
Ureteric injury	0	0	

**Number of complications in entire group (which could include more than one complication per patient).*

The debate over the extent of LND during RP is ongoing. In a recent study, Mattei *et al.* [23] mapped the primary prostatic lymphatic drainage sites during RP using a combination of preoperative spectroscopy, CT and MRI with intraoperative γ-probe localization and a bilateral extended lymphadenectomy. The external iliac and obturator nodal basins represented only 38% of the primary landing sites, prompting their group to further extend their LND to include the internal and common iliac regions. Our findings of isolated involved LNs in these regions also suggest that the nodal drainage of the prostate can vary and be under-sampled by standard template dissection. Of the five patients with positive LNs in our series, two had disease in the common iliac region. Predictive nomograms based on standard

pelvic LND from open series might underestimate involvement of this region.

LND requires additional operative time and, theoretically, can pose a higher risk of morbidity. Complications possibly related to LND were identified in 6% of patients in group 1 and 3% in group 2. Both patients with a DVT were from group 1. Limited numbers prevent any substantial inferences on the different complication rates, except that these appear to be consistent with other published series [4,24,25]. There were no cases of clinically significant lymphoceles, which might be partly attributable to our transperitoneal approach. In our assessment of all complications, most were grade 1 and might be considered part of the typical postoperative course after RP. However, this would deviate from the 'ideal postoperative course' of Dindo and Clavien [26] (in which no complications are observed), initially termed the 'normal postoperative course'. The hospital stay and EBL were also similar between the groups, as was overall operative duration.

We acknowledge that the sequential treatment of the two groups is a limitation of the study, as was the retrospective nature and the relatively few patients analysed. The short follow-up does not allow for an assessment of durable oncological outcomes, although this was not the primary aim of the study. As a preliminary experience, this study shows the feasibility, increased LN yield, and potential for improved pathological staging of a full-template LND during RALP, with complication rates that do not appear to be worse than standard LND.

Including the common iliac nodes in LND during RALP significantly increases LN yields compared to standard dissection, and identifies additional sites of nodal metastases. This modification of LND requires added operative time with no observed increase in LND-related complications in this series.

ACKNOWLEDGEMENTS

Supported by The Sidney Kimmel Center for Prostate and Urologic Cancers. We thank Terry Helms for producing the figures and illustrations.

CONFLICT OF INTEREST

None declared.

REFERENCES

1 **Hull GW, Rabbani F, Abbas F, Wheeler TM, Kattan MW, Scardino PT.** Cancer control with radical prostatectomy alone in 1,000 consecutive patients. *J Urol* 2002; **167**: 528–34
2 **Cheng L, Zincke H, Blute ML, Bergstralh EJ, Scherer B, Bostwick DG.** Risk of prostate carcinoma death in patients with lymph node metastasis. *Cancer* 2001; **91**: 66–73
3 **Boorjian SA, Thompson RH, Siddiqui S *et al.*** Long-term outcome after radical prostatectomy for patients with lymph node positive prostate cancer in the prostate specific antigen era. *J Urol* 2007; **178**: 864–70
4 **Schumacher MC, Burkhard FC, Thalmann GN, Fleischmann A, Studer UE.** Good outcome for patients with few lymph node metastases after radical retropubic prostatectomy. *Eur Urol* 2008; **54**: 344–52
5 **Bader P, Burkhard FC, Markwalder R, Studer UE.** Is a limited lymph node dissection an adequate staging procedure for prostate cancer? *J Urol* 2002; **168**: 514–8
6 **Borley N, Fabrin K, Sriprasad S *et al.*** Laparoscopic pelvic lymph node dissection allows significantly more accurate staging in 'high-risk' prostate cancer compared to MRI or CT. *Scand J Urol Nephrol* 2003; **37**: 382–6
7 **Flanigan RC, McKay TC, Olson M, Shankey TV, Pyle J, Waters WB.** Limited efficacy of preoperative computed tomographic scanning for the evaluation of lymph node metastasis in patients before radical prostatectomy. *Urology* 1996; **48**: 428–32
8 **Heidenreich A, Ohlmann CH, Polyakov S.** Anatomical extent of pelvic lymphadenectomy in patients undergoing radical prostatectomy. *Eur Urol* 2007; **52**: 29–37
9 **Touijer K, Rabbani F, Otero JR *et al.*** Standard versus limited pelvic lymph node dissection for prostate cancer in patients with a predicted probability of nodal metastasis greater than 1%. *J Urol* 2007; **178**: 120–4
10 **Allaf ME, Palapattu GS, Trock BJ, Carter HB, Walsh PC.** Anatomical extent of lymph node dissection: impact on men with clinically localized prostate cancer. *J Urol* 2004; **172**: 1840–4
11 **Heidenreich A, Varga Z, Von Knobloch R.** Extended pelvic lymphadenectomy in patients undergoing radical prostatectomy: high incidence of lymph node metastasis. *J Urol* 2002; **167**: 1681–6
12 **Clavien PA, Sanabria JR, Strasberg SM.** Proposed classification of complications of surgery with examples of utility in cholecystectomy. *Surgery* 1992; **111**: 518–26
13 **Shabsigh A, Korets R, Vora KC *et al.*** Defining early morbidity of radical cystectomy for patients with bladder cancer using a standardized reporting methodology. *Eur Urol* 2009; **55**: 164–76 [Epub ahead of print]
14 **Makarov DV, Trock BJ, Humphreys EB *et al.*** Updated nomogram to predict pathologic stage of prostate cancer given prostate-specific antigen level, clinical stage, and biopsy Gleason score (Partin tables) based on cases from 2000 to 2005. *Urology* 2007; **69**: 1095–101
15 **Cagiannos I, Karakiewicz P, Eastham JA *et al.*** A preoperative nomogram identifying decreased risk of positive pelvic lymph nodes in patients with prostate cancer. *J Urol* 2003; **170**: 1798–803
16 **Briganti A, Chun FK, 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 **Barth PJ, Gerharz EW, Ramaswamy A, Riedmiller H.** The influence of lymph node counts on the detection of pelvic lymph node metastasis in prostate cancer. *Pathol Res Pract* 1999; **195**: 633–6
18 **Weingartner K, Ramaswamy A, Bittinger A, Gerharz EW, Voge D, Riedmiller H.** Anatomical basis for pelvic lymphadenectomy in prostate cancer: results of an autopsy study and implications for the clinic. *J Urol* 1996; **156**: 1969–71
19 **Bochner BH, Herr HW, Reuter VE.** Impact of separate versus en bloc pelvic lymph node dissection on the number of lymph nodes retrieved in cystectomy specimens. *J Urol* 2001; **166**: 2295–6
20 **Stein JP, Penson DF, Cai J *et al.*** Radical cystectomy with extended lymphadenectomy: evaluating separate package versus en bloc submission for

node positive bladder cancer. *J Urol* 2007; **177**: 876–81
21 **Edelstein RA, Zietman AL, de las Morenas A *et al.*** Implications of prostate micrometastases in pelvic lymph nodes: an archival tissue study. *Urology* 1996; **47**: 370–5
22 **Bochner BH, Cho D, Herr HW, Donat M, Kattan MW, Dalbagni G.** Prospectively packaged lymph node dissections with radical cystectomy: evaluation of node count variability and node mapping. *J Urol* 2004; **172**: 1286–90
23 **Mattei A, Fuechsel FG, Bhatta Dhar N *et al.*** The template of the primary lymphatic landing sites of the prostate should be revisited: results of a multimodality mapping study. *Eur Urol* 2008; **53**: 118–25
24 **Janetschek G.** Can sentinel pelvic lymph node dissection replace extended pelvic lymph node dissection in patients with prostate cancer? *Nat Clin Pract Urol* 2007; **4**: 636–7
25 **Briganti A, Chun FK, Salonia A *et al.*** Complications and other surgical outcomes associated with extended pelvic lymphadenectomy in men with localized prostate cancer. *Eur Urol* 2006; **50**: 1006–13
26 **Dindo D, Clavien PA.** What is a surgical complication? *World J Surg* 2008; **32**: 939–41

Correspondence: Darren J. Katz, Urology Service, Department of Surgery, Memorial Sloan-Kettering Cancer Center, 1275 York Avenue, New York, NY 10021, USA.
e-mail: katzd@mskcc.org

Abbreviations: **RP**, radical prostatectomy; **LN(D)**, lymph node (dissection); **RALP**, robotic-assisted laparoscopic RP; **DVT**, deep venous thrombosis; **IQR**, interquartile range; **ASA**, American Society of Anesthesiologists.