

MP42-02

Tumor Enucleation: Functional Comparison with Standard Partial Nephrectomy

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Background

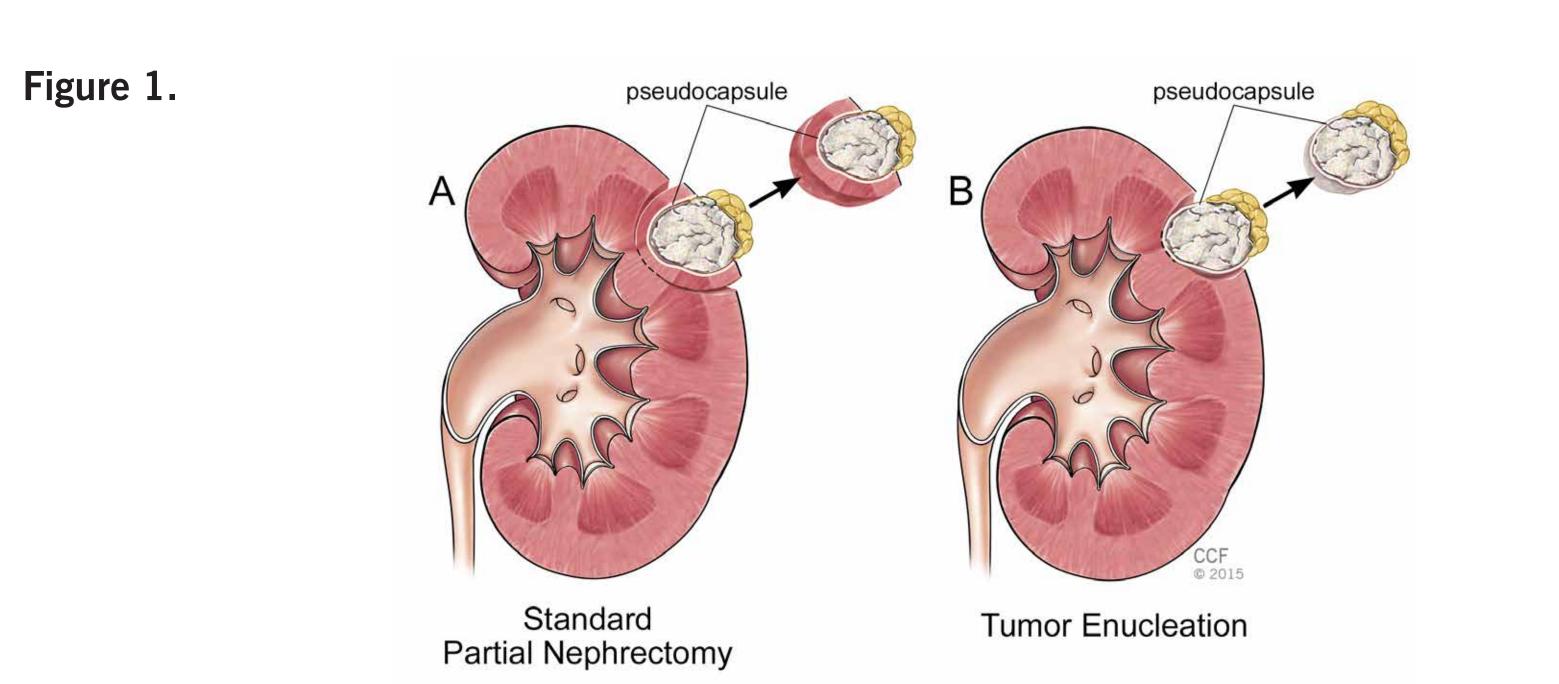
- Vascularized parenchymal mass preservation appears to be the predominant determinant of functional outcomes after nephron-sparing surgery (NSS)
- Traditionally, standard partial nephrectomy (SPN) involves intentional removal of a rim of normal healthy parenchyma along with the tumor and associates with some degree of functional decline (**Figure 1A**). On average 10% of the global function is lost with SPN
- Tumor enucleation (TE) is an alternative nephron-sparing technique in which the renal mass is dissected away from the normal parenchyma via an avascular plane along the tumor pseudocapsule (**Figure 1B**)
- TE optimizes parenchymal preservation and could yield better function than SPN; however, data about this are controversial
- The objective of our study is to compare functional outcomes based on resection strategies (TE versus SPN)

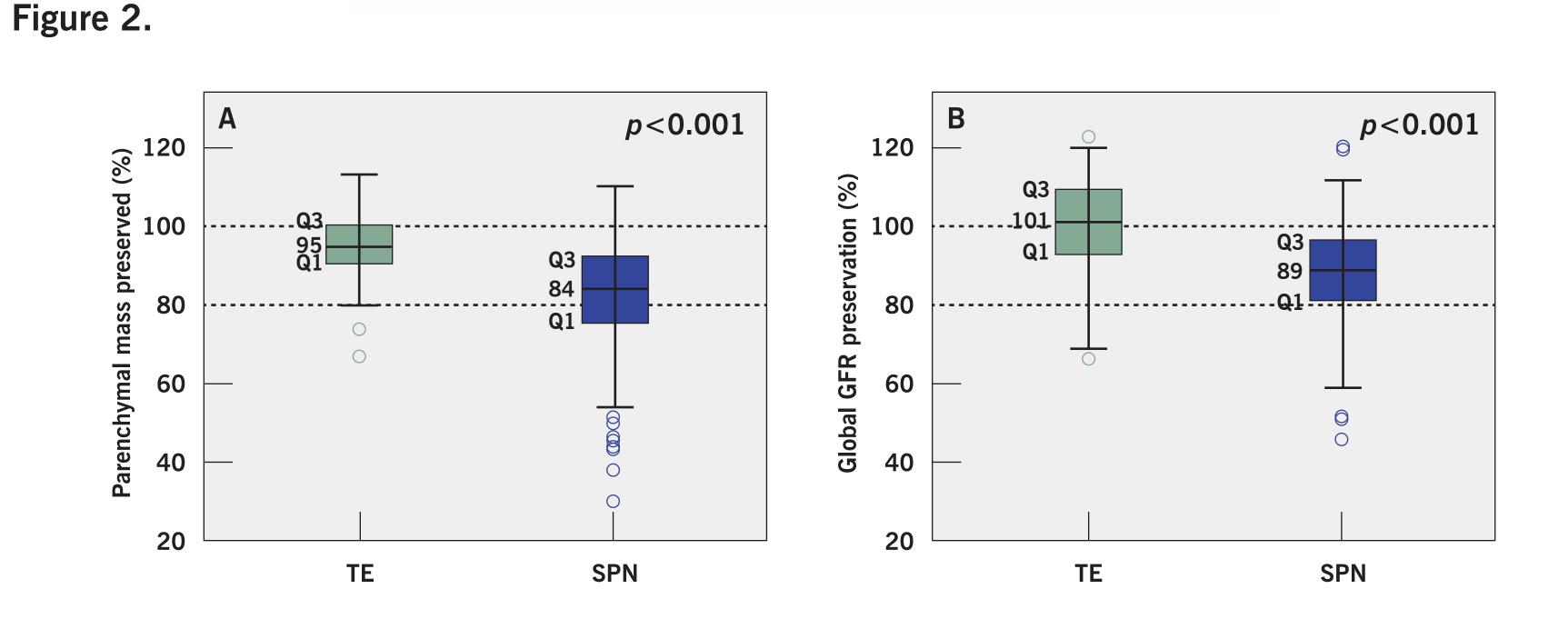
Methods

- From 2008-2015, 444 patients managed with NSS with necessary data for analysis of preservation of ipsilateral parenchymal mass and global GFR from two centers were included
- All studies were required to be <2 months prior and 3-12 months after surgery
- Patients with solitary kidney or multifocal tumors were excluded
- Ipsilateral vascularized parenchymal mass was estimated from contrast-enhanced CT scans preoperatively and postoperatively
- Global GFR was estimated from serum creatinine in the same time frames using MDRD-2 equation
- Univariable and multivariable linear regression evaluated factors associated with new baseline global GFR

Results

- Analysis included 71 TE and 373 SPN (Table 1)
- Median tumor size was 3.0 cm for TE and 3.3 cm for SPN (p=0.03). Median R.E.N.A.L scores were 7 in both cohorts
- For TE, warm and zero ischemia were used in 51% and 49%, respectively. For SPN, warm and cold ischemia were used in 72% and 28%, respectively
- Capsular closure was performed in 46% of TE and 100% of SPN (p<0.001)
- Positive margins were found in 8.5% of TE and 4.8% of SPN (p=0.2)
- Median preoperative global GFR was comparable for TE and SPN (75mL/min/1.73m² versus 78mL/min/1.73m², p=0.6)(Table 2)
- Median ipsilateral vascularized parenchymal mass preserved was 95%
 (IQR=91-100) for TE and 84% (IQR=76-92) for SPN (p<0.001)(Figure 2A)
- Median global GFR preserved was 101% (IQR=93-111) and 89% (IQR=81-96) for TE and SPN, respectively (p<0.001)(Figure 2B)
- On multivariable analysis; preoperative GFR, vascularized parenchymal mass preserved, and resection strategy, all associated significantly with new baseline global GFR (all p≤0.003)(Table 3)





Functional outcomes associated with resection strategy for tumor enucleation (TE) or standard partial nephrectomy (SPN). A) Percent ipsilateral parenchymal mass preserved. B) Percent global GFR preserved. P values are for univariable comparison in each instance.

Table 1. Patient demographics and tumor characteristics

	TE n=71	SPN n=373	p value
Age (years) (median, IQR)58 (43-66)	61 (54-69)	0.01	
Male (%)	43 (60.1)	237 (63.5)	0.7
African American (%)	7 (9.9)	22 (5.9)	0.3
BMI (kg/m ²) (median, IQR)	31 (28-36)	30 (27-35)	0.2
Hypertension (%)	44 (62.0)	241 (64.6)	0.7
Diabetes (%)	13 (18.3)	78 (20.9)	0.7
Heart disease (%)	10 (14.1)	54 (14.5)	0.9
Clinical tumor size (cm) (median, IQR)	3.0 (2.1-3.8)	3.3 (2.3-4.5)	0.03
R.E.N.A.L. score (median, IQR)	7 (6-9)	7 (5-9)	0.5
Surgical approach (%)			< 0.001
Open	0	96 (25.7)	
MIS	71 (100)	277 (74.3)	
Ischemia type (%)			< 0.001
Cold	0	103 (27.6)	
Warm	36 (50.7)	270 (72.4)	
Zero	35 (49.3)	0	
Ischemia time (minutes)(median, IQR)			
Cold		26 (23-30)	
Warm	22 (18-29)	22 (16-27)	0.7
Capsular closure (%)	33 (46)	373 (100)	< 0.001
EBL (ml) (median, IQR)	50 (20-100)	200 (100-300)	< 0.001
Postoperative complications/patient (%)	14 (19.7)	95 (25.5)	0.4
Histology			0.02
RCC	57 (80.3)	337 (90.3)	
Clear cell	39 (68.4)	237 (70.3)	
Papillary	14 (24.6)	61 (18.1)	
Chromophobe	3 (5.3)	29 (8.6)	
Other	1 (1.7)	10 (3.0)	
Benign	14 (19.7)	36 (9.7)	
Fuhrman grade (%) (for RCC)			0.002
$\leq $	41 (71.9)	165 (49.0)	
≥	10 (17.6)	138 (40.9)	
NA	6 (10.5)	34 (10.1)	
Pathologic tumor stage (%) (for RCC)			0.09
pT1a	46 (80.7)	218 (64.7)	
pT1b	9 (15.7)	79 (23.4)	
pT2	1 (1.8)	9 (2.7)	
pT3a	1 (1.8)	31 (9.2)	
Positive surgical margins (%)	6 (8.5)	18 (4.8)	0.2

Table 2. Renal parenchymal mass and function before and after TE and SPN

	TE n = 71	SPN n = 373	p value
Preoperative ipsilateral parenchymal mass (cm³) Postoperative ipsilateral parenchymal mass (cm³) Ipsilateral parenchymal mass loss (cm³) % Ipsilateral parenchymal mass preserved Preoperative global GFR (ml/min/1.73m²) New baseline global GFR (ml/min/1.73m²) % Global GFR preserved	190 (157-218) 180 (141-208) 9 (0-18) 95 (91-100) 75 (62-89) 79 (61-93) 101 (93-111)	181 (145-219) 149 (117-185) 27 (14-48) 84 (76-92) 78 (63-93) 68 (53-82) 89 (81-96)	0.7 <0.001 <0.001 0.6 0.001 <0.001

Data are presented in median (IQR)

Table 3. Analysis of factors associated with new baseline GFR after surgery

Factors	Univariable analysis		Multivariable analysis	
	Coefficient (95% CI)	p Value	Coefficient (95% CI)	p Value
Age	-0.86 (-1.00, -0.72)	0.001	-0.19 (-0.30, -0.09)	< 0.001
Male gender	1.09 (-3.09, 5.27)	0.6	0.98 (-1.22, 3.19)	0.4
BMI	0.17 (-0.12, 0.46)	0.3	-0.04 (-0.21, 0.12)	0.6
Hypertension	-11.9 (-15.8, -7.95)	< 0.001	-2.30 (-4.79, 0.19)	0.07
Diabetes	-0.76 (-5.28, 3.75)	0.7	-0.77 (-3.46, 1.91)	0.6
Heart disease	-4.68 (-10.3, 0.97)	0.1	1.29 (-1.79, 4.37)	0.6
Preoperative GFR	0.80 (0.75, 0.85)	< 0.001	0.74 (0.68, 0.79)	< 0.001
Clinical tumor size	-2.48 (-3.57, -1.40)	< 0.001	-0.34 (-1.05, 0.37)	0.4
R.E.N.A.L. score	-1.32 (-2.29, -0.35)	0.008	-0.05 (-0.66, 0.57)	0.9
Ischemia time	-0.32 (-0.50, -0.13)	0.001	-0.08 (-0.21, 0.05)	0.2
Ischemia type	0.44 (-0.31, 1.20)	0.2	-0.23 (-0.80, 0.35)	0.4
(warm vs. cold				
vs. zero)				
Percent parenchymal	0.27 (0.12, 0.42)	< 0.001	0.18 (0.09, 0.27)	< 0.001
mass preserved				
Resection strategy	-10.3 (-15.7, -4.85)	< 0.001	-6.55 (-10.8, -2.29)	0.003
(SPN vs. TE)				

Conclusions

Our analysis suggests that TE has potential to maximally preserve parenchymal mass compared to SPN and may provide optimized functional recovery. Further investigation will be required to evaluate the clinical significance of these findings in various setting.