A simplified new-generation renal mass complexity scoring system

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Partial nephrectomy is the preferred surgical approach to localized renal tumors as this technique offers favorable oncologic outcomes and maximizes long-term renal function (1,2). Ten years ago, the first wave of standardized renal mass scoring nomograms was introduced to help clinicians objectively stratify the complexity of localized renal tumors and improve operative decision-making (3,4). Since that time, multiple series have validated the use of nomograms in predicting perioperative complications and outcomes following surgery and ablative procedures (5,6). Nephrometry scores have also proven to be useful when comparing partial nephrectomy series from different institutions and when counselling patients regarding their individualized surgical risks (7). However, concerns have been raised regarding reproducibility and interobserver variability of the first-generation nephrometry systems (8). Their clinical usefulness has also been questioned as certain nephrometry calculations can be time-consuming and are unlikely to alter the course of treatment in an experienced surgeon's practice (9).

Ficarra and colleagues recognized these limitations and planned to address them by constructing a new, simplified nephrometry scoring system. In this multi-institutional retrospective study, the authors aimed to condense the existing preoperative aspects and dimensions used for an anatomical (PADUA) model by testing the strength of association of each of its variables to overall post-operative complication rates. Using preoperative cross-sectional imaging, each tumor in a cohort of 531 patients who underwent partial nephrectomy was assigned a standard PADUA score based on six anatomic variables. Contact surface area (CSA) was also calculated based on tumor size and degree of intraparenchymal extension (10). Binary logistic regression analysis was used to determine which variables carried the most clinical significance and receiver-operating curve (ROC) analysis was used to compare the new nephrometry system to the original version.

In this series, the authors found that only four of the six variables of the PADUA score were required to accurately predict the overall post-operative complication rate. The most important anatomic features were found to be (I) rim location; (II) renal sinus involvement; (III) exophytic rate; (IV) maximal tumor diameter. These variables were used to piece together a new Simplified PAdua REnal (SPARE) system, which was ultimately found to perform similar to the original PADUA model using ROC analysis. Urinary collecting system (UCS) involvement and polar location (upper/mid/lower) were found to have weaker predictive value and were omitted from the newer SPARE model. Higher SPARE scores not only predicted higher rates of overall complications (low-risk 18.4% versus high-risk 48.6%), but also correlated with prolonged operative times, longer warm ischemia times, and higher levels of estimated blood loss. SPARE scores were not useful in predicting post-operative renal function. The CSA parameter did not improve the accuracy of either nephrometry system, but was found to be an independent predictor of renal function three months after surgery.

In the current literature, at least 13 different

Table 1 Comparison of the anatomic variables incorporated into existing nephrometry scoring systems

Study	Year	Scoring system	Variables used to calculate score
Kutikov *et al.* (3)	2009	RENAL	Tumor size
			Exophytic/endophytic
			Nearness to sinus fat or collecting system
			Anterior/posterior
			Location in relation to polar lines
Ficarra *et al.* (4)	2009	PADUA	Tumor size
			Exophytic/endophytic
			Rim location
			Renal sinus involvement
			Collecting system involvement
			Polar location
Simmons *et al.* (11)	2010	C-Index	Tumor size
			Central location
Simmons *et al.* (12)	2012	DAP	Tumor size
			Axial distance
			Polar distance
Nisen *et al.* (13)	2014	RTII	Parenchymal invasion depth
			Thickness of renal parenchyma
Hakky *et al.* (14)	2014	NePhRO	Tumor size
			Location of the mass within the kidney
			Relationship to collecting system
			Spatial relationship of the tumor to other organs and vasculature
Shin *et al.* (15)	2015	RAIV	Tumor size
			Deepest depth of tumor involvement
			Width regarding planned tumor margin and ischemized volume caused by renorrhaphy
Tomaszewski *et al.* (16)	2014	RPS	Percentage of renal pelvis area within renal parenchyma
Leslie *et al.* (10)	2014	CSA	Tumor size
			Degree of intraparenchymal extension
Tannus *et al.* (17)	2014	SARR	Tumor size
			Endophytic/exophytic
			Longitudinal location
			Extension of involvement of renal parenchyma
			Relation to renal sinus
			Anterior/posterior location
Wang *et al.* (18)	2016	CLAMP	Coefficient

Table 1 (*continued*)

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Study	Year	Scoring system	Variables used to calculate score
			Location of clamping position
			Anterior hemiboundary
			Multi-hemiboundary
			Posterior hemiboundary
Spaliviero *et al.* (19)	2016	ABC	Tumor depth
			Renal arterial vascular anatomy
			Order of arterial branches that need to be dissected/transected during partial nephrectomy
Ficarra *et al.*	2019	SPARE	Tumor size
			Exophytic rate
			Rim location
			Renal sinus involvement

RENAL, radius, exophytic/endophytic, nearness to renal sinus/collecting systems, anterior/posterior, location relative to polar lines; PADUA, preoperative aspects and dimensions used for an anatomical classification system; C-index, centrality index; DAP, diameter-axial-polar; RTII, renal tumor invasion index; NePhRO, nearness to collecting system, physical location of the tumor, radius, and tumor organization; RAIV, resected and ischemized volume; RPS, renal pelvic score; CSA, contact surface area; SARR, surgical approach renal ranking; CLAMP, coefficient of each score and the location of the clamping position of the target artery and areas of the target artery entering the renal sinus: anterior boundary, multi-boundary and posterior boundary; ABC, arterial based complexity; SPARE, Simplified PADUA REnal.

nephrometry scoring systems exist (*Table 1*) and greater than 100 studies have focused on their validation, applicability, and predictive value. However, the clinical importance of renal mass scoring systems is often criticized due to subjective aspects in each grading system, limited benefit in predicting histology/grade and post-operative renal function, and impractical use in a busy clinical setting (20,21). It is not surprising that in the SPARE study, like many similar studies, maximal tumor diameter was found to be one of the strongest predictors of post-operative complications. However, in this series the authors pointed out that "size alone" was inferior to the PADUA and SPARE systems in predicting post-operative complications. Other authors have reported contradictory findings. Maximal tumor diameter alone has been shown in some series to perform better than RENAL and PADUA in predicting complications and recurrence following ablative procedures (22,23). Given that renal mass diameter is a common denominator amongst nearly all the nephrometry scoring systems and has consistently proven its predictive power (24), we must ask ourselves, what are we gaining by adding and subtracting other variables to create a longer list of available nomograms? Could we simply use tumor size and clinical intuition to drive our surgical decision-making? Is maximal tumor diameter alone sufficient for comparing series of patients undergoing nephron sparing procedures and comparing associated oncologic and functional outcomes?

When looking back at the original PADUA study, which was a prospective trial at a single institution consisting of 164 patients who all underwent open extraperitoneal partial nephrectomy without vessel clamping, the rate of overall post-operative complications was correlated with polar location, rim location, involvement of the sinus, involvement of the UCS, and percentage of tumor extension into the kidney (4). In the current SPARE study, which incorporates a larger retrospective cohort of 531 patients from multiple centers who underwent open (44.6%), pure laparoscopic (28.6%), or robot-assisted (26.7%) partial nephrectomy, polar location and UCS involvement were no longer found to be significant. This finding may be explained by the discrepancy in the maximal diameter of the tumors in each study, as the total number of larger renal masses measuring 4–7 cm (pT1b) was lower in the PADUA trial (11.8%) compared to the SPARE study (23.9%) (4). This reinforces the theory that as tumor diameter increases, the less additional variables are needed to predict post-operative complications. Still, selection bias and series heterogeneity are inherent to the various nephrometry scoring studies and likely contribute to their inconsistent findings, such as the differences reported in these two series by the same author.

The authors are commended for recognizing the limitations that exist in the current space of nephrometry nomograms and for offering a simpler approach to stratifying renal tumors. Perhaps by requiring the entry of two less variables, the SPARE model will be appreciated by current PADUA users. Perhaps SPARE's ease of use will entice a new generation of surgeons to incorporate nomograms into their daily practice. It will be interesting to see if SPARE will be externally validated and how it will compare to the other existing nephrometry systems in future series.

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Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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