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[Original Article]

Short-term Outcomes of Robotic Lateral Pelvic Lymph Node Dissection for Lower Rectal Cancer

Wataru Sakamoto, Satoshi Fukai, Takahiro Sato, Misato Ito, Takuro Matsumoto, Mai Ashizawa, Shun Chida, Hisashi Onozawa, Hirokazu Okayama, Hisahito Endo, Motonobu Saito, Zenichiro Saze, Tomoyuki Momma and Koji Kono

Department of Gastrointestinal Tract Surgery, School of Medicine Fukushima Medical University, Fukushima City, Fukushima, Japan

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Abstract

Introduction : Rectal cancer is among the main causes of cancer-related mortalities worldwide, necessitating more effective treatment strategies. It is considered that lateral pelvic lymph node dissection (LPND) for rectal cancer patients can contribute to local tumor control and that robotic LPND (Rob-LPND) may be more suitable for LPND, due to technical advantages of precise manipulation in a narrow pelvic space.

Methods : In this retrospective study, we evaluated the short-term outcomes of laparoscopic-LPND (Lap-LPND) versus Rob-LPND in patients undergoing radical surgery for rectal cancer. Operative time, blood loss, urethral catheter reinsertion, duration of pelvic drainage tube placement, drainage volume, and postoperative hospital stay were compared between Lap-LPND and Rob-LPND.

Results : Our findings revealed that Rob-LPND was associated with longer total operation time, but there was no significant difference in operation time between the two LPND techniques. Urinary catheter re-insertion rates were lower in Rob-LPND ; also, significant reductions in drainage tube duration, total drainage volume, and postoperative hospital stay were observed.

Conclusion : Rob-LPND may reduce postoperative total drainage volume and shorten postoperative hospital stays. These improvement in short-term outcomes suggest potential clinical advantages of Rob-LPND.

Key words : rectal cancer, robotic-assisted surgery, lateral pelvic lymph node dissection

Introduction

Rectal cancer is one of the leading causes of cancer mortality worldwide[1), for which treatment to improve outcomes is demanding. Radical resection, with total mesorectal excision (TME) / tumor-specific mesorectal excision (TSME), is generally accepted to be first-line treatment for resectable rectal cancer in Japan[2)]. TME/TSME surgery for rectal cancer is challenging, due to a narrow pelvic operating field and the need to preserve autonomic nerve function and mesorectal fascia integrity. In Japan, lateral pelvic lymph node dissection (LPND) is recommended for rectal cancers with distal margins beyond the peritoneal reflection and depth beyond the propria muscle[2)], making surgery even more difficult. In the late 19th century, Gerota *et al.* revealed the presence of lateral lymphatic flow in the distal rectum toward the pelvic wall[3)]. From the 1980s, LPND was developed and established mainly in Japan[4,5)] where a local recurrence rate of less than 10% was achieved, ahead of Western countries. However, the initial LPND technique was reported to cause a high incidence of postopera-

Corresponding author : Wataru Sakamoto. E-mail : ws1024@fmu.ac.jp

tive sexual and urinary dysfunction, prompting the development of autonomic nerve-preserving LPND techniques[6,7]. Currently, autonomic nerve-preserving LPND is widely accepted as one of the standardized surgical procedures for lower rectal cancer, mainly in East Asia. Regarding oncological outcome of autonomic nerve-preserving LPND, JCOG0212[8], a Japanese nation-wide randomized controlled trial, demonstrated a high rate of local control, although it failed to demonstrate any survival benefit. Therefore, the clinical efficacy of autonomic nerve-preserving LPND is not yet fully accepted worldwide. Furthermore, a long-recognized Western standard of care to control local tumor growth has been preoperative chemoradiotherapy (CRT). However, local tumor control was reported to be not completely achieved by preoperative CRT, and evidence is accumulating in support of LPND, even in the West, especially in cases where lateral lymph node metastases are already present prior to the initial treatment[9,10].

LPND started as an open technique, and, as surgery has evolved, it has shifted to a laparoscopic approach[11,12]. As compared to open LPND, laparoscopic-LPND (Lap-LPND) is associated with longer operative time, but less blood loss, with comparable degrees of postoperative complications. The first robotic LPND (Rob-LPND) was reported in 2012[13], with a belief emerging that Rob-LPND offers more precise manipulation in a narrow pelvis, since robot-assisted techniques can provide a stable and magnified view, with multidirectional articulation functions, motion scale, and elimination of tremor. There is still limited information to support Rob-LPND, mainly in East Asia[14-17], where it is at least comparable to Lap-LPND in short-term outcomes. Our hospital began Rob-LPND in 2021, from which we herein report its short-term outcomes in comparison with those of Lap-LPND.

Materials and Methods

Patients/surgery

All patients at Fukushima Medical University who underwent radical surgery for rectal cancer with bilateral Lap-LPND or Rob-LPND between January 2017 and April 2023 were enrolled in this retrospective, observational study. Lap-LPND was performed from January 2017 through March 2021, and Rob-LPND was performed from April 2021 to April 2023, in accord with our evolving standards of care. LPND was carried out if the distant margin of rectal cancer was deeper than the muscularis propria and/or below the peritoneal reflection, as recommended by Japanese Society for Cancer of the Colon and Rectum (JSCCR) guidelines for the treatment of colorectal cancer[18,19].

Patients with TNM staging of T3N0M0/T3N1M0 (per the 9th Japanese classification of colorectal, appendiceal, and anal carcinomas) had neoadjuvant chemotherapy (NAC). The NAC regimen was 4 cycles of CAPOX (oxaliplatin 130 mg/m^2 i.v. day 1, capecitabine 825 mg/m^2 p.o. days 1-15, every 21 days).

Patients with TNM stage T4b/T4 (circumferential resection margins <1 mm) and/or any N2-3 had total neoadjuvant chemotherapy (TNT), consisting of 5 cycles CAPOX as induction chemotherapy, followed by chemoradiation therapy (CRT) (1.8 Gy × 28 Fr, total 50.4 Gy, with 80 mg/m^2 of tegafur gimeracil oteracil potassium p.o.). The interval to surgery was 6 to 10 weeks after completion of CRT.

LPND was performed after completion of TME/TSME as part of a low anterior resection or abdominoperineal resection. Autonomic nerve preserving Lap-LPND/Rob-LPND procedures were as follows. 1 : Identification of ureto-hypogastric fascia, preservation of the ureter, hypogastric nerve, and pelvic nerve plexus. 2 : Identification and preservation of vesico-hypogastric fascia, including internal iliac artery and veins, and their branches. If the arteries or veins were involved by metastatic lymph nodes, the vessels were dissected with the lymph nodes. 3 : Identification and preservation of external iliac veins, the fascia of internal obturator muscle, and the obturator nerve. The obturator artery and veins are ligated at their origins and obturator foramen, then resected. 4 : Finally, dorsal attachment of fat tissue containing lymph nodes to pelvic wall is cut and sealed by electric sealing devices : ultrasonic scissors (Harmonic®) in Lap-LPND or an advanced bipolar sealing device (Vessel Sealer®) in Rob-LPND. Internal iliac lymph node and obturator lymph node compartments are dissected *en bloc*. 5 : Place a multi-channel silicon drain (6.5 mm in diameter) at the pelvic floor, with confirmation that all dissected areas are connected as one space. Typical post-Lap-LPND/Rob-LPND views are shown in Fig. 1 and Fig. 2, respectively.

Diverting ileostomy was made in cases where the distant margin of rectal cancer was within 5 cm from the oral margin of the surgical anal canal and the patient was male.

All operations in this study were done by surgeons with endoscopic surgical skills credentialled

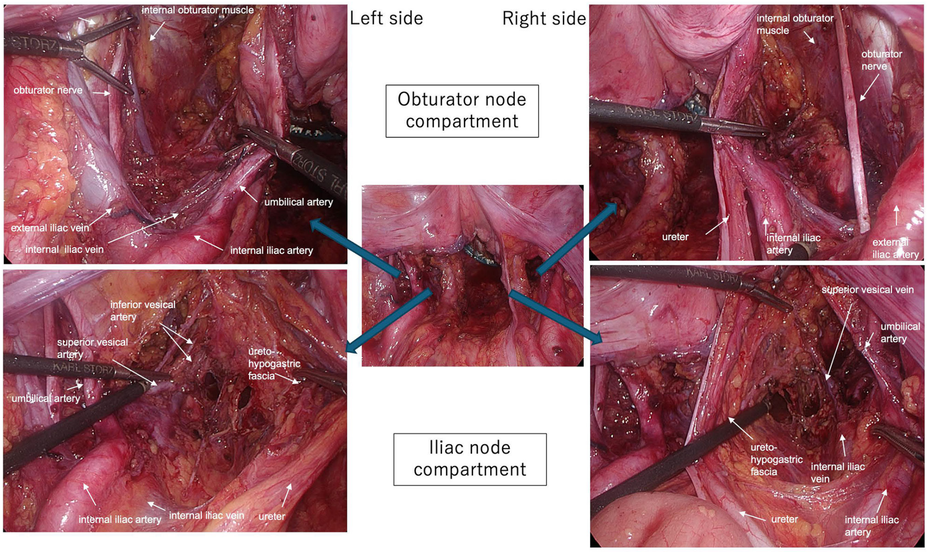

Fig. 1. Post operative view of autonomic nerve-preserving bilateral lateral pelvic lymph node dissection by laparoscopic approach (Lap-LPND) in a male patient.

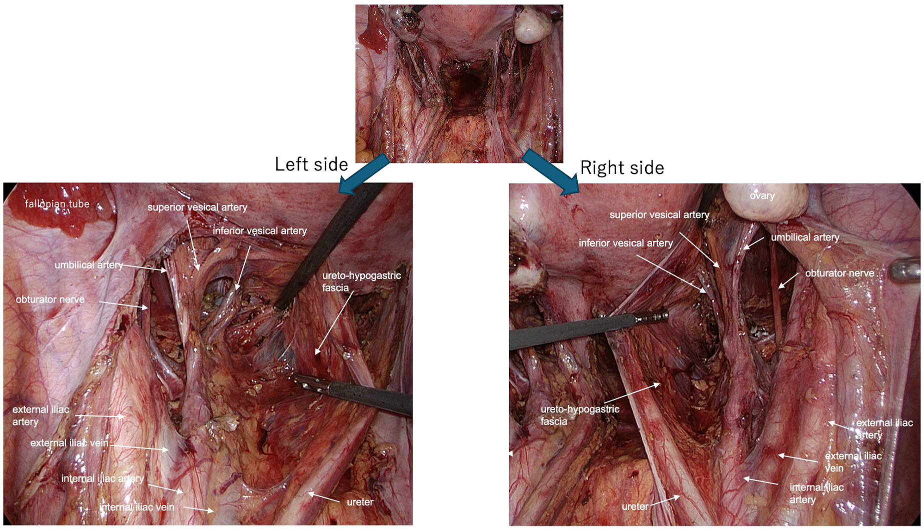

Fig. 2. Post operative view of autonomic-nerve preserving bilateral lateral pelvic lymph node dissection by robotic approach (Rob-LPND) in a female patient.

by the Japanese Society for Endoscopic Surgery.

Drainage tubes were removed when the drainage volume was under 150 mL/day and drainage content was serous. Urinary catheters were inserted just before the beginning of surgery and removed on post operative day (POD) 2 or 3. In cases without epidural anesthesia, the urinary catheter was removed POD 2. In cases with epidural anesthesia, the urinary catheter was removed the day after the epidural anesthesia catheter was removed. The volume of the epidural anesthesia reservoir is chosen by the anesthesiologist ; therefore, the removal day was POD 2 or POD 3. If patients had not urinated within 6 hours on the day of catheter removal, urinary retention was diagnosed and those patients had urinary catheter re-insertion.

This study was approved by the Ethics Committee of Fukushima Medical University, Approval vs. 30148.

Outcome Measurement

Differences between Lap-LPND and Rob-LPND were evaluated by the following factors : operation time (min), LPND operation time (min) , bleeding amount (g), urinary catheter re-insertion, duration of pelvic floor drainage tube placement (days), total drainage volume (mL, defined as "daily drainage amount (mL/day)×duration of tube placement (days)"), post operative hospital stay (days) .

Statistical Analysis

Each mean value was compared using a t-test. In comparing categorized values, chi-squared and Fisher's exact tests were applied. All statistical analyses were calculated by using SPSS Statistics version 24 (IBM, Armonk, U.S.A.).

Results

Clinical and Pathological Features

A series of 20 consecutive patients (Lap : 9, Rob : 11) were enrolled the study. Average age of the patients was 64.6 years, including 13 males and 7 females. The clinical and pathological features of the study cohort are shown in Table 1. Gender division (male/female) was 9/0 in Lap and 4/7 in Rob (P=0.003). Main tumor locations (Ra/Rb) were 3/6 in Lap and 0/11 in Rob (P=0.07). Surgical procedures (Hartmann/low anterior resection = LAR/Abdominoperineal resection = APR) were 1/5/3 in Lap and 0/2/9 in Rob (P=0.08). No significant differences were seen in clinical TNM stage. Preoperative therapy was applied for 8 cases in Lap and 11 cases in Rob (n.s., not significant). NAC was administered for 7 cases in Lap and 8 cases in Rob, CRT was administered for one case in Lap, and TNT was administered for 3 cases in Rob. LPN-positive pathology was found in 4 Lap cases and 2 Rob cases.

Table. 1. Clinical and pathological features of the study cohort.

Variables		Lap	Rob	p value
Age (± SD)		57.2 ± 14.6	61.9 ± 10.2	n.s.
Sex	Male	9	4	
	Female	0	7	P=0.003
BMI (± SD)		23.0 ± 2.8	24.2 ± 3.73	n.s.
mGPS	0	7	10	
	1	2	1	n.s.
Main tumor location	Ra	3	0	
	Rb	6	11	P=0.07
Surgical procedure	Hartmann	1	0	
	LAR	5	2	
	APR	3	9	P=0.08
cT	2	0	1	
	3	5	4	
	4a	4	3	
	4b	0	3	n.s.
cN	0	0	2	
	1a	2	2	
	1b	1	2	
	2a	2	1	
	3	4	4	n.s.
cStage	2b	0	1	
	2c	0	1	
	3b	4	5	
	3c	5	4	n.s.
Preoperative therapy	NAC	7	8	
	CRT	1	0	
	TNT	0	3	n.s.
With epidural anesthesia		4	9	n.s.
Pathologically positive LPN		4	2	n.s.

BMI : body mass index, Ra : rectum above peritoneal reflection, Rb : rectum below peritoneal reflection, LAR : low anterior resection, APR : abdominoperineal resection, NAC : neoadjuvant chemotherpy, CRT : chemoradiation therapy, TNT : total neoadjuvant therapy, LPN : lateral pelvic lymph node

Outcomes of Lap-LPND vs Rob-LPND

The results of each outcome measurement are shown in Table 2. Mean operation times were 527.4 min in Lap and 678.2 min in Rob ($P<0.001$). Mean LPND times were 232.4 min in Lap and 233.3 min (n.s.). Mean intraoperative bleeding amount was 157.8 g in Lap and 174.6 g in Rob (n.s.). Postoperative urine catheter re-insertion rate was 55.6% (5/9) in Lap and 18.2% (2/11) in Rob (p=0.160). Duration of drain tube placement was 15.7 days in Lap and 11.3 days in Rob (p=0.01). Total drainage volume was 4676 mL in Lap and 2044 mL in Rob (p<0.01). Postoperative hospital stay was 29.0 days in Lap and 17.3 days in Rob (p=0.003). There was no conversion (Lap to open or Rob to open) in this study. The average number of harvested LPNs was 21.9 in Lap and 21.5 in Rob (n.s.). Epidural anesthesia tubes were removed on postoperative day (POD) 2.0 in Lap and POD 2.2 in Rob (n.s.).

Discussion

The present report is based on a retrospective, observational study performed at a single institution with focus on comparing short-term outcomes between Lap-LPND and Rob-LPND. Table 3 shows short-term results of Rob-LPND previous reported[13,15,20-23]. Even with a small number of patients in our study, blood loss, conversion rate, and overall morbidity were comparable to other reports. Considering that our LPND procedures were all bilateral and all included preoperative therapy, it is likely that the longer operation times in this study were reasonable. Therefore, the quality of Rob-LPND performed at our institution compares favorably with other studies.

In this study, we found a longer total operation time in Rob-LPND in comparison with Lap-LPND. This observation was also made in previous reports, which compared TME without LPND[24]. Moreover, focusing on the LPND time alone, there was no difference between Lap- and Rob-LPND, suggesting that Rob-LPND is more suitable than Lap-LPND, as

Table. 2. Results of each outcome measurement.

Variables	Lap (n=9)	Rob (n=11)	p value
Operation time (min)	527.4 ± 54.2	678.2 ± 100.8	p<0.001
LPND time (min)	232.4 ± 59.9	233.3 ± 54.2	n.s.
Bleeding amount (g)	157.8 ± 168.8	174.6 ± 142.3	n.s.
Harvested LPN	21.9 ± 11.9	21.5 ±10.1	n.s.
Urinary catheter re-insertion	5	2	p=0.160
Morbidity, except for urine catheter re-insertion (CD ≧ 2)	3 (1 AL, 1 ileus, 1 CS)	1 (AL)	n.s.
Duration of drain placement (days)	15.7 ± 4.3	11.3 ± 2.6	p=0.01
Total drainage volume (mL)	4676 ± 2301	2044 ± 1146	p<0.001
Postoperative hospital stay (days)	29 ± 13.8	17.3 ± 9.2	p=0.003

Lap : laparoscopic lateral pelvic lymph node dissection, Rob : Robotic lateral pelvic lymph node dissection, LPND : lateral pelvic lymph node dissection. LPN : lateral pelvic lymph node. CD : Clavian-Dindo classification. AL : anastomotic leakage, CS : compartment syndrome. Values ± SD.

Table 3. Short-term results of Rob-LPND shown in previous reports.

Author	Year	Number of patients	Neoadjuvant treatment rate (%)	Bilateral LPND/ Unilateral LPND	Operation time (min)	Blood loss (mL)	Conversion rate (%)	Overall morbidity (CD ≧ 2) (%)
Park *et al.* (13)	2012	8	100	2/6	272	45	0	25
Yamaguchi *et al.* (15)	2016	85	12	11/74	455	25	0	31
Shin *et al.* (20)	2016	16	100	0/16	401	125	6.3	39
Kim *et al.* (21)	2018	50	86	10/40	260	35	0	28
Peacock *et al.* (22)	2020	40	100	n/a	420	150	n/a	35
Ishizaki *et al.* (23)	2023	27	100	27/27	587	113	0	33
Our report	2024	11	100	100/0	678	174	0	18

LPND : lateral pelvic lymph node dissection, CD : Clavian-Dindo classification compared to the TME part. All the LPND in this study were performed by two surgeons with endoscopic surgical skill credentials. Each of them had more than 20 laparoscopic LPND experiences before the observation period, but Rob-LPND had just launched at the start of this observation period. This could be disadvantageous for Rob-LPND results because of a learning curve, but advantages still emerged.

Of note, although not statistically significant, the urinary catheter re-insertion rate was lower in Rob-LPND in our study. A systematic review on urinary retention (UR) after TME reported that the laparoscopic approach was a risk factor for UR[16], and a comparison of laparoscopic and robotic approaches showed a lower incidence of UR in robotic patients[25]. Similarly, with regard to LPND, Yamaguchi *et al.* reported that post operative UR in Rob-LPND and Lap-LPND were 18.8% and 36.4% respectively[20]; Kim *et al.* also reported rates of 4 % and 20%, respectively[22]. Considering these studies and our present study, Rob-LPND may contribute to more precise autonomic nerve preservation as compared to Lap-LPND.

To our best knowledge, there have been no reports regarding the duration of drainage tube placement and/or total drainage volume after LPND. In this study, the duration of drainage tube placement was significantly shorter, and the total drainage volume was significantly lower in Rob-LPND, despite the inclusion of 3 cases of TNT in Rob-LPND. It is generally accepted that increased total drainage volume and longer the duration of drainage tube placement is usually observed after presurgical treatment, especially after CRT. Therefore, shorter duration of drainage placement and less volume of drainage seems to be achieved by a robotic approach. Elsewhere, less drainage volume was associated with a lower risk of lymphocele complications after LPND[26], suggesting that a robotic approach for LPND may offer advantages in reducing postoperative complication. There are several possible reasons to explain why Rob-LPND achieved a decrease in total drainage volume: 1) differences in devices used (laparoscopic coagulation shears in Lap versus advanced bipolar in Rob); 2) decreases in blunt dissection due to the multi-joint function of the robot; and 3) the improvement in surgeons' skills since the Rob-LPND launched later. Furthermore, a shorter average postoperative hospital stay was achieved by Rob-LPND, another advantage of the robotic approach.

Our study had several limitations. It was a single-center, retrospective study in which a limited number of patients could potentially introduce bias in terms of patient characteristics such as gender, tumor location, and surgical procedure distribution. Since the Lap-LPND group was regarded as a historical control, time-dependent bias could not be excluded. Especially, a big bias in the present study is that all the patents in Lap-LPND group were coincidently male. Therefore, we selected only males from the Rob-LPND group and reexamined the results. As shown in supplemental Tables 1 and 2, the trend was similar to what seen in the total patient comparison, although the population was very small in Rob-LPND. Taken together, it is likely that less volume of drainage and shorter postoperative hospital stay was possibly achieved with Rob-LPND.

In conclusion, Rob-LPND may reduce postoperative total drainage volume and shorten postoperative hospital stays. Further study with larger patient cohorts would be needed to draw firmer conclusions.

Conflict of Interest Disclosure

The authors have no conflicts of interest relevant to this study.

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