



Critical evaluation of the PADUA score in a retrospective analysis of open partial nephrectomy

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ABSTRACT

Objective: Several nephrometry scores have been developed to predict postoperative complications in partial nephrectomy based on preoperative imaging characteristics. The most widely used is the PADUA score. We retrospectively evaluated the value of the PADUA score in a consecutive series of open partial nephrectomy in our institution.

Material and methods: Two hundred and thirteen consecutive patients who underwent open partial nephrectomy from January 1, 2012 and December 31, 2016 in our department for suspected renal malignancies were included in the study. The PADUA score was determined from preoperative computed tomography scans and a retrospective analysis of complications and other relevant parameters based on chart review was performed.

Results: Two hundred and thirteen patients underwent open partial nephrectomy, and 72.7% of them had a confirmed renal cell carcinoma (62.9% stage pT1). A total of 73 patients had peri- or postoperative complications (Clavien-Dindo Grades 1-5, n=5, 37, 24, 5 and 0, respectively). Logistic and linear regression analysis did not show any correlation of complications with the preoperative three-group PADUA score. However, the PADUA scores were significantly correlated with operative and ischemia time. Dividing the patients into just two PADUA groups (<8 vs. ≥8 points) did show a significant difference in the severity of complications (OR 5.4, p<0.003).

Conclusion: The PADUA score is an indicator for the complexity of partial nephrectomy and correlates with surgical parameters. Its usefulness in predicting complications is limited.

Keywords: Complications; PADUA score; partial nephrectomy; renal tumour.

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Introduction

Partial nephrectomy has become the recommended standard treatment for renal cell carcinoma of stage cT1, whether performed by open or laparoscopic surgery. Furthermore, there is a trend to extend the indication to tumours exceeding 4 cm in diameter, if feasible.^[1-5] Several nephrometry scores have been developed which are believed to have predictive value for postoperative complications in nephron-sparing surgery. The most widely advocated score is the Preoperative Aspects and Dimensions Used for an Anatomical Classification (PADUA) score developed by Ficarra et al.^[6]

The PADUA score focusses on anatomical criteria of renal tumours. In their series, Ficarra et al.^[6] demonstrated that detailed consideration of the anatomical factors of the renal tumour in relation to its renal localization gave a relatively reliable prediction of the postoperative course concerning complications, better than just considering tumour size. The authors postulated that the use of such a score would improve the comparability between different series and different surgical techniques (e.g. open vs laparoscopic or robotic), helping to determine which technique would be the best. Also, the preoperative use of a score predicting complications was thought to be useful in

surgical decision making regarding the risk of complications versus comorbidity and other patient factors. Thus, such a score would be a reliable basis for or against the decision to offer partial nephrectomy rather than radical nephrectomy to individual patients.

The PADUA score grades clinical tumour size and renal as well as intrarenal anatomical features of tumour localization (superior, inferior, middle, lateral, medial; exo-or endophytic; infiltration of adjacent structures such as the renal sinus or the collecting system).^[6] The sum score developed as the total PADUA score is then believed to be predictive of the postoperative course after partial nephrectomy.^[6]

In our department, open partial nephrectomy through the flank approach has been the main surgical treatment option for cT1 and larger renal tumours since 2006. We do not use any nephrometry score to assess whether partial nephrectomy is considered or not. The objective of this study was to assess whether the use of the widely-recommended PADUA score would have been useful, in retrospect, for our patient management and whether we should change our routine.

Material and methods

All consecutive patients who underwent partial nephrectomy between January 1, 2012 and December 31, 2016 in our department were included. All patients had received preoperative computed tomography (CT) scans and were suspected to have a malignant renal tumour. The CT scans were reviewed and the PADUA score was assigned retrospectively by one person (VQ) who had not been involved in patient care and did not know the results. Peri- and postoperative data were retrieved from patients' records. Internal review board approval had been obtained.

The parameters evaluated were biographical data, body mass index (BMI), comorbidities, duration of hospital stay, ECOG performance status, Charlson Comorbidity index, relevant pre- and postoperative clinical chemistry (e.g. hemoglobin, serum creatinine). Surgery was performed through flank incision. Two hundred and ten out of 213 patients had been subjected to renal ischemia for tumour resection by arterial or hilar clamping. In 161 patients additional renal hypothermia with ice packs around the kidney was performed, while in 49 patients cooling procedure was not attempted. In 3 patients renal ischemia was not applied for surgery. Complications and their management were recorded and categorized as 'minor' or 'major' as well as classified according to Clavien-Dindo criteria.

Statistical analysis

Statistical calculations were done with the software package

Statistical Package for the Social Sciences version 24 (IBM SPSS Statistics; Armonk, NY, USA). Logistic regression was used to examine group differences. Dependent variables were divided dichotomously between groups. The PADUA scores were grouped into three categories [low (6-7), medium (8-9) or high (≥ 10)] as suggested by the original publication and into two categories [low (< 8), high (≥ 8)]. Effect coefficients as well as odds ratios were calculated for the PADUA score. Logistic regression analysis was performed for the interval-scaled variables. The study has been approved by the ethics committee. All included patients have declared their consent in writing.

Results

A total of 213 patients had a mean age of 66 ± 10.79 years (range, 36-87 years). Study population consisted of 75 female (35.2%) and 138 male (64.8%) patients. A total of 185 (86.9%) patients had been clinically asymptomatic, while preoperatively the remaining patients were symptomatic [flank/lumbar pain ($n=11$; 5.2%), bone pain due to metastatic disease ($n=9$; 4.2%), gross hematuria ($n=4$; 1.9%), weight loss ($n=3$; 1.4%), hypercalcemia ($n=1$)]. The indications for nephron-sparing surgery had been small tumour size in 169, solitary kidney in 16, bilateral renal tumours in 6, chronic renal disease in 7, multicystic kidney disease in 12, suspected angiomyolipoma in 2 and chronic nephritis in 1 case. Nine patients with metastases were not cytoreductively nephrectomized because of advanced renal insufficiency. There were no correlations between the PADUA score and patient age, gender, BMI or Charlson score (data not shown).

Mean tumour size as assessed by preoperative CT was 3.8 ± 2.22 cm (range, 0.8 to 17.0 cm). The preoperative clinical stages were cT1a (≤ 4 cm) in 149, (70%), T1b (< 7 cm) in 49 (23%), and cT2 (> 7 cm) in 13 (6.1%) patients. The mean PADUA score was 7.09 ± 1.48 points (Tables 1 and 2). The patients had low (6-7) ($n=150$), intermediate (8-9) ($n=47$) and high PADUA (> 10) ($n=16$) scores. Tumour stage (cT) was significantly correlated with the PADUA scores ($p < 0.001$). Postoperative pathology revealed a mean tumor size of 3.59 cm and clear cell renal carcinoma in 115 (54%), papillary renal cell carcinoma in 27 (12.6%) and benign tumours in 55 cases (25.8%).

Mean surgical time was 153.1 ± 41.6 minutes (range, 43-310 minutes). The mean renal ischemia time in 210/213 patients was 16.1 ± 7.04 minutes (range, 2-50 minutes). Mean intraoperative blood loss as collected by suction was 672 ± 576.2 mL (range, 100-2500 mL), while 5 patients received intraoperative blood transfusions. One case was converted to radical nephrectomy intraoperatively, in another case additional adrenalectomy was performed and one patient died intraoperatively due to cardiac arrest.

Table 1. Distribution of patients and PADUA Scores

Groups	PADUA score	n (%)
Low (6-7)	5	22 (10.3)
	6	62 (29.1)
	7	64 (30.0)
Intermediate (8-9)	8	29 (13.6)
	9	20 (9.4)
High (≥10)	10	8 (3.8)
	11	7 (3.3)
	12	1 (0.5)
Total		213 (100)

Table 2. Complications grouped as minor and major

Minor Complications	n	Major Complications	n
Fever	22	Urinoma	11
Transfusions	13	Hematoma	5
Acute urinary retention	3	Impaired wound healing	4
Hyperdiuresis	2	Wound abscess	3
Nausea & vomiting	2	Paralytic ileus	3
		Delirium	1
		Septicemia	1
		Renal artery thrombosis with nephrectomy	
		Renal failure with dialysis	1
		Death	2

Table 3. Complications graded according to Dindo-Clavien versus PADUA score

PADUA Score	Clavien-Dindo Grade					Total
	1	2	3	4	5	
Low (n)	4	26	15	4	0	49
Intermediate (n)	0	9	8	1	0	18
High (n)	1	2	1	0	2	6
Total	5	37	24	5	2	73

Mean hospital stay was 9±6.11 days (range, 4-55 days)73/213 patients (34.3%) had postoperative complications (Table 2). According to clinical importance we classed them as either minor (n=42) or major (n=31) complications (Table 2) as well as

according to Clavien-Dindo grades 1-5 (5, 37, 24, 5 and 2 cases, respectively) (Table 3).

There was no significant correlation of the PADUA score with intraoperative blood loss or hospital stay. There was, however, a significant positive correlation of the PADUA score with ischemia time (Pearson's correlation coefficient $R=0.363$, $p<0.001$) and ischemia time ($R=0.42$, $p<0.001$).

For postoperative complications, there were no significant correlations with the PADUA score. Dividing the patients into groups with low, intermediate or high scores as suggested by the developers of the PADUA score, there were no significant differences regarding the rate or severity of complications between the three groups (Table 4). However, dividing the patients into just two PADUA groups (<8 vs. ≥ 8 points) did show a significant difference for the severity (OR 5.4, $p<0.003$) but not the rate of complications. There was also no significant correlation between the Clavien-Dindo classification and the PADUA score nor with our classification of 'minor' vs 'major' complications (Table 4).

Discussion

The aim of our study was to evaluate the usefulness of the PADUA score for predicting complications and thus, its probable indispensability for evaluating patients for partial nephrectomy in clinical practice. The distribution of age, gender, BMI, histology and tumour stages as well as comorbidities in our cohort was very similar to that used by Ficarra et al.^[6] when they first described the PADUA score in 2009⁶. In contrast to Ficarra et al.^[6], our larger patient cohort did not confirm their findings asserting that the PADUA score with a three group classification is predictive of complications in partial nephrectomy. In contrast, in our cohort only the broader two-group classification of the PADUA score was significantly associated with the severity but not the rate of complications. Similar findings for the PADUA score were published by Okhunov et al.^[7] and Zhang et al.^[8].

There are several limitations to our study as well as to other studies assessing the value of nephrometry scores for the prediction of complications after nephron-sparing surgery. There is an unbalanced number of cases in each group as smaller T1 tumours will always be the largest group and complex cases with high PADUA scores will always be less numerous. The overall rate of complications in a series will also have an influence on the likelihood of finding statistically significant differences between groups. There is also always a definite bias in that more complex cases with a high PADUA score will more likely be managed by more experienced surgeons which will influence the rate of complications.

Table 4. Results of binary logistic regression with the three-group PADUA classification

Dependent variable	Independent variable	Odds ratio	p	95%-CI
Symptoms	PADUA grade 1	Reference		
	PADUA grade 2	2.11	0.089	0.89-5.0
	PADUA grade 3	0.52	0.541	0.06-4.20
CT-Stage T1b, T2	PADUA grade 1	Reference		
	PADUA grade 2	4.87	<0.001	2.42-9.82
	PADUA grade 3	2.36	0.122	0.79-7.0
Rate of complications	PADUA grade 1	Reference		
	PADUA grade 2	1.07	0.85	0.54-2.12
	PADUA grade 3	0.63	0.44	0.2-2.04
Severity of complications	PADUA grade 1	Reference		
	PADUA grade 2	8.82	0.001	2.46-31.64
	PADUA grade 3	0.90	0.993	0.09-9.43
Clavien-Dindo Grade	PADUA grade 1	Reference		
	PADUA grade 2	1.6	0.411	0.53-4.69
>2	PADUA grade 3	1.05	0.957	0.61-69

Taking these limitations into consideration, a three-group subdivision of a score will therefore be less likely to detect significant differences than a two-group stratification of the score. We found a significant relationship with the severity of complications only with the two-group stratification of the PADUA score. In two separate studies, Kong et al.^[9] and Tyritzis et al.^[10], also found meaningful correlations only when using a two strata PADUA classification.^[11] Lack of correlations between the Clavien-Dindo classification and the PADUA score in our cohort has been also indicated by others.^[6,9,12] It is another indication that the PADUA score is of limited clinical value.^[13,14]

However, our cohort did show a significant correlation between the PADUA score and intraoperative ischemia time and overall surgical time. This correlation with ischemia and surgical time was also reported by Zhang et al.^[8] and Waldert et al.^[12]. This relationship is, of course, entirely plausible and not surprising. We therefore think that using the PADUA score in clinical routine assessment of renal tumours is not useful and is unlikely to improve the clinical practice of partial nephrectomy.

In conclusion, the PADUA score assesses the anatomical complexity of a renal tumour with respect to partial nephrectomy. It therefore correlates with ischemia time and surgery time. Only in a broad stratification of two groups (low or high PADUA score) does it correlate with the severity of complications.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of University Rostock.

Informed Consent: Written informed consent was obtained from patients who participated in this study.

Peer-review: Externally peer-reviewed.

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