Management of IVC Thrombus-Surgical Strategies and Outcomes

Amlesh Seth¹

Received: 8 August 2016 / Accepted: 15 August 2016 / Published online: 25 January 2017
© Indian Association of Surgical Oncology 2017

Abstract Renal cell carcinoma is the most lethal among all urological cancers. The lethality increases with advancing stages of the disease. Renal tumors show a peculiar propensity to invade the venous system. Such invasion not only worsens the disease prognosis but also increases the surgical morbidity making treatment of such tumors challenging. Several small volume series have been published regarding management and outcomes of renal tumors with inferior vena cava (IVC) thrombus which show encouraging results when addressed properly. In this article, we review the outcomes and also describe the step-by-step approach to management of these tumors.

Keywords Inferior vena cava · Renal cell carcinoma · Thrombus

Introduction

Renal cell carcinoma comprises 2–3% of all adult malignancies [1]. It is the most lethal of all common urological cancers [1]. Renal tumors have a peculiar propensity to extend into the venous system. This has been reported to occur in 4–10% of patients [2]. Through the renal vein, the tumor can progress into the inferior vena cava (IVC) all the way up to the right atrium. Not uncommonly, this happens without the tumor metastasizing systemically or into the lymph nodes. Such patients are potentially curable. The technical challenge and risk

involved keeps on increasing as the proximal extent of the tumor thrombus goes higher. In some patients, the distal IVC below the level of the tumor thrombus develops a bland thrombus. That adds to the risk and morbidity of surgery in these patients.

Pre-Operative Work-Up

Minimum pre-operative work-up includes a chest X-ray, liver and kidney function panel, ECG, and CT or MRI of the abdomen. We also get a full pulmonary and/or cardiac evaluation done in case of any suspicion of any pulmonary or cardiac issues. Cardiac evaluation may include a coronary angiography in patients undergoing this surgery under cardio-pulmonary bypass. Adding a coronary artery bypass grafting in this situation does not add significantly to the complexity of the surgery. A CT or MRI of the chest is added if there is any suspicion of pulmonary metastases. In our institution, patients who undergo a removal under cardio-pulmonary bypass get a CT chest. We always get a Doppler ultrasonography in the evening prior to surgery. The ultrasonologist measures the exact length of tumor thrombus for us. Additionally, the exact distance between the proximal extent of the thrombus and the inferior edge of the liver or the opening of the hepatic veins into the IVC or the cavo-atrial junction is measured. Flow around the thrombus is looked for and space, if any, between the thrombus and the IVC wall is noted. If there is good flow around the thrombus and some space between the thrombus and IVC wall, the thrombus is unlikely to have invaded the IVC wall in that area. The reverse is not true. The study also confirms if any distal bland thrombus has formed. If there is intra-cardiac extension, a cardiac echo is repeated to visualize its proximal extent into the right atrium/ventricle/pulmonary

✉ Amlesh Seth
amlesh.seth@gmail.com

¹ Department of Urology, All India Institute of Medical Sciences, New Delhi, India

artery. The main surgeon usually stands by, when the radiologist is carrying out the Doppler ultrasonography.

Incision and Approach

The most common incision is bilateral sub-costal (chevron). In a tall, thin patient, a long midline laparotomy incision may be adequate. For a bulky right-sided tumor especially in the upper pole, a thoraco-abdominal approach may be preferable. For patients who are operated under cardio-pulmonary bypass, a long midline laparotomy incision is made which is later extended into the chest as midline sternotomy.

Early Arterial Control

Each kidney receives approximately 10% of cardiac output making a total of 20% for both the kidneys. In a patient with a large renal tumor, the arterial inflow is further enhanced. Renal tumors have large arterio-venous communications within. The problem is further compounded in these patients with IVC thrombus blocking the venous return. All the tiny little venules surrounding the tumor bloat up in the form of collaterals. These collaterals are thin walled and hence quite fragile. There may be a significant blood loss if these collaterals rupture before arterial control. In patients who undergo this surgery with either a chevron or midline incision, the posterior peritoneum is incised just medial to the inferior mesenteric vein. The abdominal aorta is palpated and exposed. The right or the left edge of the aorta is defined depending upon whether it is a right- or a left-sided tumor. Dissection proceeds slowly upwards along the edge of the aorta till the renal artery is reached. On the right side, no major structures except lymphatics are encountered till the right renal artery is reached. The right renal artery is easy to locate behind the left renal vein. On the left side, a lumbar vein draining into the left renal vein is almost invariably encountered inferior to the left renal artery. Utmost care is required in ligating this vein because the left renal vein is distended with tumor thrombus in this situation. Once this vein is ligated, the left renal artery can usually be palpated as well as visualized. Sometimes, the anatomy may be variable and the artery may be closer to the superior edge of the left renal vein. The artery should be ligated at least twice on the aortic side. The renal end should also be ligated before dividing the artery. Although all renal arteries are end arteries, still there may be significant back bleed from the renal end due to intra-tumoral arterio-venous communications. In patients who are operated by a right thoraco-abdominal incision for a right-sided tumor, a dissection on the posterior aspect of the kidney is better. Fewer collaterals are encountered posteriorly. The renal artery should be ligated and divided behind the IVC in this situation. After ligation, division of

the artery is also helpful. Division of the artery makes the kidney more mobile.

Step-by-Step Approach to the Thrombus

After early arterial ligation and division, the whole kidney is dissected free from the surrounding structures carefully ligating all the collaterals. The kidney is left hanging on the IVC through its renal vein. Further steps depend upon the level of the thrombus. Although the most commonly used classification for the level of thrombus is the Mayo Clinic classification [3], we follow a slightly different pattern in deciding the approach to the thrombus. The levels that we use are as follows:

1. Within the renal vein
2. Infra-hepatic
3. Retro-hepatic level I
4. Retro-hepatic level II
5. Supra-hepatic
6. Intra-cardiac

Retro-hepatic level I is when there is a margin of 2 cm or more between the proximal extent of the thrombus and the point of confluence of the hepatic veins with the IVC. Retro-hepatic level II is if this margin is less than 2 cm.

Renal Vein Level

If the thrombus is confined to the renal vein, a large side clamp is required on the IVC. The IVC wall needs to be dissected clear for a distance of 1–2 cm depending on the size of the thrombus. Any draining lumbar vein in the area should be double ligated and divided. A wide side clamp is applied at this juncture. The renal vein needs to be sharply divided off from the IVC. The IVC needs to be closed with either a 5-0 or a 6-0 prolene suture. As uro-oncologists, we tend to remove as much of surrounding tissue as possible, but we should be careful when dividing the renal vein. We need 2–3 mm of the IVC wall on either side for suturing. We should also remember that when we are pulling on the kidney, the renal vein-IVC junction is at a stretch. IVC walls crumple a little after this division.

Infra-Hepatic Level

If the thrombus extends into the infra-hepatic IVC, then three cross clamps are required—IVC below the thrombus, opposite renal vein, and above the thrombus. Circumferential mobilization of these three structures is required at the levels where they need to be cross clamped. All lumbar veins in the field need to be ligated. After the clamps are applied in the sequence mentioned above, the renal vein is divided at its opening into the

IVC. Further superior extension into the IVC is usually required. The extension should be kept minimal, just adequate to allow extraction of the thrombus and visualization of the inside of IVC. Sometimes a lumbar vein might have got missed. There would be some continuing blood loss in that situation. The rate of blood loss is usually acceptable in right-sided tumors. The IVC should be quickly repaired in that situation. For left-sided tumors, if the lumbar or adrenal vein remains draining into the opened part of IVC, the rate of bleeding can be significant. Therefore, for left-sided tumors, we dissect the right renal artery also. We usually clamp the right renal artery in place of the right renal vein in this situation.

Retro-Hepatic Level I

The retro-hepatic IVC has a number of small veins draining from the hepatic parenchyma into the IVC. These veins open into the anterior surface or the lateral/medial edge of the IVC. Practically, there are no tributaries into the posterior wall of the retro-hepatic IVC. The plane between the IVC and the hepatic parenchyma is a well-defined plane. Retro-hepatic IVC can be dissected all around almost to the point of opening the hepatic veins into the IVC. If the Doppler USG shows a margin of 2 cm between the superior extent of the thrombus and the point of confluence of hepatic veins with the IVC, almost invariably, it would be possible to dissect the IVC to reach a point where a cross clamp can be placed above the thrombus. This can be confirmed by compressing the IVC side to side in between the fingers. Subsequent steps are as for infra-hepatic level.

Retro-Hepatic Level II

If the superior extent of the thrombus is close to the point of hepatic veins—IVC confluence, then supra-hepatic IVC needs to be cross clamped. We take the help of our liver transplant team and use the technique described by Ciancio et al. [4] from Miami. The following ligaments need to be divided: ligamentum teres hepatis, falciform ligament, right coronary, right triangular, and left triangular. Basically, the liver has to be completely mobilized leaving it hanging on the IVC through the hepatic veins above and the portal structures below. Now, the IVC below the thrombus, opposite renal vein, and portal structures are cross clamped. The liver shrinks and the supra-hepatic IVC can be cross clamped. It is usually easy to rotate the right lobe of this shrunken liver to the left and dissect the retro-hepatic part of the IVC as described earlier. Now, if there is ample space above the thrombus in the intra-hepatic part of the IVC, a cross clamp can be placed there. The supra-hepatic and portal cross clamps can be removed. The subsequent steps are as for the infra-hepatic level. If the space is inadequate, we proceed to open the renal vein and IVC. The thrombus is taken out and the IVC inspected and cleared. The

vena-cavotomy is closed with 5-0 prolene and all the clamps are removed sequentially. The usual portal cross clamp time is between 10 and 12 min. A portal cross clamp time of up to 30 min is safe.

Supra-Hepatic Level

We prefer to operate these patients under cardio-pulmonary bypass with the help of cardiac surgeons. However, we have operated one right-sided and one left-sided tumor without bypass. We feel that a non-bypass technique is safe in a situation where the likelihood of tumor adherence to the wall of IVC is low. If the Doppler USG shows a good flow around the thrombus and some space between the IVC wall and thrombus, it may be safe to assume that the thrombus is non-adherent and non-invading. The patient with right-sided tumor was operated in the right lateral position with a thoraco-abdominal approach. The patient with the left-sided tumor was operated with a long midline laparotomy and sternotomy incision. The IVC was controlled within the pericardium by a sling around it. Within the pericardium, IVC is non-adherent and can be controlled easily with a sling. The rest of the steps are as for a retro-hepatic level II thrombus.

Intra-Cardiac Level

The most commonly employed method all over the world is exsanguination with deep hypothermic circulatory arrest. The first series was reported by Novick et al. [5] from Cleveland. The patient is put on cardio-pulmonary bypass, cooled to a temperature of 18 °C. The patient is exsanguinated with the arterial inflow being stopped and venous outflow continuing. Then, the heart-lung machine is stopped and deep hypothermic circulatory arrest instituted. The heart and IVC are opened, tumor completely removed, and then the whole process is reversed. There can be many complications, the commonest being hypothermia-associated bleeding disorder. We follow a different approach. We have described as mild hypothermia with partial circulatory arrest.

We put the patient on cardio-pulmonary bypass. One cannula is put into the superior vena cava in the usual fashion. Second cannula is put in the IVC below the thrombus. Aortic cannula is again inserted in the usual fashion. The patient is cooled to a temperature of 31 °C. The aorta is cross clamped at the supra-celiac level providing a circulatory arrest to the lower half of the body including the abdominal viscera. This provides a nearly bloodless field when the right atrium and IVC are opened. Whatever bleeding occurs can be easily sucked into the heart-lung machine. Thrombus can be completely removed from the ventricle also. Blood flow to upper half of the body including the carotid and coronary circulations is maintained. This aortic cross clamping at 31 °C should be safe

up to 30 min. We have successfully completed atrial and IVC clearance in maximum up to 18 min.

Distal Bland Thrombus

Fortunately, a distal bland thrombus is rare in Indian patients. If there is a distal bland thrombus, we follow the management algorithm advised by Blute et al. [6] from Mayo Clinic. If the distal IVC is totally blocked by the distal thrombus, then the distal IVC is divided and sewn. The problem comes when the distal IVC is partially patent. In this situation, an IVC filter is recommended, but we have scared of maintaining these patients life long on oral anti-coagulants. Fortunately, we have had only four patients out of 93 with a distal bland thrombus. We divided and sew the distal IVC in all four. Two out of these had a pre-existing complete IVC blockage and suffered no post-operative consequences. The remaining two had significant bilateral pedal edema which lasted for approximately 3 months in one and 6 months in the other. Both the patients were kept on compressive therapy.

Outcomes

There are no randomized control trials between surgical versus conservative therapy. Such trials would be unethical. Reese et al. [7] found on an analysis from SEER database estimated a median survival of 5 months for patients with RCC/IVCT not undergoing any treatment. A number of authors have reported a 5-year cancer-specific survival of approximately 60% in patients undergoing radical surgery with complete IVC thrombectomy in the absence of systemic or lymph-node metastasis (Ciancio et al. 2010; Kaag et al. 2011; Martínez-Salamanca et al. 2011; Kirkali and Van Poppel 2007) [8–11]. In our own series (unpublished), we could get data for 44 out of 83 patients operated over the last 20 years. Among these 44 patients, the median survival was 64 months. The details including patient data at baseline, intra-op parameters, post-operative complications, and long-term outcomes are being published separately. In most series, the prognosis keeps on reducing with increasing level of thrombus.

Future Considerations

As the safety of surgery in these patients is increasing with experience, surgery is being extended to patients with limited metastatic disease. The role of adjuvant- versus neo-adjuvant-targeted therapy is under study especially in patients with metastatic disease.

References

1. Campbell SC, Lane BR (2012) Malignant renal tumors. In: Wein AJ (ed) Campbell-Walsh, Urology 10th ed. International edition. p 1419
2. Campbell S, Novick A, Bukowski R (2007) Treatment of locally advanced renal cell carcinoma. In: Campbell S, Walsh P (eds) Urology. W. B. Saunders Co., Philadelphia, PA, pp. 1619–1622
3. Neves RJ, Zincke H (1987) Surgical treatment of renal cancer with vena cava extension. *Br J Urol* 59:390–395
4. Ciancio G, Gonzalez J, Shirodkar SP, Angulo JC, Soloway M (2011) Liver transplantation techniques for the surgical management of renal cell carcinoma with tumor thrombus in the inferior vena cava: step-by-step description. *Eur Urol* 59(3):401–406
5. Novick AC, Kaye MC, Cosgrove DM et al (1990) Experience with cardio-pulmonary bypass and deep hypothermic circulatory arrest in the management of retroperitoneal tumors with large vena caval thrombi. *Ann Surg* 212:472–476
6. Blute ML, Leibovich BC, Lohse CM, Cheville JC, Zincke H (2004) The Mayo Clinic experience with surgical management, complications and outcome for patients with renal cell carcinoma and venous tumour thrombus. *BJU Int* 94:33–41
7. Reese AC, Whitson JM, Meng MV (2013) Natural history of untreated renal cell carcinoma with venous tumor thrombus. *Urol Oncol* 31(7):1305–1309
8. Ciancio G, Manoharan M, Katkooi D, De Los SR, Soloway MS (2010) Long-term survival in patients undergoing radical nephrectomy and inferior vena cava thrombectomy: single-center experience. *Eur Urol* 57(4):667–672
9. Kaag MG, Toyen C, Russo P et al (2011) Radical nephrectomy with vena caval thrombectomy: a contemporary experience. *BJU Int* 107:1386
10. Kirkali Z, Van Poppel H (2007) A critical analysis of surgery for kidney cancer with vena cava invasion. *Eur Urol* 52(3):658–662
11. Martínez-Salamanca JI, Huang WC, Millan I et al (2011) Prognostic impact of the 2009 UICC/AJCC TNM staging system for renal cell carcinoma with venous extension. *Eur Urol* 59(1): 120–127