Original Article

Postoperative complications and determinant of selecting non intracorporeal urinary diversion in patients undergoing robot-assisted radical cystectomy: an initial experience

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Background: Robot-assisted radical cystectomy (RARC) with urinary diversion has become a standard surgical procedure because of its three-dimensional high-definition surgical field of view, flexibility, and stability. However, because of the highly complex steps of surgery, postoperative complications cannot be ignored.

Methods: This retrospective, single-center, observational cohort study investigated the postoperative complications following RARC at a non-high-volume center in Japan. From August 2019 to March 2023, 50 consecutive patients who underwent RARC for histologically proven muscle-invasive bladder cancer (MIBC) or high-risk non-MIBC with an indication for radical cystectomy according to the Japanese Urological Association Guideline 2019 were included. Factors correlated with the selection of extracorporeal urinary diversion (ECUD) or cutaneous ureterostomy rather than intracorporeal urinary diversion (ICUD) for urinary diversion were also investigated.

Results: In total, 33 (66%) and 31 (62%) patients experienced complications during the first 90 and 30 days after RARC, respectively. Among them, 19 (38%) and 18 (36%) patients developed Clavien-Dindo classification G2 complications, and 12 (24%) and 11 (22%) developed G3 or higher (major) complications during the first 90 and 30 days after RARC, respectively. The most common complications were gastrointestinal complications (26%) and urinary tract infections (22%). Nine patients (18%) underwent surgical intervention within 90 days of undergoing RARC. Higher infusion volume during the operations was significantly correlated with the occurrence of major complications within 90 days (P=0.025) and 30 days (P=0.0158) after RARC. Nineteen patients (38%) underwent non-ICUD. Twelve patients received ECUD as an ileal conduit or neobladder, and among them, three patients received ECUD due to intraabdominal adhesion for previous abdominal surgery or radiation, while four patients received ECUD ileal conduit due to comorbidities and advanced cases (palliative surgery) to shorten the surgery time.

Conclusions: Surgical complications related to the initial experience with RARC at a non-high-volume center in Japan cannot be ignored. Although this complicated surgical procedure requires a learning curve to achieve a stable rate of much fewer major complications after RARC, careful assessment of patients' status before surgery and critical postoperative management may reduce complication rates more quickly, even at non-high-volume centers.

Keywords: Robot-assisted radical cystectomy (RARC); intracorporeal urinary diversion (ICUD); extracorporeal urinary diversion (ECUD); complication; Clavien-Dindo classification system

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Introduction

Radical cystectomy with urinary diversion (RCUD) is a gold standard treatment for non-metastatic muscle-invasive and non-muscle invasive high-risk superficial bladder cancer (1). RCUD is a complex surgical procedure, and ideally, it should be conducted at high-volume tertiary centers by experienced surgeons. According to experts, RCUD is still associated with a high risk of complications (1).

In 2003, Menon first introduced robot-assisted radical cystectomy (RARC) with extracorporeal urinary diversion (ECUD) (2). During the last few decades, RARC has gained popularity and has been rapidly expanding in North America and Europe, and in Japan, RARC has been expanding since 2018 after being covered by public insurance (3,4). According to the results from a systematic review and meta-analysis, the benefits conferred by RARC compared to open cystectomy were a decreased need for blood transfusion and earlier hospital discharge but RARC did not have impact on oncological, safety and quality of life outcomes in the patients (5). In a prospective randomized controlled study (RAZOR), the overall adverse event rates were 67% and 69% for patients receiving RARC and open RCUD, respectively, and infectious and gastrointestinal events were the most common complications in both the groups (6). RARC remains a technically complex procedure requiring considerable experience and advanced techniques, so it is meaningful to retrospectively investigate our initial experience with RARC, which was performed at a representative non-high-volume center in Japan.

The primary endpoint of this study was to evaluate postoperative early (within 30 days) and late (within 90 days) complications and to analyze pre- and peri-operative factors associated with these complications. The secondary endpoint was to evaluate factors correlated with selecting ECUD or cutaneous ureterostomy rather than intracorporeal urinary diversion (ICUD) for urinary diversion. We present this article in accordance with the STROBE reporting checklist (available at https://tcr.amegroups.com/article/view/10.21037/tcr-23-1234/rc).

Highlight box

Key findings

- A total of 33 (66%) and 31 (62%) patients experienced complications during first 90 and 30 days after robot-assisted radical cystectomy (RARC), respectively at a non-high-volume center in Japan and these cannot be ignored.

What is known and what is new?

- RARC with urinary diversion has become one of the standard surgical procedures. However, due to high complex steps of the surgery, postoperative complications cannot be ignored.
- Higher infusion volume during the operations was significantly correlated with the occurrence of major complications both within 90 and 30 days after RARC, respectively.

What is the implication, and what should change now?

- Although this complicated surgical procedure needs learning curve to achieve stable rate of much fewer major complications after RARC, careful assessment of patients' status before surgery and critical postoperative management may reduce complication rates more quickly even at non-high-volume center.

Methods

Patients

This retrospective, single-center, observational cohort study described the postoperative complications following RARC at our institution. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). This study was approved by the Institutional Review Board of the Clinical Research Ethics Review Committee of Mie University Hospital (No. H2021-258 and No. H2023-182) and individual consent for this retrospective analysis was waived. From August 2019 to March 2023, 50 consecutive patients who underwent RARC for histologically proven muscle-invasive bladder cancer (MIBC) or high-risk non-MIBC with an indication for radical cystectomy according to the Japanese Urological Association Guideline 2019 were included. If clinical T stage was higher than cT2 or lymph node metastasis was suspected clinically, eligible patients received two to three cycles of pre-operative chemotherapy cisplatin/carboplatin together with gemcitabine. All patient characteristics were collected retrospectively through a review of inpatient and outpatient medical records on June 30th 2023. The age-adjusted Charlson comorbidity index (aCCI) was calculated according to ICD-10 (International Classification of Diseases 10th Revision) codes (7,8).

Surgical procedure

All robot-assisted surgeries were performed using the DaVinci Surgical System Xi (Intuitive Surgical, Inc. Sunnyvale, CA, USA). If the upper urinary tract urothelial carcinoma was complicated, laparoscopic or robot-assisted nephroureterectomy was performed before radical cystectomy. Surgical procedures for bladder cancer were divided into the following parts: pelvic lymph node

dissection, RARC with urethrectomy, and urinary diversion to maintain a surgeon's concentration, reduce fatigue, and train young urologists, as described by Nakane *et al.* (9). As for RARC, seven or six trocars were settled; the seventh trocar was placed in the midline just above the pubic bone for ICUD. The patients were placed in a 25° Trendelenburg position under general anesthesia, and pelvic lymph node dissection was initiated in the majority of cases. Pelvic lymph node dissection included removal of lymph nodes from an area around the bifurcation of the aorta, laterally by the genitofemoral nerve, distal to the deep circumflex iliac vein and Cloquet's lymph node, and posteriorly by the internal iliac vessels, including the sacral nodes and obturator fossa. If the clinical stage was less than cT2, the sacral nodes and common iliac nodes cranial to the crossing of the ureter were omitted. Lymph node dissection was also omitted in patients with advanced age and severe complications.

RARC was performed according to the procedures reported by Menon (2), without the nerve-sparing method. Urethrectomy was performed, except in cases with urinary diversion using a neobladder. The ICUD ileal conduit procedure has been previously reported (10). Briefly, the ileocecal junction was identified, and the terminal 15–20 cm of the ileum was spared. About 15–20 cm segments of the ileum were chosen for the ileal conduit. An endovascular stapler and cutter (endoGIA, Covidien, Norwalk, CT, USA) with a 60-mm or 45-mm vascular load was introduced into the suprapubic port. Thereafter, the stapler was placed across the bowel and mesentery to ensure perpendicular orientation to the bowel. After firing the stapler and dividing the bowel and mesentery, an identical procedure was performed at the other end of the bowel segment. Bowel continuity was restored above the segment selected for the ileal conduit. Identification of the proximal and distal ends of the ileum and excision of a small amount of the stapled bowel at each end, followed by an endovascular stapler and cutter (endoGIA, Covidien, Norwalk, CT, USA) with a 60-mm vascular load, was introduced into the suprapubic port and stapled to create a side-to-side, functional end-to-end anastomosis. Another 60-mm stapler was introduced and stapled using the same procedure to prevent anastomotic stenosis. The remaining bowel opening was closed using a 60-mm stapler introduced in the assistant 12 mm left lateral port.

The distal ends of both ureters were held in position using the fourth robotic arm for ureteroileal anastomosis using the Wallace method. The ureters were partially transected, spatulated using robotic scissors, and sutured together with 4-0 Monocryl absorbable running sutures. The lateral edges of the newly conjoined ureters were anastomosed to the proximal end of an open ileal conduit segment, by 4-0 Monocryl absorbable running suture. 6-Fr single-J ureteral stent with a guidewire was introduced into each ureter through the suprapubic port. Intestinal laparoscopic forceps introduced from the fourth robotic port were gently guided through the entire loop, starting at the previously made opening at the distal conduit and passed up to the proximal end of the conduit. The stents were secured using forceps and passed through a conduit. 4-0 Vircyl Rapide suture was used to suture the stents to the ureter or conduit: the left stent to the left ureter and the right stent to the conduit to prevent accidental dislodgement. Finally, the anterior opening of the ureteroileal anastomosis was accomplished a 4-0 Monocryl absorbable running suture over the stent. The distal end of the conduit was removed through the pre-marked ostomy site, and the proximal end of the conduit was retroperitonealized by the peritoneum on the right side of the sigmoid colon. An ECUD was performed in a mini-open incisional fashion: a 5–7 cm incision centered on the naval using the same steps as ICUD.

In the case of an orthotopic ileal neobladder, we typically used a U-shaped reservoir described by Koie *et al.* (11).

Complications

We retrospectively collected data on patient characteristics, perioperative outcomes, and all perioperative complications within 30 and 90 days after surgery. Complications were reported according to the Clavien-Dindo classification system and defined as overall (any grade), low (grades 1–2), and major (grades 3–5) complications. Postoperative ileus was defined as oral intake intolerance after cystectomy, or nausea and emesis accompanied by abdominal distension requiring gastrointestinal rest at any time postoperatively. We also collected complication data related to surgical intervention for RARC.

Selection of urinary diversion methods

Since one of the authors (T.I.) has experienced more than 15 cases of ICUD ileal conduit or neobladder in a previous institution, our fundamental strategy is to perform ICUD when we use the ileum for urinary diversion. However, we selected EUCD or cutaneous ureterostomy for the following

specific reasons: lack of proficiency as a team to perform ICUD, patient's age or comorbidities, single kidney, and patient's history of abdominal surgery. The reasons for selecting ECUD were retrospectively collected through a review of the inpatient and outpatient medical records.

Statistical analysis

Differences in the demographic features between cases with low and high complications within 30 and 90 days after surgery by Mann-Whitney *U* test or Chi-squared test and P values less than 0.05 were considered significant. There was no missing data. All analyses were performed using EZR version 1.61 (Jichi Medical University Saitama Medical Center).

Results

Table 1 shows the preoperative, perioperative, and pathological characteristics of the patients. Urinary diversion included ileal conduit, neobladder, and cutaneous ureterostomy in 35 (70%), 6 (12%), and 7 (14%) either by ECUD or ICUD. Cystectomy with bilateral nephroureterectomy was performed in two cases (4%). A total of 27 (54%) and 19 (38%) patients underwent extended, standard, or limited (only obturator lymph nodes) lymphadenectomy, respectively, whereas 4 (8%) patients did not undergo lymphadenectomy because of older age, patient complications, or palliative reasons for cystectomy for local control. Among 50 patients 9 had positive lymph node metastasis. Median positive lymph node number was 3 (maximum 18, minimum 1; IQR, 1–7) and median lymph node density (the number of positive nodes divided by total number of resected nodes) was 8.5% (maximum 63%, minimum 2.3%; IQR, 5–33%).

Table 2 shows pre-operative and peri-operative features of patients who received ileal conduit and compared them between ICDU and ECUD. Obviously, console time was significantly different between ICUD and ECUD. Interestingly, time to diet was shorter in patients who received ICUD than ECUD and it was statistically significant. However, there was no difference in G3 or higher complications within 30 and 90 days post-operation between cases with ICUD and ECUD.

Tables 3,4 show postoperative complications and grades. Briefly, 33 (66%) and 31 (62%) patients experienced complications during the first 90 and 30 days after RARC, respectively. Among them, 19 (38%) and 18 (36%) patients

Table 1 Demographic features of 50 patients who received RARC

Variables	Values
Total number patients	50
Age (years)	70 [66–75.8]
Gender	
Male	38 [76]
Female	12 [24]
BMI (kg/m^2)	22.88 [21.14–25.91]
Age-adjusted Charlson comorbidity index	
1	2 [4]
2	3 [6]
3	10 [20]
4	16 [32]
5	9 [18]
6	8 [16]
7	2 [4]
Clinical T stage	
Tis/T1	20 [40]
T2	16 [32]
T3	12 [24]
T4	2 [4]
Clinical N stage	
N0	46 [92]
N1–3	4 [8]
Neoadjuvant chemotherapy	34 [68]
Preoperative hemoglobin (g/dL)	11.5 [10.9–12.6]
Preoperative albumin (g/dL)	4.0 [3.6–4.2]
Pathological N stage	
T0	13 [26]
Ta/Tis/T1	16 [32]
T2	4 [8]
T3	13 [26]
T4	3 [6]
UPUMP	1 [2]
Pathological N stage	
N0	37 [72]
N1–3	9 [18]
Nx	4 [8]

Table 1 *(continued)*

Table 1 *(continued)*

Variables	Values
Lymph node yield (number)	28 [18–42]
No positive surgical margins	2 [4]
Operation time (min)	589 [526–652]
Console time (min)	455 [332–540]
Cystectomy + lymph-node dissection time (min)	285 [233–332]
ICUD ileal conduit time (min)	211 [193–245]
ICUD neobladder time (min)	370 [301–402]
Estimated blood loss (mL)	600 [282–1,154]
Blood transfusion	19 [38]
Transfusion volume during operation (mL)	4,200 [3,287–5,253]
Urinary diversion	
ECUD ileal conduit	11 [22]
ICUD ileal conduit	24 [48]
ECUD neobladder	1 [2]
ICUD neobladder	5 [10]
Cutaneous ureterostomy	7 [14]
None	2 [4]
Time to diet (days)	4 [2.25–5]
Hospital stay (days)	26.5 [22–34.75]

Data are presented as median [interquartile range], number or number [%]. RARC, robot-assisted radical cystectomy; BMI, body mass index; UPUMP, urothelial proliferation of unknown malignant potential; ICUD, intracorporeal urinary diversion; ECUD, extracorporeal urinary diversion.

developed G2 complications, and 12 (24%) and 11 (22%) developed major complications during the first 90 and 30 days after RARC, respectively. The most common complications were gastrointestinal complications (24%) and urinary tract infections (22%). Nine patients (18%) underwent surgical intervention within 90 days of undergoing RARC.

Table 5 shows relation with preoperative/perioperative factors and complications. Higher infusion volume during the operations was significantly correlated with the occurrence of major complications both within 90 days (P=0.025) and 30 days (P=0.0158) after RARC, respectively.

Figure 1 summarizes the reasons for selecting ileal conduit/neobladder ECUD or cutaneous ureterostomy. Twelve patients received an ECUD ileal conduit or neobladder, and among them, five cases were selected because our team had been too immature to perform ICUD even though one of the authors (T.I.) had experienced more than 15 cases of ICUD ileal conduit or neobladder. Three patients underwent ECUD due to intraabdominal adhesions for previous abdominal surgery or radiation (gastric cancer, intestinal tumor, and chemoradiation for bladder cancer at a previous hospital). Among them the case with previous surgical history for intestinal tumor, was hard to pursue ICUD, so we determined to convert ICDU to ECUD during surgery; even if we attempted to move the intestinal tract to the cranial side with the head in a low position, it did not move to the cranial side and interfered with the field of vision. The remaining four cases received an ECUD ileal conduit due to comorbidities and advanced cases (palliative surgery) to shorten the surgery time.

Discussion

We investigated complications following RARC performed at a single institution and the factors affecting the occurrence of complications. We also investigated why ECUD or cutaneous ureterostomy was selected for urinary diversion. In Japan, most radical cystectomies for bladder cancer have been performed using open approaches until April 2018, when RARC was covered by public health insurance and has become rapidly widespread (4). Therefore, most doctors, except one of the authors (T.I.), had no experience with both laparoscopic cystectomy and RARC at our institution, which might be a similar situation in most of the hospitals in Japan. Therefore, it is meaningful to summarize our initial RARC experiences, focusing peri- and post-operative complications, for sharing information to prevent and manage complications following RARC.

The present study reported overall complication rates of 66% and 62% during the first 90 and 30 days after RARC, respectively, and major complication rates of 24% and 22% during the first 90 and 30 days, respectively. Of the nine patients who underwent surgical intervention within 90 days, 7 (14%) had gastrointestinal complications (12,13).

Previous studies have shown that the overall complication rates after RARC vary from center to center (14). Recently, Yamada *et al.* collected data on all complications after radical cystectomy, including open, laparoscopic, and robot-assisted, from a large cohort in Japan (15). In their study, the overall complication rate was 69%, and that of high-grade complications was 25% within 90 days in the current cohort (15), which was relatively similar to

Table 2 Pre-operative and peri-operative features of patients who received ICUD or EUCD ileal conduit

Variables	Patients with ICUD IC	Patients with ECUD IC	P
Total number patients	24	11	–
Age (years)	70 [66.8–74.5]	73 [66.5–75.5]	0.735
Gender			>0.99
Male	18 [75]	8 [73]	
Female	6 [25]	3 [27]	
BMI (kg/m^2)	23.8 [21.6–26.5]	22.1 [18.7–26.9]	0.283
Age-adjusted Charlson comorbidity index			–
1	1 [4]	0 [0]	
2	1 [4]	1 [9]	
3	4 [17]	1 [9]	
4	10 [42]	5 [45]	
5	6 [25]	1 [9]	
6	1 [4]	2 [18]	
7	1 [4]	1 [9]	
Clinical T stage			0.462
Tis/T1	7 [29]	5 [45]	
T2	9 [38]	3 [27]	
T3	8 [33]	3 [27]	
T4	0 [0]	0 [0]	
Clinical N stage			0.354
N0	22 [92]	11 [100]	
N1–3	2 [8]	0 [0]	
Neoadjuvant chemotherapy	19 [79]	6 [55]	0.227
Preoperative hemoglobin (g/dL)	11.8 [10.9–13.2]	11.4 [11–12.5]	0.972
Preoperative albumin (g/dL)	4 [3.6–4.4]	3.8 [3.7–4.1]	0.363
Pathological T stage			0.409
T0	9 [38]	2 [18]	
Ta/Tis/T1	7 [29]	5 [45]	
T2	1 [4]	0 [0]	
T3	6 [25]	3 [27]	
T4	1 [4]	1 [9]	
Pathological N stage			0.578
N0	20 [83]	10 [91]	
N1–3	4 [17]	1 [9]	
Lymph node yield (number)	37 [23–47]	27 [10–38]	0.0723
No positive surgical margins	0	0	>0.99
Operation time (min)	612 [544–651]	538 [511–592]	0.0527
Console time (min)	510 [456–546]	321 [248–339]	<0.0001
Estimated blood loss (mL)	687 [343–870]	401 [234–999]	0.355
Blood transfusion	8	2	0.447
Time to diet (days)	4 [2–4]	5 [4–9]	0.0154
Hospital stay (days)	27 [22–34]	28 [24–31]	0.498

Data are presented as median [interquartile range], number or number [%]. ICUD, intracorporeal urinary diversion; ECUD, extracorporeal urinary diversion; IC, ileal conduit; BMI, body mass index.

Table 3 Post-operative complications (within 30 and 90 days)

Patients with ≥1 complications	Within 30 days (number)		Within 90 days (number)	
	Case with bowel-used urinary diversion (N=41)	Case without bowel-used urinary diversion (N=9)	Case with bowel-used urinary diversion (N=41)	Case without bowel-used urinary diversion (N=9)
One complication	22	3	19	3
Two complications	6	0	9	1
More than three complications	0	0	1	0

Table 4 Post-operative complication categories and grades (within 30 and 90 days)

Complication categories	Clavien-Dindo grades and number of patients															
	Grade of complications occurred within 30 days								Grade of complications occurred within 90 days							
	Case with bowel-used urinary diversion (N=41)				Case without bowel-used urinary diversion (N=9)				Case with bowel-used urinary diversion (N=41)				Case without bowel-used urinary diversion (N=9)			
	G2	G3a	G3b	G4	G2	G3a	G3b	G4	G2	G3a	G3b	G4	G2	G3a	G3b	G4
Intraabdominal abscess	2	3			1				3	3			1			
Urinary tract infection	6								9				2			
Wound infection	1				1				2				1			
Ileus	8								8							
Intestinal obstruction	1		3						1		4					
Intestinal perforation			1								1					
Wound herniation			1								1					
Abdominal herniation			1								1					
Uretero-intestinal anastomosis leakage		1								1						
Neobladder vaginal fistula			1								1					
Compartment syndrome			1								1					
Suffocation								1								1
Esophageal stenosis										1						

the rate observed in our cohort. Recently, a review of the Asian Robot-Assisted Radical Cystectomy Consortium database was published (16). The overall complication rate was 49.2%, whereas high-grade complications were 15.6% (16). The rate was relatively excellent, which might be because the Consortium is organized by nine academic institutions located in Asia and Australia, including two high-volume centers in Japan. Wijburg *et al.* performed a retrospective analysis of all consecutive RARC cases with intracorporeal reconstruction from nine European high-volume hospitals with ≥100 cases [European Association of Urology (EAU) Robotic Urology Section Scientific Working Group] (17). They analyzed the learning curve for RARC in terms of 90-day major complications (MC90), 90-day overall complications (OC90), operative time, estimated blood loss (EBL), and length of hospital stay. In total, 137 and 97 cases were needed to achieve a plateau at 14% and 48% for MC90 and OC90, respectively, which was longer than these outcomes than reaching a plateau for operative time and EBL (17). Piazza *et al.* reported the outcomes of RARC by two expert surgeons with extensive experience (>1,000 procedures) in robotic surgery. The rates of OC90 and MC90 after RARC were 46% and 16%, respectively, which were similar to the results of

Table 5 Factors correlated with postoperative major (≥ G3) complications

Factors	Post-operative high-grade (G3 or higher) complications within 30 days			Post-operative high-grade (G3 or higher) complications within 90 days		
	Yes	No	P value	Yes	No	P value
Age (years)	68	71	0.265	68.5	71	0.439
Gender (male/female)	9/2	29/10	>0.99	10/2	28/10	0.705
BMI (kg/m^2)	25.64	22.71	0.148	25.63	22.71	0.306
Blood loss (mL)	900	484	0.386	776.5	531	0.562
Infusion volume (mL)	5,050	4,000	0.0158	4,950	4,050	0.025
Operation time (min)	637	560	0.071	633.5	555	0.075
Age adjusted-Charlson comorbidity index	4	4	0.285	4	4	0.633
Preoperative hemoglobin (g/dL)	11	11.6	0.432	11	11.6	0.585
Preoperative albumin (g/dL)	3.9	4	0.534	4	4	0.855
History of abdominal surgery (yes/no)	5/6	18/21	>0.99	6/6	17/21	>0.99
Diabetes (yes/no)	4/7	13/26	>0.99	5/7	12/26	0.728
Neoadjuvant chemotherapy (yes/no)	8/3	26/13	0.33	9/3	25/13	0.296
Transfusion (yes/no)	6/5	13/26	0.293	6/6	13/25	0.496
Urinary diversion by ileum (yes/no)	10/1	31/8	0.662	11/1	30/8	0.425

BMI, body mass index.

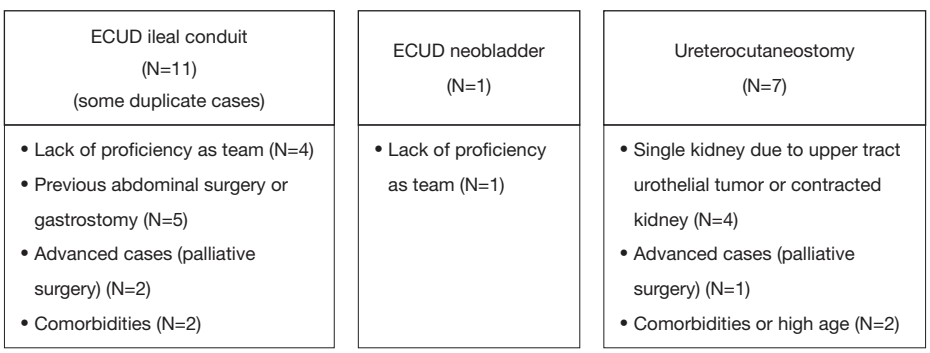

Figure 1 Reasons of selecting non-intracorporeal urinary diversion. ECUD, extracorporeal urinary diversion.

the EAU Robotic Urology Section Scientific Working Group (18). Compared to high-volume centers worldwide, the number of cases per institution is relatively small in Japan. Therefore, we divided the surgical procedures into three steps: pelvic lymphadenectomy, cystectomy with urethrectomy, and urinary diversion as modified version by Nakane *et al.* (9). This modified "Trisection method" may help the next generation of surgeons experience complex surgical procedures under the supervision of senior surgeons with limited cases in most institutions in Japan. At our institution, the major complication rate was not different between the first 25 cases (mostly performed by surgeons who had experience with more than 40 cases of RARP: first-generation surgeons) and the remaining 25 cases (performed by second-generation surgeons who were instructed by first-generation surgeons) (data not shown). However, from a safety perspective, the ability to safely complete a robotic-assisted radical prostatectomy is mandatory for the next generation surgeon before starting RARC, and this point should not be overlooked. We are still on the learning curve

of RARC to achieve the level of experts; thus, we need more cases to perform RARC carefully to reduce these major complications.

The complication rate after RARC may vary according to patient background. We analyzed factors correlated with the occurrence of major complications within 30 and 90 days after RARC. Infusion volume during the operation was the only significantly different factor between patients who experienced major complications and those without complications. Kauffman *et al.* previously reported that on multivariate analysis, age ≥65 years, operative blood loss ≥500 mL and intraoperative intravenous fluids >5,000 mL were significantly associated with postoperative major complications (19). In their cohort, 49% and 16% of patients suffered overall and major complications after RARC, respectively (19). They also found that intraoperative intravenous fluids >5,000 mL were significantly associated with postoperative overall complications (19). Possible pathophysiological mechanisms of increased complications associated with excess body fluid may lead to ileus (increased gut edema) and impaired wound healing or infection (reduced lymphatic drainage and oxygenation) (20). However, when we divided the cases into the first 25 cases and the remaining 25 cases, the infusion volume during the operations was not significantly different between patients in the last 25 cases who suffered major complications after 30 and 90 days and those without complications (data not shown). Thus, more RARC cases are needed to evaluate the factors associated with major complications after RARC.

Although RARC has become a minimally invasive procedure for patients who undergo radical cystectomy, especially at high-volume centers, most patients eligible for surgery have comorbidities that make us hesitate to perform the surgery. ICUD is a technically challenging procedure and may require longer operative times while mastering the skill and has the potential for increased early perioperative complications; thus, ECUD may have been preferred in the majority of non-high-volume centers in Japan (21). In this report, we investigated the reasons for selecting ECUD or cutaneous ureterostomy in our institution. Excluding cases while mastering RARC procedures, the main two reasons were (I) intra-abdominal adhesions associated with a history of prior abdominal surgery that may make manipulation of the bowel in the abdominal cavity difficult and (II) patients' comorbidities or age. However, increased experience with ICUD could shorten the operative time compared to ECUD and may become a preferred method of urinary diversion for patients with comorbidities or older age (22). Additionally, as Kadoriku *et al.* described in their article, ICUD ileal conduit is comparable to cutaneous ureterostomy in terms of oncological prognoses and perioperative outcomes, and can be performed safely in older patients (23).

The present study had some limitations. First, it was a retrospective study with a small sample size. Second, this study included heterogeneous patient characteristics: patients who underwent RARC and hemi- or bilateral nephroureterectomy, ICUD or ECUD ileal conduits, ICUD or ECUD neobladder, and cutaneous ureterostomy. Third, the follow-up duration was too short to evaluate the overall survival and late-phase complications (more than 90 days after RARC). Fourth, eight surgeons performed the operations; therefore, our results included technical and individual surgeon biases. Fifth, we have not yet applied enhanced recovery after surgery (ERAS) protocol for RARC, which may reduce incidence of post-operative ileus (24). Sixth, the frailty status of each patient was not assessed. Frailty may be associated not only with post-operative complications after RARC, but also with the prognosis of bladder cancer patients who have undergone radical cystectomy (24-26). Therefore, preoperative evaluation of frailty using the G-8 score could be a useful tool for predicting post-operative complications in patients.

Based on this assessment, perioperative nutrition therapy and physiotherapy for frail patients might reduce the rate of complications after RARC.

Seventh, our cases had high EBL and blood transfusion rate than those reported previously (27). Our EBL included urine spilled out in the operation field especially when performing ICUD, so thus it is relatively difficult to determine precise blood loss. Therefore, we think that our EBL was higher than the previous reports. Among 50 cases, 68% of the patients received pre-operative chemotherapy in our series. The percentage was higher than the previous reports (28), thus our cases might had relatively low reserve capacity for blood loss and needed transfusion. However, we need more cases to reach a plateau of EBL as indicated in reports by Wijburg *et al.* (17).

Conclusions

Surgical complications related to the initial experience with RARC at a non-high-volume center in Japan cannot be ignored. Although this complicated surgical procedure requires a learning curve to achieve a stable rate of much

fewer major complications after RARC, careful assessment of patients' status before surgery and critical postoperative management may reduce complication rates more quickly, even at non-high-volume centers.

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References

1. Patel SR, Lerner SP. Evolving the surgical approach for bladder cancer - robotic versus open radical cystectomy. Nat Rev Urol 2023;20:203-4.
2. Menon M, Hemal AK, Tewari A, et al. Nerve-sparing robot-assisted radical cystoprostatectomy and urinary diversion. BJU Int 2003;92:232-6.
3. Zamboni S, Soria F, Mathieu R, et al. Differences in trends in the use of robot-assisted and open radical cystectomy and changes over time in peri-operative outcomes among selected centres in North America and Europe: an international multicentre collaboration. BJU Int 2019;124:656-64.
4. Chen W, Yokoyama M, Kobayashi M, et al. Trends of radical cystectomy and comparisons of surgical outcomes among surgical approaches focusing on robot-assisted radical cystectomy: A Japanese nationwide database study. Int J Urol 2023;30:258-63.
5. Sathianathen NJ, Kalapara A, Frydenberg M, et al. Robotic Assisted Radical Cystectomy vs Open Radical Cystectomy: Systematic Review and Meta-Analysis. J Urol 2019;201:715-20.
6. Parekh DJ, Reis IM, Castle EP, et al. Robot-assisted radical cystectomy versus open radical cystectomy in patients with bladder cancer (RAZOR): an open-label, randomised, phase 3, non-inferiority trial. Lancet 2018;391:2525-36.
7. Charlson M, Szatrowski TP, Peterson J, et al. Validation of a combined comorbidity index. J Clin Epidemiol 1994;47:1245-51.
8. Charlson ME, Pompei P, Ales KL, et al. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. J Chronic Dis 1987;40:373-83.
9. Nakane K, Yamada T, Tomioka-Inagawa R, et al. Efficacy

and Safety of the "Trisection Method" Training System for Robot-Assisted Radical Cystectomy at a Single Institution in Japan. Curr Oncol 2022;29:9294-304.
10. Goto T, Sawada A, Kobayashi T, et al. Standardization of techniques for a totally intracorporeal ileal conduit after robot-assisted radial cystectomy. Journal of Japan Society for Endoscopic Surgery 2019;25:140-7.
11. Koie T, Ohyama C, Yoneyama T, et al. Robotic cross-folded U-configuration intracorporeal ileal neobladder for muscle-invasive bladder cancer: Initial experience and functional outcomes. Int J Med Robot 2018;14:e1955.
12. Catto JWF, Khetrapal P, Ricciardi F, et al. Effect of Robot-Assisted Radical Cystectomy With Intracorporeal Urinary Diversion vs Open Radical Cystectomy on 90-Day Morbidity and Mortality Among Patients With Bladder Cancer: A Randomized Clinical Trial. JAMA 2022;327:2092-103.
13. Noh TI, Shim JS, Kang SG, et al. The learning curve for robot-assisted radical cystectomy with total intracorporeal urinary diversion based on radical cystectomy pentafecta. Front Oncol 2022;12:975444.
14. Novara G, Catto JW, Wilson T, et al. Systematic review and cumulative analysis of perioperative outcomes and complications after robot-assisted radical cystectomy. Eur Urol 2015;67:376-401.
15. Yamada S, Abe T, Sazawa A, et al. Comparative study of postoperative complications after radical cystectomy during the past two decades in Japan: Radical cystectomy remains associated with significant postoperative morbidities. Urol Oncol 2022;40:11.e17-25.
16. Lee AY, Allen JC Jr, Teoh JY, et al. Predicting perioperative outcomes of robot-assisted radical cystectomy: Data from the Asian Robot-Assisted Radical Cystectomy Consortium. Int J Urol 2022;29:1002-9.
17. Wijburg CJ, Hannink G, Michels CTJ, et al. Learning Curve Analysis for Intracorporeal Robot-assisted Radical Cystectomy: Results from the EAU Robotic Urology Section Scientific Working Group. Eur Urol Open Sci 2022;39:55-61.
18. Piazza P, Bravi CA, Puliatti S, et al. Assessing pentafecta achievement after robot-assisted radical cystectomy and its association with surgical experience: Results from a high-volume institution. Urol Oncol 2022;40:272.e11-20.
19. Kauffman EC, Ng CK, Lee MM, et al. Critical analysis of complications after robotic-assisted radical cystectomy with identification of preoperative and operative risk factors. BJU Int 2010;105:520-7.
20. Silva JM Jr, de Oliveira AM, Nogueira FA, et al. The effect of excess fluid balance on the mortality rate of surgical patients: a multicenter prospective study. Crit Care 2013;17:R288.
21. Iwamoto H, Morizane S, Yamamoto A, et al. Utility of the HYBRID Method Incorporating the Advantages of Both Extracorporeal and Intracorporeal Urinary Diversion in Robotic-Assisted Radical Cystectomy. Yonago Acta Med 2022;65:288-95.
22. Tanneru K, Jazayeri SB, Kumar J, et al. Intracorporeal versus extracorporeal urinary diversion following robot-assisted radical cystectomy: a meta-analysis, cumulative analysis, and systematic review. J Robot Surg 2021;15:321-33.
23. Kadoriku F, Sasaki Y, Fukuta K, et al. A propensity score matching study on robot-assisted radical cystectomy for older patients: comparison of intracorporeal ileal conduit and cutaneous ureterostomy. BMC Urol 2022;22:174.
24. Zennami K, Sumitomo M, Hasegawa K, et al. Risk factors for postoperative ileus after robot-assisted radical cystectomy with intracorporeal urinary diversion. Int J Urol 2022;29:553-8.
25. Sugino Y, Sasaki T, Kato M, et al. Prognostic Effect of Preoperative Psoas Muscle Hounsfield Unit at Radical Cystectomy for Bladder Cancer. Cancers (Basel) 2021;13:5629.
26. Sathianathen NJ, Jarosek S, Lawrentschuk N, et al. A Simplified Frailty Index to Predict Outcomes After Radical Cystectomy. Eur Urol Focus 2019;5:658-63.
27. Tappero S, Dell'Oglio P, Cerruto MA, et al. Ileal Conduit Versus Orthotopic Neobladder Urinary Diversion in Robot-assisted Radical Cystectomy: Results from a Multi-institutional Series. Eur Urol Open Sci 2023;50:47-56.
28. Yuh B, Wilson T, Bochner B, et al. Systematic review and cumulative analysis of oncologic and functional outcomes after robot-assisted radical cystectomy. Eur Urol 2015;67:402-22.

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