Extended vs standard pelvic lymphadenectomy during laparoscopic radical prostatectomy for intermediate- and high-risk prostate cancer

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OBJECTIVE

To investigate the effect of extended vs standard pelvic lymphadenectomy (sPLND) for patients with intermediate- and high-risk prostate cancer undergoing laparoscopic radical prostatectomy (LRP).

PATIENTS AND METHODS

Of a total of 1269 patients who underwent LRP during a 109 month period, 374 (30%) had a PLND; 253 men had a sPLND (2000 to March 2008) and 121 had an extended PLND (ePLND; after April 2008) for intermediate- or high-risk prostate cancer. An extraperitoneal approach was used in all patients having sPLND and a transperitoneal approach in patients having ePLND.

RESULTS

Patient age, body mass index, gland weight, prostate-specific antigen level and Gleason grade were similar in the two groups. The ePLND group had a greater proportion of patients with cT3 disease (9.9% vs 4.2%, $P = 0.046$) and was associated with a longer operating time of 206.5 vs 180.0 min ($P < 0.001$) and a higher node count of 17.5 vs 6.1 ($P = 0.002$). Blood loss, hospital stay, transfusion and complication rates were similar in the two groups. Lymph node positivity was significantly greater ($P = 0.018$) in patients with pathological Gleason grade 7 tumours who had ePLND (9.6% vs 1.0%) but was similar for other grades of tumour.

CONCLUSION

Based on these findings, and the results of other studies which show a reduction of prostate cancer-specific mortality of 23% if lymph nodes are positive and 15% if they are negative after ePLND, and the correlation between surgical experience, lymph node yield and positivity, we recommend that all patients undergo ePLND if they are being treated with curative intent for intermediate- and high-risk prostate cancer; ePLND should replace sPLND and surgeons performing <35 cases of RP a year should stop performing RP.

KEYWORDS

laparoscopy, prostate cancer, radical prostatectomy

INTRODUCTION

At present pelvic lymph node dissection (PLND) remains the most accurate method of detecting LN involvement (LNI) in men with prostate cancer, which has an estimated incidence of 1.1–26% [1]. Although improvements in cross-sectional imaging, in the form of ultra-small superparamagnetic iron oxide particles, ^{11}C-choline positron-emission tomography with CT, single-photon emission CT combined with ^{99m}Tc-labelling of LNs, and sentinel node biopsy techniques, continue to attract interest, they have yet to match the specificity and sensitivity of PLND for detecting LNI.

The probability of detecting LNI appears to be directly correlated to the number of nodes removed [2,3], questioning the appropriateness of the current most common technique of PLND during radical prostatectomy (RP), i.e. the standard external iliac and obturator fossa PLND (sPLND) popularized by Walsh two decades ago [4].

Moreover, it appears that sPLND might not sample the LNs most at risk of harbouring metastatic prostate cancer. In 103 patients having ePLND, Heidenreich *et al.* [5] found that 42% of positive nodes were in locations outside the sPLND template. PLN status carries not only prognostic significance but also allows patients to be stratified to receive adjuvant therapy such as androgen-deprivation therapy (ADT), which has been shown to improve survival in LN-positive patients [6]. Also, several studies showed that when LNI is found at PLND to be limited to two or fewer positive nodes, these patients have a much better prognosis than when two or more nodes are involved [3,7–9]. Interestingly, the number of nodes removed is also inversely correlated with biochemical recurrence in node-negative patients [10], possibly because this is a surrogate marker of surgical skill, and perhaps also because some nodal micrometastases might go undetected at the time of pathological examination.

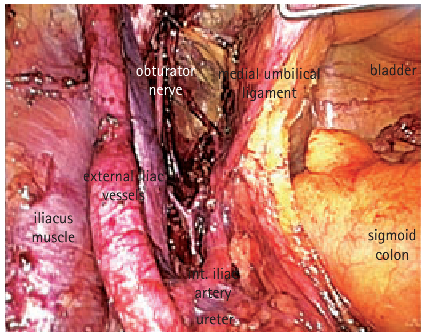
Because the histological evaluation of LNs appears still to be the only definitive test of LNI, as prostate cancer is known to 'skip' some LNs to involve more proximal nodes, and as the removal of nodes in patients with two or more LNs involved might also be therapeutic, it is logical to try to remove as many LNs as possible within the constraints of time and morbidity.

Although the concept of extended PLND (ePLND) was suggested 30 years ago by Golimbu *et al.* [11], and its validity has since

TABLE 1 Patient demographics, inpatient results and the complications of surgery

Median (range) or *n* (%) variable	sPLND	ePLND	*P*
No. of patients	311	121	
Age, years	63.0 (43–76)	63.0 (43–74)	0.22
BMI, kg/m^2	27.0 (21–40)	27.0 (19–40)	0.65
PSA level, ng/mL	11.0 (2–20)	8.0 (1–15)	0.001
Biopsy Gleason score	7.0 (4–10)	7.0 (6–10)	0.80
Clinical stage			
T1	102 (32.8)	40 (33.1)	1.00
T2	196 (63.0)	174 (57.0)	0.26
T3	13 (4.2)	12 (9.9)	0.05
Inpatient results			
Operative duration, min	180.0 (117–537)	206.5 (99–331)	<0.001
Blood loss, mL	200 (10–1300)	200 (10–800)	0.13
Conversion	0	0	1.00
Transfusion (patients)	2 (0.8)	3 (2.5)	0.27
Prostate weight, g	56.5 (20–214)	57.0 (125–125)	0.09
Hospital stay, nights	3.0 (2–5)	3.0 (2–4)	0.77
Complications	9 (3.6)	10 (8.3)	0.10
Small bowel injury		1	
Rectal injury	2		
Obturator nerve injury		2	
Ureteric injury		2	
Laparoscopic haemostasis		2	
Blocked catheter	2		
Prolonged urine leak	1		
Acute renal failure due to chronic urinary retention		1	
Wound infection	1		
Infected pelvic haematoma	1		
Symptomatic lymphocele	5		
DVT	1	1	
Bladder neck stenosis	2	1	

FIG. 1. A completed left ePLND.



been confirmed [2,5,12], reports on the merits of ePLND for prostate cancer remain contradictory. Study findings range from little benefit with an increased complication rate [13] to recommending its routine use in all men with intermediate- and higher-risk disease (PSA level >10 ng/mL, with or without Gleason score 7) having RP [5].

Here we report the initial results of one surgeon with experience of both open and laparoscopic (L)RP in performing ePLND in patients with intermediate- or high-risk prostate cancer according to the risk classification for biochemical recurrence of d'Amico *et al.* [14].

PATIENTS AND METHODS

Of 1269 patients who underwent LRP for ≤ T3N0M0 prostate cancer, performed or supervised by one surgeon during a 109-month period from 2000 to 2008, 374 (30%) had a PLND. Of these, 253 men had a sPLND (2000 to March 2008) if their PSA level was ≥10 ng/mL with or without a Gleason score of ≥8, and 121 had an ePLND (after April 2008) for intermediate- or high-risk prostate cancer according to the classification of d'Amico *et al.* [14] (Table 1). All PLNDs were done before dissection of the prostate, and nodal tissue was sent separately from each side of the pelvis, but not from each location on each side. The series was consecutive except for one patient who was operated on by open surgery, as he had recently undergone laparoscopic extraperitoneal PLND and difficulty in re-establishing the prevesical plane was anticipated. All patients had a bone scan and CT or MRI to exclude metastases.

sPLND, as previously described by Walsh [4], was performed using an extraperitoneal laparoscopic approach and consisted of excising all nodal tissue anteromedial to the external iliac vein and around the obturator vessels and nerve. ePLND was conducted via a transperitoneal approach, to gain adequate access to the internal iliac artery, and consisted of excision of all nodal tissue limited proximally by the ureter, distally by the pubic bone, laterally by the lateral border of the external iliac artery and medially by the bladder, as previously described by Mattei *et al.* [15], the principle difference from sPLND being the addition of removal of tissue along the internal iliac artery and overlying the external iliac artery (Fig. 1). Thus, the extent of the ePLND was not as great as in patients undergoing cystectomy. On the left side this was preceded by mobilization of the sigmoid colon when necessary. The remainder of the LRP procedure was done as previously described [16]. At the end of transperitoneal cases and to prevent port-site herniation, an EndoClose device (Covidien, Mansfield, USA) was used to close the deep fascia of the two 11-mm port sites. Other wounds were closed in standard fashion.

The operative duration (time from first incision to closure of the last wound) was recorded. Postoperative analgesia consisted of i.v. or i.m. morphine sulphate on demand and regular i.v. paracetamol 1 g 6-hourly on the day or surgery and regular slow-release diclofenac sodium 75 mg 12-hourly thereafter. A second-generation cephalosporin was administered as antibiotic prophylaxis for the first 48 h. Deep vein thrombosis (DVT) prophylaxis took the form of a pneumatic intermittent calf-compression device during surgery, s.c. heparin 5000 units twice daily until discharge, and calf-compression stockings. Oral fluids and diet were introduced as tolerated. The drain was removed when drainage was <100 mL/24 h. Patients were discharged home when

TABLE 2
The distribution of LNI

Variable, *n*/*N* (%)	sPLND	ePLND	*P*
Clinical			
Gleason grade			
4 and 5	0/13	0/0	1.00
6	1/144 (0.7)	0/20	1.00
all 7	1/123 (0.8)	7/80 (8.8)	0.01
3 + 4	0/79	3/57 (5.3)	0.14
4 + 3	1/44 (2.3)	4/23 (17.4)	0.09
8	1/27 (3.7)	1/12 (8.3)	1.00
9	0/2	0/7	1.00
10	0/2	0/2	1.00
T stage			
T1	1/102 (9.8)	1/40 (2.5)	0.97
T2	2/196 (1.0)	6/174 (3.5)	0.21
T3	0/13	1/12	0.96
d'Amico risk category			
Low	0/7	0/3	1.00
Intermediate	1/225 (0.4)	4/79 (5.1)	0.03
High	2/79 (2.5)	4/39 (10.3)	0.18
Pathological			
Node count	6.1 (2–8)	17.5 (2–23)	0.002
Gleason grade			
4 and 5	0/12	0/0	1.00
6	1/140 (0.7)	0/17	1.00
all 7	1/120 (0.8)	8/83 (9.6)	0.01
3 + 4	0/78	2/65 (3.1)	0.41
4 + 3	1/42 (2.4)	6/18 (33)	0.004
8	1/34 (2.9)	0/12	1.00
9	0/3	0/7	1.00
10	0/2	0/2	1.00
T stage			
2a	1/56 (1.8)	0/7	1.00
2b/c	1/184 (0.5)	0/65	1.00
3a	0/46	2/32 (6.3)	0.33
3b	1/25 (4)	6/17 (29)	0.02

comfortable. Catheters were removed at 8–14 days with no previous cystogram, except after salvage surgery, when a cystogram was done after 3 weeks. Patients were routinely administered quinolone antibiotic therapy for 7 days after catheter removal, pending the result of their catheter urine microbiology.

Data were patient-reported using a questionnaire, prospectively recorded in a database and analysed statistically; continuous variables were compared using the independent samples *t*-test and rates using Fisher's exact test.

RESULTS

Patient demographics, inpatient results and LN variables are shown in Tables 1 and 2. The median PSA level in the sPLND group was significantly higher (11.0 vs 8.0 ng/mL, $P = 0.001$) as the threshold for PLND in these patients (PSA level ≥10 ng/mL, ± Gleason score ≥8) was higher than for ePLND patients (intermediate- and high-risk disease). The greater proportion of patients with cT3 prostate cancer in the ePLND group (4.2% vs 9.9%, $P = 0.05$) relates to the acceptance of patients with locally advanced prostate cancer by the authors for LRP later in the series. By the time ePLND was introduced, operating on patients for cT3 disease was part of established practice. The groups were similar in age, body mass index, biopsy Gleason grade, prostate weight and proportion of cT1-2 cases.

The operative duration was significantly longer for ePLND cases by a median of 26.5 min (180 vs 206.5 min, $P < 0.001$). Blood loss, conversion rates and postoperative hospital stays were similar in the two groups. Although the transfusion rate was higher in ePLND patients (0.8% vs 2.5%) this was not statistically significant ($P = 0.27$).

The small bowel injury, which was not recognized at the time of LRP, occurred in a patient with a multiply operated abdomen (sigmoid colectomy with colostomy, closure of colostomy and two operations to repair a midline incisional hernia, the latter with mesh) and was caused by insertion of a port through the mesh and adherent small bowel. It was treated by open resection and anastomosis 24 h after RP, with no long-term sequelae, despite earlier abdominal wall sepsis requiring debridement. Both rectal injuries occurred in the early part of the series, were recognized during surgery, and were sutured in two layers with no sequelae. Both obturator nerve injuries recovered fully. Both ureteric injuries were managed laparoscopically, one by suture and stent insertion and the other by reimplantation and stent insertion, with no evidence of stenosis at 3 months. Two of the five symptomatic lymphoceles required laparoscopic fenestration due to re-filling after percutaneous aspiration and ongoing symptoms.

The mean LN count after ePLND was almost three times that of sPLND (6.1 vs 17.5, $P = 0.002$) and increased with experience, especially after dissection on both sides of the external iliac artery. The likelihood of LNI correlated with pathological Gleason grade up to Gleason 8. Thereafter no LN metastases were detected, possibly because there were few patients in each group (five and nine). For patients with biopsy Gleason 7 disease (0.8% vs 8.8%, $P = 0.01$), pathological Gleason 7 disease (0.8% vs 9.6%, $P = 0.01$) and who were in the intermediate-risk group (0.4% vs 5.1%, $P = 0.03$) the rate of detection of LN metastasis was significantly greater after ePLND. Clinical and pathological T stage correlated roughly with the likelihood of LNI (except for stage cT1, due to the detection of LNI in one patient) with significantly more patients with pT3b prostate cancer being found to have LNI after ePLND than after sPLND (4.0% vs 29.4%, $P = 0.02$). In LN-positive patients the median PSA level was 9.0 ng/mL.

DISCUSSION

Comparison between series of ePLND is confounded to some extent by the diligence with which pathologists at individual institutions search for LNs within the tissue they receive, but to a greater extent by a lack of standardization of the anatomical template from which nodal tissue is removed. For example, in a frequently cited paper on ePLND by Briganti *et al.* [1] the internal iliac nodes were only removed in 'some patients'. Conversely, in the series of Golimbu *et al.* [11], ePLND included the removal of presacral nodes, although removal of this group of LNs has failed to achieve widespread acceptance due to the greater technical difficulty involved and the resultant increase in complication rates. Mattei *et al.* [17] estimated that excision of LNs from the external and internal iliac plus the obturator locations will remove 65–70% of all primary lymphatic landing sites or 'sentinel' nodes, but that removal of nodes along the medial aspect of the common iliac arteries, within the aortic bifurcation and in the pre-aortic, inter-aortocaval and paracaval positions, is needed to remove 95% of primary landing sites. However, this template for PLND is even less likely to become standard because of the significantly greater operating time needed to accomplish this, the greater risk of complications, the lack of familiarity of this anatomy by most pelvic uro-oncologists, and the effectiveness of ADT (albeit temporarily finite) in treating metastatic prostate cancer. Most series of ePLND [2,5] include the removal of nodal tissue from within the obturator fossa and that located alongside the internal, and the external, iliac artery, as previous studies have reported that half of metastases are located alongside, and 25% of metastases are located *exclusively* alongside, the internal iliac artery [5,7,18–20].

The significantly longer operative duration, by 26.5 min, in the present series for ePLND than for sPLND is intuitively correct, as the procedure involves dissection of a greater volume of tissue, and confirms previous findings [5,15]. The similar operative duration reported by Briganti *et al.* [1] for the two variants of PLND is probably due to the removal of internal iliac LNs in only some patients in their series, as discussed above, in which the extent of the PLND was determined retrospectively by the number of LNs removed and not by the anatomical template used.

There were more complications after ePLND (8.3% vs 3.6%) but this difference was not statistically significant ($P = 0.10$). However, the nature of complications was different in ePLND, with fewer rectal injuries, more neurovascular and ureteric injuries, and a greater frequency of postoperative bleeding due to the greater extent of dissection, even though the intraoperative blood loss was the same for the two groups. The adoption of a transperitoneal laparoscopic approach for ePLND prevented the commonest reported complication of open PLND, i.e. symptomatic lymphocele, which occurs in up to 10% of cases [1] and which is three times more likely to follow ePLND than sPLND [13]. In this series there was a 'learning curve' for complications after ePLND, with most occurring in first half of the series. The learning curve in this series is likely to have been shortened by the common denominator of the one surgeon who operated on or supervised all cases, in contrast to the series of Briganti *et al.* [1], which included seven operating surgeons and a complication rate double that for sPLND (19.8% vs 8.2%) [1]. The results seen in the present series compare favourably with those reported by Musch *et al.* [21] in 1380 patients having open RP, in which 69% of cases had a sPLND and 31% had ePLND, with ureteric injury in 0.4%, obturator nerve injury in 0.1%, DVT/pulmonary embolism in 1.7%, and overall in 6.5%. The re-intervention rate in the series of Musch *et al.* was 6.3%, half of which was for lymphocele formation. However, complication rates are not directly comparable between all series, as most report all complications [1,13] but some report only complications thought to be directly related to PLND (ureteric, vascular and nerve injuries of the pelvic side-wall, significant lymphoceles and thromboembolic events) [21]. Inevitably, complication rates will also influence length of hospital stay [1], which thus becomes another means of assessing surgical quality, and which was similar between the two groups of patients in the present series.

As seen in other series, the node count in the present series was significantly higher for ePLND, at 17.5 vs 6.1 ($P = 0.002$), most of which are likely to have come from the internal iliac group, and others from dissection on both sides of the external iliac artery. Notwithstanding the limitations of comparing node counts between series listed above, the node count in the present series might have been lower than in other series, e.g. 28 for ePLND and 11 for sPLND [5,19] in which nodal tissue was sent as separate packages, as this is known to increase the LN count [22], i.e. the reported number of LNs does not necessarily reflect the actual number of LNs removed. However, the node yield certainly compared favourably with other series, e.g. that of Allaf *et al.* [12], in which the counts for sPLND and ePLND were 8.9 and 11.6, respectively. Briganti *et al.* [23] previously reported that node harvest and positivity at ePLND is related to previous surgical experience, but the natural variability of pelvic LN count of 8–56 (mean 20) seen by Weingartner *et al.* [24] in post mortem studies precludes setting a limit as a benchmark for surgical adequacy.

Table 2 shows a more than 10 times greater rate of detection of LNI in patients with both clinical (8.8% vs 0.8%, $P = 0.01$) and pathological (9.6% vs 0.8%, $P = 0.01$) Gleason grade 7 tumours after ePLND than sPLND, which leads to the inevitable conclusion that sPLND is substandard treatment for men with tumours of this grade, given the improved survival in node-positive patients treated with ADT reported by Messing *et al.* [6], and the prognostic information provided by knowing the number of involved nodes [3,7–9]. Knowledge of the components of the Gleason sum did not appear to be helpful in deciding which men with Gleason sum 7 disease could be spared ePLND, as the rate of LNI was similar for patients with biopsy Gleason 3 + 4 ($P = 0.14$) and 4 + 3 ($P = 0.09$). The >10 times greater detection rate of LNI for men with Gleason 7 disease is mirrored by the increased detection rate of LNI of men in the intermediate-risk group, of 5.1% vs 0.4% ($P = 0.03$). These findings lend considerable support to the notion that Gleason 7 prostate cancer is biologically much more aggressive than grades 5 and 6, and should probably not be grouped together with them in the moderately differentiated group. Whilst Table 2 also appears to provide evidence that omitting PLND in patients with Gleason grade ≤7 is safe, the upgrading of ≥30% of biopsy Gleason grade 6 seen in this and other series questions the safety of this approach. This upgrading also acts as to confound the recent nomograms produced using ePLND data [18]. Furthermore, although the omission of PLND in patients with a PSA level of <10 ng/mL, Gleason score <6 and ≤T2a prostate cancer has gained widespread acceptance, as the Partin tables predict a probability of LNI of <5% [25–27] in this group, Burkhart (cited in [4]) found LNI in 12% of patients with a PSA level of <10 ng/mL having ePLND for prostate cancer, and in 10% of patients when the PSA level was <4 ng/mL. Heidenreich *et al.* [28]

estimated a 20–25% probability of detecting occult microscopic LN metastases in intermediate-risk patients by ePLND, and a 30–40% probability in high-risk patients, with a reduction in prostate cancer-specific mortality of 23% if LNs are positive and 15% if LNs are negative, based on recent case-controlled studies.

The inclusion of only two minimal-access RP series on ePLND for prostate cancer lends further weight to the concern of Wagner *et al.* [29], that in this arena, oncological principles might be sacrificed in the interests of expediency, possibly because the operator has come from a background of upper tract laparoscopy rather than one of pelvic uro-oncology. In the robot-assisted series of Feicke *et al.* [30], in which the external iliac vessels were routinely separated to gain greater access to the obturator fossa, a similar node count was reported to that in the present series, in which there was no dissection between the iliac vessels, and in which the mean blood loss was 300 mL less. In the series of Touijer *et al.* [31], of 648 men having PLND during LRP, the use of ePLND increased the LN count from 9 to 14, and node positivity from 4.1% to 15.4%. In that feasibility study no operating times or complications were reported.

Limitations of the present study include that it was a consecutive series and not randomized, which exposes it to the risk of cohort and selection biases. The short follow-up in the ePLND groups does not permit comparison of functional results with patients who have had sPLND.

In conclusion, ePLND significantly increased the operating time ($P < 0.001$) but tripled the LN count ($P = 0.002$) and increased by more than 10 times the rate of detection of LNI in patients with clinical and pathological Gleason 7 prostate cancer, and in men in the intermediate-risk group. Furthermore, case-controlled studies [28] suggest that all patients with intermediate- and high-risk prostate cancer stand to benefit from ePLND by a reduction of prostate cancer-specific mortality of 23% if LNs are positive and 15% if they are negative.

Based on these findings we concur with the recommendation of Briganti *et al.* [32], that PLND should be performed in all intermediate- and high-risk patients with prostate cancer undergoing RP, and that ePLND should replace sPLND. As ePLND is technically more challenging than sPLND [13] it should be embraced with caution by surgeons inexperienced in RP.

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CONFLICT OF INTEREST

Covidien provides a salary for Avanish Arora and Paul Rouse.

REFERENCES

1. **Briganti A, Chun FK-H, 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
2. **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
3. **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
4. **Walsh PC.** Anatomic radical retropubic prostatectomy. In Walsh PC, Retik AB, Vaughan ED Jr, Wein AJ eds, *Campbell's Urology*, 7th edn. Vol. III, Chapt 86. Philadelphia: WB Saunders, 1997: 2565–88
5. **Heidenreich A, Varga Z, Von Knobloch R.** Extended pelvic lymphadenectomy in patients undergoing radical prostatectomy: high incidence of lymph node metastasis. *J Urol* 2001; **167**: 1681–7
6. **Messing EM, Manola J, Yao J *et al.*** Eastern Cooperative Oncology Group study EST 3886. Immediate versus deferred androgen deptivation treatment in patients with node-positive prostate cancer after radical prostatectomy and pelvic lymphadenectomy. *Lancet Oncol* 2006; **7**: 472–9
7. **Bader P, Burkhard FC, Markwalder R, Studer UE.** Disease progression and survival of patients with positive lymph nodes afer radical prostatectomy. Is there a chance of cure? *J Urol* 2003; **169**: 849–54
8. **Daneshmand S, Quek ML, Stein JP *et al.*** Prognosis of patients with lymph node positive prostate cancer following radical prostatectomy: long-term results. *J Urol* 2004; **172**: 2252–5
9. **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**: 864–71
10. **Masterson TA, Bianco F Jr, Vickers AJ *et al.*** The association between total and positive lymph node counts and disease progression in clinically localized prostate cancer. *J Urol* 2006; **175**: 1320–5
11. **Golimbu M, Morales P, Al-Askari S, Brown J.** Extended pelvic lymphadenectomy for prostate cancer. *J Urol* 1979; **121**: 617–20
12. **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
13. **Clark T, Parekh DJ, Cookson MS *et al.*** Randomised prospective evaluation of extended versus limited lymph node dissection in patients with clinically localized prostate cancer. *J Urol* 2003; **169**: 145–7
14. **D'Amico AV, Whittington R, Malkowicz SB *et al.*** Biochemical outcome after radical prostatectomy, external beam radiation therapy, or interstitial radiation therapy for clinically localized prostate cancer. *JAMA* 1998; **280**: 969–74
15. **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
16. **Eden CG, King D, Kooiman GG, Adams TH, Sullivan ME, Vass JA.** Transperitoneal or extraperitoneal laparoscopic radical prostatectomy: does the approach matter? *J Urol* 2004; **172**: 2218–23
17. **Mattei A, Fuechsel F, Warncke S, Z'brun S, Krause T, Studer UE.** Number of sentinel lymph nodes (SLN) of the prostate localised outside the areas of 'limited' versus 'extended' pelvic lymph node dissection. *Eur Urol Suppl* 2006; **5**: 176, Abstract 614

18 **Briganti A, Chun FK, Salonia A *et al.*** Validation of a nomogram predicting the probability of lymph node invasion among patients undergoing radical prostatectomy and an extended pelvic lymphadenectomy. *Eur Urol* 2006; **49**: 1019–27

19 **Heidenreich A, Von Knobloch R, Varga Z, Hofmann R.** Extended pelvic lymphadenectomy in men undergoing radical retropubic prostatectomy – data on >300 cases. *Proc ASCO* 2005; **22**: 409s, Abstract 4612

20 **Wawroschek F, Vogt H, Wengenmair H *et al.*** Prostate lymphoscintigraphy and radio-guided surgery for sentinel lymph node identification in prostate cancer. *Urol Int* 2003; **70**: 303–10

21 **Musch M, Klevecka V, Roggenbuck U, Kroepfl D.** Complications of pelvic lymphadenectomy in 1,380 patients undergoing radical retropubic prostatectomy between 1993 and 2006. *J Urol* 2008; **179**: 923–9

22 **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**: 876–82

23 **Briganti A, Capitano U, Chun FK-H *et al.*** Impact of surgical volume on the rate of lymph node metastases in patients undergoing radical prostatectomy and extended pelvic lymph node dissection for clinically localized prostate cancer. *Eur Urol* 2008; **54**: 794–804

24 **Weingartner K, Ramaswamy A, Bittinger A, Gerharz EW, Voge D, Reidmiller 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

25 **Crawford ED, Batuello JT, Snow P *et al.*** The use of artificial intelligence technology to predict lymph node spread in men with clinically localized prostate cancer. *Cancer* 2000; **88**: 2105–9

26 **Batuello JT, Gamito EJ, Crawford ED *et al.*** Artificial neural network model for the assessment of lymph node spread in patients with clinically localized prostate cancer. *Urology* 2001; **57**: 481–5

27 **Partin AW, Kattan MW, Subing ENP *et al.*** Combination of prostate-specific antigen, clinical stage and Gleason sum to predict pathological stage of localized prostate cancer: a multi-institutional update. *JAMA* 1997; **277**: 1445–51

28 **Heidenreich A, Ohlmann CH, Polyakov S.** Anatomical extent of pelvic lymphadenectomy in patients undergoing radical prostatectomy. *Eur Urol* 2007; **52**: 29–37

29 **Wagner M, Sokoloff M, Daneshmand S.** The role of pelvic lymphadenectomy for prostate cancer – therapeutic? *J Urol* 2008; **179**: 408–13

30 **Feicke A, Baumgartner M, Talimi S *et al.*** Robotic-assisted laparoscopic extended pelvic lymph node dissection for prostate cancer: surgical technique and experience with the first 99 cases. *Eur Urol* 2009; **55**: 876–84

31 **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

32 **Briganti A, Blute ML, Eastham JH *et al.*** Pelvic lymph node dissection in prostate cancer. *Eur Urol* 2009; **55**: 1251–65

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Abbreviations: **(e)(s)P(LN)D**, (extended) (standard) pelvic (lymph node) dissection; **(L)RP**, (laparoscopic) radical prostatectomy; **LNI**, LN involvement; **ADT**, androgen-deprivation therapy; **DVT**, deep vein thrombosis.