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Surgery of Renal Cancer with Extensive Caval Invasion

Suggestion for a new approach

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ABSTRACT

Radical surgery for renal cancer with invasion of the inferior vena cava can improve the patient's quality of life and, in some cases, offer longer survival or even cure. With a carefully planned surgical approach it is possible to remove renal tumours with thrombotic extension to the most proximal part of the inferior vena cava without necessity for cardiopulmonary bypass and without undue risk to the patient. In the operative procedure, good access and visual control of the proximal vena cava and all the contributing veins seem to be crucially important.

INTRODUCTION

Renal cancer is known for its tendency to invade the venous vascular tree. Of all renal cancers, one in four invades the renal venous system, around one-fourth of the invading tumours will involve the vena cava in greater or lesser degree, and such involvement will reach the level of the hepatic veins or higher in almost one of four cases. Most authors agree that vena caval involvement does not indicate a more aggressive form of tumour (1,11), and that the prognosis depends more on the histologic characteristics and local growth of the tumour in the kidney and on occurrence of tumour in the local lymph nodes or distant metastasis. Other authors have attributed prognostic significance to the level of vena caval involvement (14). It is generally accepted, however, that removal of neoplastic caval thrombus gives good palliation and improves the prospects for long-term survival (2,3,6,8) when there is no perinephric extension of tumour. As untreated vena caval involvement carries a nearly 100 per cent mortality within one year (15), removal of caval tumour thrombus should be attempted in patients with locally resectable renal cancer who are fit enough for protracted surgery.

The literature contains numerous excellent reviews of different surgical

approaches (1,3,5-10,12,13). In this paper we present our own experience with a partly new approach that provides excellent access to the upper part of the inferior vena cava, thus permitting good control of bleeding and prevention of fatal pulmonary embolism.

MATERIAL AND METHODS

In the past four years four patients were referred to our hospital because of renal cancer with involvement of the inferior vena cava up to or past the entry of the hepatic veins (Fig. 1).

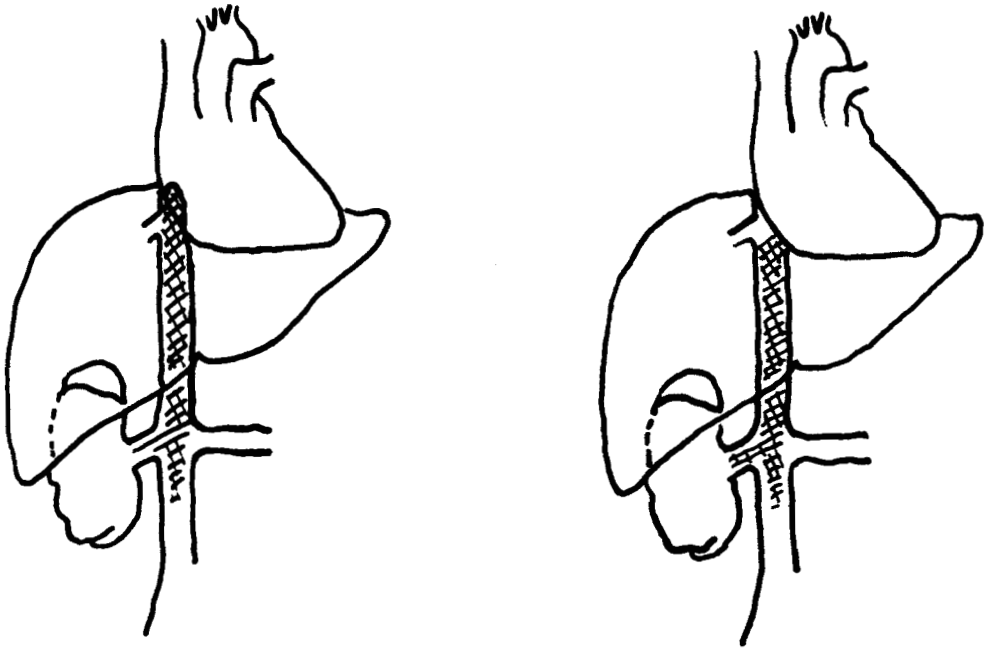

Fig. 1. Level of caval involvement. a) Cases 1 and 2, up to and above the hepatic veins, b) Cases 3 and 4, up to but not above the hepatic veins.

The age range of the two men and two women was 47 to 78 years. All underwent radical nephrectomy and caval thrombectomy. The postoperative observation time is short (at most 15 months), but at the time of writing all four patients are alive and well.

Preoperative evaluation

Excretory urography, including tomography, was performed preoperatively in

all cases. This examination was followed by selective renal angiography, computed tomography and inferior venocavography. Bone scans and chest radiography were performed in all cases for detection of distant metastases.

Operative procedure

In three of the four cases the operation was preceded by insertion of a double-lumen Swan-Ganz catheter into the renal artery on the affected side and the balloon was inflated under fluoroscopic control after premedication. The other patient was not catheterized.

The principles of the technique are schematically presented in Fig. 2. The technique can be outlined as follows. After induction of anaesthesia the patient is positioned on the operating table with a small pillow under the lower thoracic and upper lumbar spine. A midline incision is made from the sternum to just below the umbilicus and the abdomen is carefully explored for signs of metastatic disease. The renal tumour is palpated and its resectability assessed. When operability has been ascertained, the ascending or descending colon, including the right or left part of the transverse colon (hepatic or splenic flexure) is mobilized, as is the duodenum. The liver is mobilized by dividing the diaphragmatic attachments, allowing the liver to be rotated from side to side on the axis of the inferior vena cava. In this way good access is obtained to the anterior part of the vena cava. The hepatoduodenal ligament is identified and encircled with a rubber band. Rumel tourniquets are applied to the contralateral renal vein and, distally, to the vena cava. All lumbar veins are identified and divided between silk ligatures. Special care is taken to identify and divide the second pair of lumbar veins, as otherwise they may be a major source of bleeding.

A median sternotomy is then performed up to the third intercostal space and the incision is continued 5-7 cm in that space on the right side, avoiding the pleura. A sternum retractor is introduced and the pericardium opened in the midline and sewn to the wound edges. A Rumel tourniquet is applied on the intrapericardial part of the inferior vena cava. A pursestring suture of 3/0 prolene is placed round the right auricular appendage. The suture is drawn through a small-bore rubber tube. The auricular appendage is opened and the right index finger introduced through the pursestring suture, with the surgeon responsible for the thoracic part of the operation standing to the left of the patient. The proximal part of the inferior vena cava can then be palpated. By inverting the auricle as far down as possible, the orifices of the liver veins can be reached. The inferior vena cava is temporarily obstructed within the pericardium in order to assess the haemodynamic consequences of this procedure. If the arterial pressure drops considerably, the caval obstruction is released. The aorta is then mobilized in the diaphragmatic hiatus, to enable its clamping.

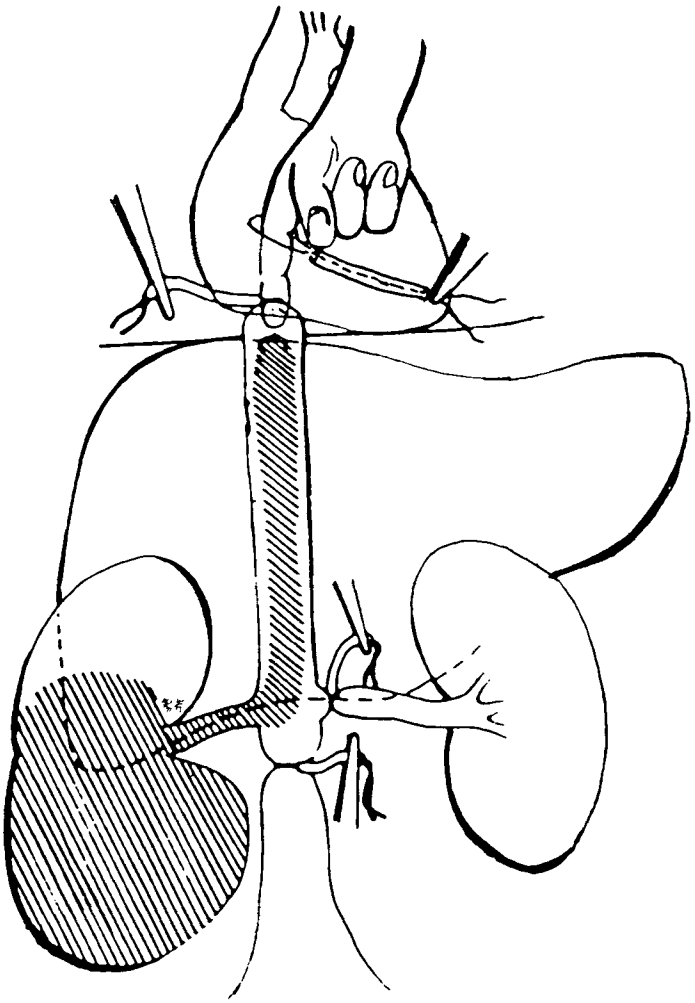

Fig. 2. Schematic view of the anatomic situation at operation of renal carcinoma with tumour invasion of the renal vein and inferior vena cava. Rumel tourniquets are applied on the contralateral renal vein, lower inferior vena cava and the intrapericardial part of the inferior vena cava. A pursestring suture is placed round the right auricular appendage with the suture drawn through a small-bore rubber tube.

All vessels contributing to the blood flow in the upper part of the inferior vena cava are then clamped - first the hepatic artery and the portal vein in the hepatoduodenal ligament, then the vein of the contralateral kidney and, finally, the lower inferior vena cava. In one of our cases the infradiaphragmatia aorta also was clamped.

The tourniquet around the intrapericardial part of the inferior vena cava is now drawn tight around the finger, and the dissection of the tumour thrombus is performed bluntly with the finger as far down as it can reach. At the same time the abdominal team makes a 5-7 cm longitudinal incision into the vena cava. The tumour thrombus is then dissected from within the vein, using alternatively a small neurosurgical dissector and tumour forceps.

After complete removal of the tumour thrombus, the opening in the vena cava is temporarily occluded with a large vascular clamp. Another clamp is applied across the entrance of the affected renal vein. The incision in the caval wall is closed with a running vascular suture and the clamp is removed. The vascular clamps are then released, beginning with the aortic clamp, then the hepatoduodenal, followed by the clamps on the distal vena cava and the renal vein of the healthy kidney. Finally the Rumel tourniquet obstructing the vena cava is released. The affected renal vein is opened and remaining tumour removed, the caval wall is sutured and the clamp removed. Thereafter a standard extracapsular nephrectomy is performed, including dissection of the hilar lymph nodes. A suction drain is placed in the abdomen and two chest tube drains in the pericardium.

RESULTS

The results in our cases are summarized in Table 1. The excessive bleeding in Case 1 arose from defective control of one lumbar vein. The prolongation of

Table 1. Current experience of the operation for renal cancer with extensive caval invasion

Case no	Age/Sex	Operating time (hrs)	Peroperative bleeding (ml)	Postoperative hospital stay (days)	Follow-up (months)
1	47/M	6.5	20 700	31	15
2	58/F	6.0	6 900	11	10
3	78/F	6.0	7 800	10	6
4	64/M	4.0	8 100	11	2

hospital stay was due to subfebrility and general malaise, with liver tests indicating non-A, non-B hepatitis.

DISCUSSION

Renal cell carcinoma has a tendency to grow along venous channels. Electron microscopy has revealed tumour cells to surround thin-walled blood vessels that often have fenestrations, allowing tumour to prolapse into the lumen (4,11). In most cases there is no actual overgrowth of tumour on the wall of the vena cava, although the tumour thrombus can be strongly adherent to the vessel wall. Most authors agree that extension of renal tumour into the inferior vena cava does not necessarily imply a bad prognosis, if radical surgery is successful (2,11). The observation by others (14) that the prognosis worsens with increasing height of thrombus extension into the vena cava can probably be ascribed to the time factor. The higher the level of tumour thrombus, the greater is the probability that the kidney tumour has been present for a long time and thus is locally advanced.

At present there is no effective therapeutic alternative to radical surgery, and we therefore believe that, whenever possible, such surgery should be attempted in cases of the described type. We have found that a sternum-splitting incision up to and extending into the third intercostal space on the right side, combined with a pursestring suture on the right auricle and introduction of the surgeon's finger into the inferior vena cava, gives excellent proximal vascular control and greatly assists the removal of tumour thrombus. Our experience also is that meticulous care in clamping and/or dividing all tributaries to the inferior vena cava gives an almost blood-free operating field. Clamping time has not given rise to problems in our cases. The left kidney has an excellent collateral venous flow and the right kidney can tolerate at least 20 minutes of clamping without ill effects. The liver can withstand a 30-minute interruption of blood supply. Introduction of a Swan-Ganz catheter into the renal artery and insufflation of the balloon before surgery facilitates the dissection of the renal vein, as preliminary clamping of the artery is not then required.

Brief total obstruction of the inferior vena cava is tolerated by most patients. The arterial blood pressure regularly falls. If the fall is too pronounced, the pressure is raised again by clamping the infradiaphragmatic aorta. This additional manoeuvre probably is not dangerous, as the liver and the contralateral kidney are already compromised. It was necessary in only one of our four cases.

No signs of embolism or metastases to the lungs have appeared in any of our patients.

In one of the four patients the tumour thrombus extended into the hepatic veins, obstructing the blood flow of the liver, which was grossly enlarged. At the end of the operation, however, the liver had become markedly smaller. The preoperative symptoms of abdominal fullness subsided after the operation.

REFERENCES

1. Beck, D.A.: Renal cell carcinoma involving the inferior vena cava. Radiological evaluation and surgical management. J Urol 118:533-537,1977.
2. Cherrie, R.J., Goldman, D.G., Lindner, A. & de Kernion, J.B.: Prognostic implications of vena caval extension of renal cell carcinoma. J Urol 128: 910-912,1982.
3. Clayman, R.V., Gonzales, R. & Froley, E.E.: Renal cell cancer invading the inferior vena cava. J Urol 123:157-163,1980.
4. Colvin, R.B. & Dickersin, G.R.: Pathology of renal tumors. In: Genitourinary Cancer. Ed. Skinner, D.G. & de Kernion, J.B. . Saunders, Philadelphia, Ch 4:84,1978.
5. Cummings, K.B., Li, W.I., Ryan, J.A., Horton, R. & Paton, R.R.: Intraoperative management of renal cell carcinoma with supradiaphragmatic caval extension. J Urol 122:829-832,1979.
6. Gittes, R.F.: Locally extensive renal cell carcinoma - current surgical management of invasion of vena cava, liver or bowel. Proc 1st Internat Sympos on Kidney Tumours. Ed. Küss, R., Murphy, G.P., Khoury, S. & Karr, J.P.. Liss, New York:497-507,1982.
7. Giuliano, L., Martorana, G., Giberti, C. & Pescatore, D.: Il trattamento chirurgico dell`adenocarcinoma renale con trombosi neoplastica della vena cava inferiore. Minerva Chirurgica 36:401-408,1981.
8. Kearney, G.P, Waters, B.W., Klein, L.A., Richie, J.P. & Gittes, R.B.: Results of inferior vena cava resection for renal cell carcinoma. J Urol 125: 769-773,1981.
9. Klein,F.A., Smith, V.M.J. & Greenfield, L.J.: Extracorporeal circulation for renal cell carcinoma with supradiaphragmatic vena caval thrombi. J Urol 131:880-883,1984.
10. McCullough, D.L. & Gittes, R.F.: Vena cava resection for renal cell carcinoma. J Urol 112:162-167,1974.
11. Skinner, D.G., Pfister, R.F. & Colvin, R.: Extension of renal cell carcinoma into the vena cava: the rationale for aggressive surgical management. J Urol 107:711,1972.
12. Smith, B.M., Mulherin, J.L., Sawyers, J.L., Turner, B.J., Prager, R.L. & Dean, R.H.: Suprarenal vena cava occlusion. Principles of operative management. Ann Surg 199:656-668, 1984.
13. Sogani, P.C., Herr, H.W., Bains, M.S. & Whitmore, W.F.: Renal cell carcinoma extending into inferior vena cava. J Urol 130:660-663,1983.
14. Sosa, E.R., Muecke, E.C., Vaughan, D.E. & McCarron, J.P.: Renal cell carcinoma extending into the inferior vena cava. The prognostic significance of the level of vena caval involvement. J Urol 132:1097-1100,1984.

15. Valvo, J.R., Cos, L.R., Altebarmakian, V.K., Khuri, F.J. & Cocket, A.T.K.: Surgery and immunotherapy in renal cell carcinoma involving inferior vena cava. Urology 20:359-364,1982.

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