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## Renal Cell Carcinoma Extending into the Right Ventricle: Successful Resection with Cardiopulmonary Bypass

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### Summary

Successful total removal of a renal cell carcinoma extending through the tricuspid valve into the right ventricle is reported. The rarity of this case prompted a review of the literature in which only right atrium involvement in this type of tumor was found.

### Key words

Renal cell carcinoma – Tumor thrombus – Inferior vena cava – Right ventricle – Cardiopulmonary bypass.

### Bis in den rechten Ventrikel reichendes Nierenkarzinom: erfolgreiche Resektion mit Hilfe des extrakorporalen Kreislaufs

Wir berichten über die erfolgreiche Resektion eines Hypernephroms mit Tumorausdehnung in die Vena cava inferior und durch die Trikuspidalklappe bis in den rechten Ventrikel. In der Literatur finden sich nur Angaben über Ausdehnung in den rechten Vorhof. Die Möglichkeit, diese Tumoren radikal zu entfernen, und die guten Langzeitresultate bei Patienten mit ähnlicher Tumorausdehnung, berechtigen ein aggressives chirurgisches Vorgehen.

### Introduction

Malignant tumors of the kidney are more commonly associated with intravascular tumor invasion and subsequent thrombosis of the great vessels than any malignancies of other organs (9). Renal carcinoma invades the inferior vena cava (IVC) in approximately 5 per cent of the patients and in 10 to 40% of them the tumor extends into the right atrium as well (5). To our knowledge, "per continuitatem" invasion into the right ventricle through the tricuspid valve has never been described. Extension of renal cell carcinoma through the inferior vena cava into the cardiac cavities presents a formidable clinical and surgical challenge, but there is an excellent chance for cure.

The only effective therapy for intravascular invasion of renal cell carcinoma is radical nephrectomy and complete removal of the tumor. Total removal of the tumor thrombus may require cardiopulmonary bypass (CPB) to assure completeness of resection, to prevent embolization during operation and to reduce the amount of intraoperative blood loss.

### Case report

A 53 year-old woman had experienced episodes of collapse, ankle edema, and mild exertional dyspnea; she was admitted to a peripheral hospital and complained about malaise and a weight loss of 3 kilograms; she had no pains and no hematuria or any other disorder of the urinary tract. The echocardiography lead to the suspicion of an atrial myxoma and the patient was admitted to our clinic for further investigations.

On admission, physical examination demonstrated no abdominal mass and no evidence of right heart failure.

Increased blood pressure was registered (170/100 mmHg) and cardiac auscultation revealed a 2/6 systolic murmur in the 2nd intercostal space at the left sternal border, which changed in character according to the patient's position.

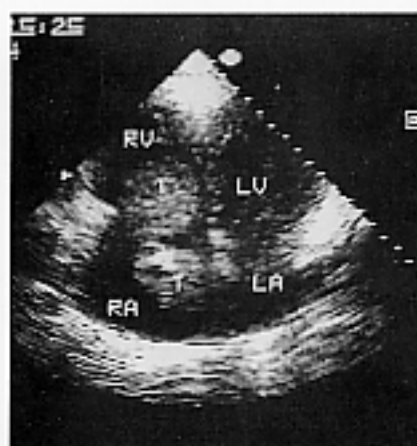
All laboratory values, including serum creatinin and urea, were within normal limits. The urine cytology report was negative.

Abdominal sonography demonstrated a tumorous mass in the upper pole of the right kidney.

Echocardiography demonstrated normal wall motion of both ventricles, moderate dilation of the right atrium and ventricle with slightly elevated central venous pressure (11 mmHg) and systolic pressure in the right ventricle (55 mmHg). No signs of tumor infiltration of the cardiac wall were detected but the tricuspid valve was partially obstructed (Fig. 1). Magnetic resonance imaging (MRI) confirmed the presence of the tumor and showed intravascular extension through the renal vein and the IVC into the right-sided cardiac cavities (Fig. 2). There was no evidence of metastases.

### Operative technique

At median sternotomy and laparotomy, exploration did not show manifest evidence of metastatic disease. The anatomical situation found at operation is shown in Fig. 3. After mobilization of the right kidney which was left attached only by the main renal vein, the patient was heparinized and the ascending aorta and superior vena cava were cannulated. During dissection, special attention was directed to avoid any manipulation of the IVC and of the heart. The IVC was cannulated just below the confluence of the left renal vein to allow normal venous return from the left kidney when cross-clamping IVC distal of the tumor thrombus.



**Fig. 1** Partial obstruction of the tricuspid valve and prolapse of the tumor into the right ventricle demonstrated by echocardiography; no cardiac wall infiltration of the tumor.



**Fig. 2** Magnetic resonance imaging of our patient showing extension of the inferior vena cava tumor thrombus into the right heart cavities.

Normothermic cardiopulmonary bypass was instituted and ventricular fibrillation induced electrically.

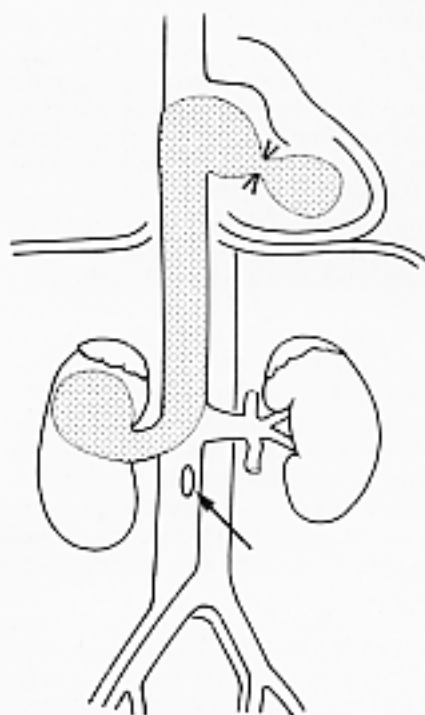
A small portion of the anterior wall of the IVC was resected tangentially together with the right renal vein and the tumor thrombus was separated from the wall of the IVC by blunt dissection. After opening the right atrium, exploration of the right heart cavities showed a tumor obstructing the tricuspid valve and extending into the right ventricle. It could be removed easily in one piece. Fig. 4 shows the complete tumor specimen with the 18cm long tumor thrombus extending from the renal vein through the tricuspid valve into the right ventricle.

Repair of the IVC was performed with a running suture, the right atriotomy was closed and, after defibrillation, the patient was weaned from CPB and heparin was reversed.

Pathological examination revealed a well differentiated clear cell carcinoma confined in Gerota's fascia (stage IIIa, grading 1). The postoperative course was uneventful, except for a moderate renal failure (maximal creatinin value 245  $\mu\text{mol/L}$ ) during the first 4 weeks. The patient was discharged on the 11th postoperative day. Follow-up 6 months postoperatively showed a patient in a very satisfactory general condition and without signs of tumor recurrence or metastasis.

#### Comment

The most common retroperitoneal tumors associated with an inferior vena cava thrombus are hypernephroma and



**Fig. 3** Schematic demonstration of anatomical situation found at operation. Note complete occlusion of the inferior vena cava and the absence of a distal clot. The arrow shows the place where the inferior vena cava was cannulated.



**Fig. 4** Picture of the pathological specimen showing the renal cell carcinoma and the tumor thrombus in its full length (18 cm).

Wilms tumor (5, 9, 10). The incidence of IVC involvement in this type of tumor is 5%. In such cases, an aggressive treatment is warranted if the tumor is localized and complete surgical removal can be accomplished. Unfortunately the classical triad (flank pain, hematuria and palpable renal

mass) represents advanced disease and more frequently the patients complain about various unspecific symptoms.

Thrombosis of the IVC associated with malignant renal tumors was first reported in 1911 by *Pleasants* (13). First successful extraction of intravascular tumor thrombus during clamping of the IVC above and below the thrombus was described in 1913 by *Berg* (3). In 1971 *Anderkani* and associates recorded the first instance of intraatrial removal of a renal cell carcinoma tumor thrombus using CPB (1).

Accurate preoperative information regarding presence and extent of an IVC and intracardiac tumor thrombus is essential for planning of the appropriate operation. Magnetic resonance imaging (MRI) is a very precise method for detecting the full extent of IVC and cardiac thrombi (14); cavography should be reserved for patients with unclear MRI. Cardiac echography is useful to assess intracardiac involvement of the tumor and its relation to the cardiac wall. We do not see any reason for routine coronarography in this special group of patients as recommended by *Novick* and associates (10), unless specific risk factors for coronary disease are present.

During surgical extraction of tumor from the IVC and the heart, prevention of embolization by safe manipulation is essential. Several techniques have been described to remove large caval thrombi when distal caval control cannot be achieved below the liver (2, 6, 7, 11, 15). In patients with cardiac involvement, normothermic bypass represents the safest technique and offers several advantages: retransfusion of blood loss that can occur during the dissection, prevention of a thrombus fragmentation and pulmonary embolism and proper exposure of the involved IVC segment in its full length. Cannulation of the IVC below the confluence of the left renal vein allows decongestion of the liver and splanchnic territory and maintains the venous return from the left kidney during CPB. We are not convinced that there is a necessity for deep hypothermic circulatory arrest (10) for this procedure. This option is time consuming, induces additional metabolic and clotting derangements: visualization of tumor within vena cava and its subsequent removal could be easily achieved during 37 minutes normothermic CPB in our patient. Postoperative bleeding was not a problem after this short procedure using CPB. Despite the fact that aprotinin can be used to reduce postoperative bleeding and blood transfusions, application of this drug must be carefully evaluated in this special group of patients; preoperatively thrombosed vena cava, possible paraneoplastic coagulopathy and incidence of deep venous thrombosis reported by *Novick* are important factors influencing the decision to use aprotinin or not (4, 10).

For patients with nonmetastatic renal cell carcinoma and IVC involvement, 5-year survival rates of 47 to 68% have been reported after complete surgical excision. However it has been reported that the risk of metastases and early death in renal cell carcinoma is increased with suprahepatic extension when compared with infrahepatic thrombi (11). This observation was not confirmed by *Novick*; in his series, intra-atrial thrombi were associated with neither an increased risk of metastases nor compromised patient survival (10). Cephalic extent of the thrombus had no bearing on survival in the cases of *Freed* and *Paul* (8, 12).

This case demonstrates the necessity for instituting aggressive surgical treatment in patients with important venous extension of renal cell carcinoma; once the tumor has been removed, long term survival can be expected. The

thoraco-abdominal approach described is safe, effective, and allows excellent exposure for radical tumor resection and tumor thrombus extraction.

#### Postscriptum

Laas et al. reported recently (*Europ. J. Cardiothorac. Surg.* 5 (1991) 653–656) the Hannover experience with 8 patients presenting with tumor-related obstruction of the IVC extending into the right atrium (n = 5) and ventricle (n = 3). Total resection of tumor with disobliteration of the IVC was possible in all patients with encouraging results: 6 patients alive after a mean follow-up of 24 months.

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