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Case report

Robot-assisted laparoscopic resection of a retroperitoneal metastatic tumor encircling the left renal vein and inferior vena cava: A case report

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ABSTRACT

Robot-assisted laparoscopic surgery is a recently developed minimally invasive technique. Compared to traditional laparoscopy, it offers enhanced visualization and improved precision. Although it has been widely adopted for resection of retroperitoneal tumors, its application in the management of malignant tumors encircling major blood vessels has rarely been reported. Here, we present a case of successful robot-assisted laparoscopic resection of a retroperitoneal tumor encircling the left renal vein and inferior vena cava. The patient had a history of ovarian cancer and two laparotomies. The robotic surgery resulted in minimal surgical trauma. Intraoperative blood loss was estimated to be 50 mL. The patient passed flatus within 36 hours postoperatively. Postoperative pathology confirmed that the resected tumor was metastatic ovarian clear cell carcinoma. Computed tomography scan at the six-month follow-up showed no tumor recurrence. The case provides further clinical evidence for robot-assisted laparoscopic surgery in treating malignancies encircling major blood vessels.

1. Introduction

Ovarian cancer is a significant global health burden, with an estimated annual incidence of 10.6 per 100,000 women.[1] Unfortunately, a vast majority of patients have tumor recurrences and lymph node metastases within 5 years of initial diagnosis, even with standard treatment.[2] Managing patients with metastatic ovarian malignancies can be challenging and is influenced by anatomical sites, primary treatments, and comorbidities.[3,4] Despite rapid advances in medical treatment, such as platinum-based regimens, surgical resection plays a major role in the management of disease.[5,6] Recently, robotic surgery has emerged as an effective surgical procedure for advanced-stage ovarian cancer. Compared to traditional laparotomy, it is suggested to be associated with improved aesthetic results and potentially a longer overall survival.[7] Yet, because robotic surgery lacks tactile feedback, there is limited literature regarding resection of ovarian cancer encircling major vessels. Here, we present a case of metastatic ovarian cancer encircling the left renal vein and inferior vena cava. The tumor was successfully resected using the da Vinci robotic system.

2. Case description

2.1. Medical history

A 54-year-old female patient was admitted to the Department of Vascular Surgery, Peking Union Medical College Hospital, due to a "retroperitoneal mass".

The patient was found to have a lower abdominal mass 6 years earlier and was diagnosed with an ovarian tumor. In June 2020, she underwent ovarian tumor resection, hysterectomy, bilateral salpingo-oophorectomy, pelvic lymph node dissection, and omentectomy. Postoperative pathology revealed ovarian clear cell carcinoma. In March 2022, follow-up ultrasound revealed a left pelvic lesion, and PET/CT suggested recurrent ovarian cancer. She underwent pelvic mass resection; postoperative pathology showed an epithelial-derived tumor consistent with recurrent clear cell carcinoma. After the second surgery, she received regular chemotherapy and was treated with niraparib from September 2022 to November 2025.

In November 2025, ultrasound showed a mass posterior to the pancreatic head, and MRI revealed a space-occupying lesion between the

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posterior aspect of pancreatic head and the inferior vena cava (IVC). Contrast-enhanced chest-abdomen-pelvis CT indicated a soft-tissue mass in the retroperitoneum with mild enhancment after contrast. Based on three-dimensional (3D) reconstruction of contrast-enhanced CT, the mass encased approximately 1/3 of the abdominal aorta, 1/2 of the IVC, and 3/4 of the left renal vein, with multiple stenoses in both veins (Fig. 1A–1C). PET/CT scan showed a mass at the renal hilum level between the IVC and the abdominal aorta, with a maximum standardized uptake value (SUVmax) of 13.4, suspected metastasis (Fig. 1D). The patient had a history of appendectomy 30 years earlier, cesarean section 18 years earlier, and bowel obstruction 2 years earlier that resolved after conservative treatment.

2.2. Preoperative evaluations

After admission, a multidisciplinary team discussion was held involving the Departments of Obstetrics & Gynecology, General Surgery, Urology, Anesthesiology, Intensive Care Unit, and Blood Transfusion. Department of Obstetrics & Gynecology: The current lesion is relatively localized but is closely related to the IVC, abdominal aorta, pancreaticoduodenal region, and renal vein. Surgical resection is challenging. Our department can assist intraoperatively. Department of General Surgery: Our department can assist intraoperatively; adequate bowel preparation should be performed preoperatively. Department of Anesthesiology: The lesion is closely related to the IVC and left renal vein. The patient should be fully informed of the possible need for nephrectomy and the risk of massive bleeding and renal insufficiency. Department of Urology: Fully inform the patient of the risk of nephrectomy and renal insufficiency. Intensive Care Unit: Our department can prepare a bed; fully inform the patient about the risks. Department of Blood Transfusion: Fully inform the patient about the risk of adverse transfusion reactions and provide voluntary blood donation education.

According to consultations from most specialists (urologists, gynecologists, and anesthesiologists), the patient was at substantial risk of requiring nephrectomy and bleeding, primarily due to potential injury to major vessels (renal vessels and IVC) during resection. Conventional laparoscopic surgery was inadequate to handle this lesion; therefore, we chose robot-assisted surgery with a more precise and flexible control system for this patient. Preoperatively, contingency plans were made for possible intraoperative complications. For minor injuries to a major vessel that necessitates only simple repair, the robotic surgical system would be used for vascular repair. For severe injuries to a major vessel—particularly the IVC or aorta that require patch repair or prosthetic graft replacement, conversion to open laparotomy would be performed to complete the necessary reconstruction.

2.3. Surgical and treatment details

The patient underwent robot-assisted laparoscopic resection under general anesthesia using the da Vinci Xi robotic system (IS4000; Intuitive Surgical, CA, USA). The intraoperative trocar placement is shown in Fig. 2. After pneumoperitoneum was established, laparoscopic exploration revealed multiple small-bowel adhesions due to previous surgeries. The adhesions were carefully lysed. The colonic mesentery was then opened, the descending duodenum and pancreatic head were retracted to the left side of the abdomen, and the retroperitoneal mass was visualized after opening the Toldt's fascia. The mass was carefully dissected free from the IVC, abdominal aorta, and left renal vein, and completely resected for pathological examination (Fig. 3A–3C). Intraoperative blood loss was approximately 50 mL. One pelvic drain was placed. She was successfully weaned and extubated on the morning of postoperative day 2. The patient passed flatus 36 hours after surgery, and oral intake was gradually resumed. The drain was removed on postoperative day 3, and the patient was discharged on day 4.

2.4. Follow-up

Postoperative pathology confirmed ovarian clear cell carcinoma (Fig. 3D). Immunostaining: PAX-8 (+), CA-125 (focal+), CK20 (-), CK7 (+), ER (-), Ki-67 (index 50%), p16 (patchy+), p53 (wild-type expression), PR (-), WT-1 (-), calretinin (-). The patient was recommended to undergo follow-up every three months for the first two years after

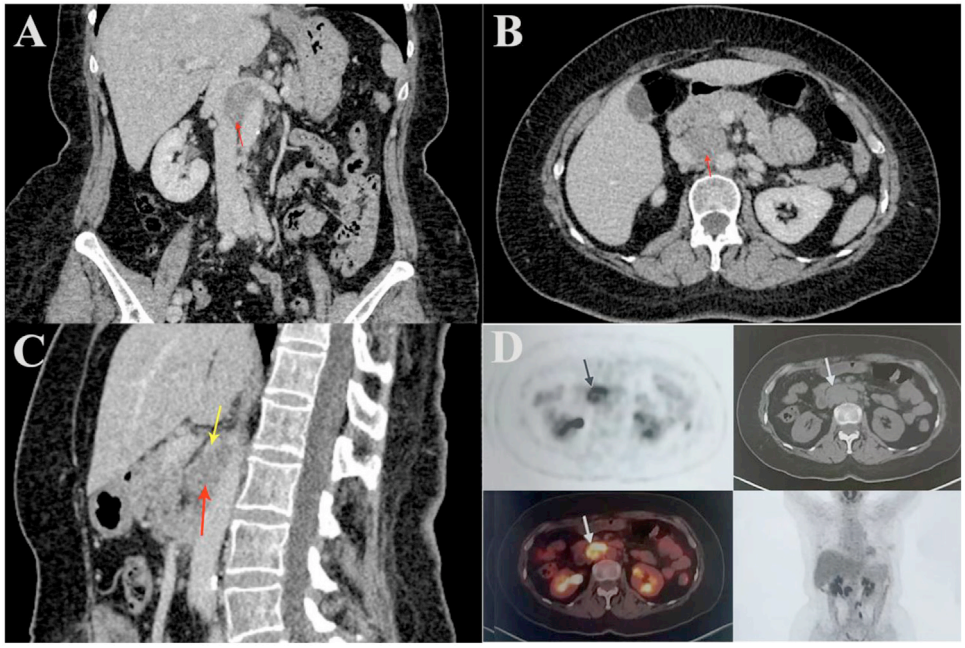


Fig. 1. Preoperative images of retroperitoneal tumor. (A) Coronal section of abdominal enhanced-contrast CT: The tumor (red arrow) resides between the inferior vena cava (IVC), left renal vein, and abdominal aorta. Significant stenosis of the IVC and left renal vein was observed due to tumor compression. (B) Axial section of abdominal enhanced-contrast CT: The tumor (red arrow) encircles approximately 1/2 of the IVC and 1/3 of the abdominal aorta. (C) Sagittal section of abdominal enhanced-contrast CT: The tumor (red arrow) encircles approximately 3/4 of the left renal vein (yellow arrow). (D) PET/CT: Tumor resides at the renal hilum level between the IVC and the abdominal aorta, with a maximum standardized uptake value (SUVmax) of 13.4. The white and black arrows indicate the location of tumor.

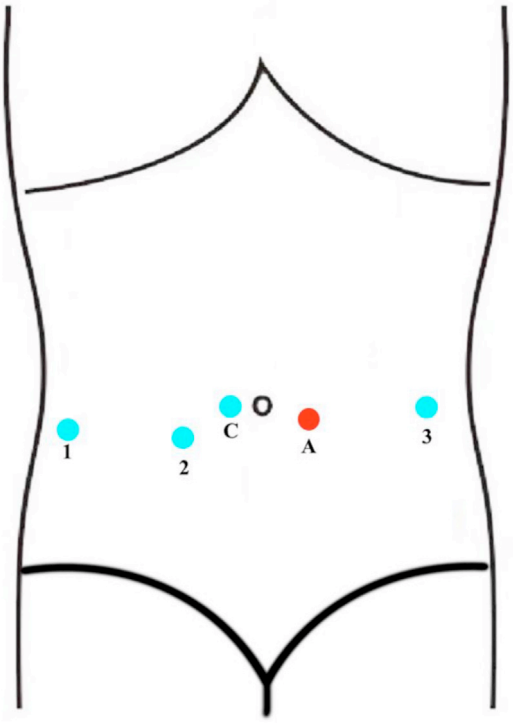


Fig. 2. Position of trocars. C: robotic camera; A: assistant's port; 1, 2, 3: robotic arm.

surgery, then every four months in years three to five, and every six months after five years. The follow-up consists of a careful physical examination, serum assessment of tumor markers such as CA-125, and radiological scan (CT or MR) if necessary. CT at the 6-month follow-up revealed no recurrence with patent left renal vein and IVC (Fig. 4).

3. Discussion

The da Vinci robotic surgical system was adopted early for pancreatic surgery and was considered as a milestone in minimally invasive surgery.[8] It offers 3D high-resolution visualization, wrist-like articulated instruments, and tremor-filtering technology, surpassing conventional laparoscopy for fine dissection in narrow spaces.[9] It was first introduced into China more than a decade ago for related procedures.[10] With the development of this technique, the da Vinci robotic system has been widely used in general surgery, urology, obstetrics and gynecology, orthopedics, and other disciplines.[11–13] However, in the field of vascular surgery, particularly for procedures involving major vessels, clinical experience with surgical robots remains very limited. A possible reason is that the haptic feedback and dexterity of robotic systems still cannot match those of the human hand. Previously, robotic laparoscopic surgery has been mainly used for non-malignant tumors or malignant tumors that do not involve major abdominal vessels. Robotic laparoscopy has also been reported for resection of recurrent gynecological malignancies[14] and cytoreductive surgery.[15] However, there is limited clinical evidence for robotic resection of malignant tumors that encase major abdominal vessels.

This patient had a retroperitoneal malignant tumor encasing the left renal vein, IVC, and abdominal aorta. The tumor was also closely related to the right renal artery. Conventional open surgery usually requires an incision longer than 20 cm, with considerable intraoperative blood loss and a higher risk of postoperative incisional pain and incision-related complications.[16] Moreover, the patient had already undergone two previous laprotomies and had a history of postoperative bowel obstruction. If an open approach with a Kocher maneuver for retraction of the small intestine and duodenum had been used, prolonged recovery of gastrointestinal function and increased risk of adhesive bowel obstruction would have been expected. Our team successfully performed robot-assisted laparoscopic surgery. Although the operative time was relatively long, there was no severe bleeding; the patient resumed gastrointestinal function rapidly postoperatively, trauma was reduced, and hospital stay was

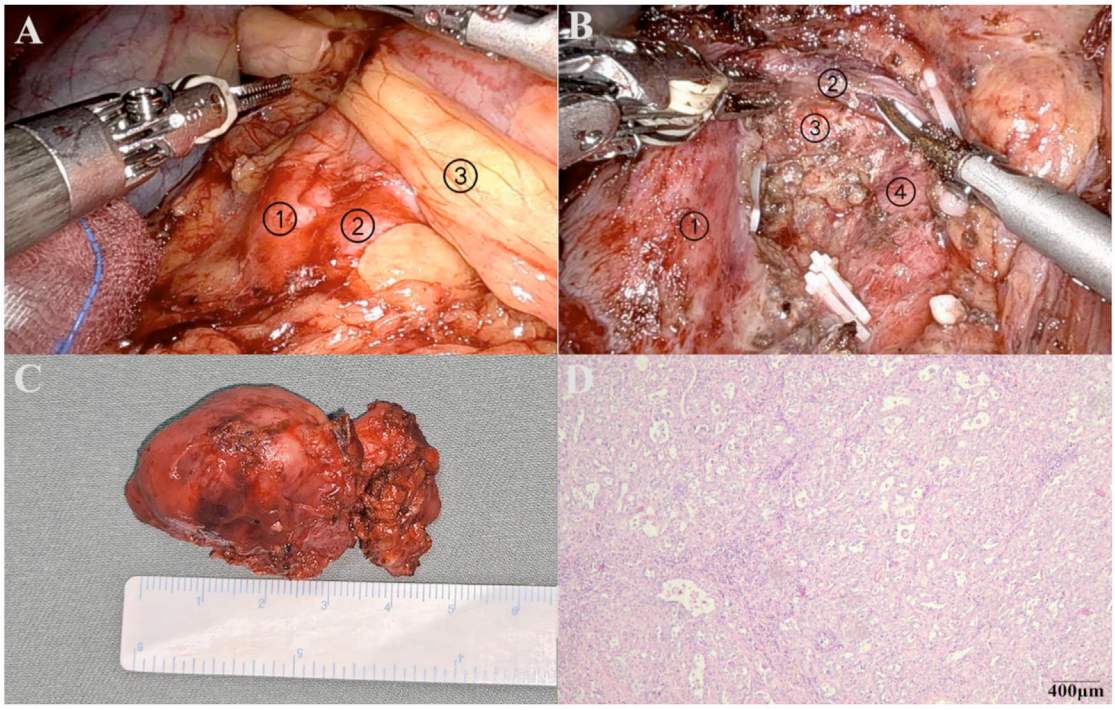


Fig. 3. Intraoperative view and pathological examination. (A) laparoscopic view before resection: ① IVC, ② tumor, ③ duodenum; (B) laparoscopic view after resection ① IVC, ② left renal vein, ③ left renal artery, ④ abdominal aorta; (C) gross image of resected tumor; (D) Hematoxylin and Eosin staining of tumor specimen shows ovarian clear cell carcinoma: clear cells, eosinophilic cells, and hobnail cells can been seen.

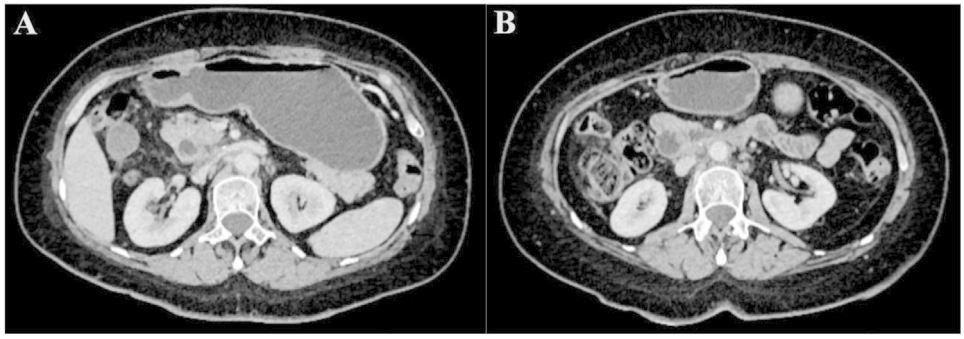


Fig. 4. Contrast-enhanced CT scan at six-month follow-up. Both images show patent left renal vein and IVC with no sign of tumor recurrence. (A) axial section at the level of the left renal vein; (B) axial section at the level of renal hilum.

shortened. The main technical challenge was dissecting the IVC and left renal vein. Unlike the arterial adventitia, the venous adventitia is usually thin, requiring careful identification and delicate manipulation under high-resolution visualization. Atraumatic forceps should be used to gently retract the IVC and renal vein to avoid tearing the veins.[17] Lumbar veins draining into the posterior aspect of the IVC should be carefully ligated to prevent bleeding. Preoperative assessment of the 3D relationship between the tumor and major blood vessels is of utmost importance to the success of resection. If a malignant tumor has encased more than three-fourths of the main vein, ligation or reconstruction of that main vein should be considered. Particularly, if the right renal vein is encased, right nephrectomy should generally be considered because the right renal vein is relatively short and usually difficult to reconstruct in such cases.[18] For lesions encasing major arteries, proximal and distal control of the artery with vessel loops can be considered to enhance surgical safety.

Compared to open resection, robot-assisted surgery was associated with reduced blood loss, shorter post-operative hospital stay, and decreased operative time.[17] This advantage is magnified in surgeries carried out in narrow spaces that require delicate manipulation. Recently, Xie and colleagues reported successful robotic laparoscopic resections of benign and borderline retroperitoneal tumors involving major abdominal vessels.[19] Yet, as the degree of tumor encasement of major blood vessels increases, surgical difficulty and complication rates increase dramatically.[19] Thus, for patients who require multiple operative sites and vessel reconstruction, robot-assisted surgery alone may not be sufficient. There were also concerns that robotic-assisted surgery may influence recurrence patterns and worsen oncologic prognosis due to technical limitations. These limitations mainly include the use of pneumoperitoneum, restricted visualization, and lack of tactile feedback. However, a recently published retrospective study did not support this assumption.[7] In this cohort with advanced ovarian cancer who achieved complete cytoreduction, recurrence patterns and oncologic outcomes were comparable between robotic and open surgery. Patients treated with robotic surgery had significantly longer median overall survival compared with those treated with open surgery.[7] Nevertheless, prospective trials are needed to further determine the role of robot-assisted surgery in treating advanced ovarian cancer.

In summary, with careful preoperative assessment and meticulous intraoperative technique, robot-assisted laparoscopic resection is feasible for metastatic ovarian cancer encasing major blood vessels. This case also provides important clinical evidence for the application of the robotic surgical system in the field of vascular surgery.

Authors' contributions

Chen YX contributed to the conception, writing–review & editing, and funding acquisition. Di X wrote the initial draft of the manuscript. Huang HG, Wang WB, Ma X, and Yang YS were involved in investigation. Yang YF participated in data curation. Yang YS participated in formal analysis. All authors are responsible for the integrity of the work and were involved in the final decision to submit the manuscript for publication.

Patient consent

Written informed consent was obtained from the reported patient for the publication of this case report.

Declaration of generative AI and AI-assisted technologies use

The authors declare that neither generative AI nor AI-assisted technologies was used in the preparation of this article.

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Conflict of interest

The authors declare no conflict of interest.

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