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Original Article

Robot-Assisted Radical Prostatectomy: Modified Ultradissection Reduces pT2 Positive Surgical Margins on the Bladder Neck

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The purpose of this study was to compare the positive surgical margin (PSM) rates of 2 techniques of robot-assisted radical prostatectomy (RARP) for pT2 (localized) prostate cancer. A retrospective analysis was conducted of 361 RARP cases, performed from May 2005 to September 2008 by a single surgeon (KHR) at our institution (Yonsei University College of Medicine). In the conventional technique, the bladder neck was transected first. In the modified ultradissection, the lateral border of the bladder neck was dissected and then the bladder neck was transected while the detrusor muscle of the bladder was well visualized. Perioperative characteristics and outcomes and PSM rates were analyzed retrospectively for pT2 patients (n = 217), focusing on a comparison of those undergoing conventional (n = 113) and modified ultradissection (n = 104) techniques. There was no difference between the conventional and modified ultradissection group in mean age, BMI, PSA, prostate volume, biopsy Gleason score, and D'Amico prognostic criteria distributions. The mean operative time was shorter ($p < 0.001$) and the estimated blood loss was less ($p < 0.01$) in the modified ultradissection group. The PSM rate for the bladder neck was significantly reduced by modified ultradissection, from 6.2% to 0% ($p < 0.05$). In conclusion, modified ultradissection reduces the PSM rate for the bladder neck.

Key words: robot-assisted radical prostatectomy, prostate cancer, surgery, surgical margin, technique

Prostate cancer is the second most common cancer in men worldwide. Localized disease is often managed with radical prostatectomy. The main objective of radical prostatectomy (RP) is complete tumor resection with negative margins. A positive surgical margin (PSM) following RP is a significant risk factor for recurrence and correlates with decreased cancer-specific and overall survival [1–4]. Radical prostatectomy, when first introduced, was associated with considerable perioperative morbidity, including blood loss and thromboembolic events. The adverse sequelae have, however, been reduced with the introduction of less invasive techniques.

Though the outcomes of laparoscopic and open radical prostatectomy are similar [5], a significant barrier to the widespread implementation of laparoscopic RP is the technical difficulty associated with the laparoscopic suturing of the urethrovesical anastomosis. Additionally, laparoscopic radical prostatectomy (LRP) has been criticized for a high incidence of PSM [6].

Robot-assisted radical prostatectomy (RARP)

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employing the da Vinci Surgical System (Intuitive Surgical, Sunnyvale, CA, USA) was first introduced in 2000 [7]. The da Vinci system is a master-slave robot that incorporates three-dimensional visualization, movement scaling and fully articulated wristed instrumentation. These factors allow all surgeons, even those with limited laparoscopic experience, to perform complex dissections and suturing. Despite these improvements, RARP is also associated with a higher rate of PSM than the open technique.

The most commonly reported sites for PSM in both the open [1] and laparoscopic approaches [2, 8-10] are the apex, the posterolateral surface of the prostate, and the bladder neck (6-69%, 6-54%, 10-30% respectively). The antegrade approach used for LRP/RARP poses a challenge for bladder neck dissection [11] and likely contributes to the higher PSM rate reported for LRP/RARP compared to open surgery [9, 10]. Comparison of PSM rates across studies is difficult given the variation in patient demographics and clinicopathologic variables among the series; however, rates of PSM in organ-confined disease may be compared because PSMs are largely preventable in patients with organ-confined disease.

The da Vinci system was introduced to our practice in July 2005. Since then, we have performed over 400 cases of RARP. This is the largest Asian series by a single surgeon (KHR) at a single institution. The initial cases were performed using the classic Vattikuti Institute prostatectomy technique [11]. However, bladder neck dissection with this technique is difficult in cases with large median lobes or a previous transurethral resection of the prostate (TURP). We subsequently modified this technique and optimized it for the robotic system. In this report, we detail our current technique and compare our results for pT2 disease using the 2 methods.

Materials and Methods

Patient selection. Between July 2005 and September 2008, RARP was performed in 361 patients at our institution. Case details and outcomes were retrospectively analyzed. We first implemented our modified technique with case 193 in November 2007. The first 361 consecutive RARP cases can therefore be divided into 2 groups: group 1, cases 1 to 192; and group 2, cases 193 to 361. Among them, only pT2 disease patients (217 cases) were included in this analysis (113 conventional cases, 104 modified ultradissection cases). Yonsei University Severance Hospital institutional review board approval was obtained for this study. Patients provided written consent for participation in the study at admission, before surgery.

Conventional technique. Our initial cases were performed using the Vattikuti Institute prostatectomy technique [11]. Briefly, the endopelvic fascia was incised, the prostatic apex was mobilized, and the dorsal vein complex (DVC) was secured. The bladder neck was then circumferentially incised, exposing and transecting the vasa. The seminal vesicles were skeletonized and transected. A posterior dissection was performed, preserving the neurovascular bundles (NVBs) in selected cases. The apex was then transected and the vesico-urethral anastomosis formed with two continuous sutures. The precise identification of the bladder neck in this technique is difficult, which may contribute to the increased risk of PSM [11].

Ultradissection technique. We modified the conventional technique to dissect out and identify the bladder neck more precisely. After developing the extraperitoneal space, the fat overlying the puboprostatic ligaments was removed. Prior to incising the endopelvic fascia or ligating the DVC, the lens was switched to 30° for the bladder neck dissection. Ultradissection of the bladder neck as described by Gaston *et al.* [12, 13] was performed in a modified manner. This technique is described in detail in our previous paper [14]. Briefly, the detrusor muscle fibers were identified and the lateral border of the bladder neck separated until the dissection reached the surface of the seminal vesicle (Fig. 1). Unlike the original method described by Gaston's group, the seminal vesicle was not dissected further. Following bilateral dissection of the bladder neck, the detrusor muscle was well visualized. Then, the bladder neck was transected. This technique allows bladder neck preservation even for a prostate with a large median lobe or a previous TURP. Following the bladder neck transection, the remainder of the procedure is similar to the conventional technique.

Pathologic examination. All specimens were inked and sectioned in a standard manner. The base was shaved and submitted in 2 to 4 cassettes. The

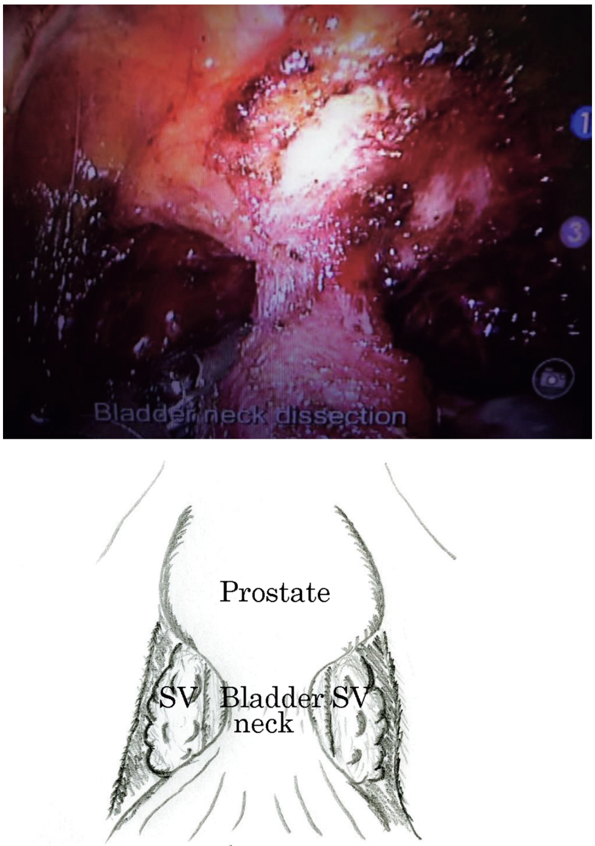

Fig. 1 Bladder neck dissection. The picture shows a well-preserved bladder neck. The detrusor muscle fibers are identified and the lateral border of the bladder neck is exposed down to the seminal vesicles. Following bilateral dissection of the bladder neck, the bladder neck is transected. SV, seminal vesicle.

apex was also shaved perpendicular to the axis of the urethra and sliced radially into 5 to 8 segments. The remaining prostate and seminal vesicles were serially sectioned in the transverse plane at 3- to 5- mm intervals. A PSM was defined according to a standard protocol, which is the presence of the tumor at the resection margin. All specimens were reviewed by one pathologist. In PSM cases, the location and the amount of cancer involvement were mapped and determined according to the method of Eichelberger and associates [15]. All carcinomas were graded using the Gleason system and staged using the 2002 TNM system.

Statistical analysis. Descriptive results were reported for all studied parameters. The chi-square test was used to compare the number of positive and negative surgical margins in each group and the risk profiles for surgical margin positivity among the 2 groups. The chi-square test was also used to test the homogeneity of the Gleason score, the clinical stage and the pathologic stages of the 2 groups. Student's *t*-test was used to compare the mean age, BMI, PSA, prostate volume, biopsy Gleason score, operative time, and estimated blood loss (EBL) for the 2 groups. All statistical analysis tests were performed with Statistical Analysis Software 9.1 (SAS Institute, Cary, NC, USA).

Results

Mean follow-up times were 22.3 ± 9.9 (conventional) and 11.5 ± 5.1 (modified ultradissection) months. Clinical characteristics were similar between the groups (Table 1). There was no difference between the conventional and modified ultradissection groups with respect to the mean age (62.4 and 63.0 years, $p = 0.56$), BMI (24.6 and 24.1 kg/M^2, $p = 0.17$), PSA (8.3 and 8.2, $p = 0.89$), prostate volume (37.0 and 38.0, $p = 0.70$) or biopsy Gleason score (6.2 and 6.5, $p = 0.06$). The D'Amico prognostic criteria [16] distributions were similar. We also analyzed the risk

Table 1 Patient characteristics (pT2)

		Conventional	Modified ultradissection	*p*-value
Follow up (mos)		22.3 ± 9.9	11.5 ± 5.1	
Age (yr)		62.4 ± 8.2	63.0 ± 7.6	0.56
BMI (kg/m^2)		24.6 ± 2.6	24.1 ± 2.4	0.17
PSA (ng/mL)		8.3 ± 4.3	8.2 ± 4.8	0.89
Prostate Volume (cm^3)		37.0 ± 18.0	38.0 ± 18.0	0.70
Biopsy Gleason Score		6.2 ± 0.9	6.5 ± 0.8	0.06
D'amico criteria	N (%)			
low risk		43 (38.1)	36 (34.6)	0.60
Intermediate risk		49 (43.4)	45 (43.3)	0.99
High risk		21 (18.6)	23 (22.1)	0.52
Risk profile for PSM	N (%)			
Low-risk profile*		47 (41.6)	45 (43.3)	0.80
High-risk profile†		66 (58.4)	59 (56.7)	0.80
Nerve sparing	N (%)	109 (96)	94 (90)	0.07
N		113	104	

Data are presented as means ± standard deviations or numbers of patients with percentages in parentheses.
PSM (positive surgical margin)
*PSA < 10 ng/mL, Gleason score < 8, and 2 cores involved.
†PSA ≥ 10 ng/mL, Gleason score 8-10, or ≥ 3 cores involved.

of PSM according to the risk profile described by Wieder and Soloway (Table 1) [1], and found no difference between the 2 groups. Table 2 compares the pathologic and margin results in detail. The rate of PSM on the bladder neck was significantly reduced, from 6.2% to 0 ($p < 0.05$), by the modified ultradissection. There was no change in the rate of PSM in the other areas. The overall rate of PSM in the modified ultradissection group was reduced; however, the difference was not statistically significant (16.8 and 13.5%, $p = 0.49$). The PSA data need to be followed. Table 3 compares intraoperative and postoperative data and complications. The mean operating time was shorter (218 and 195min, $p < 0.001$) and the mean estimated blood loss was less (381 and 282cc,

Table 2 Pathologic features after RARP

	Conventional	Modified ultradissection	*p*-value
Gleason Score	6.4 ± 0.8	6.6 ± 0.8	0.11
Positive surgical margins (%)	19 (16.8)	14 (13.5)	0.49
apex	12 (10.6)	12 (11.5)	0.84
lateral	1 (0.9)	3 (2.9)	0.27
base	2 (1.8)	1 (1.0)	1.000
bladder neck	7 (6.2)	0	<0.05
(Multiple sites)	3 (2.7)	2 (1.9)	1.000
N	113	104	

Data are presented as means ± standard deviations or numbers of patients with percentages in parentheses. The rate of positive surgical margin on the bladder neck was significantly reduced by modified ultradissection ($p < 0.05$).

Table 3 Intraoperative and postoperative data and complications

	Conventional	Modified ultradissection	*p*-value
Mean operative time (min)	218±49	195±38	<0.001
Mean blood loss (mL)	381±341	282±198	<0.01
Mean duration of catheter (d)	12.9±4.6	8.9±1.8	<0.0001
Mean hospital stay (d)	5.7±3.6	4.4±2.1	<0.01
Intraoperative complication			
Rectal injury	1 (0.9)	2 (1.9)	0.61
Small bowel injury	0	1 (1.0)	0.48
Overall complications	22 (19.5)	16 (15.4)	0.54
***Medical complications**			
Deep vein thrombosis	0	0	NA
Pulmonary embolism	0	0	NA
Pneumonia	0	1 (1.0)	0.48
Other cardiopulmonary diseases	0	0	NA
Urinary tract infection	8 (7.1)	4 (3.8)	0.38
Orchiepididymitis	0	0	NA
Septicemia	0	0	NA
Duodenal ulcer	0	0	NA
Postoperative ileus	6 (5.3)	11 (10.6)	0.21
***Surgical complications**			
Conversion to open surgery	0	0	NA
Wound infection or hematoma	0	0	NA
Scar hernia	0	0	NA
Rectourethral fistula	0	0	NA
Hemorrhage	0	0	NA
Ureteral section	0	0	NA
Lymphocele	7 (6.2)	0	**0.02**
Urinary leakage (reintervention)	0	0	NA
Anastomotic stricture	1 (0.9)	0	1.000
N	113	104	

Data are presented as means ± standard deviations or numbers of patients with percentages in parentheses. The overall complication rates were similar fot the conventional and ultradissection groups: 22 (19.5%) vs. 16 (15.4%), $p = 0.54$. The overall rates of medical complications were also similar: 14 (12.4%) vs. 16 (15.4%). $p = 0.66$.

$p < 0.01$) in the modified ultradissection group (Table 3). The mean duration of catheter use (12.9 vs. 8.9 days, $p < 0.0001$) and the length of hospital stay (5.7 vs. 4.4 days, $p < 0.01$) were shorter in the modified ultradissection group. The overall complication rates were similar for the conventional and ultradissection groups: Clavien grade I-II complication, 18.6 and 15.4%, respectively ($p = 0.53$); Clavien grade III-V, 0.9 and 1.9%, respectively ($p = 0.52$). The incidences of rectal and small bowel injury were 1 (0.9%) vs. 2 (1.9%), $p = 0.61$ and 0 vs. 1 (1.0%), $p = 0.48$, respectively. The overall rates of medical complications were similar: 14 (12.4%) vs. 16 (15.4%), $p = 0.66$. Most complications were minor, with the same pattern of occurrence in the 2 groups: urinary tract infection (UTI), 8 (7.1%) vs. 4 (3.8%), $p = 0.38$; ileus, 6 (5.3%) vs. 11 (10.6%), $p = 0.21$; pneumonia, 0 vs. 1 (1.0%), $p = 0.48$; and anastomotic stricture, 1 (0.9%) vs. 0, $p = 1.0$. The incidence of lymphoceles was significantly lower in the modified ultradissection group: 7 (6.2%) vs. 0, $p = 0.02$. These results are listed in Table 3.

Discussion

The primary objective of radical prostatectomy is the complete surgical resection of the cancerous tumor. A PSM is an independent risk factor for recurrence after radical prostatectomy [17-19]. The incidence of PSM in previously reported open prostatectomy series varied from 16% to 46% [18]. Its incidence in laparoscopic series has been 16-26% [10, 20-22]. In the reported series for RARP, the overall PSM rate has varied between 6% and 35.5% [23, 24]. Variations in clinicopathologic characteristics across techniques make direct comparisons difficult. PSM occurs either as the result of inadvertent entry into the prostate (iatrogenic) or by cutting across an extraprostatic tumor that extends beyond the limits of resection (non-iatrogenic) [25]. PSM in patients with organ-confined disease (Stage pT2), therefore, is largely preventable.

In our series, the rate of PSM at the bladder neck decreased significantly, from 6.2 to 0%, with the implementation of modified ultradissection. Our initial cases were performed using the classic Vattikuti Institute prostatectomy technique (conventional technique) [11], which complicates the identification of the true bladder neck [11]. The dissection along the median border of the bladder neck is technically difficult in cases with a large median lobe or a history of a prior TURP since the urethra is deviated from the midline. A large median lobe also increases the operative time for the RARP due to the increased time required for posterior bladder neck and seminal vesicle dissection [26]. Finally, patients with larger prostates have significantly more blood loss (175 vs. 226 mL).

Modified ultradissection required a significantly shorter operative time (195 vs. 218 min, $p < 0.001$) and resulted in less blood loss (282 vs. 381 cc, $p < 0.01$) than the conventional technique. These improvements may be the result of not only the procedural improvements but also increased familiarity with the procedure and robotic system, as all ultradissection cases were performed after the conventional cases.

Clavien grades of complications did not differ statistically between the 2 groups. When we analyzed complications in detail, the only difference was the reduction in the incidence of lymphoceles in the ultradissection group (0 vs. 7 (6.2%), $p = 0.02$). All were treated conservatively. The reason for the reduced rate of lymphoceles in the modified ultradissection is not clear. The use of lymphadenectomy in the ultradissection group was more extensive than that of the conventional group. It was performed bilaterally in the external iliac, obturator and infraobturator beds. Fatty tissue and lymph nodes medial to the genitofemoral nerve from the iliac bifurcation to the inguinal ring were also removed. Symptoms vary depending on the size, site, and presence of infection. Significant lymphoceles can cause pelvic pain, voiding difficulty, leg edema, deep venous thrombosis, and hydronephrosis. Infected lymphoceles are often associated with febrile morbidity. The incidence of symptomatic lymphoceles in an endoscopic extraperitoneal radical prostatectomy series was 2.5% ($n = 45$). In previous reports of LRP and RRP, the incidence of lymphoceles has ranged from 0 to 11% [27-31]. The incidence in the present study is within that range.

The main strength of this study is that it minimizes the degree of variation of various clinical and pathologic parameters. We retrospectively selected only pT2 disease in our series and analyzed the rate of PSM for each of the 2 techniques. Patient characteristics were also similar for the 2 groups. The risk profiles for PSM as described by Wieder and Soloway were similar for the 2 groups [1]. Finally, the rate of nerve sparing was also similar (96% vs. 90%, $p = 0.07$, Table 1).

The present study has several limitations. The data were collected retrospectively. All surgery was performed by a single surgeon. Thus, these results may not have general applicability or reproducibility. Additionally, the surgeon's gain in experience over time likely contributed to the decrease in PSM rate; however, the decrease was greater than what would be expected from experience alone, given that the learning curve for this procedure is typically associated with mastery at 50 cases [32]. Therefore, while the findings of this study are promising, they await confirmation in a prospective randomized trial.

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