

Radical nephrectomy (RN) in the treatment of renal cell carcinoma remains the “gold standard”, but sparing techniques (nephron sparing surgery, NSS), consisting of enucleation, partial nephrectomy or *ex vivo* resection, are increasingly gaining in importance. The techniques allow the achievement of better results, with a low rate of complications and mortality. *Ex vivo* resection is a technique which is becoming equivalent to radical nephrectomy. The risk of multifocal cancer ranges from 6.5 to 28%, whereas when the tumour has a diameter not exceeding 4 cm, the risk of multiplicity drops to 5%. The main risk involved in NSS is the possibility of recurrence in the ipsilateral kidney. The incidence of recurrence ranges between 0 and 10% and it is the lowest when the tumour has a low malignant potential and does not exceed 4 cm in diameter. Sometimes, due to the lack of the other kidney, this is the only opportunity that allows preservation of function of the remaining kidney.

The paper describes a patient with a single kidney, affected by a tumour with a diameter of more than 5 cm, reaching the pyelocalyceal structure. Due to infiltration of the renal calyx, the *ex vivo* technique was adopted, allowing appropriate resection with an oncologically adequate margin and accurate supply of the urinary tract. The technique of surgery and the outcome of treatment in the very few cases described so far are discussed.

**Key words:** renal carcinoma, partial resection, autotransplantation.

## 8-year follow-up after partial *ex vivo* resection of tumour in a single kidney followed by autotransplantation

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### Introduction

Clear cell renal carcinoma accounts for 90% of all cases of kidney cancer and 2-3% of all malignancies [1]. It is usually diagnosed during the sixth and seventh decade of life, although the mean age of diagnosis is gradually becoming lower. Radical nephrectomy (RN) in the treatment of clear cell renal carcinoma has ceased to be the “gold standard” for T1a renal tumours and in some cases of stage T1b tumours, where it has been replaced by nephron sparing surgery (NSS) techniques consisting of enucleation, partial nephrectomy or *ex vivo* resection [2, 3]. The main risk involved in NSS techniques is the possibility of cancer recurrence in the ipsilateral kidney because of incomplete resection of malignant tissue or multifocality of lesions. The risk of multifocal cancer forms is 10-20% [4].

NSS techniques allow the achievement of better results, with a low rate of complications and mortality. For stage T1a and T1b tumours with a diameter below 4 cm, and in selected cases also below 7 cm, the incidence of local and general recurrence does not demonstrate statistical differences between RN and NSS [5, 6]. Also, the survival rates of patients undergoing partial nephrectomy compared to radical nephrectomy are not lower for technically feasible interventions on tumours with a diameter below 7 cm [7]. In the absence of technical possibilities for *in situ* resection of tumours exceeding 5 cm in diameter, the only option left is *ex vivo* resection followed by kidney autotransplantation. This type of surgery is much more technically challenging and more risky to the patient, but for selected cases it may be the only alternative to RN.

The case reported in this article involves a patient with a single kidney, affected by a tumour with a diameter of more than 5 cm, reaching the pyelocalyceal structure. Because of infiltration of the renal calyces, the *ex vivo* technique was adopted, allowing appropriate resection with oncologically adequate margins and accurate supply of the urinary tract.

### Case description

The kidney tumour was diagnosed in a patient, aged 48, by ultrasound imaging and then confirmed by computed tomography (CT). The patient had previously undergone nephrectomy of the left kidney due to staghorn lithiasis and pyelonephritis.

CT of the abdomen was performed preoperatively, revealing incomplete rotation of the right kidney and, in the dorsal part of the kidney, a solid mass, relatively well circumscribed, measuring 55 × 48 mm, contrast enhanced after the administration of contrast material. The tumour was not found to infil-

trate the renal hilus. Slight dilatation of the pyelocalyceal system was noted, along with thickening of the posterior (Gerota's) layer of the renal fascia. No abdominal metastases were found. The status post nephrectomy on the left side was evidenced (Fig. 1).

On admission, the concentration of urea and creatinine in blood serum were (UN) 36 mg/dl and (Cr) 1.2 mg/dl, respectively.

### Treatment method

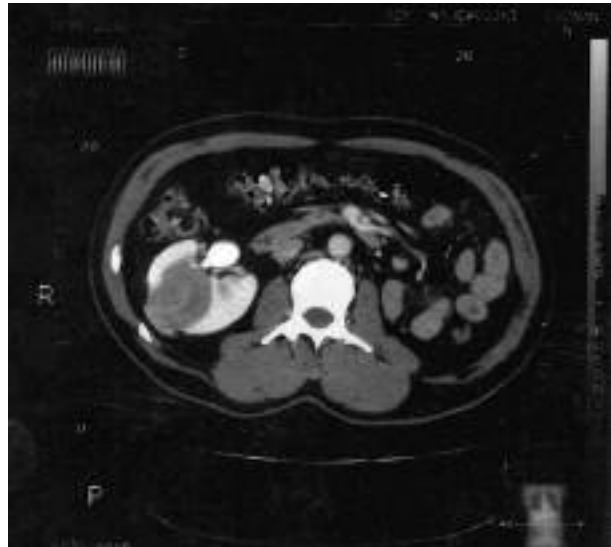
The procedure was performed using a Johnson & Johnson Ethicon Endo-Surgery Harmonic Scalpel®, an ultrasonically activated scalpel with three basic qualities of action: coaptation, coagulation and cavitation. The scalpel has a minimum thermal effect on the tissues subjected to cutting and coagulation, making it possible to avoid tissue carbonization and incrustation.

The kidney was removed transperitoneally together with the renal capsule, perirenal tissue and lymph nodes. Then, on the table, following perfusion with cold HTK solution, the tumour was removed with an ultrasonic scalpel, with a margin reaching the renal collecting system (Fig. 2). The pyelocalyceal system and renal parenchyma were then reconstructed via suturing and tissue glue. After cooling and reconstruction, the patient's own kidney was transplanted back in the right iliac fossa by performing an anastomosis of three renal arteries and a single renal vein (Fig. 3) with external iliac vessels, and the ureter with urinary bladder with single sutures on a pigtail catheter (Fig. 4). The duration of warm ischaemia was 45 minutes. Acute tubular necrosis (ATN) occurred postoperatively. The patient required a total of nine haemodialysis procedures in the postoperative period. Packed RBC were transfused and erythropoietin (Eprex®) was administered, together with an antibiotic (cephalosporin) for protective effect.

The subsequent histopathology examination revealed the following findings: Clear cell renal carcinoma. No infiltration of the renal hilus. Infiltration into Gerota's posterior fascia. According to the 2009 classification, the histopathological tumour grade was determined as grade 3 – T3 N0 M0 (Figs. 5 and 6).

A follow-up CT examination performed 7 days postoperatively demonstrated a post-resection scar in the central area. No pathological enhancement or focal lesions were visualized. Retroperitoneal lymph nodes were not enlarged (Fig. 7).

Angio-CT examination of the transplanted kidney performed 2 weeks postoperatively showed the status after wedge resection (i.e. complete resection) of the tumour with a minor infarcted focus within the superior extremity of the kidney on the medial side. Other observations included moderate dilatation of the renal collecting system, three renal arteries anastomosed to the external iliac artery, and two arteries running medially (both 3 mm in diameter), demonstrating moderate lumen narrowing in the initial sections. The third artery, with a lateral course, the widest (4 mm in diameter), had no visible stenosis. Upon removal of the pigtail catheter, 4 weeks postoperatively, the patient was discharged home.



**Fig. 1.** Solid mass measuring 55 × 48 mm, relatively well circumscribed, visible in the dorsal part of the right kidney and contrast enhanced after the administration of contrast material. The tumour does not infiltrate the root of the kidney. Mild dilatation of the pyelocalyceal system



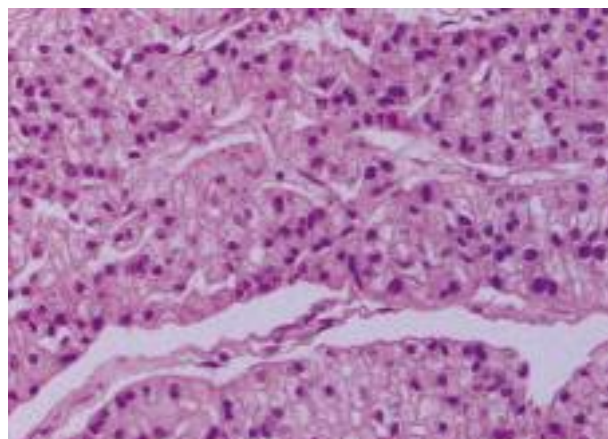
**Fig. 2.** View post tumour resection with visible penetration into the pyelocalyceal system



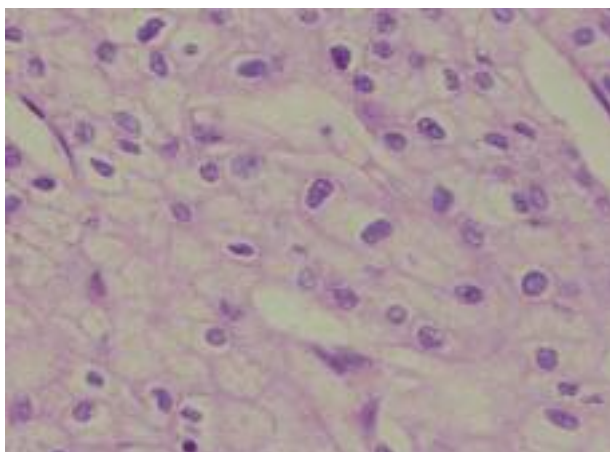
**Fig. 3.** Kidney with three renal arteries and single renal vein. Two arteries in the upper part of the kidney were first anastomosed side-to-side and then anastomosed in two separate positions to the side of the external iliac vessels



**Fig. 4.** The kidney was sewn to the external iliac vessels using semicontinuous suture technique. The ureter was fixed to the urinary bladder with interrupted sutures. View showing tumour resection site in the dorsal part of the kidney with the pyelocalyceal system secured by sutures and sealed with tissue glue



**Fig. 5.** Histological pattern of clear cell renal carcinoma. Wide vascular lumens are visible. Moderately pronounced variation in the appearance of nuclei and nuclear hyperchromasia. H&E stain. Magnification 500×



**Fig. 6.** Histological pattern of clear cell renal carcinoma. Clearly visible cellular membranes. Marked hyperchromasia of part of the nuclei. H&E stain. Magnification 950×



**Fig. 7.** Follow-up CT examination demonstrating central post-resection scar. No pathological enhancement or focal lesions were visualized. Retroperitoneal lymph nodes unenlarged

**Table 1.** Haemoglobin (HGB), white blood cell (WBC), haematocrit (HTC), urea (UN) and creatinine (Cr) levels

	HGB (g/dl)	WBC	HTC	UN	Cr
2002	11.7	6.6	35.2	41	1.5
2003	11.8	6.8	41.3	43	2.3
2004	12.3	7.1	42.1	40	2.4
2005	13.6	6.5	39.9	54	1.9
2006	14.2	6.8	42.8	67	2.1
2007	14.6	7.8	40.8	91	2.4
2008	14.7	6.3	39.5	82	2.3
2009	14.5	6.2	39.3	80	2.4

Six weeks postoperatively the patient was rehospitalized due to hydronephrotic dilatation of the pyelocalyceal system and dysfunction of the transplanted kidney accompanied by elevated serum concentrations of creatinine (7.0 mg/dl) and urea (142.3 mg/dl). A revision of the retroperitoneal space revealed a hard cartilaginous infiltration at the site of the ureter-bladder anastomosis. The ureter

was reimplanted in the bladder with single sutures on the pigtail catheter. The patient did not require haemodialysis. Because of infection identified within the urinary tract, an antibiotic was introduced. The patient also received 2,000 units of erythropoietin (Eprex®) once a week. The function of the transplanted kidney was stabilized. The patient was discharged home with normal laboratory parameters (Table 1). Other examinations (bone scintigraphy, chest radiography) revealed no progression of the disease.

Eight years postoperatively, the function of the kidney is normal, with a moderate dilatation of the pyelocalyceal system, and urea and creatinine concentration in the blood serum amounting to 2.3 mg/dl and 82 mg/dl, respectively. The GFR is 33 ml/min/1.73 m<sup>2</sup>.

## Discussion

Nephron sparing surgery (NSS) techniques are fully-fledged procedures comparable to radical nephrectomy in the treatment of renal carcinoma, particularly in patients with a single kidney, bilateral renal tumours and impaired kidney function, and patients with tumours below 4 cm in



diameter and correct renal function [2, 3, 8]. In the initial period, the main argument raised against NSS was a higher rate of complications relative to radical nephrectomy. Possible complications include haemorrhaging, urinary leakage, urinary fistula, renal artery thrombosis and acute renal failure [9-12]. Stephensen *et al.* demonstrated, however, that NSS and RN techniques had similar complication rates [13-15].

Other studies also confirmed comparable survival times in patients after NSS and after RN surgery [3, 7, 9, 16]. The greatest benefit of NSS is preservation of kidney function. The risk of recurrence remains the most severe disadvantage of NSS, mainly due to occult multifocality undetected intraoperatively. The incidence of recurrence ranges between 0 and 10%, and it is the lowest when the tumour has a low malignant potential and does not exceed 4 cm in diameter [16, 17]. The problem of leaving a safe margin in the NSS procedure remains open to debate. If the margin is too wide, despite higher oncological safety, it may compromise renal function. The latest research confirms that the width of the resection margin is of no real significance as long as minimum "oncological cleanliness" is ensured [18, 8, 10].

Borderline cases, such as the one discussed in this article, concerning a patient with a single kidney, suffering from renal carcinoma with the tumour size exceeding 5 cm and infiltrating Gerota's posterior fascia and the pyelocalyceal system, need to be addressed on an individual basis. It is important, however, that the duration of warm ischaemia of the kidney does not exceed 30 minutes. For prolonged ischaemia, local hypothermia with ice or kidney perfusion with cold solution is employed to reduce damage to the renal parenchyma. Lowering the temperature of the kidney to 15-20°C extends the acceptable period of ischaemia up to 3 hours without any risk of parenchymal damage. Some sources claim that perfusion with cold Custodiol (histidine-tryptophan-ketoglutarate – HTK) may improve late results of *ex vivo* kidney sparing surgery [19].

What our case demonstrates is that in spite of technically challenging conditions, *ex vivo* resection followed by autotransplantation is a correct solution that allows long-term functioning of the organ and patient's survival and helps avoid renal replacement therapy (haemodialysis), which is debilitating to the patients. The experience of medical centres in operations of this type is limited and it is difficult to present an objective analysis of late outcomes. These are, usually, isolated procedures or operations performed in groups of several people [20, 21-24]. Such borderline cases are usually conditional on the operator's experience.

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