



Robot-assisted radical nephrectomy with inferior vena cava thrombectomy: a case report

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Background: Recently, robot-assisted surgery has been widely used to treat several urological cancers. Robot-assisted radical nephrectomy (RARN) was approved by the health insurance system in April 2022; however, RARN with inferior vena cava tumor thrombectomy (IVCTT) is still challenging. Also, its safety and feasibility have not yet been established owing to lack of literature, especially in Japan.

Case Description: We performed RARN with IVCTT in four patients between April 2022 and March 2023 at Fujita Health University Hospital. To reduce the risk of tumor embolism and major hemorrhage, an “IVC-first, kidney-last” robotic technique was developed. The safety and feasibility of RARN with IVCTT were evaluated by assessing the perioperative outcomes. Three women and one man were enrolled in this study. The median age was 72 years, and the tumor was on the right side in all cases. According to the Mayo Clinic thrombus classification, two patients were classified as level I, and the others were classified as level II. The two patients at level I did not undergo presurgical treatments, whereas the others at level II underwent presurgical treatments, which were combinations of tyrosine kinase inhibitors and immune-checkpoint inhibitors. The median operation and console times were 341 and 247 min, respectively. The median bleeding volume was 577 mL, and no complications beyond grade III of the Clavien-Dindo classification were observed. The median length of postoperative hospital stay was 10 days.

Conclusions: Although the sample size was relatively small, we demonstrated the safety and feasibility of RARN with IVCTT in the Japanese population.

Keywords: Robot-assisted radical nephrectomy (RARN); inferior vena cava tumor thrombectomy (IVCTT); renal cell carcinoma (RCC); case report

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Introduction

Inferior vena cava (IVC) thrombus occurs in approximately 6–10% of renal cell carcinoma (RCC) cases (1). Radical nephrectomy (RN) with IVC tumor thrombectomy (TT)

using open surgery has remained the gold standard for the treatment of RCC with an IVC thrombus (2) since the first report by Skinner *et al.* in 1972 (3). There have been a few reports on RN with IVC tumor thrombectomy

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(IVCTT) using a laparoscopic approach (4,5). However, the application of the laparoscopic approach for RN with IVCTT is limited because of the complexity of the operation and potentially fatal complications. With the widespread adoption of robot-assisted surgery, Abaza *et al.* first performed robot-assisted RN (RARN) with IVCTT (6). Recently, Garg *et al.* reported that when experienced surgeons performed RARN with IVCTT in carefully selected patients, acceptable outcomes could be obtained, according to a systematic review and meta-analysis of perioperative outcomes (7).

In Japan, RARN was approved by the health insurance system in April 2022. Motoyama *et al.* reported the first successful treatment with RARN with IVCTT (8). However, because a few well-experienced urologists in a limited number of high-volume centers currently performed RARN with IVCTT owing to the high levels of surgical complexity and variation; its safety remains unknown, especially in Japan. In this study, we evaluated the safety and feasibility of RARN with IVCTT by assessing perioperative outcomes in a few initial cases. We present this case in accordance with the CARE reporting checklist (available at <https://tcr.amegroups.com/article/view/10.21037/tcr-23-855/rc>).

Case presentation

We performed RARN with IVCTT in four patients between April 2022 and March 2023 at Fujita Health University Hospital. The patients' characteristics, including age, sex, body mass index (BMI), and American Society of Anesthesiologists (ASA) score, were recorded preoperatively. Clinical disease characteristics included the tumor side,

metastatic disease, and presurgical treatment. Levels of IVC thrombi were depicted using Roman numerals and classified according to the Mayo Clinic thrombus classification (9). Surgical parameters included the surgical approach, surgical time, console time, estimated blood loss (EBL), excised weight, negative surgical margins, thromboembolism, need for anticoagulation, grade of complications [Clavien-Dindo (CD)] (10), pathology, postoperative hospital stay, and hospital stay.

The characteristics of the patients, including age, sex, BMI, IVC thrombus level at diagnosis, metastases, and presurgical treatment, are shown in *Table 1*. Among the two cases with presurgical treatment, one was administered avelumab plus axitinib for 8 months, while the other was administered pembrolizumab plus lenvatinib for 7 months. In both cases, the IVC thrombus decreased from level II to level I before surgery.

Before surgery, all patients underwent unenhanced abdominal computed tomography (CT) and four-phase dynamic contrast-enhanced CT examinations using ultrahigh-resolution CT to construct three-dimensional images for intraoperative navigation. IVC filters were not placed in any case. All RARN with IVCTT procedures were performed using the da Vinci Xi Surgical System (Intuitive Surgical, Sunnyvale, CA, USA) by four surgeons who completed the Japan-approved da Vinci certification program.

The patients were positioned in a modified left lateral decubitus position with flank elevation. Three robotic ports and one camera port were placed on the lateral side of the rectus abdominis muscle. The placement of a 5 or 12 mm assistant port is shown in *Figure 1*. Regarding the summary of the RARN procedure with IVCTT, the caudal IVC, cephalic IVC, and left renal vein was secured using twice-wrapped vessel loops after exposing the bilateral renal veins and IVC (*Figure 2A*). The lumbar veins draining into the IVC were dissected to avoid backflow in all four cases. The right renal artery was clamped or dissected at the intercaval region of IVC and aorta. The position of the IVC tumor thrombus was visualized using a laparoscopic ultrasound probe to identify its upper limit (*Figure 2B*). The caudal IVC, left renal vein, and cephalic IVC were clamped using twice-wrapped vessel loops and bulldogs from the caudal side. Subsequently, the IVC wall was cut, and the thrombus was removed along with the right renal vein (*Figure 2C*). IVC reconstruction was performed using 4-0 polypropylene (*Figure 2D*). After IVC reconstruction, the cephalic IVC, left renal vein, and caudal IVC were released

Highlight box

Key findings

- We demonstrated the safety and feasibility of robot-assisted radical nephrectomy (RARN) with inferior vena cava tumor thrombectomy (IVCTT) in the Japanese population.

What is known and what is new?

- RARN with IVCTT is still challenging.
- Safety and feasibility of RARN with IVCTT have not yet been established owing to lack of literature, especially in Japan.

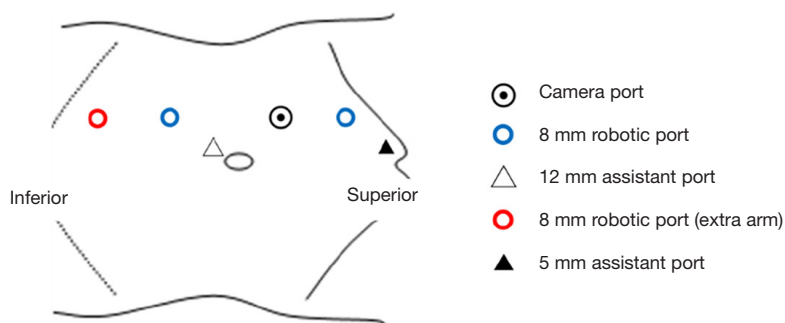
What is the implication, and what should change now?

- RARN with IVCTT should be carefully selected, especially in Japan, where these procedures have just been introduced.

Table 1 Patients' clinical characteristics

Case No.	Age, year	Sex	BMI, kg/m ²	Tumor side	IVC thrombus level at diagnosis	Metastatic diseases	Presurgical treatment
1	81	F	24.5	R	I	None	–
2	69	F	30.2	R	I	None	–
3	74	M	21.4	R	II	None	Avelumab + axitinib for 8 months
4	64	F	18.7	R	II	Lung	Pembrolizumab + lenvatinib for 7 months
Median	72		22.9				

BMI, body mass index; IVC, inferior vena cava; F, female; M, male; R, right.

**Figure 1** Port placement for robot-assisted radical nephrectomy with inferior vena cava tumor thrombectomy.

from the cranial side. RARN was completed after removal of the right adrenal gland. Systemic heparinization was not performed before IVC clamping; however, diluted heparin was injected into the IVC at the end of IVC reconstruction.

Perioperative factors, including ASA score, IVC thrombus level at operation, surgical approach, surgical time, console time, EBL, excised weight, negative surgical margins, thromboembolism, need for anticoagulation, pathology, complications (CD) ≥ 3 , postoperative hospital stay, and hospital stay, are shown in *Table 2*. In all cases, thromboembolism did not occur and anticoagulation was not needed.

All procedures performed in this study were in accordance with the ethical standards of the institutional research committee and with the Helsinki Declaration (as revised in 2013). Fujita Health University Ethics Review Committee approved this study (No. HM19-265) and waived patient consent due to the retrospective nature of this study.

Discussion

Open RN (ORN) with IVCTT remains the gold standard

treatment for RCC with IVC tumor thrombi. However, recent advances in minimally invasive robot-assisted surgery have enabled urologists to perform RARN using IVCTT. Robotic surgeries often provide some superior benefits (e.g., less pain, smaller incision, easier recovery) than those of open surgeries; however, these advantages vary depending on the difficulty of the surgery. Garg *et al.* performed a systematic review to assess the safety and feasibility of RARN with IVCTT regarding perioperative outcomes and compared these outcomes with those of ORN. Compared to ORN, RARN with IVCTT was associated with a lower blood transfusion rate, fewer overall complications, and shorter hospital stay. They concluded that RARN with IVCTT appeared to be safe and feasible with acceptable perioperative outcomes when well-experienced urologists performed them in carefully selected patients (7).

In Japan, it has only been a short time since RARN was approved by the health insurance system in April, 2022. In the context of RARN with IVCTT, no studies have been conducted since the first report by Motoyama *et al.* (8). Accordingly, the safety of RARN for IVCTT still remains unknown, particularly in Japan.

In the present study, we performed RARN with IVCTT

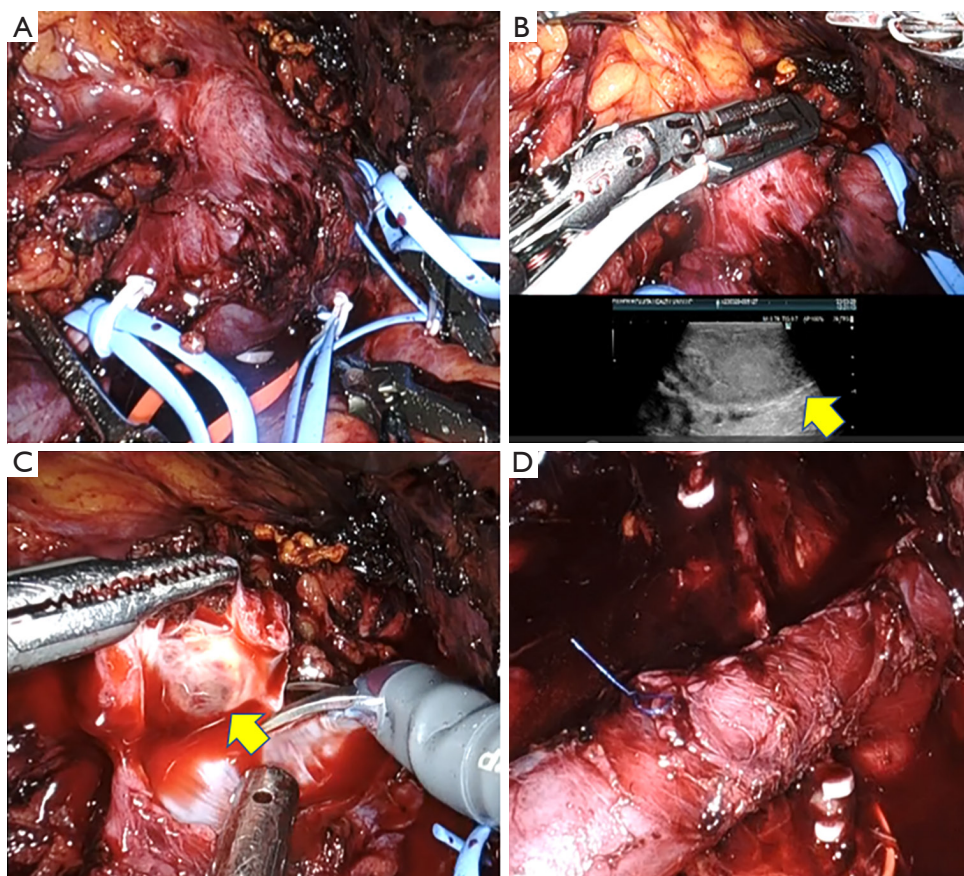


Figure 2 Key pictures of robot-assisted radical nephrectomy with IVC tumor thrombectomy. (A) Securing of the caudal IVC, cephalic IVC, and left renal vein by twice-wrapped vessel loops. (B) Visualization of IVC tumor thrombus (arrow) using a laparoscopic ultrasound probe. (C) Removal of IVC thrombus (arrow) along with the right renal vein. (D) IVC reconstruction with 4-0 polypropylene. IVC, inferior vena cava.

in four patients. In all cases, an IVC filter was not used for presurgical treatment. So far, several investigators have advocated indications for the use of IVCFs. Some investigators have shown that preoperative filter placement could complicate proximal surgical control and tumor thrombus removal (11), whereas others have shown that preoperative placement involves incorporation of the tumor into the filter (12,13). A Cochrane Database review was completed in 2010, which stated that no recommendation could be made regarding the use of IVCFs (14).

No significant intraoperative or postoperative complications occurred in any of the patients, resulting in satisfactory perioperative outcomes. Notably, all procedures for RARN with IVCTT were performed at the level I of the Mayo Clinic thrombus classification, which was considered a reason for satisfactory perioperative outcomes. In two cases, the IVC thrombus decreased from level II

to level I owing to presurgical treatments, which were combinations of tyrosine kinase inhibitors and immune-checkpoint inhibitors (ICIs). Dason *et al.* have reported that significant extrarenal disease, excessive surgical morbidity, poor performance status unrelated to IVC thrombus, and patient preference were relative indications for presurgical treatments (2). Other studies have shown that immediate cytoreductive nephrectomy (CN) for metastatic RCC (mRCC) is currently considered only for a limited number of patients, while deferred CN could be applied in a larger patient population that has favorably responded to systemic therapy (15). In the ICI era, a small number of case reports and case series have described deferred CN for patients with mRCC who achieved complete response (CR) or nearly CR (16-20). Pignot *et al.* concluded that delayed CN in patients who responded to ICI treatment provided promising oncological outcomes, and most patients could discontinue

Table 2 Perioperative outcomes

Case No.	IVC ASA thrombus score level at operation	Approach	Surgical time, min	Console, min	EBL, mL	Excised weight, g	Negative surgical margins	Thromboembolism	Needs of anticoagulation	Complication (≥CD III)	Pathology	Postoperative hospital stay, day	Hospital stay, day
1	2	I	327	231	550	293	–	None	None	None	Clear cell, pT3b	11	14
2	2	I	519	435	2,300	685	–	None	None	None	Clear cell, pT3b	11	13
3	3	I	355	256	53	555	–	None	None	None	Clear cell, pT3b	9	12
4	2	I	286	238	604	198	–	None	None	None	Clear cell, pT3a	8	11
Median	2		341	247	577	424						10	13

ASA, American Society of Anesthesiologists; IVC, inferior vena cava; EBL, estimated blood loss; CD, Clavien-Dindo.

systemic treatment (20). However, from a surgical perspective, ICI-based combination therapy results in a severe desmoplastic reaction, which increases perinephric adhesions and inflammation, thus increasing surgical complexity (21). Accordingly, ongoing prospective studies, such as PROBE and NORDIC-SUN, will better define the role of CN in the rapidly evolving treatment landscape of mRCC in combination with ICI-based systemic therapy.

In contrast, RARN with IVCTT of more than level II IVC thrombus has been amongst the most challenging urologic-oncologic surgeries and has been reported in a limited series (22-26). Complete mobilization of the liver and placement of a tourniquet in the suprahepatic infradiaphragmatic IVC proximal to the thrombus are needed in the management of a level III tumor thrombus. Moreover, the management of level IV tumor thrombus using a robotic approach is an evolving technique. Hui *et al.* reported the use of thoracoscopic isolation and occlusion of the supradiaphragmatic IVC (24). Some studies have reported that RARN with IVCTT was feasible even for more than level II thrombi, however, it could be true that these procedures have proven to be highly risky and require advanced robotic technique. To maximize intraoperative safety and chances of success, a thorough understanding of careful patient selection and a highly experienced robotics team is essential. Considering the results of ongoing prospective studies regarding the role of CN in the rapidly evolving treatment landscape for mRCC with a combination ICI-based systemic therapy, the procedure of RARN with IVCTT should be carefully selected, especially in Japan, where these procedures have just been introduced.

Conclusions

Favorable perioperative outcomes were obtained in four patients who underwent RARN with IVCTT. Although the sample size was relatively small, we demonstrated the safety and feasibility of RARN with IVCTT in the Japanese population.

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Footnote

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