Renal Cell Carcinoma with Tumor–Thrombus Extension into the Right Ventricle

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Renal cell carcinoma is a tumor with the distinct feature that it can invade through the renal vein into the inferior vena cava, and can grow intravascularly, sometimes extending into right cardiac chambers. Surgical resection provides the only reasonable chance for a cure, and cardiopulmonary bypass with hypothermic circulatory arrest is used to resect an intracardiac extension of the tumor because the tumor-thrombus adhered strongly to the hepatic vein and to the endocardium of the right atrium (RA). We present 2 patients, with renal cell carcinoma extending into the right ventricle, who have lived for more than five years after the operation.

Keywords: renal cell carcinoma, cardiopulmonary bypass, hypothermic circulatory arrest

INTRODUCTION

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 while the tumor may extend up to the right cardiac chambers in 1% of cases.1) In such cases, with extension into the right ventricle, conventional antineoplastic therapy alone (radiotherapy and chemotherapy) is not effective in the treatment of RCC. However, radical nephrectomy with en bloc excision of the cavoventricle tumor-thrombus extension results in the complete remission of symptoms and in a substantial improvement in late survival in such patients.2) According to Sweeney et al.,3) there are 4 stages of cavoatrial tumor-thrombus extension: in type I the intravascular tumor has reached the renal vein but not the IVC, in type II the IVC is occupied up to the level of the hepatic veins, while in types III and IV the supradiaphragmatic IVC and the right cardiac chamber are involved. A radical nephrectomy with simultaneous excision of the tumor can be done easily by a skillful urologist in type I and II RCC, via mobilization of the IVC and its temporary proximal and distal occlusion. However, cases of type III and IV demand the use of extracorporeal circulation and hypothermic circulatory arrest to achieve a perfect visualization of the intracaval or intracardiac part of the tumor, and to allow its radical excision. Here, we report 2 cases involving excision of a primary RCC with tumor-thrombus extending from the IVC into the right ventricle (type IV).

CASE REPORT

Case 1

A 68 year-old female with unremarkable medical history presented with edema of the lower legs and gross hematuria of 2 months duration. Physical examination revealed a right abdominal mass and cardiac rub. Blood tests were normal. Computed tomography scan showed a right renal tumor with thrombus extending from the renal vein into the right ventricle (Fig. 1A). The transthoracic echocardiography (TTE) showed a mobile thrombus extending from the right atrium into the right ventricle (Fig. 1B). However, the behavior of the tumor-thrombus into the right atrium was not recognized at all. The metastatic evaluation was unremarkable.
Case 2

A 57 year-old man with an unremarkable medical history was admitted to our hospital with symptoms of right-sided heart failure. On physical examination, mild tachycardia and bilateral pretibial edema were detected. In his laboratory examination, anemia and elevated levels of hepatic enzymes and creatinin were found. A right-sided RCC extending from the IVC into the right ventricle was detected by the computed tomography scan. The metastatic evaluation was unremarkable.

Surgical management

The surgical procedure was performed in collaboration with a urological team. During surgery, the tumor-thrombus was monitored with transesophageal echocardiography (TEE). Both patients underwent the same operation, involving the following basic steps. The right kidney was mobilized through a bilateral subcostal incision with superior midline T-extension (Fig. 2A), leaving only the vein tethering the kidney (the right renal artery and the right ureter were ligated and sectioned). The liver

Fig. 1  A: Computed tomography scan in a 68 year-old female with renal cell carcinoma, showing a large tumor-thrombus extending into the right ventricle. 
B: Transthoracic echocardiography (TTE) image showing a mass with irregular shape in the right ventricle arising from right atrium (RA) (arrow).
was mobilized too. The incision was extended from the xiphoid to the sternal notch (Fig. 2A). Cardiopulmonary bypass (CPB) was established as usual; arterial cannula (20 Fr) was placed in the ascending aorta, venous cannulas were placed in the superior vena cava (24 Fr) and right femoral vein (21 Fr). The patient was cooled to 22°C (nasopharyngeal temperature); immediately before hypothermic circulatory arrest (HCA), the ascending aorta was cross clamped, and cold blood cardioplegic solution was administered for myocardial protection antegrade. Cell-saving techniques were not used for a blood aspiration. The right atrium (RA) was opened near the orifice of the IVC; the bloodless field allowed for complete intravascular tumor-thrombus extirpation (Fig. 2B). The tumor-thrombus was transected at the hepatic vein level; an incision was made around the origin of the right renal vein and extended cephalad along the IVC. Gentle traction then permitted en bloc removal of the kidney and remaining thrombus. After the IVC and RA were closed, the patient was weaned from CPB and cannulas were removed; the abdomen and chest were closed simultaneously.

Patient information such as operation, histology, and pathologic stage are listed in Table 1. The both patients did not have complications such as pneumonia, wound infection, deep venous thrombosis, and renal dysfunction in the perioperative period. At 5 years after surgery, the evidence of recurrence was not recognized in the both patients. However, the lung metastasis was detected by CT scan at 7 or 6 years after operation in the both patients.

**Discussion**

In this study, we have described excision of a primary RCC with tumor-thrombus extending from the IVC into the right ventricle in 2 patients. In 1913, Berg et al. first described nephrectomy and vena caval thrombectomy for RCC that extended into the IVC. Thereafter, radical tumorectomy with vena caval thrombectomy has become a safe treatment for cases of cavoatrial tumor thrombosis, with operative mortality rates ranging from 2.7% to 13% and an expected 5 year survival ranging from 30% to 72%. Skinner and coworkers reported that tumor-thrombus, regardless of the degree of extension, if without metastasized local nodes or perinephric fat involvement, has a 5 year survival rate similar to that for a tumor that remains inside the renal capsule. Similarly, Ioannis and coworkers report that prognosis (5 year survival is 50%–68%) is very good for a stage IIIa tumor (with no lymph or distal metastases). However, incomplete tumor resection is associated with poor prognosis (5 year survival: 10%–17%). Moreover, RCC is not responsive to conventional chemotherapy or radiotherapy, and; therefore, surgical treatment provides
the safest and most effective technique for removing this tumor. 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 right cardiac chambers (type IV), en bloc tumor excision requires the use of CPB, which, in some circumstances, must be accompanied by HCA.

These methods, utilizing extracorporeal circulation, do have the disadvantages of prolonged operation time, a higher risk of bleeding, renal dysfunction, and neurological complications. In fact, Ciancio and colleagues\(^5\) considered that CPB often resulted in renal dysfunction, which may be subclinical or manifests as postoperative acute renal failure. However, in some cases of type IV thrombus, the thrombus or tumor is localized and adheres strongly to the IVC wall, to the hepatic vein, to the endocardium, or to the tricuspid valve. Because the aim of surgical therapy is the radical removal of neoplastic tissue, including the tumor-thrombus in the right cardiac chamber, we consider that a bloodless surgical field is crucial. Using CPB without HCA has some disadvantages, such as reduced visualization and exposure of the IVC and the RA within the surgical field, higher risk of warm hepatic and renal ischemia, higher risk of pulmonary embolism (PE), ischemic liver, and acute tubular necrosis.\(^5\) On the other hand, using CPB with HCA has several advantages. There is a bloodless surgical field with reduced risk of cellular spreading, PE, and fatal hemorrhage; there is reduced risk of warm hepatic and renal ischemia, reduced risk of incomplete tumor excision, and there is optimal visualization of the IVC lumen (in particularly of the hepatic vein) and of the RA.\(^5\) In our 2 cases, preoperative TTE and intraoperative TEE showed that the tumor-thrombus in the right cardiac chamber adhered strongly to the hepatic vein and to the endocardium of the RA. Therefore, it was necessary to use the CPB in combination with HCA for complete tumor-thrombus excision. Moreover, there was no hospital death in our small cases and no perioperative complications occurred in either case. Although the only case 1 patient underwent interferon therapy after surgery, both patients have lived for more than 5 years after operation in a state without a recurrence. We consider that complete resection of the entire tumor is mandatory for a reasonable attempt at a long survival. Although the last issue is the humoral and cellular immunosuppressive effects of CPB with respect to dissemination or progression of cancer, Suzuki and coworkers\(^9\) showed no significant adverse effects of CPB on cancer recurrence and late survival. Moreover, Haferkamp et al.\(^10\) report that of the 30 surgical patients with distant metastases at surgery the 14 who underwent interferon-\(\alpha\) and interleukin-2 based immunotherapy had significantly higher median survival than the 16 with no immunotherapy (13.5 months vs 5.1 months, \(P = 0.0159\)).

Given this background, we consider that it is important to estimate the amount of adherence, supra-hepatic extension and mobility of the tumor-thrombus by preoperative TTE or intraoperative TEE. If the tumor-thrombus adhere strongly to the hepatic vein and to the endocardium of the RA, the use of CPB with HCA is necessary to perform nephrectomy with en bloc excision of the cavoatrial

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HCA: hypothermic circulatory arrest, CPB: cardiopulmonary bypass.
tumor-thrombus. Although the number of patients in this study is very small, our experience suggests that CPB with HCA has improved safety and the technical efficacy of this approach to tumor extirpation.

Disclosure Statement

There are no conflicts of interest to declare.

References