

# Recurrent Renal Tumor Thrombus in Inferior Vena Cava After Surgery: Surgical Management and Clinicopathological Features from a Large Chinese Center

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## Research Article

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## Abstract

**Background:** To summarize the surgical technique and clinicopathological features of recurrent renal tumor thrombus in inferior vena cava (IVC) after surgery.

**Methods:** We retrospectively analyzed the clinicopathological data of nine patients with recurrent renal tumor thrombus in IVC after surgery, who were admitted to Peking University Third Hospital between November 2015 and March 2021.

**Results:** Among the nine patients, six patients (66.7%) developed recurrent tumor thrombus in the IVC after radical nephrectomy; two cases (22.2%) were recurrent tumor thrombus in the IVC after partial nephrectomy. One patient (11.1%) underwent partial nephrectomy first and radical nephrectomy for the second time. The recurrence of tumor thrombus in the IVC occurred after the operation. All the nine patients underwent open surgery for IVC thrombectomy. Eight patients (88.9 %) were operated smoothly. Among these eight patients, six patients (75%) underwent IVC segmental resection, and two patients (25%) underwent IVC thrombectomy. Another patient underwent IVC tumor thrombus exclusion. Median operative time was 380 (IQR: 338.5–540.5) min. Median estimated intraoperative blood loss was 1200 (IQR: 600–2250) ml. According to the modified Clavien classification system, one patient had grade I complications, three patients had grade II complications, and one patient had grade IVa complications. During a 20-months (range, 2-58 months) follow-up, tumor-specific death occurred in three patients and distant metastasis occurred in six patients.

**Conclusions:** The operation of recurrent renal tumor thrombus in IVC after surgery is difficult. For patients with high-risk renal cell carcinoma, more close follow-up should be conducted after operation.

## 1 Background

Renal cell carcinoma (RCC) is a common malignant tumor in urology(1). Renal cell carcinoma has signs of venous invasion(2). Tumors are easy to break through the kidney and enter the renal vein, and enter the inferior vena cava (IVC) or even the right atrium along the blood flow direction(3–5). In locally advanced RCC, 4 % to 10 % of patients are complicated with inferior vena cava tumor thrombus(6, 7). RCC with IVC tumor thrombus has higher surgical complexity and higher incidence of surgical complications than localized RCC(8). Therefore, the safety and effectiveness of surgical treatment of RCC with IVC tumor thrombus has important clinical significance. At present, most of the research objects are concentrated in patients with RCC combined with IVC tumor thrombus at the first visit(9). However, there are few studies on recurrent tumor thrombus in the IVC after partial or radical nephrectomy(10–12). In this study, we retrospectively analyzed the clinicopathological data of 9 patients with recurrent renal tumor thrombus in IVC after surgery, who were admitted to Peking University Third Hospital between November 2015 and March 2021. The surgical techniques and clinical pathological characteristics were summarized to improve the diagnosis and treatment experience.

## 2 Methods

Among the nine patients in this study, there were six males and three females. The average age is 56.6 years old and the average BMI is 23.4kg/m<sup>2</sup>. Five cases of primary renal tumors were located on the right side and four cases on the left. Preoperative assessment of the American Society of Anesthesiologists (ASA) was performed in four cases with grade I and five cases with grade II. IVC tumor thrombus was classified according to the Mayo classification(7), including zero case of Mayo 0, one case of Mayo I, five cases of Mayo II, two cases of Mayo III and one case of Mayo IV.

According to the clinical manifestations of the patients, they were divided into those without obvious clinical symptoms, those with only local symptoms (such as hematuria, low back pain, abdominal mass, etc.), and those with only systemic symptoms (such as fatigue, weight loss, fever, etc.), and those with both local and systemic symptoms. All patients underwent enhanced computed tomography (CT) examination of the urinary system preoperatively to evaluate the side, size of the tumor, whether there were perirenal fat invasion, lymph node metastasis and distant metastasis, and enhanced magnetic resonance imaging (MRI) examination of IVC to identify the characteristics of tumor thrombus. (Fig. 1) The length and width of the IVC tumor thrombus were measured at the coronal position. The presence or absence of bland thrombus (non-neoplastic thrombus) was determined by the delayed phase of enhanced MRI(13). According to the imaging characteristics, whether the tumor thrombus invaded the vascular wall(14) and whether there was a tumor thrombus growing against the direction of venous return were judged.

All patients underwent open surgery. The procedure was as follows. Chevron incision was used when the primary renal tumor was located on the right side. From the xiphoid process to the mid-axillary line at 2cm below the right costal margin, it extended about 10cm below the left costal margin, forming a "herringbone" incision. If the primary renal lesion was located on the left side, the open surgical incision was symmetrical to the right renal tumor incision. Surgical methods for patients with different tumor thrombus grades were as follows. If the Mayo I tumor thrombus was short, IVC tumor thrombus could be squeezed into the renal vein by "milking" technique and downgraded to grade 0. Cut off the renal vein using Hem-o-lok clip at the proximal end. For patients with Mayo II tumor thrombus, the contralateral renal vein, caudal IVC, and cephalic IVC were dissociated and exposed. The caudal IVC, contralateral renal vein, and cephalic IVC were sequentially clamped using the vascular blocking tape. The IVC wall was cut, and the thrombus was removed. If the tumor thrombus was found to invade the IVC wall, it is necessary to segmental resect the invaded vena cava wall(15). For Mayo III patients, several short hepatic veins should be cut and a long enough IVC should be dissociated to provide surgical vision. The ligamentum teres hepatis, left and right triangular ligament, sagittal ligament and coronal ligament were cut off, and the liver was dissociated and turned left. The posterior IVC and hepatic vein were fully exposed. Intraoperative ultrasound can be used to explore the superior pole of tumor thrombus in vena cava. Fully dissociate and expose the liver and the first hepatic portal. The distal IVC of tumor thrombus was blocked first, then the contralateral renal vein, hepatic artery and portal vein were blocked in turn, and finally the proximal IVC was blocked. For Mayo IV patients, the technique of avoiding thoracotomy and cardiopulmonary bypass was selected. The diaphragm was cut longitudinally during operation. The "milking" technique was used to squeeze the atrial tumor thrombus into the IVC with fingers and block the pathway of upward displacement of the tumor thrombus.

According to the nature of tumor thrombus and the degree of vascular wall invasion, IVC surgery was divided into simple IVC thrombectomy, distal IVC transection (retaining the contralateral renal vein back into the IVC), and segmental IVC resection. After cutting the IVC wall during the operation, if the tumor thrombus was filled and completely blocked the IVC, considering the invasion of the IVC wall, a segmental resection of the inferior vena cava was required. For right primary renal tumors with recurrent tumor thrombus in the IVC, 4 – 0 Prolene suture can be used for continuous suture of the left renal vein, the distal end and the proximal end of the IVC during the operation, and the blood can be refluxed only by the branches of the left renal vein. For left primary renal tumor with recurrent tumor thrombus in the IVC, the blood reflux channel from the right renal vein to the distal end of the IVC can be retained, and the proximal end of the inferior vena cava can be sutured. If intraoperative adrenal invasion or metastasis is found, adrenalectomy is needed. Renal hilar lymph node dissection is required during the operation if renal hilar lymph node enlargement is found.

The pathological types of renal cell carcinoma, WHO / ISUP nuclear grading, and whether renal hilar lymph node metastasis were analyzed according to postoperative pathology. The preoperative serum creatinine and 1 week after operation were counted to reflect the changes of renal function before and after operation. The modified Clavien classification system was used to evaluate the postoperative complications(16), among which grades  $\geq$  three were defined as severe complications(17).

The first follow-up was conducted within one month after the operation, focusing on postoperative complications. Then the patients were followed up every 3–6 months, every 6–12 months after 2 years, and every year after 5 years. Patients with residual tumor or postoperative recurrence or distant metastasis were treated with tyrosine kinase inhibitors.

### 3 Results

Among the nine patients in this group, six cases (66.7%) had clinical symptoms, and all showed local symptoms. Six patients (66.7%) underwent radical nephrectomy for RCC, and recurrent tumor thrombus was found in the IVC during postoperative follow-up. Partial nephrectomy was performed in two patients (22.2%) due to RCC. Tumor recurrence was found in the affected kidney during postoperative follow-up, and renal tumor broke through the renal vein to form tumor thrombus in the IVC. Another patient underwent partial nephrectomy because of RCC. Local recurrence of the affected kidney was found during postoperative review. The second radical nephrectomy was performed for local recurrence. The recurrence of tumor thrombus in the IVC was found during postoperative follow-up. Before the operation of inferior vena cava tumor thrombus in nine patients, no obvious metastatic tumor was found in renal hilum lymph nodes. Four patients (44.4%) considered ipsilateral adrenal metastases before surgery. Four patients (44.4%) found other metastases except for adrenal metastasis. Three patients had pulmonary metastasis and one patient had thoracic spine metastasis combined with pulmonary metastasis. There were five patients (55.6%) with IVC tumor thrombus combined with bland thrombus (non-neoplastic thrombus). The average length of IVC tumor thrombus was 7.7 cm, and the average width was 2.5 cm. (Table 1) All the nine patients underwent open surgery for IVC thrombectomy. Eight patients (88.9 %) were operated smoothly. Among these eight patients, six patients (75%) underwent IVC segmental resection, and two patients (25%) underwent IVC thrombectomy, namely IVC incision, tumor thrombus removal and vascular suture. Another patient (11.1%) underwent IVC tumor thrombus exclusion, simple palliative nephrectomy and ipsilateral adrenal metastasis resection. Four patients (44.4%) underwent renal hilar lymph node dissection. Adrenalectomy was performed in four cases (44.4%) due to the consideration of ipsilateral adrenal metastasis. Median operative time was 380 (IQR: 338.5–540.5) min. Median estimated intraoperative blood loss was 1200 (IQR: 600–2250) ml. Median intraoperative infusion of suspended red blood cells was 400 (IQR: 0–950) ml, median intraoperative infusion of plasma volume was 0 (IQR: 0–400) ml. (Table 2) The median postoperative hospital stay was 11 (IQR: 9–25) d. The serum creatinine before median operation was 97 (IQR: 84.5–126)  $\mu\text{mol/L}$ , serum creatinine at one week after surgery was 111 (IQR: 67.5–133)  $\mu\text{mol/L}$ . Eight cases (88.9%) were clear cell renal cell carcinoma, and one case (11.1%) was papillary renal cell carcinoma. No lymph node metastasis was reported in all patients undergoing intraoperative lymph node dissection and three cases of adrenal metastasis were found after adrenalectomy.

**Table 1**  
Preoperative data of patients with recurrent inferior vena cava tumor thrombus(n = 9)

No	Mayo grade	Gender	Age (yr)	BMI (kg/m <sup>2</sup> )	Clinical symptoms	Primary renal tumor side	Renal tumor size (cm)	Previous surgery	ASA grade	Preoperative lymph node metastasis	Preoperative adrenal metastasis	distant metastasis except adrenal gland	Pres of b thrc
1	I	Male	53	26.6	Local symptoms	Left	Unknown	First partial nephrectomy, second radical nephrectomy	I	No	No	No	No
2	I	Male	49	16.2	Local symptoms	Right	10.6	Radical nephrectomy	I	No	Yes	Pulmonary	Yes
3	I	Female	47	23.6	Local symptoms	Right	5.4	Radical nephrectomy	I	No	Yes	No	Yes
4	I	Male	55	24.8	Local symptoms	right	5.0	Radical nephrectomy	I	No	No	Pulmonary, thoracic spine	No
5	I	Female	56	25.4	Local symptoms	Left	4.8	Radical nephrectomy	I	No	Yes	No	No
6	I	Male	65	25.0	Local symptoms	Left	Unknown	Radical nephrectomy	I	No	No	No	No
7	I	Male	56	20.1	No	Right	9.5	Partial nephrectomy	I	No	No	Pulmonary	Yes
8	II	Male	64	26.7	No	Left	6.0	Partial nephrectomy	II	No	No	Pulmonary	Yes
9	I	female	64	22.3	No	Right	4.6	Radical nephrectomy	I	No	Yes	No	Yes

**Table 2**  
Intraoperative data of patients with recurrent inferior vena cava tumor thrombus(n = 9)

No	Mayo grade	Surgical approach	Operative time (min)	Estimated blood loss (ml)	Infusion of suspended red blood cells (ml)	Infusion of plasma volume (ml)	Renal hilar lymph node dissection	Ipsilateral adrenalectomy	Inferior vena cava segmental resection
1	I	Open	380	1300	800	400	No	No	Yes
2	I	Open	350	1500	0	0	Yes	No	Yes
3	I	Open	312	300	0	0	Yes	Yes	Yes
4	I	Open	340	700	400	0	No	No	Yes
5	I	Open	563	500	400	200	No	Yes	Tumor thrombus exclusion
6	I	Open	520	700	0	0	Yes	No	No
7	I	Open	405	1200	1100	400	No	Yes	Yes
8	II	Open	561	7000	4400	2000	No	No	No
9	I	Open	337	3000	800	0	Yes	Yes	Yes

In this group, five cases (55.6%) had postoperative complications, including one case (11.1%) with severe complications. One case of grade I complication, manifested as edema of both lower extremities, was improved after conservative observation. Three cases of grade II complications, including one case of postoperative gastroparesis, gradually improved after fasting and rehydration therapy. One case of incomplete intestinal obstruction was improved after fasting rehydration therapy. Anemia accompanied by coagulation dysfunction in 1 case, after infusion of plasma and suspended red blood cells improved. Grade II complications occurred in three cases (33.3%), including postoperative gastroparesis in one case, gradually improved after fasting rehydration therapy, incomplete intestinal obstruction in one case, improved after fasting rehydration therapy, anemia with coagulation dysfunction in one case, improved after transfusion of plasma and suspended red blood cells. Grade IVa complication was found in one case with renal insufficiency, which was improved by hemodialysis.

During a 20-months (range, 2–58 months) follow-up, tumor-specific death occurred in three patients and distant metastasis occurred in six patients. TKI drugs or mTOR inhibitors were used after operation. (Table 3)

**Table 3- Postoperative data of patients with recurrent inferior vena cava tumor thrombus[n=9]**

No	Mayo grade	Postoperative hospital stay (d)	Preoperative		Postoperative		Pathological type	Nuclear grade	Perirenal fat invasion	Pathological renal hilar lymph node metastasis	Pathological ipsilateral adrenal metastasis	Inferior vena cava wall invasion		Postoperative complications	Follow-up time (month)	Survival status	Postoperative recurrence	Postoperative metastasis	Postoperative adjuvant therapy
			serum creatinine ( $\mu\text{mol/L}$ )	(1 wk) serum creatinine ( $\mu\text{mol/L}$ )															
1	III	27	97	63	ccRCC	3	No	No	-	Yes	II	49	Survival	No	No	Axitinib			
2	IV	21	89	111	ccRCC	-	-	No	-	Yes	II	20	Death	No	Yes	Sunitinib, Axitinib			
3	II	9	88	72	ccRCC	3	No	No	Yes	Yes	0	37	Survival	No	Yes	No			
4	II	9	113	121	ccRCC	2	-	No	-	Yes	I	23	Death	No	Yes	No			
5	II	9	81	55	ccRCC	-	-	No	Yes	Yes	0	19	Survival	No	No	Sunitinib, Everolimus			
6	II	10	119	113	ccRCC	-	-	No	-	No	0	10	Survival	No	No	No	No		
7	II	11	709	845	ccRCC	3	No	No	-	Yes	IVa	9	Survival	No	Yes	Sorafenib			
8	I	31	133	145	ccRCC	3	No	No	-	No	0	2	Survival	No	Yes	No			
9	III	23	68	91	PA	3	No	No	Yes	Yes	II	58	Death	No	Yes	Sorafenib			

ccRCC= clear cell renal cell carcinoma, PA=Papillary adenocarcinoma.

## 4 Discussion

There are few studies on the recurrence of tumor thrombus found in the IVC after partial nephrectomy or radical nephrectomy for renal tumors. Previously, most were case studies. Parker et al evaluated the prognosis of patients with recurrent vena cava tumor thrombus after prior nephrectomy for RCC. They found that surgical resection is complex but feasible, and the survival rate after resection is very low, the median time of recurrence and death was 4 (IQR: 1.7–16) months and 12 (IQR: 6–30.4) months, respectively(10). Rosen et al reported that under the care of experienced robotic surgeons, robotic resection of recurrent RCC with IVC thrombus is a potential treatment(18). Ciancio et al introduced the transplantation-based thrombectomy method, which provided good exposure and vascular control, so as to minimize the incidence of complications and provide a safe treatment option for patients(19). This study retrospectively analyzed the data of nine cases of recurrent renal tumor thrombus in IVC after RCC surgery, which was a relatively large sample size study in the current related studies.

The surgical incision for recurrent tumor thrombus in the IVC after RCC surgery was chosen as an abdominal Chevron incision. If the initial partial nephrectomy or radical nephrectomy is done by an open approach. During the second operation, it is necessary to remove the skin scar from the first herringbone incision to ensure the good wound healing ability of the wound after this operation. If the first operation is retroperitoneal laparoscopic approach, the second operation still chooses the abdominal Chevron incision. The first operation was partial nephrectomy, and the second operation requires to remove the affected kidney. The experience in this group of patients found that the first operation will cause severe intra-abdominal tissue adhesions, increasing the difficulty of surgery.

Surgery for recurrent tumor thrombus in the inferior vena cava is a secondary operation, and intraoperative adhesions increase the difficulty of the operation. In areas with severe adhesions, the IVC adheres to the surrounding intestines. When intestinal adhesions are involved, the use of scissors should be used to avoid thermal damage to the intestines, such as ultrasonic scalpel or monopolar electrotome. One patient (Case nine) had severe adhesion between the jejunum and the IVC, which was separated with sharp scissors. The intestinal wall was partially damaged, and 4 – 0 absorbable suture was used to repair the intestinal canal rupture. In another patient (Case eight), the tumor adhered to the diaphragm, psoas major muscle and spleen. During the operation, the invaded psoas major muscle, spleen and diaphragm were excised and repaired with silk suture. One patient in this group (Case five) was found to be extremely malignant during the operation. The vascular wall of the IVC was stiff, and the tumor thrombus invaded the vascular wall and involved the hepatic vein. The possibility of tearing the IVC wall and hepatic vein wall during operation is great, and tumor thrombus of the IVC should be excluded. Only the left adrenal gland tumor was removed. Our experience shows that surgery for recurrent IVC tumor thrombus is difficult.

Surgical treatment of the IVC region is an important core step in the surgical procedure of recurrent tumor thrombus in the IVC. Preoperative CT and other imaging examinations should be used to accurately determine the extent of the tumor thrombus in the IVC, such as the distal and proximal location of the IVC tumor thrombus. For Mayo III and IV tumor thrombus, transesophageal ultrasonography can be used during operation. Intraoperative ultrasound was used to help determine the extent of tumor thrombus, and to determine whether there was tumor thrombus in the renal vein in the contralateral renal vein or in the branch of renal vein. Preoperative imaging suggested or intraoperative found that tumor thrombus extensively invaded the vessel wall, and segmental resection of the IVC should be performed during the operation (six of the nine patients in this group underwent segmental resection). After removing the invaded IVC wall, ensure that the remaining IVC wall has no tumor remnants to avoid recurrence. For the vascular end of the IVC, 3 – 0 vascular line can be used to suture the distal end of the inferior vena cava. For the contralateral renal vein, it should be carefully judged whether there is cancer thrombus invaded during the operation. If there is tumor thrombus invasion in the contralateral renal vein, the affected renal vein should be resected and the vessel wall should

be sutured continuously with 4 – 0 vascular line. If there is no tumor thrombus in the contralateral renal vein, the blood outflow tract from the contralateral renal vein to the distal end of the IVC can be preserved as much as possible.

Clearing the time interval between the initial RCC surgery and the detection of recurrent tumor thrombus in the IVC is of great significance for understanding the characteristics of the disease. In this study, we found that the median time interval between the first and second operation was 20 months (range: 6 to 36) months. This helps to pay attention to the probable time of recurrent tumor thrombus in the IVC during follow-up after initial surgery. Patients at high risk should be followed up more closely. IVC ultrasonography should be used as a routine examination after RCC surgery. In addition, regular urinary CT imaging examination is also necessary. Two of the patients in this group had recurrent tumor thrombus in the IVC after partial nephrectomy. The enlightenment for us is that the initial diagnosis of tumors with a diameter of less than 7 cm (stage T2) (20)should be carefully read, and the differential diagnosis of T3a (renal vein tumor thrombus or renal sinus invasion) should be paid attention to. Patients with recurrence risk should be fully informed of the corresponding risk. Partial nephrectomy is a treatment for localized RCC, and more reasonable clinical diagnosis should be made before operation. Radical nephrectomy should be performed for T3a RCC to avoid tumor recurrence.

We acknowledge that this study has some limitations. In this retrospective study, no case-control study was conducted between patients with recurrent tumor thrombus in the IVC and patients with traditional RCC and IVC tumor thrombus. The number of patients is limited, although it is a study with a large number of cases reported in the literature at present, multi-center and larger sample size studies can be carried out.

## 5 Conclusions

The operation of recurrent renal tumor thrombus in IVC after surgery is difficult. For patients with high-risk renal cell carcinoma, more close follow-up should be conducted after the operation.

A: 49-year-old male, right renal cell carcinoma after radical resection. Enhanced CT of the urinary system suggested a filling defect of the inferior vena cava, and obvious enhancement was observed after enhancement. Tumor thrombus was suspected to invade the inferior vena cava wall. Segmental inferior vena cava resection was performed during operation.

B: 56-year-old female, left renal cell carcinoma after radical nephrectomy. Urinary enhanced CT showed tumor thrombus in the inferior vena cava. During the operation, it was found that the tumor thrombus invaded the inferior vena cava wall and could not be separated. Exclusion of tumor thrombus was performed.

C: 56-year-old male, recurrent right renal cell carcinoma with inferior vena cava tumor thrombus after partial nephrectomy. Enhanced CT of the urinary system showed thickening of the right renal vein and inferior vena cava, with irregular mass shadows and obvious enhancement.

D: 64-year-old female, recurrent inferior vena cava tumor thrombus after right radical nephrectomy. Enhanced CT of the urinary system showed filling defects in the inferior vena cava. It could be seen that the starting part of the left renal vein was thickened, and the tumor entered the left renal vein 1 cm. In addition, the left lumbar vein tumor thrombus could be seen.

## Abbreviations

IVC: inferior vena cava

RCC: renal cell carcinoma

BMI: body mass index

ASA: American Society of Anesthesiologists

CT: computed tomography

MRI: magnetic resonance imaging

IQR: interquartile range

TKI: Tyrosine kinase inhibitors

mTOR: mammalian target of rapamycin

ccRCC: clear cell renal cell carcinoma

PA: Papillary adenocarcinoma.

## Declarations

### Ethical Approval and consent to participate

All procedures performed in studies involving human participants were in accordance with the ethical standards of the Peking University Third Hospital ethics committee. Informed consent was obtained from all individuals. This study was approved by the institutional review board of the Peking University Third Hospital (the number of the ethics approval: No.2018-396-01).

## Consent for publication

Not applicable.

## Availability of data and materials

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

## Competing interests

The authors declare that they have no competing interests.

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## Authors' contributions

ZL, YXL, GDZ, LLM: study conception and design, literature search, clinical studies, data analysis, statistical analysis, manuscript preparation, manuscript editing. LYG, PH, SYT, XZ: study conception and design, literature search, clinical studies, data analysis, manuscript editing. SDZ, XJT, SMW, CL, HXZ: study conception and design, clinical studies, manuscript editing. LLM: guarantor of the integrity of the entire study. The authors have read and approved this manuscript, and ensure that the listed authors' contributions are accurate.

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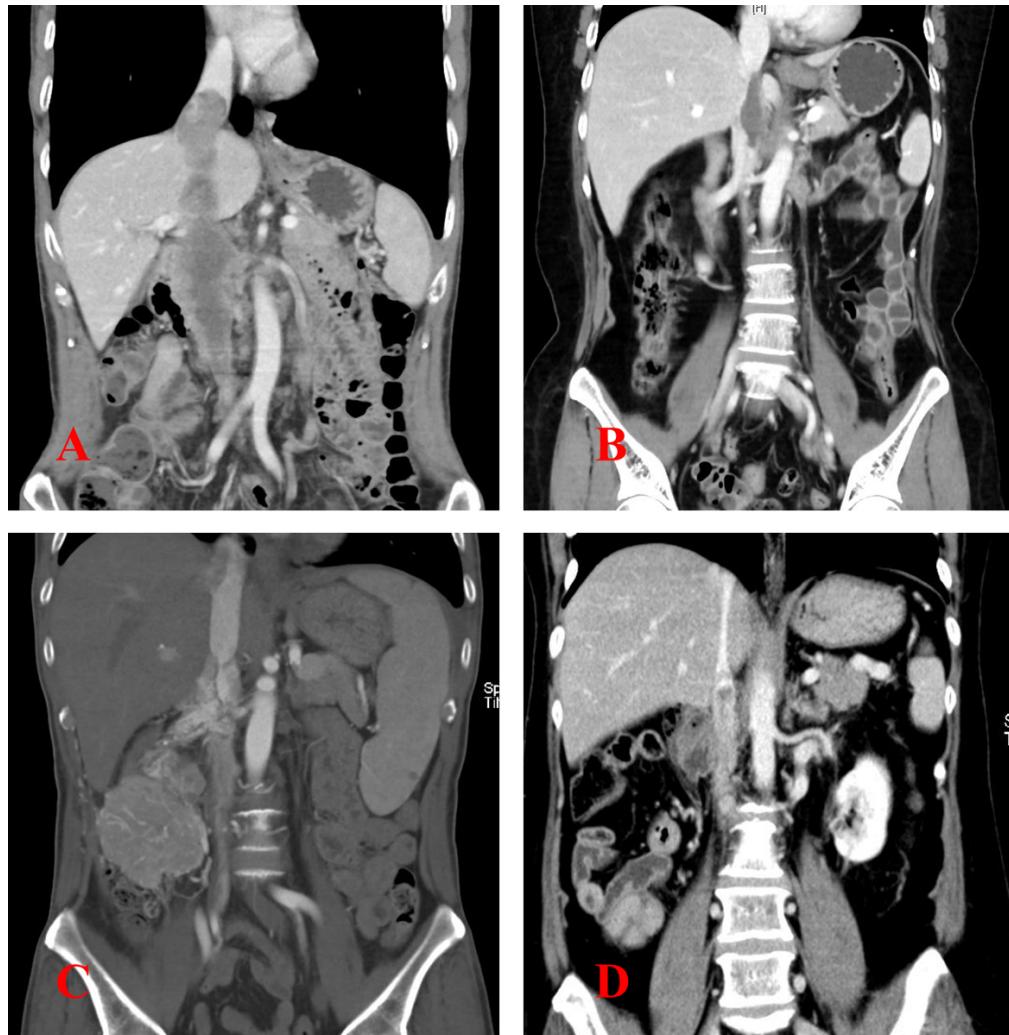
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## Figures



**Figure 1**

Preoperative imaging examination of recurrent rectal tumor thrombus in inferior vena cava after surgery