Imaging tools to assess surgical margins and pseudocapsule features before partial nephrectomy for small renal masses

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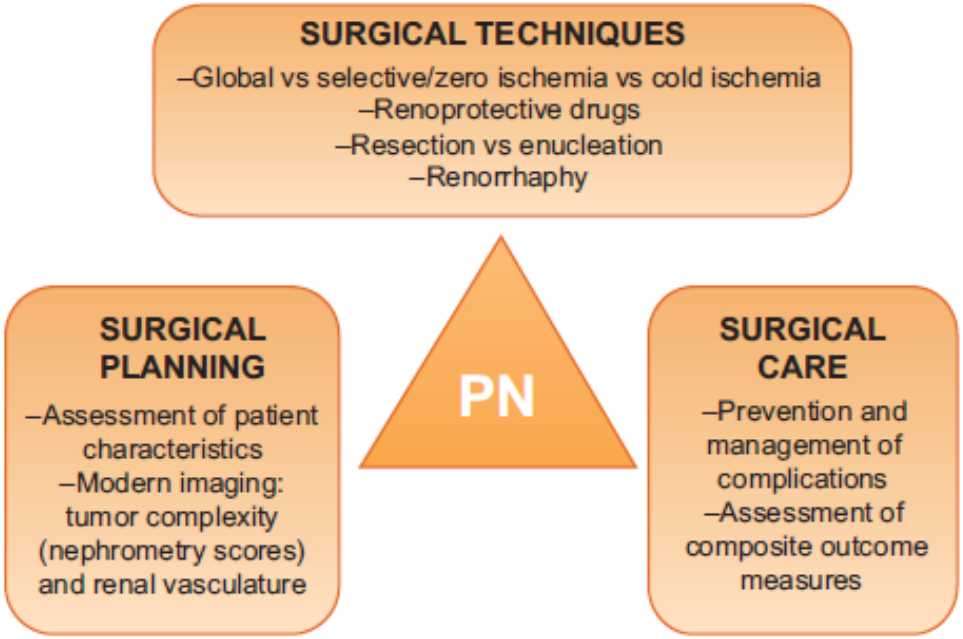

Fig. 1 – The contemporary anatomy of partial nephrectomy (PN).

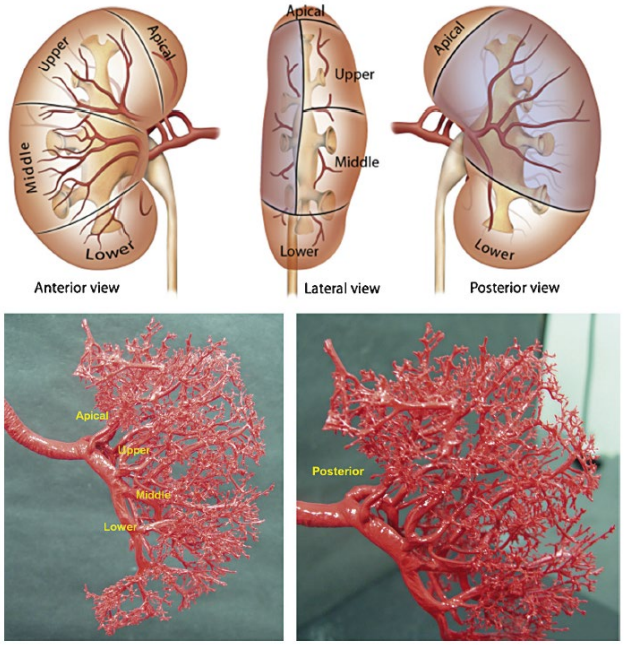

Fig. 3 – Graves' anatomic classification of segmental renal arteries. In addition to the classical variant, a high percentage of patients show anatomic variations. Courtesy of V. Ficarra, University of Udine, and V. Macchi, University of Padua.

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Simple tumor enucleation may not decrease oncologic outcomes for T1 renal cell carcinoma: A systematic review and meta-analysis

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Objective: To evaluate the clinical efficacy and safety of simple tumor enucleation (TE) for clinical T1 renal cell carcinoma.

Materials and methods: A systematic search of PubMed, EMBASE, and Cochrane Central Register of Controlled Trials databases was performed to identify all trials that compared TE and traditional partial nephrectomy (PN) for patients with clinical T1 renal cell carcinoma.

Results: A total of 7 studies involving 3,218 patients were identified and included in this meta-analysis. Compared with the PN group, the TE group had significantly shorter estimated operation times (mean difference [MD] = −21.93; 95% CI: −31.07 to −12.78; $P < 0.001$), shorter warm ischemia times (MD = −1.96; 95% CI: −3.80 to −0.13; $P = 0.04$), less blood loss (MD = −36.63; 95% CI: −57.49 to −15.77; $P = 0.0006$), and lower surgical complication rates (odds ratio [OR] = 0.66; 95% CI: 0.47–0.92; $P = 0.02$). Furthermore, there was no significant difference between the 2 groups in hospital stay duration (MD = −0.46; 95% CI: −0.93 to 0.02; $P = 0.06$), changes in estimated glomerular filtration rate (MD = 3.35; 95% CI: −2.78 to 9.48; $P = 0.28$), positive surgical margin rates (OR = 0.34; 95% CI: 0.10–1.14; $P = 0.08$), and local recurrence rates (OR = 0.71; 95% CI: 0.24–2.06; $P = 0.52$).

Conclusion: Compared to traditional PN, TE is an effective and safe treatment for T1 renal tumors, and TE appears to have acceptable early oncology outcomes. Owing to the limited number of clinical trials and the predominantly retrospective data on this subject, there is a need for properly designed studies to confirm our findings.

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REVIEW

Positive surgical margins and local recurrence after simple enucleation and standard partial nephrectomy for malignant renal tumors: systematic review of the literature and meta-analysis of prevalence

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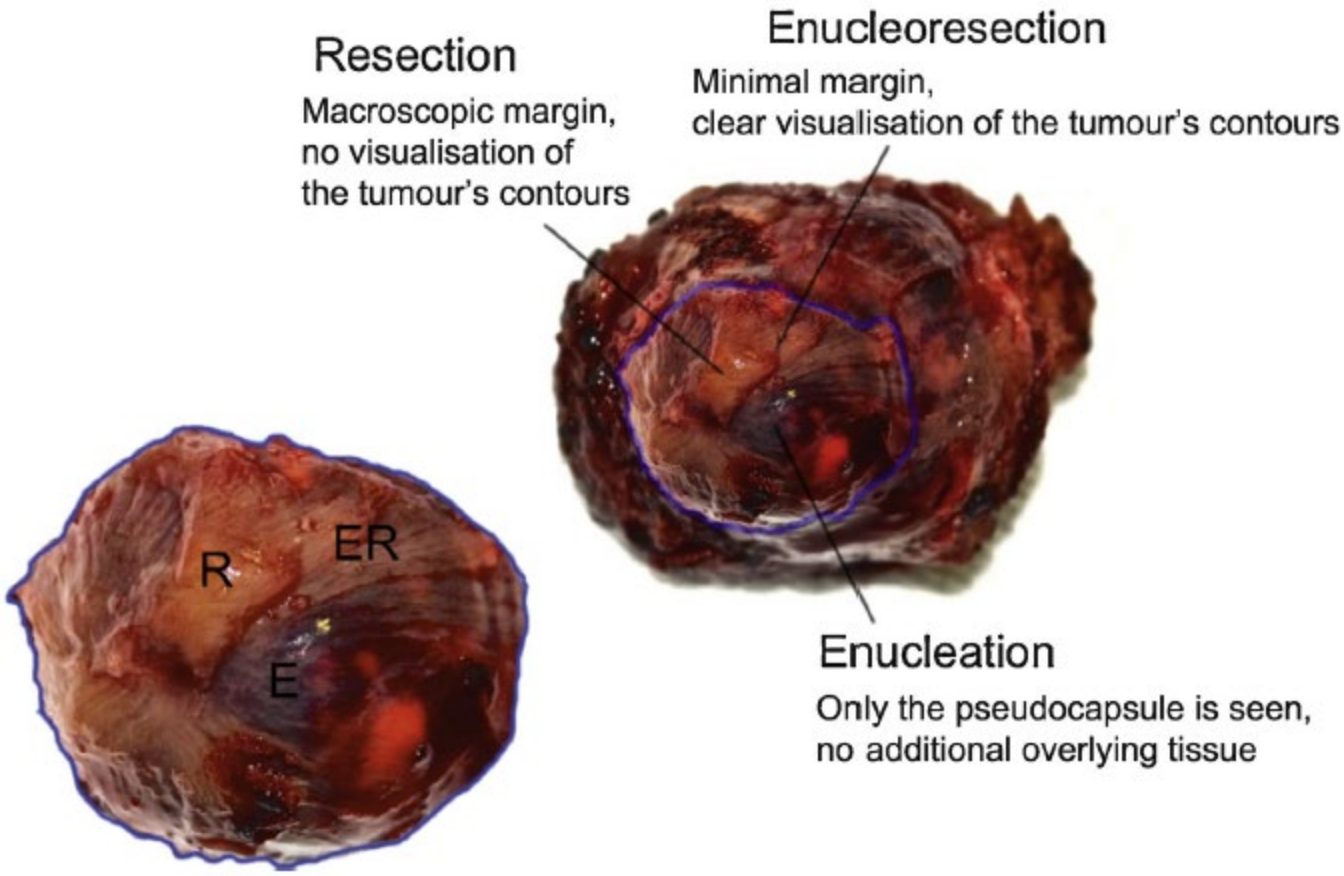
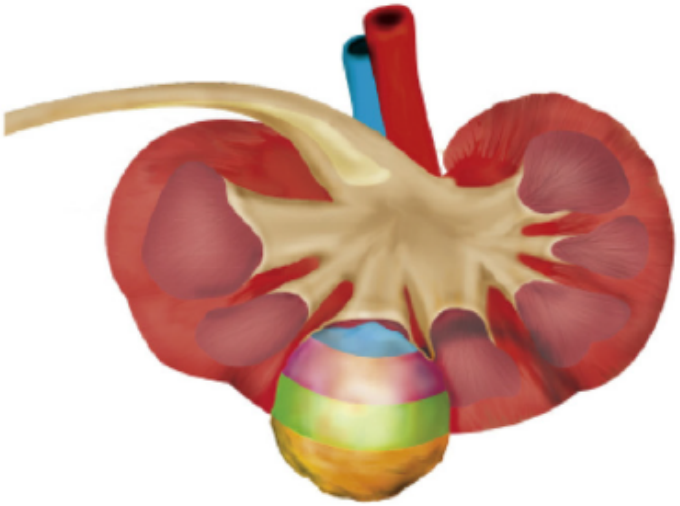
INTRODUCTION: The definition of the safest width of healthy renal margin to achieve oncological efficacy and therefore of the safest resection technique (RT) during partial nephrectomy (PN) continues to be widely debated. The aim of this study is to evaluate the prevalence of positive surgical margins (PSM), loco-regional recurrence (LRR) and renal recurrence (RER) rates after simple enucleation (SE) and standard partial nephrectomy (SPN) for malignant renal tumors.
EVIDENCE ACQUISITION: A systematic review of the English-language literature was performed through August 2016 using the Medline, Web of Science and Embase databases according to the PRISMA criteria. A systematic review and meta-analysis was performed in those studies that defined the exact anatomical location of recurrence after PN.
EVIDENCE SYNTHESIS: Overall, 33 studies involving 11,282 patients were selected for quantitative analysis. At a median follow-up of 43 (SE) and 52 (SPN) months, the pooled estimates of the prevalence of PSMs, LRR and RER were 2.7% (95% CI: 1.5-4.6%, P<0.001) and 0.4% (95% CI: 0.1-2.2%, P=0.018), 2.0% (95% CI: 1.4-2.8%, P<0.001) and 0.9% (95% CI: 0.5-1,7%, P=0.04), 1.5% (95% CI: 0.9-2.3%, P=0.001) and 0.9% (95% CI: 0.5-1,7%, P=0.40) in patients undergoing SPN and SE, respectively.
CONCLUSIONS: Our systematic analysis and meta-analysis demonstrates that SE is noninferior to SPN regarding PSM, LRR and RER rates in patients undergoing PN for malignant renal tumors. Further studies using standardized reporting tools are needed to evaluate the role of resection techniques for oncologic outcomes after PN.


Resection
Macroscopic margin,
no visualisation of
the tumour's contours
Enucleoresection
Minimal margin,
clear visualisation of the tumour's contours
R
ER
E
Enucleation
Only the pseudocapsule is seen,
no additional overlying tissue



Enucleation:
Tumor resected along pseudocapsule without additional overlying tissue

Enucleoresection:
Minimal margin of parenchyma with tumor contour readily visible

Resection:
Tumor contour cannot be appreciated through resected parenchyma

c:
capsulotomy

For the *Surface* area:
0 = Enucleation
1 = Enucleoresection/Resection

For the *Intermediate* and *Base* areas:
0 = Enucleation
1 = Enucleoresection
2 = Resection

Fig. 1 – Surface–intermediate–base (SIB) scoring system for standardized reporting of nephron-sparing surgery resection techniques.

Renal tumor pseudocapsule

- Fibrous band of compressed renal parenchyma that isolates the tumor from the surrounding healthy renal parenchyma and provides a natural dissection plane during surgery

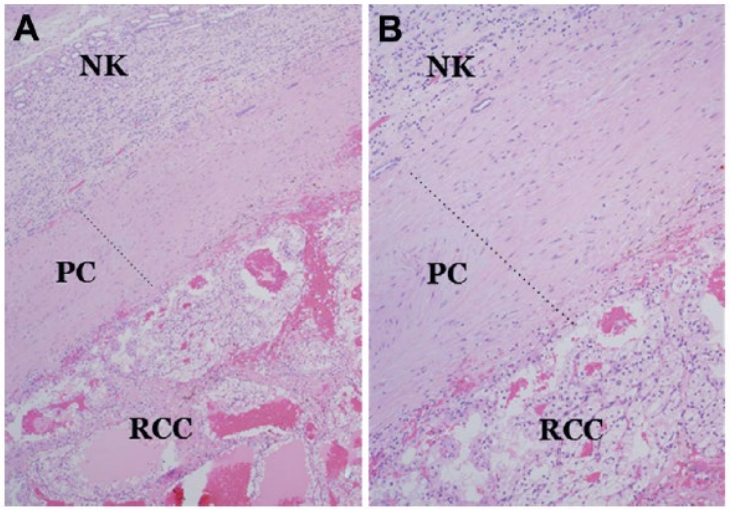


Figure 1. Microscopic investigation reveals clear cell RCC with intact pseudocapsule. Inferior portion exemplifies carcinoma isolated from superior portion of healthy parenchyma by pseudocapsule (*PC*). *NK*, normal kidney. *A*, reduced from ×5. *B*, reduced from ×10.

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Table 3. *Tumor PC and tumor-parenchyma interface by malignancy*

	Benign	Malignant	p Value
No. pts (%)	13	111	—
No. PC (%):	12 (92)	107 (96)	0.4
Intrarenal	4 (31)	91 (82)	<0.001
Extrarenal	11 (84)	93 (85)	1
Mean ± SD PC thickness (mm):	0.3 (0.2)	0.7 (0.5)	0.05
Intrarenal	0.3 (0.2)	0.7 (0.5)	0.05
Extrarenal	0.3 (0.2)	0.7 (0.6)	0.03
No. overall PC invasion (%):	2 (15)	51 (45)	0.04
Intrarenal	0	36 (39)	0.3
Extrarenal	2 (18)	28 (30)	0.5
Mean ± SD clinical tumor size (cm)	3.1 (1.2)	4 (2.7)	0.3
Mean ± SD surgical margin width (mm)	6.4 (3.4)	3.8 (3.2)	0.017
Mean ± SD No. arterioles:			
3 mm or Less distant from tumor	2.3 (1.6)	2.8 (1.2)	0.046
Greater than 3 mm distant from tumor	1.8 (0.7)	2.8 (1.2)	0.006
Mean ± SD arteriolar diameter (mm):			
3 mm or Less distant from tumor	0.4 (0.1)	0.4 (0.1)	0.104
Greater than 3 mm distant from tumor	0.5 (0.2)	0.6 (0.2)	0.111

Table 2. *Intrarenal and extrarenal PC presence and invasion by histological features*

		Intrarenal PC (96 tumors)			
	Overall	Presence	p Value	Invasion	p Value
Mean ± SD malignant tumor size*	3.9 ± 2.6	3.9 ± 2.7	0.7	3.8 ± 2.4	0.95
No. malignancy pathological stage (%):†					
T1a	66 (59)	55 (57)	0.07	24 (25)	0.5
T1b	27 (24)	24 (25)		10 (10)	
T2	3 (2.7)	2 (2)		1 (1.04)	
T3a	6 (5.4)	5 (5.2)		0	
T3b	5 (4.5)	2 (2.1)		1 (1.04)	
T4	1 (0.9)	1 (1.04)		0	
No. tumor type (%):†					
Malignant	111 (90)	91 (82)	<0.001	36 (37.5)	0.1
Benign	13 (10)	4 (31)		0	
No. malignancy subtype (%):†					
Clear cell	77 (69)	70 (73)	<0.001	25 (26)	0.09
Chromophobe	12 (11)	6 (6)		1 (1.04)	
Papillary	16 (14)	12 (12.5)		8 (8)	
Other	6 (5)	3 (3.12)		2 (2.1)	
No. malignancy Fuhrman grade (%):†					
I/II	74 (67)	64 (68)	0.13	27 (28)	0.5
III/IV	37 (33)	27 (28)		9 (9.4)	

* Continuous (Kruskal-Wallis test p values).
† Categorical (Fisher exact test p values).

Bi- or triphasic contrast-enhanced CT

- Enhancement of >15–20 Hounsfield units (HU) is considered the most important indicator of malignancy and is best assessed in the nephrographic phase.
- The corticomedullary phase is used to assess the arterial system (number of renal arteries, feeding mass arteries)
- The urographic phase to assess proximity to and involvement of the renal collecting system
- Pseudocapsule (PC) detection sensitivity 10-26%

Radiographics 38:2021–2033, 2018
AJR Am J Roentgenol 166(5):1151–1155, 1996
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Magnetic resonance imaging (MRI)

- Problem solving tool in patients with indeterminate CT scans (eg, for complex cystic lesions, very small masses, enhancement of 10–20 HU) or contrast medium allergies
- Better for detecting perirenal fat invasion and evaluating the cranial and caudal extent of a venous thrombus in the IVC, as well as delineating benign thrombus from tumor thrombus

PC on MRI

- first described, in 1985, the PC on MRI, appearing as a low-intensity band separating the tumor from the normal renal parenchyma or perirenal fat on both T1 and T2 sequences
- T2-weighted images, however, were found to be the most sensitive for detecting the PC, interposed between the higher intensity of the tumor and normal renal parenchyma
- PC detection sensitivity 54-93%

Radiographics 38:2021–2033, 2018
AJR Am J Roentgenol 166(5):1151–1155, 1996
AJR Am J Roentgenol 166(5):1151–1155, 1996

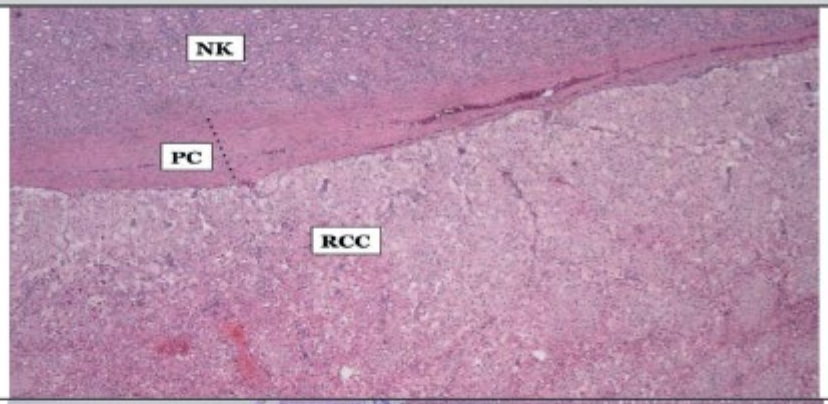
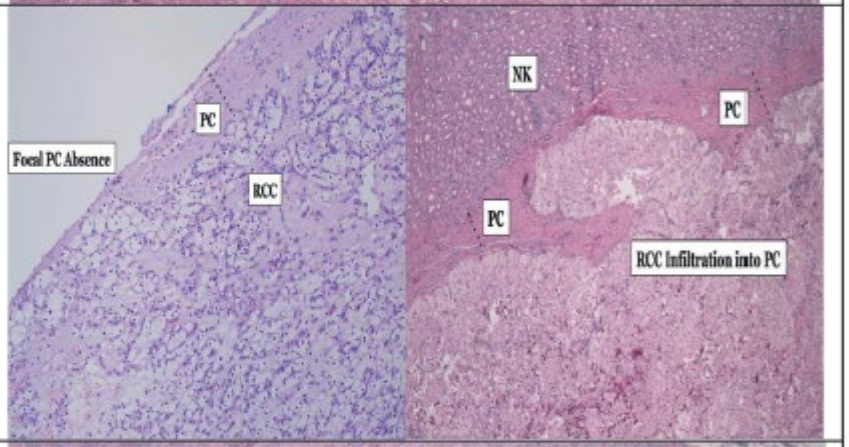
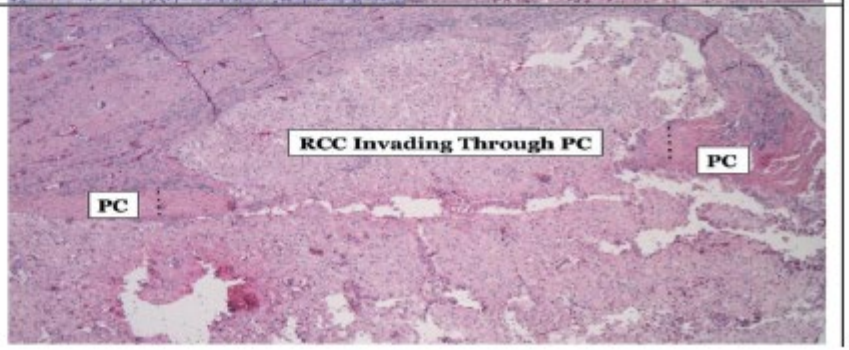
i-Cap Score	Description	Representative Image
1	Pseudocapsule is completely intact on the normal parenchyma side.	
2	Pseudocapsule has either a focal absence or <100% infiltration of carcinoma into the PC but not into the normal parenchyma.	
3	Any degree of carcinoma infiltration completely through the PC and into the normal parenchyma.	

Figure 2. *i*-Cap scoring system. *NK*, normal kidney. *PC*, pseudocapsule. Reduced from ×10.

New classification system to standardize MRI report on PC status: MRI-Cap

- MRI-Cap 0: No visible hypointense rim surrounding the tumor on T2- and T1-weighted images
- MRI-Cap 1: Presence of a clearly identifiable, continuously intact, hypointense rim surrounding the lesion on T2-weighted images
- MRI-Cap 2: Presence of a PC, which appears focally interrupted but in the absence of an obvious infiltration beyond its boundaries assessed on T2-weighted images. No clear interruption visible on T1-weighted images
- MRI-Cap 3: Presence of PC which appears clearly interrupted and infiltrated assessed on both T2- and T1-weighted images

World Journal of Urology (2020) 38:407–415

Accuracy of magnetic resonance imaging to identify pseudocapsule invasion in renal tumors

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Table 2 ρ coefficient, sensitivity, specificity, PPV, NPV and AUC of MRI PC evaluation compared to i-Cap

	MRI-Cap 0 / i-Cap 0	MRI-Cap 1/ i-Cap 1	MRI-Cap 2 / i-Cap 2	MRI-Cap 3 / i-Cap 3	Global
ρ coefficient	0.89 (IC95% 0.83–0.94)	0.75 (IC95% 0.60–0.84)	0.76 (IC95% 0.63–0.85)	0.87 (IC95% 0.79–0.92)	0.94 (IC95% 0.90–0.96)
Sensitivity	97.8%	77%	88%	94%	
Sensibility	83.3%	95.5%	90%	95%	
PPV	95.8%	83.3%	79%	88%	
NPV	90.9%	93.5%	95%	97%	
AUC	0.91	0.86	0.89	0.94	

Arterial spin labelling MRI for detecting pseudocapsule defects and predicting renal capsule invasion in renal cell carcinoma

H. Zhang [a,†], Y. Wu [b,†], W. Xue [c], P. Zuo [d], N. Oesingmann [e], Q. Gan [f], Z. Huang [a], M. Wu [a], F. Hu [a], M. Kuang [g], B. Song [a,*]

Table 3
Two-by-two table for T2-weighted imaging (T2WI) versus the reference standard.

T2WI	Histopathology		Total
	+	−	
+	13	2	15
−	0	5	5
Total	13	7	20

+/−, Renal capsule invasion/not invasion.

Table 4
Two-by-two table for T2-weighted imaging (T2WI) + arterial spin labelling (ASL) versus the reference standard.

T2WI+ASL	Histopathology		Total
	+	−	
+	12	0	12
−	1	7	8
Total	13	7	20

+/−, Renal capsule invasion/not invasion.

	T2 WI	T2 WI+ASL
sensitivity	100%	92.3%
specificity	71.4%	100%
PPV	86.7%	100%
NPV	100%	87.5%

Clinical Radiology 72 (2017) 936–943

Conclusion (I)

- MRI in patients with RCC should be indicated preferably when CT scan is unable to detect intact PC surrounding the entire tumor and simple enucleation is considered.

Conclusion (II)

- The combination of simple enucleation and minimally invasive renorrhaphy could yield maximum renal function at postoperative follow-up.

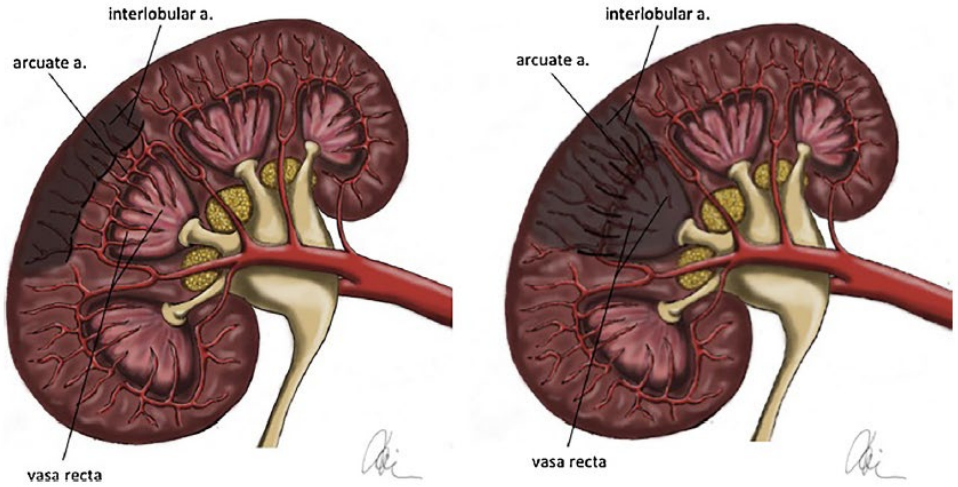

Fig. 2 – Suture of the cortex. (A) The suture has been performed superficial enough in order to avoid the involvement of the arcuate arteries: the blood supply to the medullar parenchyma by the vasa recta is spared. (B) The suture has been deepened with involvement of the arcuate arteries and subsequent ischaemia of both the cortical and the medullar parenchyma.

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