Resection of a hypernephroma involving the IVC: a safe algorithm

Postępowanie chirurgiczne w leczeniu raka jasnokomórkowego nerki naciekającego żyłę główną górną

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Abstract

Objectives: To report a stepwise approach for the successful resection of a complex pathology: renal cell carcinoma invading the IVC into a variable length (level I-IV extension).
Methods: An algorithm of the plan of action, according to the level of extension of the tumour, is presented.
Results: MRI is needed to determine the extent of IVC involvement. Perioperative TOE is useful to quantify the adherence, cephalad extension and mobility of the tumour. A team approach of anaesthetists/urologists is necessary. Start with mobilization of the affected kidney. No irrevocable steps until resection guaranteed.
Mobilization of infra- and supra-hepatic IVC. For level I-II disease: use intermittent caval clamp, and cell saver. For level III: institute CPB (venous cannulae: SVC, right femoral vein). Control of the cavo-atrial junction. Use Pringle manoeuvre and prepare to briefly cross-clamp the supra-celiac abdominal aorta if necessary. Right atrium can be opened and tumour mobilized from above and below and simultaneously pushed and drawn down and extracted.
For level IV or suspected suboptimal thrombectomy for level III disease use a brief period of total circulatory arrest (TCA). Repair the cavotomy with a pericardial patch.
Conclusions: Success of IVC surgery depends on careful patient selection and attention to detail. Total clearance of the IVC from a well adherent tumour (using endarterectomy technique and a bloodless field) is probably the single most important factor for prognosis.
Key words: Renal tumour involving the IVC, renal cell carcinoma growing into the right atrium.

Streszczenie

Cel: Próba stworzenia algorytmu postępowania chirurgicznego w leczeniu raka jasnokomórkowego nerki naciekającego żyłę główną górną w zależności od poziomu penetracji nowotworu do żyły głównej dolnej
Metoda: Propozycja algorytmu postępowania chirurgicznego w zależności od wysokości nacieku żyły głównej dolnej (poziom I–IV nacieku).
Wyniki: 1. Przedoperacyjne wykonanie rezonansu magnetycznego dla określenia poziomu zaawansowania raka jasnokomórkowego w stosunku do żyły głównej dolnej. 2. Śródoperacyjne użycie przezprzełykowego badania ECHO dla oceny rozległości w stosunku do układu żyły wrotnej oraz ruchomości guza. 3. Niezbędna jest ścisła współpraca kardiochirurga z zespołem anestezjologów i urologów. Rozpoczęcie zabiegu od uruchomienia zmienionej nowotworowo nerki. Kontynuacja zabiegu uzależniona od resekcyjności nowotworowej nerki. Uruchomienie żyły głównej dolnej nad- i podprzeponowo. Poziom I–II nacieku: przerywane użycie zacisków żylnych do klemomowania żyły głównej dolnej oraz użycie *cell savera*. Poziom III: zastosowanie krążenia pozaustrojowego (kaniulacja żylna; żyła główna górna i żyła udowa prawa). Kontrola ujścia żyły głównej dolnej do prawego przedsionka. Użycie manewru Pringla i przygotowanie się do zaklemowania aorty brzusznej powyżej pnia trzewnego. Otwarcie prawego przedsionka, uruchomienie guza od dołu i góry z następczym jego wyłuszczeniem i usunięciem. Poziom IV lub podejrzenie niemożności wykonania całkowitej trombektomii w poziomie III: użycie krótkotrwałego całkowitego zatrzymania krążenia w KPU. Plastyka ubytku powstałego w żyle głównej dolnej po resekcji nowotworu łatą osierdziową.
Wnioski: Powodzenie zabiegu jest ściśle zależne od dokładnej selekcji pacjenta przy kwalifikacji. Odseparowanie guza ze ścian żyły głównej górnej za pomocą technik endarterektomii oraz uzyskanie bezkrwawego pola operacyjnego (w celu dokładnego usunięcia nowotworu) jest najprawdopodobniej jednym z najważniejszych czynników rokowniczych.
Słowa kluczowe: rak jasnokomórkowy naciekający żyłą główną górną, rak jasnokomórkowy, naciekający prawy przedsionek serca.

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Introduction

Although rare (4-8% of patients undergoing surgery for renal cell carcinoma) IVC involvement should not preclude surgical therapy [1]. Furthermore, the overall 5-year survival following successful resection in such a cohort of patients can be up to 50% [2].

The level of IVC extension dictates the surgical strategies and mandates the development of a plan of action that should be safe, reproducible and reliable.

Favourable outcome in patients with non-metastatic renal carcinoma and IVC involvement correlates with complete clearance of the IVC from tumour-thrombus. This principle sometimes can only be achieved following an optimal exposure of the inferior vein concomitantly with clearance of the IVC – right atrial junction. Furthermore, prevention of tumour disruption and pulmonary embolism has to be considered during manipulation of the tumour.

The guidelines regarding the various techniques for the resection of renal tumours with IVC extension are very scattered in the literature. In this article we attempt to provide a systematic approach of the surgical strategies in a stepwise fashion.

Surgical Approach

A multidisciplinary approach is needed. Metastatic disease is a contraindication for surgical therapy and has to be ruled out.

Abdominal MRI (Figs. 1, 2) is useful to determine the extent of IVC involvement with tumour-thrombus. Perioperative TOE further contributes to planning the operation because it provides information regarding the amount of adherence, supra-hepatic extension and mobility of the tumour.

The initial step consists of mobilization of the affected kidney with retroperitoneal lymphadenectomy. Venous bleeding is usually encountered if the IVC is blocked by tumour. No irrevocable steps are taken until the resection is guaranteed.

For level I-II disease there is invariably no cardiothoracic involvement. Mobilization of infra-hepatic IVC is required. Limited cavotomy with the brief use of an intermittent caval clamp above and below the lesion is usually adequate. Cell saver suction system is used if bleeding from large retroperitoneal collaterals is to be encountered.

The actual need for cardiac surgical involvement is usually contemplated when the tumour-thrombus involves level III. We favour a standard midline laparotomy and assessment of resectability of the renal tumour.

Mobilization of the affected kidney together with mobilization of the infra- and supra-hepatic IVC is carried out. Following sternotomy, institution of CPB is achieved using a split venous cannula: SVC and right femoral vein. Control of the cavo-atrial junction is attempted in order to prevent tumour embolization. That can be achieved by splitting the diaphragm through the central tendon towards the IVC. The porta hepatis is dissected so that the liver blood supply can be briefly interrupted (Pringle manoeuvre) during cavotomy to further facilitate a bloodless surgical field. Furthermore, by applying briefly a cross clamp on the subdiaphragmatic aorta during caval extirpation of the tumour bloodless operative conditions can be achieved.

Level IV involvement presents a challenge; the disease extends into the RA with various degrees of infiltration and adherence into the wall of IVC. Under those circumstances the use of total circulatory arrest (TCA) has become the centre of an argument. The pathophysiological sequelae of the use of TCA are balanced against the risk of a suboptimal tumour clearance. We like others believe that with such extension of the disease the wall of the IVC is infiltrated by the tumour and unless a complete bloodless field is instituted, only by blunt dissections, it is impossible to achieve complete clearance.

Therefore for level IV extension of the tumour or for suspected suboptimal thrombectomy for level III disease

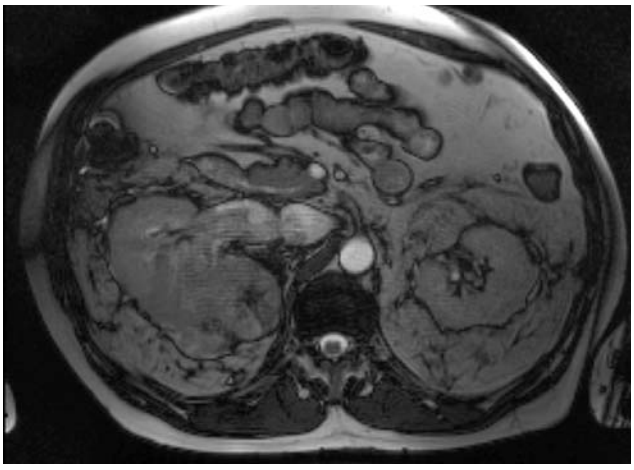

Fig. 1. MRI images of a level IV disease

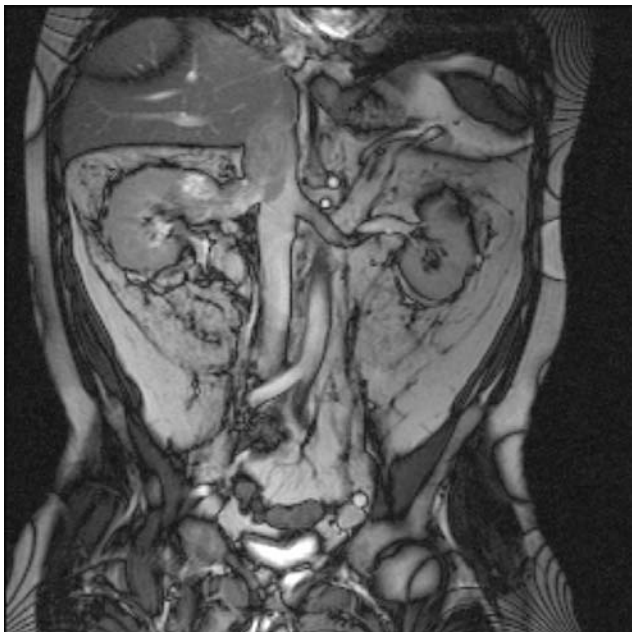

Fig. 2. MRI images of a level IV disease

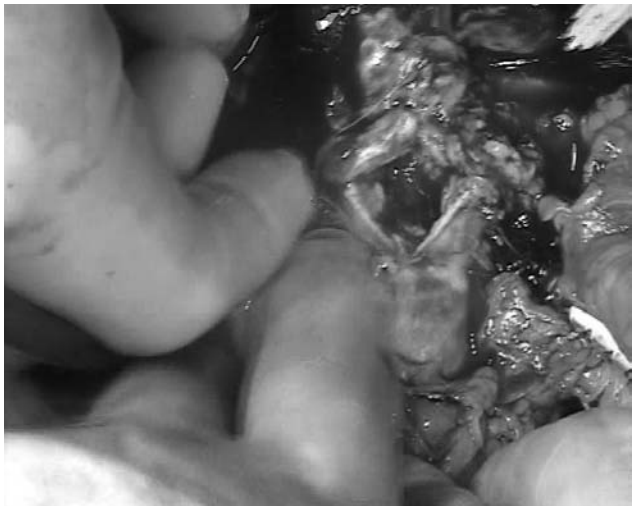

Fig. 3. Opening the IVC and removal of the tumor; intraoperative images

we advocate a brief period of TCA. During the cooling period in an arrested heart the RA is opened and tumour mobilization around the ostium of the IVC is carried out. Endarterectomy knives further facilitate optimal extirpation of the tumour by negotiating anatomical planes (Fig. 3) of excision. During TCA the cava is incised up to 10 cm cephalad in a longitudinal fashion taking care to include with the specimen the origin of the renal vein which is usually involved with the tumour. Clearance of the inside of the IVC using sharp and blunt dissections can be then carried out under direct vision. Having mobilized the tumour proximally at the IVC – RA junction, final extraction is usually achieved in continuity with the nephrectomy specimen. Furthermore, tumour embolization to the lungs is avoided. This way provides a controlled bloodless environment for facilitation of complete tumour clearance. Always the cavotomy is repaired with a pericardial patch. Tutaj gdzieś tab. I.

Discussion

The literature is lacking major series of the complex pathology of renal cell carcinoma with luminal propagation of the tumour into the IVC.

This is genuinely an uncommon condition; furthermore it is usually level III and IV of tumour extension that alarms urologists to seek cardiothoracic expertise. According to Lubahn et al. [3] about 50% of patients with renal tumours involving the IVC warrant cardiothoracic involvement. Furthermore, the overall incidence of extensive IVC disease involving the right atrium according to Hermanek et al. [4] is around 1%.

Levels I and II are usually treated by local resection. However, although the involvement of the IVC in renal cancer is generally not a vascular invasion by the malignancy [5] one could argue that following removal of the thrombus-tumour from the IVC invariably there is an area that indicates sub-endothelial invasion.

Tab. I. Surgical steps for IVC involvement

Level	Plan of action
I-II	No cardiothoracic involvement / back up only
III	CPB, brief Pringle manoeuvre and if necessary brief cross clamp of the sub-diaphragmatic aorta If suboptimal thrombectomy, then brief TCA
IV	CPB, TCA

Level III disease poses a challenge especially when the tumour is densely adhering to the venal wall or when the hepatic veins contain propagating segments of tumour. Generally for level III disease some institutions [6] favour cavotomy without the use of CPB or with the use of veno-venous bypass [3]. The latter group in a large series of patients concluded that the need for invasive cardiovascular procedures increased the risk of perioperative complications. The advantages of using veno-venous bypass are restoration of haemodynamic instability during venal clamping and also the fact that there is no need for systemic heparinisation. However, one would argue that without CPB and possibly without additional manoeuvres to reduce the venous return (i.e. Pringle) a bloodless field cannot be achieved during cavotomy. Furthermore, the imposed haemodynamic instability at the time has another adverse impact: the surgeon is "pushed" to complete the extirpation of the thrombus against time. That can tend to lead to debulking of the tumour. It could also lead to dislodgement of tumour material and subsequent pulmonary embolism. Therefore, in addition to CPB for level III disease, we would also favour the approach by Chowdhury et al. [7] whereby intermittent cross clamp of the sub-diaphragmatic aorta is applied. This brief manoeuvre would further optimize the conditions for a bloodless surgical field.

In the situation where the IVC is completely occluded by the tumour in level III disease then probably the patient may tolerate clamping of the IVC at the junction with the RA without significant haemodynamic compromise. Then one could debate that CPB is not necessary. Nevertheless, one should bear in mind that debulking of the tumour increases the incidence of local recurrence. Conversely, according to Chiappini et al. [8] tumour extension into the IVC to whatever degree is not associated with an adverse prognosis, provided a complete resection is advocated. Therefore the principles of total local clearance should take into consideration:

1) proper pre-operative evaluation of the extension of the tumour,
2) optimal control of haemodynamic conditions during cavotomy,
3) ability to visually assess the extent of the tumour invasion,
4) avoidance of tumour fragmentation and embolization,
5) repair of the IVC without narrowing of the vessel.

Controversy still exists regarding the need for total circulatory arrest (TCA). Sosa et al. [9] reported poor survival

for patients with level IV disease. Cerwinka et al. [10] advocate excision of supra-diaphragmatic tumours off pump with no TCA. In contrast, Chiappini et al. [8] and Mazzola et al. [11] claim that the use of TCA provides a safe technique for removing the tumour thrombus in a bloodless field, and has good early and long-term results. We like Schimmer et al. [12] believe that when the tumour thrombus is invading the caval wall or reaches the right ventricle then TCA becomes a necessity. We reckon that this approach has improved the safety and efficacy of a difficult surgical undertaking by facilitating controlled dissection, providing a bloodless field, and reducing the risk of tumour embolization.

However, according to Cooper et al. [13] the use of TCA increases by up to 40% the risk of complications and also adds to the perioperative mortality. Furthermore, as per Schimmer et al. [12] the risk of bleeding (at least theoretically) could be exponentially high due to 1) the profound hypothermia itself, 2) an extended bypass time as a result of cooling-rewarming, and 3) the fact that these patients have undergone an extensive retroperitoneal procedure and have accessory venous collaterals from the IVC obstruction.

In summary, extensive level III and level IV disease presents a surgical challenge. In this paper we have elaborated on the pros and cons of the various approaches. Clearly we recommend CPB for level III disease and brief periods of TCA for level IV.

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