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Right Radical Nephrectomy with Type-IV IVC Tumor Thrombectomy Using Venovenous Bypass Instead of Cardiopulmonary Bypass—A Case Report

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Abstract

A renal mass with level Level IV IVC thrombus is usually managed with radical nephrectomy and IVC thrombectomy. This procedure requires the assistance of a cardiac surgeon and is usually done under complete cardiopulmonary bypass. However, the use of cardiopulmonary bypass is associated with reduced cardiac venous return and can consequently decrease cardiac output, adversely affecting haemo-dynamic stability and systemic arterial perfusion. This can lead to relative ischemia of the abdominal viscera, lower limbs and kidneys. We report a case where radical nephrectomy with IVC thrombectomy was done under venovenous bypass, thus avoiding the complications associated with the cardiopulmonary bypass.

Keywords

Nephrectomy, IVC Thrombus, Cardiopulmonary Bypass, Venovenous Bypass

1. Introduction

Radical Nephrectomy with removal of type III & IV IVC thrombus usually requires the use of cardiopulmonary bypass (CPB), deep hypothermia and circulatory arrest, which is associated with risk of renal and hepatic failure, neurologic dysfunction, postoperative sepsis and systemic coagulopathy. We operated

this case using veno-venous bypass (VVB) in place of cardiopulmonary bypass (CPB) so that most of the above complications could be avoided.

2. Case Report

A 56-year-old man presented to us with complaints of weakness. On evaluation he was found to have anemia and right renal mass with type IV IVC thrombus *i.e.*, tumor thrombus extending up to the right atrium. Other investigations did not reveal any metastasis to other organs. He was counseled for Right Radical Nephrectomy with IVC Thrombectomy. Anemia was corrected by preoperative blood transfusion.

Under general anesthesia, abdomen was opened by chevron incision. Resectability was confirmed by evaluating for evidence of metastatic disease. Right colon was reflected medially and duodenum was kocherized. Right kidney was mobilized outside the Gerota's fascia, with minimal traction to prevent embolism of tumor thrombus. Right renal artery, gonadal vein and right ureter were ligated and divided. Right triangular ligament and coronary ligament of liver were divided, permitting right lobe of liver to be rotated medially and cephalad, which exposed retrohepatic IVC up to the diaphragm. Infrarenal IVC and left renal vein was dissected, exposed and Rummel tourniquets were placed.

Median sternotomy incision was given by CTVS team and mediastinum opened exposing the heart. Access was gained to the left femoral vein using an 18 G 6.3 cm needle. A 60 cm J-tip 0.035-inch guidewire was passed through the needle into the femoral vein. The needle was removed and a 12 F dilator was passed over the guidewire. A 20 Fr heparin-bonded arterial bypass cannula was then inserted into the femoral vein and sutured into position. Using a similar technique an 18 Fr bypass cannula was inserted into the internal jugular vein. The cannulas were then connected by heparin-bonded tubing to a perfusion pump (Biomedicus, Minnetouba, Minnesota, USA). Transesophageal Echocardiography was used to see intra-atrial part of thrombus.

Venovenous Bypass (VVB) was instituted. Infrarenal IVC and left renal vein were clamped along with Pringle maneuver on the portal vein and hepatic artery. Flow through the bypass system was kept at around 10% of the cardiac output, as measured by a Swann Ganz pulmonary catheter.

Now anterior surface of renal vein was incised over the thrombus and venotomy extended posteriorly with scissor. Right kidney with thrombus attached was extracted out with gentle traction on it with patient in Trendelenburg position and using positive pressure respiration. Movement of tumor thrombus was monitored by TEE to ensure complete thrombus extraction. Now Infrahepatic IVC was also clamped. IVC was flushed with heparinized saline and evaluated for residual fragments. Two side biting satinsky clamps were applied at venotomy site and Rummel tourniquets were released. VVB was discontinued and IVC closed with 4-0 prolene (**Figure 1**).

On termination of the procedure the cannulae were disconnected from the

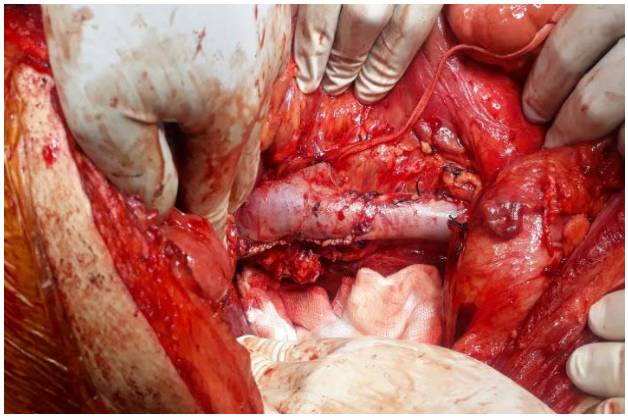

Figure 1. IVC repair after thrombectomy.

perfusion pump, but left in situ for 24 h and then removed.

3. Discussion

Renal Cell Carcinoma (RCC) can invade through the renal vein into the Inferior vena Cava (IVC), and can then extend intraluminally, with tumor-thrombus formation occurring in 5% - 15% of all cases (**Figure 2**). Tumor thrombus may extend up to the right cardiac chambers in 1% of cases [1].

Multiple classification systems exist for venous tumor thrombus level in case of renal cell carcinoma. According to the Mayo staging system, the following levels are described:

Level 0—thrombus extending to the renal vein.

Level I—thrombus extending into the IVC to no more than 2 cm above the renal vein.

Level II—thrombus extending into the IVC to more than 2 cm above the renal vein but not to the hepatic vein.

Level III—thrombus extending into the IVC to above the hepatic vein but not to the diaphragm.

Level IV—thrombus extending into the supradiaphragmatic IVC or right atrium.

Surgery to remove type III & IV IVC thrombus is technically challenging and can be associated with significant morbidity and mortality. It usually requires the use of cardiopulmonary bypass (CPB), deep hypothermia and circulatory arrest [2], which is associated with risk of renal and hepatic failure, neurologic dysfunction, postoperative sepsis and systemic coagulopathy [3]. In order to avoid these risks, veno-venous bypass (VVB) can be considered in place of cardiopulmonary bypass (CPB) in most of the Type III and a few selected cases of Type-IV IVC thrombus. It is associated with less side effects as compared to CPB.

In our case, we have described the technique of excision of a right side primary renal mass with tumor-thrombus extending via IVC into the right atrium (Type-IV) using veno-venous bypass instead of CPB (**Figure 3**).

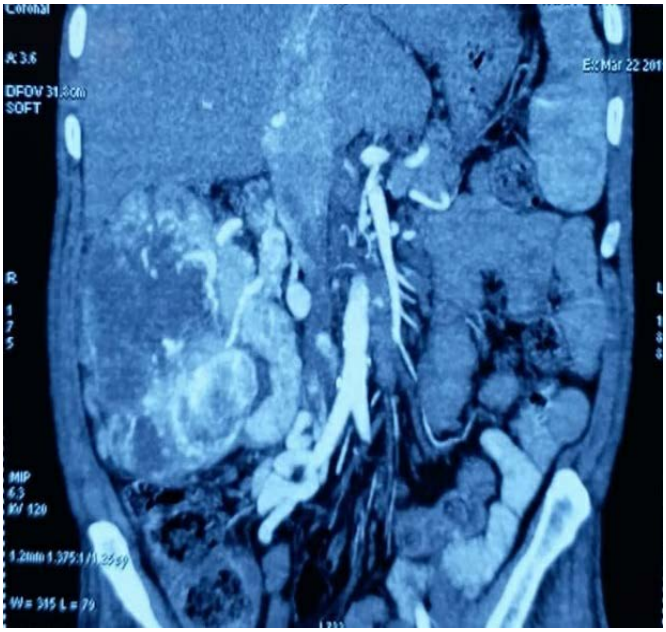

Figure 2. CT scan showing right renal mass with IVC thrombus.

Figure 3. Right radical nephrectomy specimen with tumor thrombus.

In 1913, Berg *et al.* first described nephrectomy and vena caval thrombectomy for RCC that extended into the IVC [4]. Thereafter, radical nephrectomy with vena caval thrombectomy has become a safe treatment for cases of venacaval tumor thrombosis, with operative mortality rates ranging from 2.7% to 13% and an expected 5-year survival ranging from 30% to 72%.

When the tumor-thrombus is localized to within the infrahepatic IVC (type I or II), tumor extraction is usually accomplished after proximal and distal control of the IVC.

When the tumor-thrombus extends into the suprahepatic IVC (type III & IV), en bloc tumor excision requires the use of either CPB with hypothermic circulatory arrest or veno-venous bypass (VVB).

Traditionally the use of CPB was utilized in almost all cases of level III and IV tumor thrombi.

Due to the known complications of renal and hepatic failure, neurologic dysfunction, postoperative sepsis and systemic coagulopathy associated with CPB, alternative technique of veno-venous bypass (VVB) has been attempted to reduce these complications [3].

Initially utilized for liver transplantation, VVB has the advantage that it does not require systemic anti-coagulation, as the cannulas are pre-coated with heparin. The use of VVB in IVC thrombectomy has been described extensively in the literature. One retrospective study conducted by Granberg *et al.* has compared VVB versus CPB bypass in the setting of RCC and IVC tumor thrombi [5]. This study demonstrated patients undergoing VVB (n = 13) had significantly shorter bypass, operative, and anesthesia times than did patients treated with CPB (n = 28). The study also demonstrated trends towards decreased intraoperative blood loss, reduced transfusion requirements, and a shorter length of hospitalization with VVB.

The advantages of VVB in orthotopic liver transplantation have been extensively documented [6].

Cross-clamping of the IVC, in the absence of VVB, reduces cardiac venous return and can consequently decrease cardiac output, adversely affecting haemo-dynamic stability and systemic arterial perfusion. This can lead to relative ischemia of the abdominal viscera [7], lower limbs and kidneys. Augmentation of the venous return by the administration of large volumes of intra-venous fluids can precipitate acute right ventricular failure on declamping the IVC. By maintaining cardiac venous return, VVB prevents the above complications. Systemic anticoagulation is not required for VVB and this avoids the possible coagulopathy that sometimes occurs during cardiopulmonary bypass [8]. The risks of profound hypothermia associated with cardiopulmonary bypass are not apparent with VVB [9].

Once the tumor thrombus extends into the right atrium, most of studies advocate the use of cardiopulmonary bypass with deep hypothermia and circulatory arrest for removal of the tumor thrombus [10].

In our case we attempted to determine if VVB can be utilized safely over CPB in patients undergoing type-IV IVC tumor thrombectomy with concomitant radical nephrectomy for renal tumor. In our case we kept everything ready for CPB and initially tried with VVB. Since tumor thrombus was not adherent to IVC wall anywhere throughout the length of IVC, after cross clamping the IVC along with pringle maneuver tumor thrombus was easily and quicky taken out by venotomy and then side biting Satinsky clamp was applied for further suturing. During this period of IVC cross clamping venous return was provided by VVB, without any complication and thus CPB was avoided.

4. Conclusion

Veno-venous bypass is a versatile technique during TYPE III & IV IVC thrombectomy and devoid of risks involved with CPB. It can be considered instead of

CPB in type IV IVC thrombectomy with radical nephrectomy in carefully selected cases.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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Abbreviations

IVC—Inferior Vena Cava.

VVB—Venovenous Bypass.

CPB—Cardiopulmonary Bypass.