Surgical Management of Renal Cell Carcinoma with Inferior Vena Cava Thrombus: Experience from a Nepalese University Tertiary Care Center

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ABSTRACT

Background

An inferior vena cava (IVC) thrombus in Renal Cell Carcinoma (RCC) represents a challenging and complex scenario, requiring meticulous surgical planning and multidisciplinary care. We describe our experience in the surgical treatment of RCC with IVC thrombus extending to different levels of IVC and even reaching the right atrium.

Method

This is a retrospective observational study of patients who underwent surgery for RCC with IVC thrombus over 10 years from July 2014 to August 2024 in Tribhuvan University Teaching Hospital. Descriptive analysis assessed demographic characteristics, imaging, surgical treatment, and outcomes regarding complications and survival.

Result

A total of 35 RCC cases with IVC thrombus were retrospectively reviewed (mean age: 63.28 years; range: 35–75). Level II thrombus was most common (40%), while level IV was seen in six patients (17.14%). Of the level IV cases, four underwent cardiopulmonary bypass (CPB); in the remaining two, thrombus regression allowed clamping; one above and one just below the diaphragm. Among seven level III cases, two required supradiaphragmatic clamping, four were clamped between the diaphragm and hepatic veins, and one below the liver. In two cases with IVC wall invasion, segmental resection with end-to-end suturing was performed. High-grade (Clavien-Dindo IV–V) complications were noted in four level IV cases, with two perioperative deaths linked to CPB (pneumonia, pulmonary embolism). Clear cell carcinoma was the predominant subtype (94.29%), with papillary carcinoma in the remainder. Pathological nodal metastasis was present in 14.29%. Three-year overall survival was inversely related to thrombus level: 64.29% (level I), 62.5% (II), 57.14% (III), and 33.33% (IV). Distant metastasis, seen in 25.71%, was the leading cause of late mortality, particularly in node-positive cases.

Conclusion

The management of RCC with IVC thrombus is challenging, requiring meticulous surgical planning and multidisciplinary care. High-level IVC thrombus (Level III and IV) was associated with high perioperative morbidity and even mortality.

Key-Words: Renal Cell carcinoma, IVC Thrombus, Management, outcome

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Introduction:

Renal cell carcinoma (RCC) is the most common type of kidney cancer in adults, accounting for approximately 90% of all kidney malignancies.[1,2] Among the various presentations of RCC, an inferior vena cava (IVC) thrombus occurs in 10% of cases, and it represents a particularly challenging and complex scenario, requiring meticulous surgical planning and multidisciplinary care.[1,2] Natural history of RCC with IVC thrombus without treatment remains poor, with a median survival of five months and a one-year disease-specific survival of only 29%.[3] On the other hand, it has durable cancer-free survival with a five-year Disease Specific Survival of 40-60% after radical nephrectomy.[4-7] We describe our experience in the surgical treatment of RCC with IVC thrombus extending to different levels of IVC and even reaching the right atrium.

Material and Methods:

We retrospectively studied 35 cases of RCC with IVC thrombus who underwent surgical treatment over 10 years from July 2014 to August 2024 at Tribhuvan University Teaching Hospital, Kathmandu, Nepal. All data, including demographics, imaging, surgical treatment, and outcomes, were obtained from either the prospectively maintained proformas or hospital records. Approval from the Institutional Review Committee was obtained for ethical clearance.

1. Preoperative assessment and preparation

Preoperative assessment of the tumor (tumor thrombus extent, local extent into the perirenal adipose tissue, status of adrenal gland, retroperitoneal or intraabdominal adenopathy or metastases, renal vascular anatomy, enlarged collateral vessels) was carried out with cross-sectional imaging which included either contrast enhanced CT scan of abdomen and chest or Magnetic Resonance Imaging of chest and abdomen or both. Tumor thrombus was classified according to the classification proposed by Montie and colleagues (Table 1).[8] Transthoracic echocardiography (TEE) was done for level III and IV thrombus. Doppler USG of the lower extremities was performed if clinical symptoms were consistent with DVT of the lower extremities. Similarly, patients underwent a bone scan and an MRI of the brain based on clinical presentation. A multidisciplinary team meeting was carried out among urologists, radiologists, anesthesiologists, oncologists, gastroenterologists/hepatic surgeons, cardiovascular surgeons, and cardiologists for surgical planning and optimal outcomes. Anticoagulation with either unfractionated heparin or lower molecular weight heparin was started in all cases of IVC thrombus to reduce bland thrombus formation and the risk of pulmonary embolism. Preoperative embolization was performed in those cases where there was bleeding from the primary tumor or very large tumors/retroperitoneal lymphadenopathy precluding earlier control of the renal artery.

2. Intraoperative Management and Operative Procedure

All cases underwent an open approach with either a modified Makuuchi or chevron incision. Intraoperative monitoring of IVC thrombus level III or IV was done with transesophageal echocardiography. Following the medial displacement of the colon and duodenum for right-sided tumors, the renal artery is initially tied off, and the kidney is mobilized while dissecting the inferior vena cava. IVC caudal and cephalic to the thrombus and left renal vein in case of right-sided tumors, and right renal artery and vein in case of left-sided tumors were taken under control. In right-sided tumors, infrarenal IVC, left renal vein, and suprarenal IVC were closed in that order with

Table 1: Classification of patients with renal cell carcinoma according to tumor thrombus level[8]

Tumor thrombus level	Definition
0	Thrombus limited to the renal vein; detected clinically or during assessment of the pathological specimen
I	Thrombus extending into IVC
II	Thrombus extending >2cm above the renal vein but below the hepatic veins
III	Thrombus at the level of or above the hepatic veins, but below the diaphragm
IV	Thrombus extending above the diaphragm

Rummel tourniquets or clamps, whereas infrarenal IVC, right renal artery, and suprarenal portion of the inferior vena cava were sequentially ligated in that order.

If the thrombus extends retrohepatically and superior clamps cannot be applied inferior to hepatic veins, the liver was medialized (Langenbach's maneuver) to take control of the IVC just inferior to the diaphragm. If the IVC was clamped above the major hepatic veins, clamping the porta hepatis (Pringle maneuver) was performed, where clamping time of 20 minutes or less was maintained to reduce the risk of ischemic hepatic injury and portal vein thrombosis. For IVC thrombus above the diaphragm, supradiaphragmatic control was taken either with thoracic intercostal incision or through a small diaphragmatic incision. Thrombus in the right atrium, which could not be milked downwards in the IVC, needed sternotomy and cardiopulmonary bypass in all the cases. Venovenous bypass was utilized in those cases who did not tolerate suprahepatic IVC clamping.

Level I thrombus was removed by applying a Satinsky clamp circumferentially in the IVC and removing the IVC thrombus en bloc by incising the renal vein ostium. In other IVC thrombi, cavotomy and thrombectomy were done. IVC was flushed with heparinized saline, and the intima inspected for signs of caval invasion, which, if present, was resected and sent for biopsy. IVC reconstruction was done with a Dacron graft if the IVC diameter was less than 50% or if the IVC could not be ligated. The sequence used for removing the clamps from the IVC and renal vein mirrored the order in which they were initially applied.

3. Postoperative care

Postoperatively, the patient was monitored in the intensive care unit, and anticoagulants were continued.

4. Data collection and analysis

After data collection, all data were recorded in Microsoft Excel, and descriptive analysis was carried out using Statistical Package for Social Sciences v26 (IBM Corp., Armonk, N.Y, USA).

Results

A total of 35 cases were studied, with a mean age of the cases was 63.28 years (35 to 75 years). Most of the cases (40%) had level II IVC thrombus, with level IV thrombus in 6 (17.14%) cases (Table 2). Total of 62.86% of the tumors were right-sided. Only three cases underwent preoperative embolization. Level I and II IVC thrombus was dealt with either Modified Makuuchi or Chevron incision, and apart from these incisions, Level III and Level IV tumors required intercoastal incision in one case each, and sternotomy was required in four cases of Level IV tumors. For IVC thrombus above the diaphragm, supradiaphragmatic control was taken either with a thoracic intercoastal incision in two cases or through a small diaphragmatic incision in one case. All cases of thrombus in the right atrium, even after ligation of the renal artery, needed sternotomy and cardiopulmonary bypass. Venovenous bypass was utilized in one case of Level III thrombus. Out of six Level IV thrombi, four needed Cardiopulmonary bypass, whereas the thrombi shrank in two, one still in the IVC above the diaphragm, requiring supradiaphragmatic clamping, and the others were located below the diaphragm, where clamping was carried out just superior to the hepatic veins at the subdiaphragmatic level. Similarly, out of seven Level III thrombi, two needed IVC clamping above the diaphragm, and the clamp was applied between the diaphragm and hepatic veins in four cases. In one case, the thrombus shrank to the level below the hepatic veins so that it was possible to apply a clamp infrahepatically. Two cases had thrombus infiltrating the IVC wall intraoperatively, for which the IVC segment was resected with the superior and inferior ends sutured (Table 3). Sixteen cases required transfusion of different blood components perioperatively. High-grade complications, Clavien Dindo (IV and V), were seen in four of six cases of RCC with Level IV thrombus (Table 4). Two out of four cases requiring CPB had perioperative mortality due to pneumonia and pulmonary embolism. Clear cell Carcinoma was the major histopathological subtype in 94.29% of the cases, with papillary carcinoma and primitive neuroectodermal tumor (PNET) in the remaining cases. Total of 14.29% of the cases had positive pathological regional lymph nodes. The 3 year overall survival and cancer-specific survival rate were 64.29% and 85.71%; 62.5% and 75%; 57.14% and 71.42 %; and 33.33% and 33.33% in IVC thrombus levels I, II, III, and IV thrombi respectively (Table 5). In addition to perioperative deaths, the major cause of death was distant metastasis, occurring in 9 cases (25.71%). All cases with pathological lymph nodes succumbed due to distant metastasis within three years of surgery.

Table 2: Baseline Characteristics RCC with different levels of IVC Thrombus(N=35)

Thrombus Level		I	II	III	IV
Number of cases(N)		14	8	7	6
Age(years)		61.2510.31	67.38.21	58.7112.15	65.89
Sex	Male	9	6	4	4
	Female	5	2	3	2
Side	Right	9	5	5	3
	Left	5	3	2	2
Preoperative Embolization		0	0	1	2

Table 3: Intraoperative approach to RCC with IVC Thrombus

Thrombus Level	I	II	III	IV
Incision				
Modified Makuuchi	9	5	5	3
Chevron	5	3	2	2
Thoracic (Intercostal)	0	0	1	1
Sternotomy	0	0	0	4
The level of cephalic IVC clamped				
Infrahepatic	14	5	1	0
Infradiaphragmatic Suprahepatic	0	3	4	1
Supradiaphragmatic IVC	0	0	2	1
Cardiopulmonary bypass	0	0	0	4
Venovenous bypass needed	0	0	1	0

Table 4: Postoperative Complications as Graded by Clavien-Dindo Classification

Thrombus Level	I	II	III	IV
Postoperative complications				
0	8	4	0	0
I	2	1	1	0
II	1	1	4	2
III	0	0	0	0
IV	1	1	2	2
V	0	0	0	2

Table 5: Overall One-Year and Three-Year Cancer-Specific Survival

Thrombus Level	I	II	III	IV
1 year	14/14	8/8	7/7	3/3
3 years	9/11	5/6	4/5	2/2

Discussion

RCC with IVC thrombus poses a challenging situation, requiring meticulous surgical planning and perioperative multidisciplinary care. As our center is a tertiary care center with a multidisciplinary team consisting of urologists, cardiothoracic and vascular surgeons, cardiac anesthesiologists, gastrointestinal and hepatic surgeons, and intensivists, most of the cases are referred to our center.

Preoperative embolization was done in patients presenting with retroperitoneal bleeding and those with very large tumor thrombi or retroperitoneal lymphadenopathy at the level of the renal hilum, making dissection of the renal artery very difficult. It helped to shrink the IVC thrombus

and also to perform nephrectomy with less blood loss.[2-4] Preoperative angioembolisation is not recommended as a routine procedure as it has the potential risk of tumor embolization and is associated with ischemia-related flank pain and tumor lysis syndrome.[11] The incision in most of the right-sided tumors was modified Makuuchi in the right flank, whereas a chevron incision was given for all left-sided tumors, which helps in performing left radical nephrectomy as well as addressing IVC thrombus with adequate liver mobilization.[12,13] For IVC thrombus above the diaphragm, supradiaphragmatic control was taken either with a thoracic intercoastal incision or through a small diaphragmatic incision. Every case involving thrombus extension into the right atrium required a sternotomy along with cardiopulmonary bypass. Venovenous bypass was utilized in one case that did not tolerate suprahepatic IVC clamping, leading to hemodynamic instability.

As the level of IVC thrombus increases, complexity related to surgical technicality and perioperative care increases. Level III and IV thrombi were always planned for possible bypass, including deep hypothermic arrest along with intraoperative transesophageal echocardiographic preparation. The need for a sternotomy or thoracic incision was only decided after ligating the renal artery, which may shrink the tumor thrombus significantly to the level that the tumor thrombus can be extracted intraabdominally, completely avoiding thoracic incision. The Level IV thrombi shrank in two, one still in IVC above the diaphragm, requiring supradiaphragmatic clamping, and the other below the diaphragm with clamping at the level situated beneath the diaphragm and directly above the hepatic veins.

RCC has a poor prognosis if left untreated and on the other hand, surgery is associated with high perioperative morbidity and mortality, especially in those cases with high levels of IVC thrombus.[14-16] In our study, 45.71% required transfusion of different blood components perioperatively. High-grade complications (Clavien Dindo IV and V) were seen only in RCC with Level IV thrombus. Acute kidney injury and pneumonia were the major complications leading to prolonged ICU stay in these cases.

Except for two cases, all the cases could survive up to five years in the case of Level I thrombus, with only two cases of Level IV thrombus living beyond five years after surgery. The study done by Chen et al[17] showed 3-year overall survival in Level I-II and III-IV thrombus to be 59 % and 48%, respectively, which is similar to our study (63.63% and 46.15%, respectively). Lymph node positivity was associated with poor survival in our study, as demonstrated by the study carried out by Chen et al.[17] Overall survival decreased with increased level of thrombus as seen in many studies, whereas some studies have shown that thrombus level was not an independent prognostic indicator for long-term survival.[4,7,8,18]

As this was a retrospective study, many important data regarding the clinicopathological variables could not be collected in all the cases. Similarly, inadequate data and the loss of follow-up of many patients limited the calculation of median survival, progression-free survival, and cancer-specific survival over the long term. As the information about adjuvant therapy was not adequate, it was not included in our study.

Conclusion

Managing RCC with IVC thrombus remains complex and demands a well-planned surgical approach along with multidisciplinary collaboration. Advanced thrombus levels (III and IV) are particularly associated with increased perioperative risks, including significant morbidity and occasional mortality. While some deaths occur in the immediate postoperative period, the majority of late mortality is attributable to distant metastatic progression.

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