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Early experience with robot-assisted radical cystectomy and intracorporeal ileal conduit urinary diversion at Fujita Health University School of Medicine

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Abstract

Objectives: Open radical cystectomy (ORC) is a highly invasive, but widely performed, standard treatment for muscle-invasive bladder cancer (MIBC). Robot-assisted radical cystectomy (RARC) is increasingly performed worldwide as a minimally invasive procedure that can replace ORC. In June 2011, we started performing RARC procedures in which urinary diversion is performed intracorporeally. We compared the safety and invasiveness of RARC and ORC procedures that were performed in the same period.

Methods: Sixteen patients who underwent RARC and intracorporeal ileal conduit urinary diversion (IC-ICUD) were included. Robot-assisted surgery was performed with a head-down tilt of 30° and radical cystectomy was performed transperitoneally. The head-down tilt was then adjusted to 10°–15° for performing IC-ICUD.

Results: All RARC+IC-ICUD procedures were completed without conversion to ORC. The median operation time was 373 min (276–497 min), median console time was 320 min (227–431 min), and median estimated blood loss volume was 200 ml (100–1500 ml). No ≥grade 3 complications as per the Clavien–Dindo classification were identified. RARC had lower blood loss and transfusion rates compared with ORC, thereby shortening the postoperative hospital stay.

Conclusions: We reported our experiences with RARC+IC-ICUD and describe the operative method. IC-ICUD accelerates postoperative recovery of intestinal function and decreases the rate of complications, such as intestinal obstruction and ureteral stenosis. Our findings suggest that RARC+IC-ICUD can be performed with minimal invasiveness and high safety in patients with MIBC.

Keywords: Cystectomy, Robot-assisted radical cystectomy (RARC), Bladder cancer, Intracorporeal ileal conduit, Urinary diversion

Introduction

Open radical cystectomy (ORC) is widely performed as the standard surgical method for muscle-invasive bladder cancer (MIBC). However, ORC is regarded as a relatively highly invasive procedure associated with high intraoperative blood loss and intestinal complications following urinary diversion through intestinal segments. Laparoscopic radical cystectomy (LRC) is a comparatively less invasive procedure than ORC and is gaining popularity in Japan.[1,2] However, because of technical difficulties and the longer procedural time for performing laparoscopic urinary diversion, previous reports have indicated that extracorporeal urinary diversion (ECUD) using a small incision is being commonly performed.[3]

Robot-assisted radical cystectomy (RARC) was first reported by Menon et al. in 2003,[4] and the use of this technique has been spreading worldwide since this time. In Japan, only two robot-assisted procedures—robot-assisted radical prostatectomy (RARP) for prostate cancer and robot-assisted partial nephrectomy for renal cancer—are covered by public health insurance. However, RARC is not covered by public health insurance. The robot-assisted ileal conduit method was first reported as an option for intracorporeal urinary diversion (ICUD) in 2004,[5] and *in situ* neobladder construction was reported in 2011.[6] Intracorporeal ileal conduit urinary diversion (IC-ICUD) can be performed relatively easily using robot-assisted surgery.

In June 2011, we started performing RARC+IC-ICUD as a minimally invasive, safe surgical procedure, and started performing laparoscopic urinary diversion through intestinal segments in all patients. In this study, we describe surgical methods used in our department in patients who underwent IC-ICUD and compare them with patients who underwent ORC during the same time.

Methods

Subjects

Since June 2011, we started performing RARC+IC-ICUD in 16 patients with bladder cancer. In this study, we excluded cases with a clear invasion to adjacent organs or lymph node metastasis (Table 1). Four surgeons with experience in performing RARP in ≥40 patients performed the surgeries. This study was approved by the independent ethics committee of the Fujita Health University of Medicine, Aichi, Japan (HM17-156). Informed consent was obtained by formal documents approved by Institutional Review Board (IRB) at our hospital.

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Table 1 Patients' characteristics

Case	Age (y)	Sex	BMI (kg/m^2)	Clinical T stage	NAC	Past history
1	66	M	17.9	T4	GC	Tuberculosis
2	75	M	21.1	T2	GC	Mediastinal tumor
3	84	F	27.4	T3b	GC	—
4	84	M	23.2	T2	—	—
5	78	M	23.1	T1	GC	Lap-colectomy, Reiter synd
6	72	F	16.8	T3	GC	SLE, hysterectomy
7	63	M	22.9	T3	G+CBDCA	—
8	72	M	23.7	T3	G+CBDCA	Gastrectomy prostate Ca. (IMRT)
9	67	M	20.0	T3a	G+CBDCA	—
10	72	M	26.0	T1	GC	Nephroureterectomy, sigmoid Ca.
11	68	M	25.6	T3	GC	DM, HT, HL
12	69	M	25.1	T3	GC	Gastrectomy
13	68	M	21.9	T3b	GC	—
14	67	M	18.4	T3b	GC	CRF
15	73	M	24.5	T2	GC	AML
16	68	M	24.1	T2	GC	Open cholecystectomy
Median	76		23.2			

BMI; body mass index, NAC; neoadjuvant chemotherapy, lap-cholectomy; laparoscopic cholectomy, Reiter synd; Reiter syndrome, SLE; systemic lupus erythematosus, IMRT; intensity-modulated radiation therapy, DM; diabetes mellitus, HT; hypertension, HL; hyperlipidemia, CRF; chronic renal failure, AML; angiomyolipoma, GC; gemcitabine+cisplatin, G+CBDCA; gemcitabine+carboplatin, Ca.; carcinoma

Operative method

Port placement and setup

A camera port was placed 3 cm cephalad to the umbilicus transabdominally using open laparotomy under general anesthesia. Three robotic ports (an extra arm on the right side of the patient) and two assistant ports (15 and 12 mm) were placed (Figure 1). The robot was docked to start surgery on the console at a steep head-down tilt of approximately 25°–30°.

Robot-assisted radical cystectomy

A retroperitoneal incision was made to identify both ureters and we caudally dissected them with the seminal ducts to expose the seminal vesicles. A peritoneal incision was then made on the lateral aspect of the bladder, and the paravesical tissues were caudally dissected to free the intrapelvic fascia. The same procedure was performed on the opposite side so that the peritoneum underlying the seminal vesicles could be dissected from both sides and the seminal vesicles could be completely separated. Bilateral seminal vesicles were then elevated and Denonvilliers' fascia was resected to continue caudally separating the prostate from the rectum (Figure 2). The ureters were clipped in this state and ligated and cut. The stump was clamped using a Hem-o-Lok® (Teleflex, USA) clip with a suture thread as a marker when performing the urinary diversion (Figure 3). The ureter stump was promptly subjected to pathological testing; if the stump was positive, resection was continued proximally until it became negative. Furthermore, the lateral ligament was peeled to the apex of the prostate using a sealing device. When all lateral procedures were completed, the space of Retzius was exposed. The abdominal air pressure was increased to 15 cmH_2O to separate the dorsal vascular complex. The dorsal vascular complex stump was carefully sutured for ensuring hemostasis. During radical urethrectomy, caudal dissection of the urethra was amply continued in synchronization with the console robotic surgery. The peritoneum was dissected away from the bulbous and penile spongy parts of the urethra, and the membranous part of the urethra was extracted extraperitoneally through the abdominal cavity. The Hem-o-Lok® was used to clamp and separate the urethra after removing the urethral catheter, while

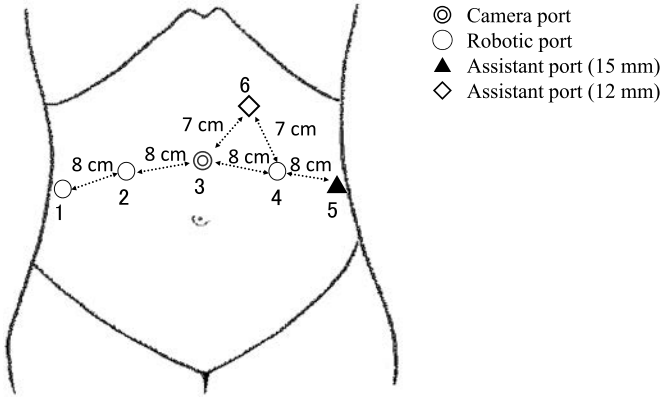

Figure 1 Port placement configuration.
The camera port and three robotic ports were placed at positions 1, 2, 3, and 4. Additionally, 15-mm and 12-mm assistant ports were used at positions' 5 and 6.

ensuring that leakage of urine was avoided (Figure 4). The separated bladder and prostate were then placed inside the Endcatch™ II, which was inserted from the 15-mm port and placed intraperitoneally. In women, the bladder was dissected with the uterus, and bilateral uterine adnexa were removed transvaginally.

Lymph node dissection and moving the ureter

Bilateral internal, external, common iliac, and obturator lymph nodes were resected. After resection, the bifurcation of the common iliac artery was exposed. We used ProGrasp Forceps (Intuitive Surgical Inc., USA) on the extra arm on the right side to guide the left ureter to the right side posterior to the sigmoidal colon.

Isolation of the ileal conduit and peritoneal fixation

The head-down tilt was attenuated to approximately 10°–15°. We used a graduated soft catheter (15 cm) and marked 15–20 cm of the distal ileum to be exposed using crystal violet (Figure 5). The mesentery was then resected, and a linear stapler was used

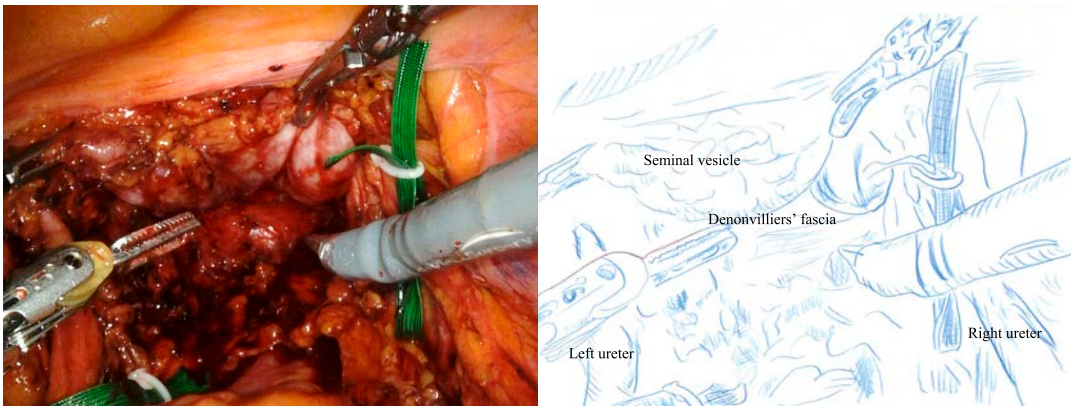

Figure 2 Dissecting Denonvilliers' fascia.
Both seminal vesicles are pulled up, and Denonvilliers' fascia is dissected to widely separate and expand both sides. To decrease the risk of rectal trauma, this procedure is performed as caudally as possible to dissect the rectum completely from the prostate.

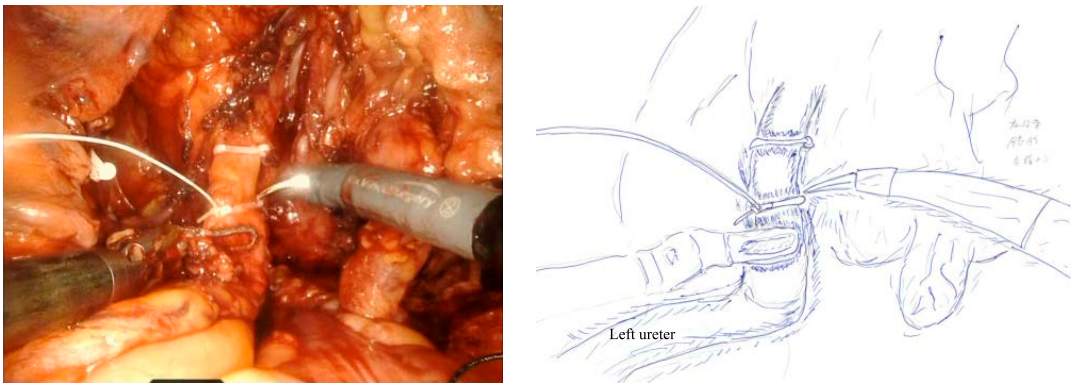

Figure 3 Transection of the left ureter.
The proximal side is clamped using a Hem-o-Lok® with a thread as a marker during urinary diversion. The left ureter must be moved to the right during anastomosis of the ileal conduit and should be transected as close to the bladder side as possible.

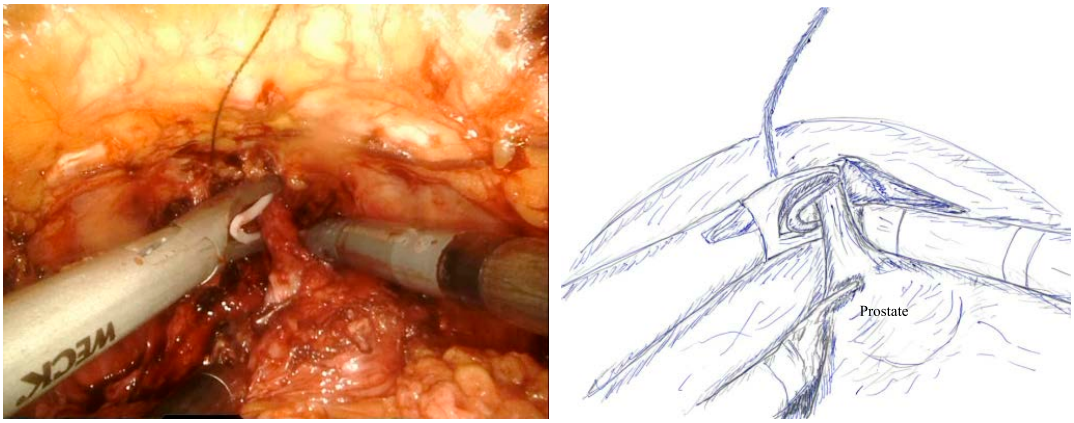

Figure 4 Transection of the urethra.
During radical urethrectomy, caudal dissection of the urethra should be amply continued in synchronization with the console robotic surgery. The bulbous and penile spongy parts of the urethra are dissected from the perineum, and the membranous part of the urethra is extracted extraperitoneally through the abdominal cavity. After removing the urethral catheter, the urethra is carefully transected using the Hem-o-Lok® to avoid urinary leakage.

to clamp the ileum on both sides. Additionally, the linear stapler was used to create a functional end-to-end anastomosis of the proximal and distal ends of the ileum. The serous surface of the anastomotic site was reinforced using 3-0 Vicryl™ sutures (Johnson and Johnson, USA). Finally, we fixed the proximal stump of the ileal conduit to the right lower abdominal peritoneum, which enabled the uretero-ileal anastomotic site and the conduit to be fixed in the retroperitoneum.

Uretero-ileal anastomosis

Using the Bricker procedure, uretero-ileal anastomosis was

separately performed for the left and right sides. The ureteral anastomotic site of the ileal conduit was dissected to identify the mucus membrane of the ileum. First, 4-0 PDS™ sutures (Johnson and Johnson, USA) were used to anastomose the posterior surface of the left ureter with the ileal conduit using approximately three suture knots Second, the distal stump of the ileal conduit was transected and a ureteral stent (Single J) with a guidewire was inserted through the extra port on the right side. Third, the catheter was inserted into the ureter through the anastomotic site, and retrogradely inserted to the renal pelvis. The distal end of the catheter was then pulled from the distal side of the conduit toward the stoma using a large needle driver. The catheter was then sutured to fix the stomal site, and continuous sutures were made using 4-0 PDS™ sutures on the ureteral surface with the ileal conduit (Figure 6). We then completed the intracorporeal ileal conduit by repeating the same procedure on the right side. Finally, a skin incision was made to create the stoma and pull out the distal side of the ileal conduit extracorporeally. The device was undocked to complete the console operation.

Assessment of perioperative outcomes

We performed retrospective analysis on a consecutive series of patients undergoing radical cystectomy (16 RARC and 15 ORC) in our department in the same period (from June 2011). We examined our database for patients' demographics (age, sex, and body mass index), preoperative disease characteristics (those who underwent neoadjuvant chemotherapy and clinical stage), operative characteristics (operative time, estimated blood loss, those who underwent blood transfusion), and perioperative variables (start of ingestion, length of hospital stay, perioperative complications, and readmission [within 30 days]). The Clavien–Dindo classification[7] ver 2.0 was used for assessing perioperative complications. Results are expressed as median (range). For statistical analysis, we used PASW Statistics 18 (SPSS™) to conduct the χ^2 test. Statistical significance was set at $P<0.05$.

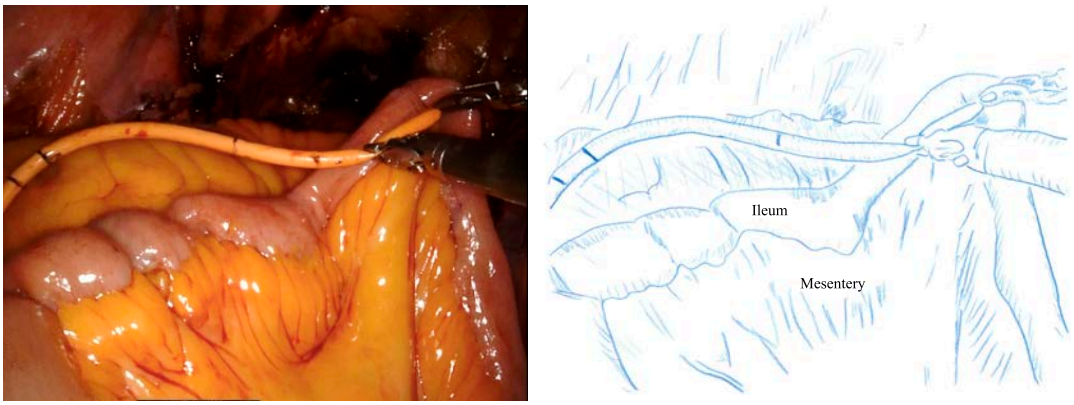

Figure 5 Marking of the isolated enteric tract.
A distance of 15–20 cm of the end of the ileum is marked with crystal violet for isolation. A linear stapler is used to isolate the ileum by treating the mesentery. The length is adjusted according to the size of the patient.

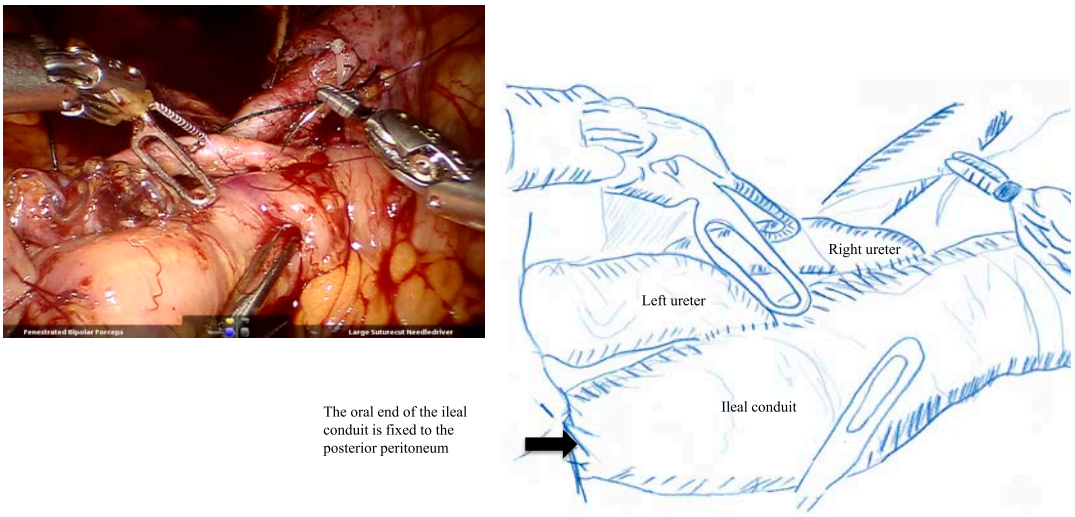

Figure 6 Uretero-ileal anastomosis (Bricker procedure).
Uretero-ileal anastomosis is conducted separately for the left and right sides with the Bricker procedure. The ureteral anastomotic site of the ileal conduit is dissected to identify the ileal mucosa. The posterior side of the ureter is anastomosed with the ileal conduit by approximately three suture knots. The distal stump of the ileal conduit is dissected and a ureteral stent (Single J) is inserted with a guidewire through the extra port on the right side. The catheter is inserted into the ureter through the anastomotic site and guided in reverse insertion to the renal pelvis. The distal end of the catheter is pulled out from the distal side of the conduit toward the stoma. The catheter is sutured for fixture on the stomal site, and sutures to anastomose the remainder of the ureter with the ileal conduit should be continued.

Results

Sixteen patients underwent RARC with an intracorporeal ileal conduit. The median age of patients was 76 years (range, 63–84 years), and 14 were men and two were women. The clinical staging was T1, T2, T3, and T4 in two, four, nine, and one patient, respectively. Six patients had a history of laparoscopic surgery (Table 1). For neoadjuvant chemotherapy, 12 patients received gemcitabine+cisplatin and three received gemcitabine +carboplatin therapy. RARC was completed in all of the patients without conversion to open or laparoscopic surgery. The median operative and console times were 373 (276–497 min) and 320 (227–431 min) min, respectively, and the estimated blood loss (EBL) was 200 ml (100–1500 ml; Table 2). Although three patients received allogeneic blood transfusions, only one received allogeneic transfusions because of intraoperative blood loss (case 7: bleeding from the anterior side of the rectum during urethrectomy). Transfusions were provided to the remaining two patients for preoperative anemia. Although robot-assisted surgery caused no complications, lower leg compartment syndrome occurred in one patient (case 15). Patients started oral consumption of meals on postoperative day 1 (1–4) and were discharged 21 days (13–30 days) after surgery. Pathological results were pT0 in four, pTis in two, pTa in one, pT2 in two, pT3 in six, pT4 in one, and pN1–2 in three patients, and one patient was stump-positive. Perioperative complications included ≥grade 2 complications in the Clavien–Dindo classification in five (31.3%) patients. No ≥grade 3 complications were observed in this study. In particular, paralytic ileus (Clavien–Dindo classification grade 2), localized peritonitis (grade 2), pyelonephritis (grade 2), and lower leg compartment syndrome (grade 2) were observed in two (12.5%), one (6.3%), one, and one patient, respectively. However, all of these patients recovered after conservative treatment. Readmission within 30 days of discharge occurred in two (12.5%) patients (one case each of pyelonephritis and retroperitoneal space infection), and none of the patients required reoperation.

We compared 15 cases of ORC and 16 cases of RARC performed in our department in the same period. No significant differences were observed in the patients' background between the groups (Table 3). Comparative studies showed that the RARC group had a significantly lower EBL ($p<0.001$), transfusion rate ($p<0.001$), duration of postoperative hospital stay ($p=0.010$), and rate of postoperative complications ($p=0.0191$) than did the ORC group (Table 4).

Discussion

Radical cystectomy is an extremely invasive surgery, with a 2.4% mortality rate within 90 days of the operation and a 48.5% complication rate.[8] Laparoscopic cystectomy has been reported since the 1990s as a form of minimally invasive surgery. In 1995,

Table 2 Operative and pathological data

Case	Operation time (min)	Console time (min)	EBL (ml)	Blood transfusion	Perioperative complication (Clavien-Dindo grade)	Pathological examination	Ingestion (days)	LOS (days)	Readmission within 30 days
1	450	417	150	−	Peritonitis (2)	G3>2, pT3a, pN2, RM0	4	27	—
2	350	330	400	−	—	G2, pTa, pN0, RM0	3	16	—
3	352	309	200	+	—	High grade, pT3b, pN0, RM0	1	30	—
4	313	268	200	−	—	pTis, RM0	1	21	—
5	335	267	450	−	—	pT0, pN0	2	21	+Pyelonephritis
6	391	353	100	−	—	G3, pT2a, pN0, RM0	2	15	+Pelvic inflammation
7	495	347	1500	+	—	G2>3, pT2a, pN0, RM0	1	18	—
8	276	227	200	−	—	G3, pT3a, pN0, RM0	1	13	—
9	401	383	1400	+	Pyelonephritis (2)	pTo, pN1, RM0	2	18	—
10	362	290	100	−	—	G3, pT3a, RM0	1	20	—
11	368	281	100	−	—	G2-3, pT3a, pN1, RM0	2	12	—
12	292	231	150	−	Ileus (2)	G3>2, pT3b, pN0, RM0	1	22	—
13	471	420	150	−	Ileus (2)	G2, pTis, pN0, RM0	4	18	—
14	378	311	250	−	—	G3, pT4, pN0, RM1	1	19	—
15	497	431	550	−	Compartment syn. (2)	pT0, pN0	2	17	—
16	435	359	150	−	—	pT0, pN0	1	13	—
Median	373	320	200				2	21	2 (12.5%)

EBL; estimated blood loss, LOS; length of stay, syn.; syndrome

Table 3 Patients' background in the RARC and ORC groups

	RARC (n=16)	ORC (n=15)	*P* value
Age (y)	76 (63–84)	72 (52–82)	n.s
Male/female	14/2	12/3	n.s
BMI, kg/m^2	23.2 (16.8–27.4)	22.3 (14.4–27.6)	n.s
Neoadjuvant chemotherapy	15 (93.8)	14 (93.3)	n.s.
Clinical staging			
T1	2 (12.5)	1 (6.6)	n.s
T2/T3/T4	4(25.0)/9(56.3)/1(6.3)	4(26.7)/8(53.3)/1(6.7)	n.s

RARC; robot-assisted radical cystectomy, ORC; open radical cystectomy, BMI; body mass index, n.s.; not significant.
Data are presented as median (interquartile range) or n (%).

Table 4 Operative and postoperative outcomes

		RARC (n=16)	ORC (n=15)	*P value*
Operative time		373 (276–497)	397 (250–564)	n.s
EBL, ml		200 (100–1500)	1783 (350–4505)	<0.001
Blood transfusion		3 (18.8)	13 (86.7)	<0.001
Ingestion, days		2 (1–4)	3 (1–8)	n.s
LOS, days		21 (13–30)	33 (13–81)	0.010
Perioperative complications	≥Grade 2	5 (1.2)	11 (73.3)	0.0191
	≥Grade 3	0 (0)	2 (13.3)	n.s.
Readmission within 30 days		2 (12.5)	2 (13.3)	n.s.

RARC; robot-assisted radical cystectomy, ORC; open radical cystectomy, EBL; estimated blood loss, LOS; length of stay, n.s.; not significant.
Data are presented as median (interquartile range) or n (%).

Sanchez et al.[9] reported LRC and ileal conduit urinary diversion for bladder cancer. However, this procedure did not gain widespread popularity because of its procedural difficulties.

In contrast, RARC has been introduced to many institutions since it was first reported in 2003 by Menon et al.[3] because it is minimally invasive and has highly stable surgical operability. Kader et al.[10] compared 100 cases each of ORC and RARC. They reported that although the operative time in ORC was shorter, RARC was superior in terms of blood loss, transfusion rate, duration of hospital stay, and complications within 90 days after surgery, which are similar results as the present study. We consider that the reason for a shorter operative time for RARC at our institution is that ORC was often performed by residents. Furthermore, Bochner et al.[11] reported that 54 (90%) operated cases were ≤*c*T2, and had a lower EBL and a lower rate of complications. Our study showed excellent outcomes, even though we performed RARC in relatively advanced stage patients at our department. In our study, there was a discrepancy between the clinical stage and the pathological diagnosis. We performed neoadjuvant chemotherapy for 15 (93.8%) patients. Grossman et al.[12] reported that compared with radical cystectomy alone, use of neoadjuvant chemotherapy followed by radical cystectomy increases the likelihood of eliminating residual cancer in the cystectomy specimen. Their report supports our finding that the clinical stage appeared to be higher than the pathological diagnosis after surgery.

The numbers of patients treated with RARP per institution and per surgeon in Japan are increasing following the growing popularity of the da Vinci surgical system. An increasing number of institutions have postponed introducing LRC because of procedural difficulties, although they have introduced minimally invasive and highly operable RARC. Hayn et al.[13] reported that the higher the number of patients treated with RARP at the time of introducing RARC, the better the outcomes of operative time, blood loss, and number of dissected lymph nodes. In our hospital, we selected surgeons who had previously performed RARP in at least 40 patients and they smoothly executed the procedure. This suggests that RARC can be relatively easily introduced by surgeons who are proficient in RARP.

In our department, we adopted ICUD as the urinary diversion method since introducing RARC. Kamran et al.[14] compared 935 patients who underwent ICUD and ECUD in a multicenter study and found no significant difference in the operative time between techniques. However, they found that ICUD had significantly better outcomes for the readmission rate within 30 and 90 days after surgery, gastrointestinal tract complications, and post-operative infections compared with ECUD. Another study compared ICUD with ECUD and showed that ICUD had significantly less EBL and a lower complication rate than did ECUD.[15] One of the advantages of ICUD is that the pneumoperitoneum does not have to be interrupted. Bleeding can be decreased and the surgical wound can also be minimized because the surgery can be continued without exposing the intestinal tract to air. This decreases the risks of complications, such as infections of the operative wound or intestinal occlusion. Intestinal edema can also be decreased and the risk of bodily fluid imbalance can be lowered. Additionally, a lower risk of complications, including postoperative ureteral stenosis, can be expected because there is no need for excessive pulling or external exposure of the urinal tract.

However, some reports have noted that the operative time of ICUD is longer than that of ECUD.[14] Because a longer time is required for the operation in the head-down tilt lithotomy position, complications associated with this position may occur. Indeed, lower leg compartment syndrome occurred in one patient in our department. This patient had the longest console time among the 16 patients, lasting for 431 min. In our department, head-down tilt was attenuated to 10°–15° before performing urinary diversion. Because this case of compartment syndrome was experienced, we have additionally started providing bilateral lower leg massage every 4 h after entering the lithotomy position. We massage both lower limbs to promote blood flow and gain lower thigh support; this practice has been designed to release unnecessary pressure.

Uretero-conduit anastomosis, a procedure that requires expertise if performed via laparoscopic surgery, can be performed relatively easily with robot-assisted surgery. Because this procedure requires intestinal anastomosis, this would ideally be executed with the cooperation of a gastrointestinal surgeon during the early stages of introduction. In our department, we reconstructed the small intestine under the guidance of a gastrointestinal surgeon for initial cases and we have been following perioperative digestive management based on the enhanced reconery after surgery (ERAS) protocol.[16] As a general rule, we do not perform preoperative preparation of the small intestine or postoperative nasogastric tube placement. We intentionally avoid intraoperative cleansing of the ileal conduit to prevent intraperitoneal contamination by drainage. There were no serious intraperitoneal complications, such as generalized peritonitis or abscess formation in our study. To date, we have been performing RARC+IC-ICUD with relative safety. We will continue to gather data on more patients who are treated with this minimally invasive surgery for MIBC to improve and fine-tune surgical techniques through these experiences.

Conclusions

In this study, we report on the early experiences of RARP and IC-ICUD at our hospital and provide detailed descriptions of our operational methods. RARC for MIBC decreases blood loss, decreases the transfusion rate, and shortens postoperative hospital stay compared with ORC. IC-ICUD accelerates postoperative improvement of intestinal function and decreases the rate of complications, such as intestinal occlusion and ureteral stenosis. When used in combination with IC-ICUD, RARC can be performed with a minimal level of invasiveness and a high level of safety.

Conflict of Interest

There are no conflicts of interest.

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