The Influence of Prior Abdominal Surgery on Robot-Assisted Partial Nephrectomy

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Abstract

Background: The aim of this study was to evaluate the influence of prior abdominal surgery on perioperative outcomes in patients who underwent robot-assisted partial nephrectomy.

Methods: We reviewed patients with small renal tumors who underwent robot-assisted partial nephrectomy from October 2011 to September 2020 at our institution. Comparisons between patients with prior abdominal surgery and with no prior abdominal surgery were based on perioperative outcomes. Furthermore, patients underwent transperitoneal robot-assisted partial nephrectomy was compared between those with and without prior abdominal surgery. The Mann–Whitney U test and the chi-square test were used for statistical analyses of variables.

Results: Of 156 patients who underwent robot-assisted partial nephrectomy, 90 (58 %) had no prior abdominal surgery, whereas 66 patients (42 %) underwent prior abdominal surgery. No significant differences in perioperative outcomes were observed between with and without prior abdominal surgery groups. In transperitoneal approach robot-assisted partial nephrectomy, 31 patients (38.8 %) had prior abdominal surgery, whereas 49 patients had no prior abdominal surgery. Trocar insertion time in the with prior abdominal surgery group took longer than the without prior abdominal surgery group (32 vs. 28.5 min, $p = 0.031$). The other perioperative outcomes were no significant differences. In the conversion rate, no significant difference was observed between the two groups ($p = 0.556$).

Conclusions: Prior abdominal surgery does not appear to affect Robot-assisted partial nephrectomy. Robot-assisted partial nephrectomy can be a safe procedure for patients with prior abdominal surgery. In transperitoneal approach robot-assisted partial nephrectomy with prior abdominal surgery, trocar insertion time was longer, but no significant differences were found in other outcomes. The conversions to radical nephrectomy and open partial nephrectomy were not associated with prior abdominal surgery. Transperitoneal approach robot-assisted partial nephrectomy is thus considered a safe procedure for patients with prior abdominal surgery.

Background

Partial nephrectomy (PN) is a gold standard surgical procedure for small renal tumors in patients fit for surgery [1, 2]. Good outcomes have already been proven for both the open PN and laparoscopic PN (LPN) for renal tumors [3]. While a study has showed no significant differences in long-terms oncological outcomes between PN and radical nephrectomy [4], PN was superior to radical nephrectomy with respect to length and quality of life [5], LPN is difficult procedure to require advanced laparoscopic techniques for tumor resection and reconstruction. Following the first report of robot-assisted partial nephrectomy (RAPN) by Gettman et al. in 2004 [6], RAPN has been surigical procedure to replace LPN that may help with some of these techniques. The previous study has already demonstrated that RAPN is not inferior to laparoscopic and open approaches with respects to warm ischemia time (WIT), positive surgical margins

(PSMs), and perioperative complications [7–10]. In Japan, RAPN was administered by the Japanese Ministry of Health, Labor and Welfare in 2016. RAPN has become rapidly and widely used in Japan.

Prior abdominal surgery is related to accelerate adhesions, therefore, patients with prior abdominal surgery have an increased risk of organ injury. The previous study reported that more than 90% of patients with prior open abdominal surgery occur peritoneal adhesions [11]. Peritoneal adhesions may increase the risk of trocar injuries and perioperative complications and extend operative time and length of hospital stay.[12–15]. There were a few studies for outcomes of RAPN after prior abdominal surgery previously [16–18].

In this study, we evaluated the perioperative outcomes of RAPN in Japanese patients who had undergone prior abdominal surgery.

Methods

In this study, patients with small renal tumors underwent RAPN from October 2011 to September 2020 in our institution were retrospectively analyzed. This study was approved by the ethics committee of Tottori University Faculty of Medicine (approval nuber: 20A165). This study was performed in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki declaration. We confirmed medical history included prior abdominal surgery from a medical questionnaire administered at the initial assessment. Perioperative data included surgery duration, estimated blood loss (EBL), number of blood transfusions, WIT, and postoperative complications. RENAL (radius, exophytic/endophytic properties, nearness to renal sinus, anterior/posterior, and location relative to renal poles) nephrometry scores were determined using the formula by Kutikov and Uzzo [19]. A record of surgical outcomes was made by the operating room circulating nurse, which included total surgical time, trocar insertion time, robotic console time, and the other time. Trocar insertion time was defined as the time between the start of operation and the time the robotic system was rolled in. Console time was defined as the time spent by the surgeon using the robotic console. Perioperative complications were classified as grade II or more using the Clavien–Dindo grading system [20]. Trifecta achieved was defined as no perioperative complications, no PSMs, and WIT < 25 min.

At our institution, 5-trocars are placed for the transperitoneal approach, whereas the retroperitoneal approach entails the standard placement of a 4-trocar system. Camera ports were placed by open laparotomy. Adhesiolysis was performed to allow for the placement of additional trocars with laparoscopic and was performed to until we could start console and further adehesilysis was carried out under robotic assistance.

We divided the patients into two groups: with prior abdominal surgery group and without prior abdominal surgery group. Prior abdominal surgery was defined as laparoscopic and open surgery, which included appendectomy, gynecological surgery, cholecystectomy, hernia repair, colorectomy, gastrectomy, panperitontis, cesarean section, total nephrectomy, robot-assisted radical prostatectomy (RARP), esophagectomy, splenectomy, hepatectomy, and mesenteric tumor resection open biopsy.

The data were analyzed using SPSS v. 21.0 statistical software (IBM, Chicago, IL, USA). Comparison of the medians between groups was made using the Mann–Whitney U test. The nominal variables were compared using chi-square test. Statistical significance was defined as a *P* value of less than 0.05.

Results

Table 1 describes detail patient characteristics. Of the 156 patients, there were 66 (42%) patients with prior abdominal surgery and 90 (58%) patients with no surgery. Significant differences were observed between the two groups in the baseline patient characteristics of age, sex, and age-adjusted Charlson Comorbidity Index (CCI). There were no significant differences among the baseline patient characteristics of body mass index (BMI), tumor size, preoperative estimated glomerular filtration rate (eGFR), RENAL nephrometry score, and type of surgical approach. The types of abdominal procedures undergone are showed in Table 2. Fifty-two patients underwent one prior abdominal surgery once, whereas 14 patients underwent multiple abdominal surgeries. The most common prior surgery was Appendectomy (n = 29), followed by gynecological surgery (n = 14).

Table 1
Patients characteristics

Variable	Total	Prior surgery	No Prior surgery	P-value
Number of patients (%)	156	66 (42)	90 (58)	
Sex (male/female)	109/47	39/27	70/20	0.014
Age (years)	65 (34–87)	69.5 (43–87)	62 (34–86)	0.001
BMI (kg/m2)	23.5 (16.9–42.0)	23.0 (18.8–42.0)	23.6 (16.9–39.5)	0.177
Age CCI	3 (0–9)	4 (0–9)	2 (0–6)	0.001
Tumor size (mm)	25 (11–46)	25 (12–43)	24 (11–46)	0.255
Preoperative GFR (mL/min/1.73m2)	73.2 (17.9-121.3)	71.4 (28.5-110.3)	74.4 (17.9-121.3)	0.305
R.E.N.A.L nephrometry score	7 (4–10)	7 (4–10)	7 (4–10)	0.476
Approach (n.Trans/Retro)	80/76	31/35	49/41	0.418

Table 2
Type of prior abdominal surgery underwent before RAPN

	Total	Transperitoneal	Retroperitoneal
Appendectomy	29	15	14
Gynecological surgery	14	6	8
Cholecystectomy	8	1	7
Hernia repair	6	2	4
Colorectomy	6	1	5
Gastrectomy	4	1	3
Panperitontis	4	4	
Caesarean section	4	3	1
Radical nephrectomy	2		2
RARP	1	1	
Open biopsy	1	1	
Esophagectomy	1		1
Mesenteric tumor resection	1	1	
Splenectomy	1		1
Hepatectomy	1		1
Multiple abdominal surgeries	14	5	9

Table 3 shows the perioperative outcome and the comparison between prior abdominal surgery and no surgery. The median total surgical time was 237 min, median console time was 161 min, median EBL was 25 mL, and median WIT was 22 min. Open conversion and nephrectomy conversion involved 7 patients (4.5%), % change eGFR was 10.1%, PSMs were observed in 2 (1.4%) patients, blood transfusions were performed in 2 (1.4%) patients, perioperative complication rate was 10.1% (15/156 patients), and the trifecta achievement rate was 62.8% (98/156 patients). No perioperative mortalities occurred in this study. For the groups with and without prior surgery, respectively, the median total surgical times were 230 and 238 min ($P = 0.639$), median console times were 160 and 165 min ($P = 0.306$), median EBL were 20 and 30 mL ($P = 0.156$), median WIT were 21 and 22.5 ($P = 0.123$), conversions were 5 (7.6%) and 2 (2.2%) patients ($P = 0.134$), % change eGFR were 9.6% and 10.4% ($P = 0.764$), PSMs were observed in 2 (3.3%) and 0 (0%) patients ($P = 0.168$), blood transfusions were observed in 1 (1.6%) and 1 (1.1%) patients ($P = 1.000$), perioperative complications occurred in 6 (9.8%) and 9 (10.3%) patients ($P = 1.00$) and trifecta was achieved in 39 (63.9%) and 59 (59.8%) patients ($P = 0.732$).

Table 3
Perioperative outcome for all patients

	Total	Prior surgery	No Prior surgery	P-value
Operative time (min)	237 (112–456)	230 (112–414)	238 (141–456)	0.639
Consol time (min)	161 (69–325)	160 (69–259)	165 (69–325)	0.306
EBL (ml)	25 (5-400)	20 (5-400)	30 (5-400)	0.156
Warm ischaemia time (min)	22 (0–53)	21 (7–53)	22.5 (0–47)	0.123
Conversion (n.%)	7 (4.5)	5 (7.6)	2 (2.2)	0.134
% change eGFR (n.%)	10.1 (0-40.6)	9.6 (0-36.9)	10.4 (0-40.6)	0.764
Positive surgical margin (n.%)	2 (1.4)	2 (3.3)	0 (0)	0.168
Blood transfusion (n.%)	2 (1.4)	1 (1.6)	1 (1.1)	1.000
Perioperative complication Clavien-Dindo >Ⅱ (n.%)	15 (10.1)	6 (9.8)	9 (10.3)	1.000
Trifecta achievement (n.%)	98 (62.8)	39 (63.9)	59 (59.8)	0.732

Furthermore, we assessed transperitoneal RAPN. Among the 80 patients that underwent transperitoneal RAPN, 31 (38.8%) had prior history of abdominal surgery and 49 (61.2%) did not. Twenty-six patients had only one prior abdominal surgery, while 5 had undergone multiple prior abdominal surgeries, and appendectomy was the most common prior surgery (n = 15), followed by gynecological surgery (n = 6) (Table 2). Table 4 lists baseline patient characteristics and perioperative outcomes for transperitoneal RAPN in patients with prior abdominal surgery compared with patients without prior surgery. Statistically significant differences were observed in age and age-adjusted CCI, but none observed in sex, BMI, tumor size, preoperative eGFR, and RENAL nephrometry scores. For the groups with and without prior surgery, respectively, the median total surgical times were 269 and 241 min (P = 0.185), the median console times

were 182 and 176 min ($P = 0.946$), the median trocar insertion times were 32 and 28.5 min ($P = 0.031$), median EBL were 25 and 35 mL ($P = 0.373$), median WIT were 19 and 19 min ($P = 0.797$), conversion rates were 6.5% and 2.0% ($P = 0.556$), % change eGFR were 10% and 12% ($P = 0.996$), PSMs were observed in 1 (3.4%) and 0 (0%) patients ($P = 0.377$), blood transfusions were performed in 1 (3.4%) and 0 (0%) patients ($P = 0.377$), perioperative complications involved 3 (10.3%) and 5 (10.4%) patients ($P = 1.00$) and trifecta was achieved in 16 (55.2%) and 28 (58.3%) patients ($P = 0.816$).

Table 4
Patients characteristics and preoperative outcomes for Transperitoneal approach

Variable	Prior surgery	No Prior surgery	P-value
Number of patients	31 (38.8)	49 (61.2)	
Sex (n. male/female)	19/12	37/12	0.214
Age (years)	67 (43–82)	59 (38–84)	0.007
BMI (kg/m2)	22.67 (18.8–42)	23.70 (16.9–39.5)	0.211
Age CCI	3 (0–9)	2 (0–3)	0.007
Tumor size (mm)	25 (12–43)	26 (15–46)	0.382
Preoperative GFR (mL/min/1.73m2)	77.0 (28.5-104.2)	76.4 (24.75–99.88)	0.781
R.E.N.A.L nephrometry score	7 (4–10)	7 (4–10)	0.286
Operative time (min)	269 (177–414)	241 (174 – 46)	0.185
Consol time(min)	182 (106–259)	176 (119–325)	0.946
Trocar insertion time(min)	32 (20–69)	28.5 (12–60)	0.031
EBL(ml)	25 (5-400)	35 (5-300)	0.373
Warm ischaemia time (min)	19 (13–53)	19 (15–47)	0.797
Conversion(n.%)	2 (6.5)	1 (2.0)	0.556

Variable	Prior surgery	No Prior surgery	P-value
% change eGFR (n.%)	10 (0–37)	12 (0–37)	0.996
Positive surgical margin (n.%)	1 (3.4)	0 (0)	0.377
Blood transfusion (n.%)	1 (3.4)	0 (0)	0.377
Perioperative complication Clavien-Dindo >Ⅱ (n.%)	3 (10.3)	5 (10.4)	1.000
Trifecta achievement (n.%)	16 (55.2)	28 (58.3)	0.816

The reasons for conversion to radical nephrectomy and open partial nephrectomy are shown in Table 5. Six patients were converted to radical nephrectomy because of uncomplete tumor resection, 1 patient was converted to open partial nephrectomy. However, no significant differences were observed between the patients with and without prior abdominal surgery groups in the transperitoneal ($P = 0.556$) and all other approaches ($P = 0.134$). The conversions were unrelated to history of prior abdominal surgery.

Table 5
Conversion and the reasons for conversion

	Total	Prior surgery	No Prior surgery	P-value
Conversion	7	5	2	0.134
To radical nephrectomy	6	4	2	
To open partial nephrectomy	1	1	0	
Transperitoneal approach	3	2	1	0.556
Reason				
Uncomplete tumor resection	2	1	1	
Strong adhesions	1	1	0	

Discussion

In the present study, we retrospectively assessed the influence of prior abdominal surgery on RAPN. There were a few studies for the outcomes of RAPN with prior abdominal surgeries [16–18]. The present studies is the initial report about influence of prior abdominal surgery on RAPN in Japanese patients.

Generally, prior abdominal surgery is associated with the formation of abdominal adhesions [11]. Such adhesions have been demonstrated to complicate minimally invasive surgery and extend surgical time [11–15]. Szomstein et al. reported that approximately one-third of patients underwent prior abdominal surgery have been no adhesions, and up to 10% of those with no prior abdominal surgery have bowel adhesions. However, the type or number of prior abdominal surgeries was unrelated to the severity [21].

Several studies have investigated the effects of prior abdominal surgeries on laparoscopic and robotic urological surgeries [22, 23]. Seifman et al. evaluated 190 patients who underwent laparoscopic upper tract surgery, 76 of whom had prior abdominal surgery. Patients with prior abdominal surgery had an increased risk of perioperative complications and longer length of stay [23]. On the other hand, Parsons et al. assessed 700 patients who underwent laparoscopic urological surgery, of which 366 (52%) had prior abdominal surgery, and found no significant difference in EBL, the rate of conversion to open surgery, and perioperative complications rate. They concluded that prior abdominal surgery does not appear to affect adversely the performance of urological laparoscopy [22]. Several reports have investigated the influence of prior abdominal surgery on RARP [24–26]. Ginzburg et al. described that prior abdominal surgery does not increase in operative time, consol time, PSM, and perioperative complications for RARP [24]. Similarly, Siddiqui et al. found that there were no significant differences in operative time, EBL, between prior abdominal surgery patients and no patients on RARP [25]. We also have previously reported on the influence of prior abdominal surgery on RARP. Of the 150 patients who underwent RARP, 94 (63%) had no prior abdominal surgery. We found a significant difference in port insertion time, but none in total operative time, robotic console time, EBL, and perioperative complications between the two groups [26]. From these studies, RARP wasa a safe procedure, prior abdominal surgery was associated with no significant increase in perioperative outcomes.

A few reports have been published on the outcomes of RAPN with prior abdominal surgeries [16–18]. Petros et al. evaluated that 95 patients underwent transperitoneal RAPN with prior abdominal surgery, 54 had no prior abdominal surgery, whereas 41 patients underwent prior abdominal surgery. There were no significant differences of surgical time, WIT, length of hospital stay, and EBL, and significant differences in adhesiolysis. They concluded that transperitoneal RAPN is feasible in the setting of prior abdominal surgery [16]. Similarly, Zangar et al. evaluated 627 patients who underwent RAPN, 321 of whom had prior abdominal surgery. No significant differences were reported in surgical outcome, surgical time, WIT, EBL, and perioperative complications rate. They also concluded that RAPN can be safely performed in patients with prior abdominal surgery [17]. Furthermore, Abdullah et al. reports the first large multi-institutional report on perioperative outcomes of RAPN in patients with prior abdominal surgery. They evaluated 683 patients who underwent RAPN, 216 of whom had had prior abdominal surgery. Their study did not show statistically significant differences in surgical time and perioperative complications between patients with and without prior abdominal surgery. However, their study showed higher EBL in the with prior abdominal surgery group. They concluded that RAPN was a safe and feasible option in patients with prior abdominal surgery, and, while an increase in EBL was found, it did not translate into an increase in transfusion rate, operative time, or complications [18]. Similarly, we found that prior abdominal surgery

did not increase surgical time, EBL, WIT, complications, and transfusion rate. Our study concluded that RAPN was a safe procedure in patients with prior abdominal surgery.

Our present study is the first report evaluating the influence of prior abdominal surgery in Japanese patients who underwent RAPN. Significant differences in age, sex, and age-adjusted CCI, but no significant differences were observed in the other preoperative characteristics between the with and without prior abdominal surgery groups. These findings on the influence of prior abdominal surgery are consistent with those in most previous reports with respect to total operative time, robotic console time, EBL, WIT, conversion rate, % change eGFR, positive surgical margin, blood transfusion rate, perioperative complications, and trifecta achievement rate. Furthermore, we evaluated patients who underwent transperitoneal approach RAPN. Similarly, apart from age and age-adjusted CCI, no significant differences were found in preoperative characteristics, in operative time, robotic console time, EBL, WIT, conversion rate, % change eGFR, positive surgical margin, complications, and blood transfusion rate. However, a significant difference in port insertion time was observed (32 and 28.5 min, respectively; $P = 0.031$). The results of this study are similar to our previous reports on the influence of prior abdominal surgery on surgical outcomes of RARP [26]. Therefore, RAPN appears to be a safe procedure for patients with prior abdominal surgery.

The present study showed 7 patients were converted to open PN or radical nephrectomy. The reasons of conversion included incomplete tumor resection (n = 6), and strong adhesions (n = 1). Arora et al. reported that the rate of conversion for RAPN was low, and BMI and CCI were independent predictors of conversion. Tumor factors such as clinical stage, location, or RENAL score were not significantly associated with increased risk of conversion [27]. In our study, the rate of conversion to open PN or radical nephrectomy were no statistically significant differences ($P = 0.134$) between patients with and without prior abdominal surgery. In transperitoneal RAPN, 3 patients were converted to open PN or radical nephrectomy. the rate of conversion to open PN or radical nephrectomy were not statistically significant ($P = 0.556$) between patients with and without prior abdominal surgery. The rates of conversion were unrelated to prior abdominal surgery, and prior abdominal surgery was not associated with increased risk of conversion.

Some limitations of our study are to be recognized. First, our study included a single-institution analysis with a small number of patients. Therefore, early cases and various prior abdominal surgeries were included, and all prior abdominal surgeries were comprehensively evaluated. Second, this study involved multiple surgeons. However, the surgeons have performed many robotic surgeries, and the surgical techniques were presumably were same.

In conclusion, Prior abdominal surgery does not appear to affect Robot-assisted partial nephrectomy. RAPN can be a safe procedure for Japanese patients with prior abdominal surgery. In transperitoneal approach RAPN with prior abdominal surgery, an increase in trocar insertion time was observed, but no significant differences were found in all other perioperative outcomes. The conversions to radical nephrectomy and open partial nephrectomy were not associated with prior abdominal surgery.

Transperitoneal approach RAPN is thus considered a safe procedure for Japanese patients with prior abdominal surgery.

Abbreviations

RAPN: Robot-assisted partial nephrectomy

PN: Partial nephrectomy

LPN: Laparoscopic partial nephrectomy

WIT: Warm ischemia time

RENAL: Radius, exophytic/endophytic properties, nearness to renal sinus, anterior/posterior, and location relative to renal poles

PSMs: Positive surgical margins

EBL: Estimated blood loss

RARP: Robot-assisted radical prostatectomy

CCI: Charlson Comorbidity Index

BMI: Body mass index

eGFR: Estimated glomerular filtration rate (eGFR)

Declarations

Ethics approval and consent to participate

This study was a retrospective study approved by the ethics committee of Tottori University Faculty of Medicine. Informed consent was obtained in the form of opt-out on the web-site. Approval number is 20A165.

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and/or analysed during the current study available from the corresponding author on reasonable request.

Competing interests

Authors of this article hace no conflict of interest.

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Authors' contributions

Conception and design: TY, MH, and AT. Acquisition: TY, ST, YK, HI, and KH. Analysis and Interpretation of data: TY, MH, SM, and AT. Drafting of the manuscript: TY, and MH.

Supervision: MH, and AT. All authors read and approved the final manuscript.

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