What is PADUA score?

- Preoperative Aspects and Dimensions Used for an Anatomical (PADUA) scores

- Preoperative classification system integrating
tumor size and the most important anatomical features of renal tumors
suitable for nephron-sparing surgery (NSS)

Anatomical features[*]	Score
Longitudinal (polar) location	
Superior/inferior	1
Middle	2
Exophytic rate	
≥50%	1
<50%	2
Endophytic	3
Renal rim	
Lateral	1
Medial	2
Renal sinus	
Not involved	1
Involved	2
Urinary collecting system	
Not involved	1
Dislocated/infiltrated	2
Tumour size (cm)	
≤4	1
4.1–7	2
>7	3

[*] Anterior or posterior face can be indicated with a letter ("a" or "p") following the score.

Score assigned to each anatomical feature included in the preoperative aspects and dimensions used for an anatomical (PADUA) classification

Tumor classification
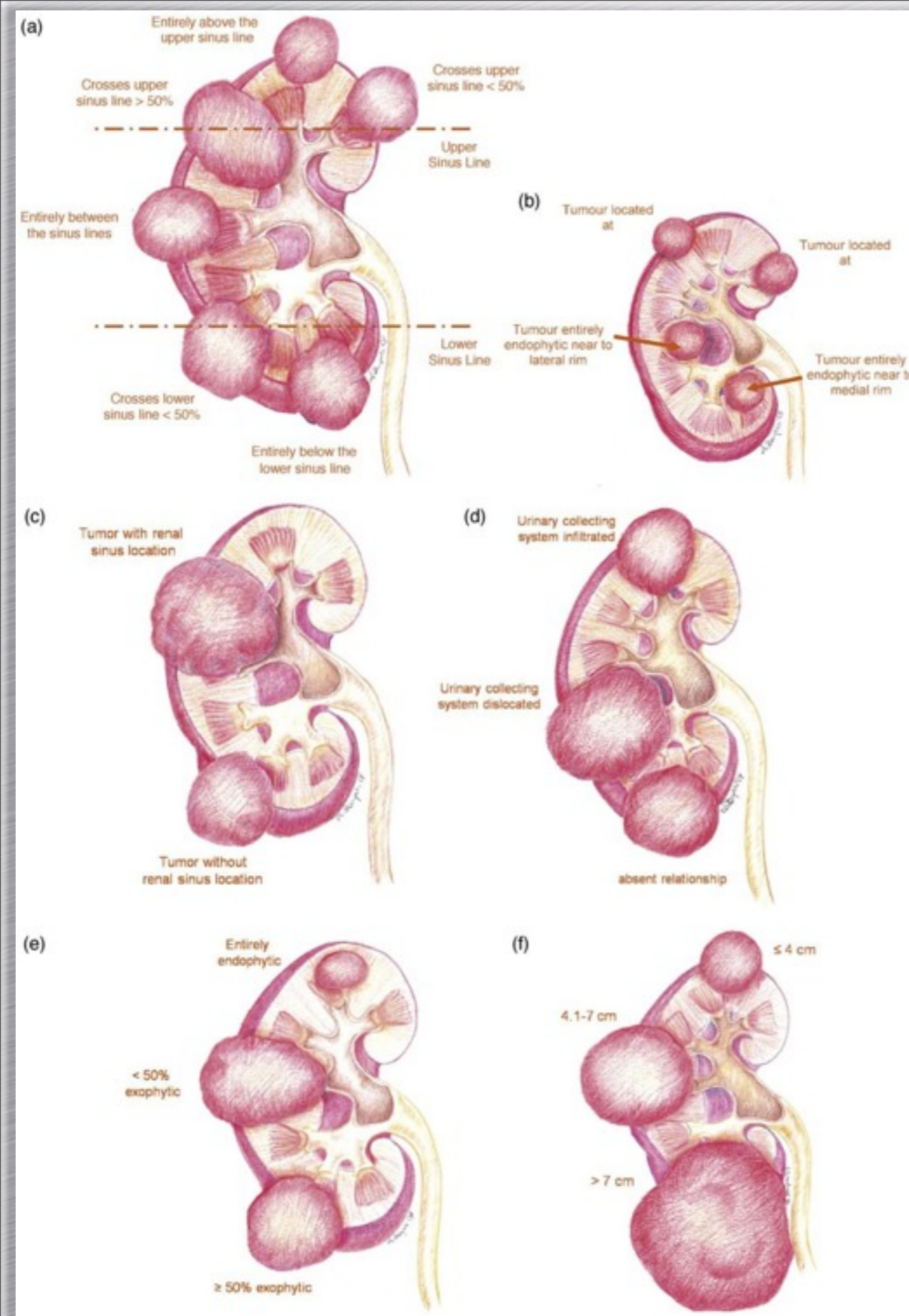
(a) Longitudinal classification

(b) margin location of tumors
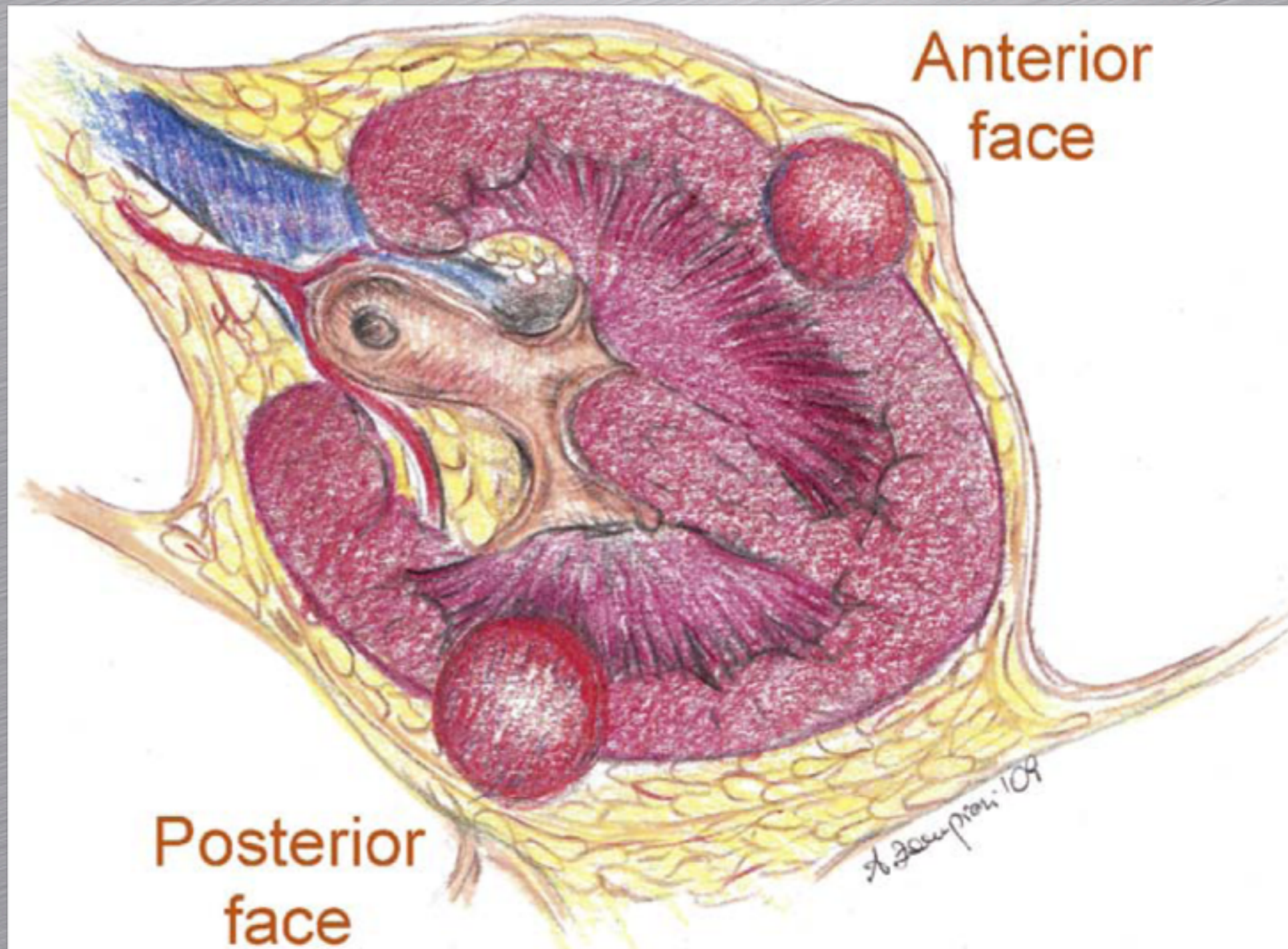
(c) tumor relationship with renal sinus

(d) tumor relationship with urinary collecting system

(e) tumor deepening into the parenchyma

(f) tumor size

Definition of anterior and posterior face of the kidney

Why do we need a preoperative score system?

- to standardize tumor assessment

- to minimize the observer-dependent bias

- to improve clinical outcome

- to prevent complications

- to predict ischemia time

Original Validation of PADUA score

Variable	HR	95% CI	*p* value
Padua score			
6–7	Reference		
8–9	14.535	3.984–53.031	<0.001
≥10	30.641	7.753–120.948	<0.001
BMI (≤25 vs >25)	0.513	0.217–1.211	0.12

HR = hazard ratio; CI = confidence interval; BMI = body mass index.

- 164 consecutive patients
- underwent open NSS
- significant correlation to complication rate

Ficarra V et al. Eur Urol 2009; 56: 786-93

External Validation of PADUA score

Uni- & multivariate Cox proportional hazards models for complication prediction

	Univariate		Multivariate	
	HR (95% CI)	P	HR (95% CI)	P
Gender				
Males				
Females	0.23 (0.03–1.78)	0.158		
Age	0.99 (0.94–1.04)	0.620		
Tumour location				
Central				
Upper pole	0.86 (0.19–3.86)	0.846		
Lower pole	0.87 (0.22–3.47)	0.841		
Tumour dimension, cm	1.09 (0.67–1.77)	0.732		
Histological type				
Clear-cell				
Other	0.72 (0.08–6.21)	0.765	2.23 (0.21–23.57)	0.504
Papillary	4.62 (1.32–16.15)	0.017	4.88 (1.34–17.76)	0.016
Chromophobe				
Fuhrman	1.33 (0.69–2.57)	0.391		
PADUA score	2.94 (1.79–4.83)	<0.001	3.08 (1.71–5.57)	<0.001
PADUA score ≥8	19.51 (2.49–152.7)	0.005	16.43 (2.07–130.20)	0.008

- 74 consecutive patients
- underwent open NSS
- significant correlation to complication rate along with histological type

Tyritzis et al. BJU Int 2011; 109: 1813-8

External Validation of PADUA score

Correlation between PADUA score and
warm ischemia time (WIT), console time, and blood loss

PADUA score	WIT	Console time	Blood loss
6–7	17.6 ± 5.9	77 ± 30.6	89.8 ± 74.2
8–11	22.8 ± 7.2	104 ± 31.2	195 ± 223
P value	<0.002	0.001	0.009

- 62 consecutive patients
- underwent robotic NSS
- significant correlation to:
  - complication rate
  - warm ischemia time
  - consol time
  - repair of pelvicalyceal system

International/Multicenter Validation of PADUA score

Correlation between PADUA score and
warm ischemia time (WIT), console time, blood loss and urinary collecting system (UCS)

PADUA risk group	Cases, no.	WIT, min (median and IQR)[*]	Console time, min (median and IQR)[*]	Blood loss, ml (median and IQR)[*]	UCS repair, no. (%)[**]
Low (score 6–7)	140	16 (12–20)	100 (80–150)	77 (50–100)	35 (25)
Intermediate (score 8–9)	124	20 (15–25)	120 (90–175)	100 (50–197)	55 (44.4)
High (score 10–13)	83	20 (17–24)	120 (104–164)	100 (50–150)	58 (69.9)
p value	–	<0.001	0.004	<0.001	<0.001

PADUA = Preoperative Aspects and Dimensions Used for an Anatomical; WIT = warm ischemia time; IQR = interquartile range; UCS = urinary collecting system.
[*] Kruskall-Wallis test.
[**] Pearson χ^2 test.

- 347 patients
- from 4 different centers (USA & Europe)
- underwent robotic NSS
- significant correlation to:
  - warm ischemia (WIT) time
  - consol time
  - blood loss
  - urinary collecting system (UCS) repair

Ficarra et al. Eur Urol 2012; 61: 395-402

International/Multicenter Validation of PADUA score

Correlation between PADUA score and intraoperative, postoperative and overall complications

PADUA risk group	Cases, no.	Intraoperative complications	Overall postoperative complications	Minor postoperative complications	Major postoperative complications
Low (score 6–7), no. (%)	140	0	5 (3.6)	5 (3.6)	0
Intermediate (score 8–9), no. (%)	124	5 (4)	23 (16.9)	17 (13.7)	6 (4.8)
High (score 10–13), no. (%)	83	5 (6)	13 (15.6)	9 (10.8)	4 (4.8)
p value	–	0.02	<0.001	0.009	

PADUA = Preoperative Aspects and Dimensions Used for an Anatomical.

- 347 patients
- from 4 different centers (USA & Europe)
- underwent robotic NSS
- significant correlation to complications

Ficarra et al. Eur Urol 2012; 61: 395-402

Critical Appraisal of the PADUA Classification and Assessment of the R.E.N.A.L. Nephrometry Score in Patients Undergoing Partial Nephrectomy

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Purpose: We validated the PADUA classification and assessed the R.E.N.A.L. nephrometry score to predict perioperative complications of partial nephrectomy. In addition, we assessed their interobserver variability, and the ability to predict the use of ischemia and ischemia time.

Materials and Methods: Data from consecutive cases of partial nephrectomy with or without ischemia from 3 centers were retrospectively collected. Associations between preoperative variables and complications were evaluated in univariate and multivariate analyses. Reproducibility was assessed by determining Fleiss' generalized kappa and intraclass correlation coefficients in a subcohort scored by 3 physicians with different degrees of urological expertise.

Results: A total of 134 partial nephrectomies were included in the study and 31 cases (23%) presented with complications. On univariate analyses complications were associated with age ($p = 0.02$), tumor size on computerized tomography ($p = 0.01$), pT stage ($p = 0.001$), and PADUA ($p = 0.001$) and R.E.N.A.L. scores ($p = 0.02$). In 3 multivariate models PADUA score 10 or greater (OR 3.98, $p = 0.01$), R.E.N.A.L. score 9 or greater (OR 4.21, $p = 0.02$), tumor size in cm (OR 1.35, $p = 0.02$) and age (OR 1.04, $p = 0.04$) were independent predictors of complications. The R.E.N.A.L. nephrometry score predicted the use of ischemia ($p = 0.03$) and both scores predicted ischemia time (both $p < 0.001$). Kappa was 0.37 to 0.80 for PADUA components and 0.23 to 0.73 for R.E.N.A.L. components. The intraclass correlation coefficient was 0.73 for PADUA and 0.70 for R.E.N.A.L. score.

Conclusions: The highest categories of PADUA and R.E.N.A.L. scores as well as clinical tumor size predict the risk of perioperative complications of partial nephrectomy. Both scores can indicate ischemia time. Their reproducibility is substantial but the implementation of these systems in clinical practice needs further refinement.

Negative external Validation of PADUA score

None Correlation between PADUA / RENAL score and intraoperative, postoperative and overall complications

- 81 patients

- underwent laparoscopic NSS

- by a single surgeon

- only central tumor loocation has significant correlation to complications

- higher PADUA or RENAL scores were only associated with increased risk of hemoglobin loss and prolonged hospital stay

Kruck et al. Wordl J Urol 2012; [Epub ahead of print]

Preoperative and Intraoperative Observations May Differ During Laparoscopic Nephron-Sparing Surgery

Abstract

Purpose: We retrospectively reviewed the preoperative radiologic findings and operational videos of a group of patients who were undergoing laparoscopic nephron-sparing surgery (NSS), to determine whether we should decide the operational approach (laparoscopic *vs* open or radical nephrectomy) on the basis of only the preoperative aspects and dimensions used for an anatomic (PADUA) classification.

Patients and Methods: In total, 41 laparoscopic NSS operations were performed during a 34-month period for suspicious solid renal lesions. Clinicopathologic variables, PADUA scores, operative parameters, and renal functional outcomes were prospectively recorded and analyzed. Meanwhile, a similar classification (intraoperative aspects and dimensions used for an anatomic [IADUA] classification) was used to compare the preoperative imaging modality findings with intraoperative findings.

Results: There was a 73.2% difference between PADUA and IADUA scores. Sixteen (39%) patients had PADUA scores >IADUA scores, 14 (34%) had PADUA scores <IADUA scores, and only 11 (27%) had similar PADUA and IADUA scores. For the study cohort, the mean operative time (OT) was 128 minutes (range 50–250) min, the mean estimated blood loss (EBL) was 199 mL (range 10–1000 mL), the mean warm ischemia time was 35.2 minutes (range 15–60 min), and the mean change in glomerular filtration rate was 8.17 mL/min/1.73m^2 (range −41–26 mL/min/1.73m^2). The mean pathologic tumor size was 32.7±12.3 mm. Thirteen complications were recorded according to the modified Clavien system. PADUA and IADUA were not correlated with EBL and OT, and higher scores failed to predict perioperative complications.

Conclusions: Reproducible standardized classification systems are necessary for renal masses. Intraoperative findings for renal masses, however, may differ from the preoperative radiologic evaluation. Thus, the decision for the type of surgical approach should not be based solely on preoperative assessment, such as the PADUA score.

External validation of PADUA score

Multivariate analysis of factors predicting complications
after nephron-sparing surgery (NSS)

	Risk ratio	95% confidence interval	*p* value
Age	1.0035	0.98–1.03	0.784
Open vs. laparoscopic NSS	0.9169	0.42–1.98	0.826
PADUA score	1.3418	1.14–1.59	0.001

- 240 consecutive patients

- underwent open or laparoscopic NSS

- Only PADUA score correlated significantly with:

  - complication rate

  - ischemic time

  - overall operative time

Waldert et al. World J Urol 2010; 28: 531-5

External validation of PADUA score for pT1b (4,1-7cm) RCC

- from 240 patients, 63 (26%) patients with pT1b RCC

- underwent open (89%) or laparoscopic (11%) NSS

- With increasing size,
  a significant rise in complications was observed

  - 22% in tumors ≤4 cm vs. 32% in tumors 4,1–7 cm

  - however mainly Clavien I

- in tumors >4 cm in diameter,
  PADUA score is reliable predictor of complications

- PADUA score could function as
  a tool for selecting tumors >4 cm suitable for NSS

How PADUA score could help managing small renal mass (SRM)?

- What remains to be determined is whether R.E.N.A.L., PADUA or some other derivative of these systems will provide the most accurate, reproducible and helpful information for SRM management.

- One benefit of improved preoperative assessment of SRMs is the ability to provide reasonable expectations regarding the complications and ischemic outcome of NSS for a given tumor.

- Thus, the clinician can more accurately portray the risks and benefits of alternative options as well. Patients in situations deemed too challenging for NSS can be offered other options or referred (eg thermal ablation, cyotherapy).

Take home message

- The PADUA score is a reliable tool to preoperatively predict:

    - the risk of complications, and

    - important parameters such as ischemic time

- It is applicable to renal masses treated with open, laparoscopic or robotic NSS.

- It can help clinicians in selecting patients suitable for:

    - laparoscopic/robotic surgery or

    - teaching NSS or

    - referring to alternative therapies