RENAL Nephrometry Scores and Perioperative Outcomes in Open Partial Nephrectomy

Nadeem Bin Nusrat[1], Sana Kundi[2], Assad Ur Rehman[1], Nauman Zafar[1], Sarmad Imtiaz Bajwa[1] and Saira Imtiaz[1]

[1]*Department of Urology, Pakistan Kidney and Liver Institute and Research Centre, Lahore, Pakistan*
[2]*Department of Radiology, Pakistan Kidney and Liver Institute and Research Centre, Lahore, Pakistan*

ABSTRACT

Objective: To evaluate the efficacy of RENAL nephrometry scores in guiding open partial nephrectomy for renal malignancies and comprehend perioperative factors influencing outcomes.

Study Design: Observational study.

Place and Duration of the Study: Department of Urology, Pakistan Kidney and Liver Institute and Research Centre, Lahore, Pakistan, from September 2017 to June 2023.

Methodology: The study includes 48 eligible patients undergoing partial nephrectomy for kidney cancer. RENAL scores, preoperative CT scans, patient data, and tumour specifics were collected. Perioperative outcomes, including Clavien-Dindo classification for complications, were recorded. Patient characteristics, tumour details, and continuous variables such as estimated glomerular filtration rate (eGFR) were analysed using IBM SPSS version 20.0.

Results: The study included 48 patients (33 males and 15 females) with a median age of 53 years and a median RENAL score of 8. Clear-cell carcinoma was the dominated histological type (70.83%). The average follow-up duration was 30 months. The RENAL score correlated significantly with ischaemia time, blood loss, tumour size, drainage day, and catheter out day. Postoperative elevation in serum creatinine was associated with male gender and eGFR.

Conclusion: Partial nephrectomy is highly effective for small, locally limited renal tumours, providing favourable outcomes with minimal complications. Tumour size is crucial for reporting, aiding research, and patient counselling. Despite limited correlation with complications, the RENAL nephrometry score remains valuable for defining renal mass characteristics and precise planning in complex localised renal cell carcinoma operations.

Key Words: *RENAL nephrometry scores, Perioperative outcomes, Open partial nephrectomy, Retrospective analysis, Renal tumours, Renal mass characteristics.*

How to cite this article: Nusrat NB, Kundi S, Rehman AU, Zafar N, Bajwa SI, Imtiaz S. RENAL Nephrometry Scores and Perioperative Outcomes in Open Partial Nephrectomy. *J Coll Physicians Surg Pak* 2024; **34(12)**:1524-1529.

INTRODUCTION

Renal cell carcinoma (RCC), constituting 2 to 3% of adult malignancies, is experiencing a steady increase of about 2.5% annually. Advanced imaging techniques have led to the incidental detection of over half of renal tumours at early stages, redefining RCC as the radiologist's tumour rather than the classic triad's internist's tumour.[1,2] Its global prevalence is notably rising in Asian countries, including China, Japan, and India.[3-5] The lack of RCC incidence statistics in Pakistan necessitates a comprehensive registration of renal cancer. Nephron-sparing surgery (NSS) *via* partial nephrectomy (PN) has become the primary approach for smaller kidney tumours, gaining substantial research attention.[6]

Correspondence to: Dr. Saira Imtiaz, Department of Urology, Pakistan Kidney and Liver Institute and Research Centre, Lahore, Pakistan
E-mail: saira.khan@pkli.org.pk

Received: September 01, 2023; Revised: May 14, 2024; Accepted: May 15, 2024
DOI: https://doi.org/10.29271/jcpsp.2024.12.1524

In Pakistan, the increasing trend of partial nephrectomy (PN) for minor renal tumours mirrors the global landscape. The ongoing debate between partial and radical nephrectomy persists, even for small kidney tumours that may benefit from less invasive treatments. Tools such as the RENAL (radius, exophytic / endophytic features, tumour proximity to the collecting system or sinus in millimetres, anterior/posterior placement relative to polar lines) nephrometric scoring system have emerged to fulfil the scientific demand for evidence-based criteria. This radiographic tool, assessing tumour complexity through five variables and assigning scores ranging from four to twelve, helps categorise tumours as low, moderate, or high complexity. This article presents the authors' initial experience with PN.[7]

Clinician's choice to perform PN is mostly based on the features of the tumour, however, preoperative evaluations should also take the patient's comorbidities and general health into account. Postoperative problems and reduced survival following peripheral neuropathy have been linked to older age, male gender, medical comorbidities (hypertension, diabetes, congestive heart failure, and coronary artery disease), smoking, and obesity.[8] This study aims to evaluate the efficacy of the RENAL nephrometric scoring system in guiding renal

tumour surgery, addressing the increasing prevalence of partial nephrectomy and enhance evidence-based treatment decision-making for improved patient care.

METHODOLOGY

This study received approval from the Institutional Review Board of the Pakistan Kidney and Liver Institute and Research Centre in Lahore, Pakistan, before the initiation of the study. Through the hospital's IT network, the authors were able to get the medical records of each patient receiving treatment for kidney cancer. Between September 2017 and June 2023, 117 patients had open partial nephrectomy procedures at the study centre. Sixty-nine individuals were disqualified due to low RENAL scores, loss of follow-up, data loss, a single kidney, numerous tumours, or bilateral tumours. The final group contained 48 patients in total. The authors obtained the medical records of all patients undergoing treatment for kidney cancer from the hospital's information system. To participate in the study, patients were required to meet the following criteria: Records of patients with small-size tumours, chronic nephritis, and chronic renal illness, 20 years of age or older, and who received PN in the Department of Urology at the Pakistan Renal and Liver Institute and Research Centre in Lahore, Pakistan.

Inclusion criteria were patients pathologically diagnosed with localised RCC and a few uncommon tumours (tumours stage pT1a-pT3a);[9] pathological types identified by pathology, including clear-cell RCC, papillary RCC, chromophobe RCC, and unclassified types; RENAL score of patients ranging from 5x to 9x; and patients surgically treated with NSS. To evaluate the outcomes of PN for a specific tumour and to counteract the influence of prior cancer history, patients with multiple tumours, bilateral tumours, or those having PN history on the contralateral side in the past three years were eliminated from the analysis. As previously described, NSS was carried out utilising the conventional open surgical method.[10] Warm ischaemia and extraperitoneal access were used for open NSS. An experienced surgeon performed interventions on all patients.

Patient characteristics encompassed continuous variables such as age, and categorical variables including age group, gender, and body mass index (BMI). Comorbidities such as hypertension, diabetes mellitus, coronary heart disease, and American Society of Anaesthesiologists (ASA) scores were recorded categorically. Tumour data encompassed site, stage, pathological type, laterality, postoperative ISUP grade, renal vein invasion, sarcomatoid change, necrosis, renal sinus fat invasion, margins, lymph node mets, and Leibovich score. RCC diagnoses were confirmed post-surgery *via* pathology. Continuous variables pre- and post-surgery were eGFR, creatinine, and blood urea nitrogen (BUN). Perioperative outcomes were captured both continuously and categorically, including length of hospital stay (LOS), estimated blood loss (EBL), drainage day removal (DDR), catheter out day (COD), operative time in minutes (OTM), warm ischaemia time (WIT), follow-up time (FUT), and complications based on Clavien-Dindo (CD) classification. CD scores denoted complications post-surgery.[11] The authors used IBM SPSS (Version 20.0) for the analysis. Continuous variables were expressed as mean ± standard deviation or median (IQR), and categorical variables as frequencies. The authors employed paired t-tests for pre/postoperative comparisons, chi-square tests for associations, linear regression for predicting serum creatinine elevation, and independent t-tests to compare gender differences in serum creatinine. Bivariate correlation examined relationships. Significance was set at $p < 0.05$.

RESULTS

In total, 48 patients were included in the NSS cohort. Demographics, history, and comorbidity are detailed in Table I.

Table I: Patients' demographics, history, and comorbidity.

Variables	Frequency (N)	Percentage (%)
Age group		
20-40	10	20.8
41-60	22	45.8
61-80	16	33.3
Gender		
Male	33	68.8
Female	15	31.3
Ethnicity		
Punjab	46	95.8
KPK	2	4.2
Occupation		
Businessman	10	20.8
Housewife	14	29.2
Farmer	4	8.3
Labour	6	12.5
Government servant	14	29.2
BMI		
Healthy	21	43.8
Overweight	9	18.8
Obese	18	37.5
Smoker		
Yes	28	58.3
No	20	41.7
Surgical history		
Yes	21	43.7
No	27	56.3
Hypertension		
Yes	31	64.6
No	17	35.4
Diabetes		
Yes	18	37.5
No	30	62.5
IHD		
Yes	5	10.4
No	43	89.6
Chronic pyelonephritis		
Yes	4	8.3
No	44	91.7
Symptoms		
Symptomatic	8	16.7
Asymptomatic	40	83.3
Diagnosis		
Incidental	40	83.3
Haematuria, Flank pain	4	8.3
UTI, Haematuria, Flank pain	4	8.3
Additional comorbidities		
Yes	25	52.1
No	23	47.9
ASA		
1	4	8.3
2	18	37.5
3	26	54.2
Indications of PN		
Small size tumour	43	89.6
Chronic nephritis	4	8.3
Chronic kidney disease	1	2.1

Serum creatinine was observed to be raised in most of the patients in both pre- and post-operative settings. A linear regression model was used to find out the significant predictor for raised serum creatinine. Using both pre- and post-operative values of eGFR and serum creatinine, eGFR was found to be the significant predictor. The authors applied independent t-test to find out whether significant differences existed between genders in reference to serum creatinine. Results showed significant differences in creatinine levels between males and females in preoperative settings. Preoperative biopsy ISUP grading was only done in 14.6% patients in which G1 was seen in 10.4% and G2 in 4.2%. Open partial nephrectomy was used as the surgical approach. Patients' perioperative data findings were: LOS 40 ± 2.029 days, mean DDR 2.88 ± 0.815 days, mean WIT 5.44 ± 5.343 minutes, mean EBL 370.35 ± 179.48 mL, mean COD 3.02 ± 0.978 days, mean OTM 95.31 ± 32.83 minutes. The mean FUT was 29.99 months in the NSS group, with a median of 30 months. RENAL score grade showed a positive relationship with WIT (Pearson r = 0.478, p = 0.001), EBL (Pearson r = 0.65, p <0.001), tumour size in centimetres (Pearson r = 0.472, p = 0.001). RENAL score category showed significant association with WIT (χ^2 = 9.007, df = 3, p = 0.029), tumour size in centimetres (χ^2 = 25.3, df = 15, p = 0.047), primary tumour stage (χ^2 = 11.8, df = 5, p = 0.037). RENAL score grade showed association with DDR (χ^2 = 38.2, df = 16, p = 0.001), and COD (χ^2 = 31.45, df = 16, p = 0.01). Smoking also showed a significant association (p = 0.043, df = 1) as well as correlation with perioperative complications (Pearson r = 0.294, p = 0.042).

Tumour characteristics included laterality, site, type, size, stage, pre- and post-operative ISUP grade, renal vein invasion, sarcomatoid change, necrosis, renal sinus fat invasion, margins, lymph node mets, Leibovich score, and preoperative RENAL score grade. Among the 48 patients included in the study, 54.2% had right-sided and 45.8% had left-sided tumours with 35.4% located in the upper pole site, 45.8% in the lower pole, and 18.8% in the mid-pole. Clear cell RCC was 70.8%, papillary RCC 12.5%, unclassified RCC 2.1%, clear cell papillary tumour 4.2%, renal oncocytoma 4.2%, angiomyolipoma 4.2%, and chromophobe RCC 2.1%. Median tumour size was 5.135 ± 2.1361 cm. Tumour staging revealed 41.7% pT1b, 37.5% pT1a, 6.3% pT2a, 6.3% pT3a, and 4.2% pT2b. Preoperative ISUP grading showed G1 in 10.4% of cases and G2 in 4.2%; while post-operatively ISUP G1 was in 14.6%, G2 in 54.2%, G3 in 6.3%, and G4 in 6.3%. Renal vein invasion was absent and sarcomatoid change was observed in 6.3% of cases. Regarding necrosis, it was noted as follows: 10% in 4.2% cases, 20% in 20.8%, 30% in 4.2%, and 40% in 2.1% cases. Renal sinus fat invasion occurred in 12.5% cases. Margins were free in 93.8% cases, involved in 6.3% cases. No metastatic lymph nodes were detected. Leibovich score identified: 58.3% patients as low risk, 8.3% as intermediate, and 10.4% as high risk. RENAL score grading revealed 5x 4.2%, 6a 2.1%, 6p 4.2%, 6x 6.3%, 7a 10.4%, 7p 2.1%, 7x 14.6%, 8x 18.8%, and 9x 37.5%. Postoperative complications were observed in 11 out of 48 patients, categorised as minor and major. This nephrectomy score did not, however, correlate with postoperative complications. Patients were categorised into three groups based on their RENAL scores: Low (6-7), intermediate (8-9), and high (10-12). The low RENAL score group comparised 2 patients (4.2%) with a score of 6 and 6 patients (12%) with a score of 7, making up a total of 13 patients (27.1%). The intermediate RENAL score group included 9 patients (18.8%) with a score of 8 and 18 patients (37.5%) with a score of 9, with a total of 27 patients (56.3%). However, there were no patients with high RENAL scores (10-12). Postoperative complications were categorised as minor and major. Among the minor complications (n = 8), the most common was fever with 4 cases, followed by wound infection with 4 cases, abdominal distension with 2 cases, and hyperdiuresis with 1 case. Additionally, there was one case for each of bed sores, acute gastroenteritis, and psychological instability. On the other hand, major complications (n = 3) included perinephric collection, fever with intra-abdominal collection, and haematoma formation, each occurring once. Complications are graded using the Clavien-Dindo classification *versus* RENAL scores as described in Table II.

Table II: Clavien-Dindo *versus* RENAL score.

Clavien-Dindo Grade						
RENAL score	**1**	**2**	**3**	**4**	**5**	**Total**
Low	0	0	0	0	0	0
Intermediate	7	1	3	0	0	11
High	0	0	0	0	0	0
Total	7	1	3	0	0	11

Table III: Correlation between RENAL score grade and eGFR

Bivariate correlation between variables		Correlation coefficient	Significance (Two-tailed)
Preoperative RENAL score grade	eGFR	-0.293	p = 0.043

**Correlation is significant at the 0.05 level. **Correlation is significant at the 0.01 (Two-tailed) level.*

For continuous data, preoperative RENAL score grade and post-eGFR exhibited a negative connection. Preoperative RENAL score grade and eGFR had a moderately negative linear association, as indicated by the negative correlation coefficient of -0.293. The eGFR dropped when the preoperative RENAL score grade rose. The statistical significance of this association, as indicated by the p-value of 0.043, suggested that it is improbable that the observed link is the result of pure chance (Table III).

A paired samples t-test showed a statistically significant decrease in eGFR levels preoperatively (M = 90.713 ± 29.7683) and postoperatively (M = 65.075 ± 22.2244; t = 9.303, p <0.001, d = 47). The mean eGFR decreased by a substantial amount, as indicated by the large effect size (d = 47). The t-value of 9.303 and a very low p-value (p <0.001) suggested that this decrease is unlikely to be due to chance. Patients' level of creatinine before operation (M = 0.9665 ± 0.42408) to after operation (M = 1.3913 ± 0.98855; t = -3.916, p <0.001, d = 47) showed a statistically significant increase. The mean creatinine levels increased, as indicated by the positive effect size (d = 47). The negative t-value (-3.916) and a very low p-value (p <0.001) suggested that this increase

is unlikely to be due to chance. Patients' level of BUN before operation increased from (M = 14.071 ± 5.0365) to (M = 16.002 ± 6.7008; t = -2.265, p <0.028, d = 47) after operation, where t is test statistic (t), d is effect size which indicated a statistically significant increase in BUN levels. The mean BUN level increased, as suggested by the positive effect size (d = 47). The negative t-value (-2.265) and a p-value of 0.028 indicated that this increase is statistically significant, though the p-value was not as extreme as the other tests. So, the PN had significant effects on eGFR, creatinine levels, and BUN levels. The reported effect sizes (d = 47) indicated substantial changes in these variables due to the operation. Additionally, the low p-values (p <0.001 or p <0.028) further supported the notion that these changes were not due to random chance which might be other factors discussed above.

DISCUSSION

In this retrospective analysis, the authors aimed to critically assess the link between RENAL nephrometry scores and perioperative outcomes after open partial nephrectomy (OPN) in a single centre. Additionally, the study evaluated the RENAL score's predictive value for complications and its relevance in clinical practice for guiding partial nephrectomy decisions. The demographic distribution of the cohort was parallel to that of Draeger *et al*.[12] The present study unveils significant insights into the intricate relationship between tumour complexity and surgical outcomes in the renal surgery.

Over 60% of kidney tumours are now incidentaly identified due to the increased accesibility and affordability of the diagnostic imaging methods.[13] Early-stage and smaller tumour appearances are the results of this trend. According to studies by the Memorial Sloan-Kettering Cancer Centre,[14] malignancies were accidentally found in 80% of kidney cancer patients having surgery. According to a different study, 61% of tumours were mistakenly discovered during unrelated medical exami-nations.[15] In this study, 83.3% (40 out of 48 patients) of diagnoses were made by accident, whereas 8.3% of cases had haematuria or flank pain and another 8.3% had symptoms of the lower urinary tract. This shows that even though many patients had incidentaly discovered renal tumours during evaluation for non-specific abdominal pain, a sizable portion still presented late in the course of their illness.

The present results suggested the significance of the RENAL nephrectomy score in PN as in various studies.[16,17] A study performed by Soeroto *et al*., reported that 25 patients had median age of 61 years and a mean tumour diameter of 7.207 cm which aligns with the present study's results where the median age of 48 patients was 53 years and the mean tumour size was 5.135 ± 2.1361 cm. Another important finding of this study was the significance of the RENAL nephrectomy score in PN for perioperative outcome prediction. Since, it can identify the operation and various outcomes of the partial nephrectomy surgery, this score can be utilised on a daily basis.[18]

Abou Heidar *et al*. further clarified how the RENAL nephrometry score was used to forecast oncological, surgical, and perioperative outcomes. When compared to the present study, these results may be useful in improving surgical techniques and preoperative patient counselling.[19] On long-term follow-up, the total recurrence rates after NSS ranged from 0 to 10.6%.[20] In a study by Shvero *et al.*, 2.8% of the participants had local recurrence.[21] In the present study, no patient had metastases after a three-year follow-up.

The comprehensive assessment of perioperative outcomes, including complications, duration of stay, and surgical margin status, provides a holistic view of surgical success. This study did not identify a direct link between RENAL scores and complications, contradicting some earlier studies that suggested a positive correlation between tumour complexity and postoperative complications.[22,23] This discrepancy could be attributed to advancements in the surgical techniques, perioperative care, and patient selection, all of which may collectively mitigate the impact of tumour complexity on complications.

The study's strength is that it is one of the first to investigate any possible connections between the results of RENAL nephrometry scores and the postoperative course after open partial nephrectomy. The combination of tumours complexity and surgical outcomes adds to the corpus of knowledge already known about renal surgery. This comprehensive outcome assessment offers a complete picture of how tumour complexity-related factors affect surgical results. By highlighting the significance of considering tumour characteristics in evaluating surgical candidates for open partial nephrectomy, the study's findings have the potential to direct clinical practice. Improved preoperative patient assessments and focused treatments to enhance outcomes may result from the found connections.

Although this investigation advances knowledge of the connection between RENAL scores and surgical outcomes, some restrictions should be considered. The retrospective design introduces potential biases and limited control over the confounding variables. Additionally, the single-centre nature of the study could affect the generalisability of this study's findings to broader populations. Inherent to retrospective studies, missing data can introduce bias and limit the ability to draw definitive conclusions. The study primarily focuses on short-term perioperative outcomes. Longer-term follow-up is necessary to understand the potential influence of tumour complexity, recurrence rates, and overall survival.

This study highlights the intricate interplay between tumour complexity and perioperative outcomes in patients undergoing open partial nephrectomy. The observed correlation between RENAL nephrometry scores with WIT, EBL, tumour size, primary tumour stage, DDR, and COD reaffirms the clinical utility of the scoring system. Further research, ideally employing prospective multicentre designs, is essential to validate and expand upon the findings, potentially guiding the development of comprehensive preoperative assessments and personalised interventions to optimise surgical outcomes.

CONCLUSION

For locally limited, relatively small renal tumours, partial nephrectomy (PN) proves highly effective with favourable outcomes and a low complication profile. Tumour size emerges as a straightforward parameter for reporting, aiding research, and patient counselling. PN demonstrates superior renal function preservation and oncological outcomes. The RENAL nephrometry score strongly influences surgical choices, but its correlation with surgical problems is lacking. Despite its limited predictive value for complications, the nephrometry score remains a valuable tool, defining renal mass characteristics and aiding precise planning for targeted operation on complex localised renal cell carcinoma.

ETHICAL APPROVAL:

This study has been approved by the Institutional Review Board of Pakistan Kidney and Liver Institute and Research Centre, Lahore, Pakistan, with reference number PKLI-IRB/AP/147.

PATIENTS' CONSENT:

Written informed consent was obtained from all the patients.

COMPETING INTEREST:

The authors declared no conflict of interest.

AUTHORS' CONTRIBUTION:

NBN, AUR, NZ, SK, SIB: Study concept, design, and data acquisition.

SI: Analysis, interpretation of data for the work, drafting of manuscript, and critical revision of the manuscript.

All authors approved the final version of the manuscript to be published.

REFERENCES

1. Padala SA, Barsouk A, Thandra KC, Saginala K, Mohammed A, Vakiti A, *et al*. Epidemiology of renal cell carcinoma. *World J Oncol* 2020; **11(3)**:79-87. doi: 10.14740/wjon1279.
2. Jemal A, Siegel R, Ward E, Hao Y, Xu J, Murray T, *et al*. Cancer statistics, 2008. *A Cancer J Clin* 2008; **58(2)**:71-96. doi: 10.3322/CA.2007.0010.
3. Rini BI, Campbell SC, Escudier B. Renal cell carcinoma. *Lancet* 2009; **373**:1119-32. doi: 10.1016/s0140-6736(09) 60229-4.
4. Milonas D, Skulcius G, Baltrimavicius R, Auskalnis S, Kincius M, Matjosaitis A, e*t al*. Comparison of long-term results after nephron-sparing surgery and radical nephrectomy in treating 4- to 7-cm renal cell carcinoma. *Medicina* 2013; **49(5)**:36. doi: 10.3390/medicina49050036.
5. Arabsalmani M, Mohammadian-Hafshejani A, Ghoncheh M, Hadadian F, Towhidie F, Vafaee K, *et al*. Incidence and mortality of kidney cancers, and human development index in Asia; a matter of concern. *J Nephropathol* 2017; **6**:30-42. doi: 10.15171/jnp.2017.06.
6. Kunkle DA, Egleston BL, Uzzo RG. Excise, ablate or observe: The small renal mass dilemma - A meta-analysis and review. *J Urol* 2008; **179(4)**:1227-34. doi: 10.1016/j.juro. 2007.11.047.
7. Khalil M, Khan N, Ali A, Abu Bakar M, Adnan S, Fiaz S, *et al*. Outcomes of nephron sparing in a specialist cancer hospital of a developing country. *Cureus* 2019; **11(2)**:e4150. doi: 10.7759/cureus.4150
8. Huynh MJ, Wang Y, Joshi M, Krasnow R, Yu AX, Mossanen M, *et al*. Patient factors predict complications after partial nephrectomy: Validation and calibration of the Preoperative risk evaluation for partial nephrectomy (PREP) score. *BJU Int* 2021; **127(3)**:369-74. doi: 10.1111/bju.15240.
9. Sobin LH, Gospodarowicz MK, Wittekind C. TNM classification of malignant tumors. ed. 7th, Hoboken, New Jersey: Wiley-Blackwell; 2009.
10. Kutikov A, Uzzo RG. The renal nephrometry score: A comprehensive standardized system for quantitating renal tumor size, location, and depth. *J Urol* 2009; **182**:844-53. doi: 10.1016/j.juro.2009.05.035.
11. Clavien PA, Barkun J, de Oliveira ML, Vauthey JN, Dindo D, Schulick RD, *et al*. The clavien-dindo classification of surgical complications: Five-year experience. *Ann Surg* 2009; **250(2)**:187-96. doi: 10.1097/SLA.0b013e3181b 13ca2.
12. Draeger DL, Sievert KD, Hakenberg OW. Critical evaluation of the PADUA score in a retrospective analysis of open partial nephrectomy. *Turk J Urol* 2018; **44(3)**:208-12. doi: 10.5152/tud.2018.52721.
13. Sanchez-Martin FM, Millan-Rodriguez F, Urdaneta-Pignalosa G, Rubio-Briones J, Villavicencio-Mavrich H. Small renal masses: Incidental diagnosis, clinical symptoms, and prognostic factors. *Adv Urol* 2008; **6**. doi: 10.1155/2008/ 310694.
14. Kwon EO, Carver BS, Snyder ME, Russo P. Impact of positive surgical margins in patients undergoing partial nephrectomy for renal cortical tumors. *BJU Int* 2007; **99**:286-9. doi:10.1111/j.1464-410X.2006.06623.x.
15. Campbell SC. Commentary RE: increased incidence of serendipitously discovered renal cell carcinoma. *Urology* 2020; **145**:333. doi: 10.1016/j.urology.2020.04.025.
16. Muter SA, Khudhair MK, Abbas KM, Al-Ani N. Utilizing the renal nephrometry score to predict the surgical technique and peri-operative outcomes of renal masses. *Al-Kindy Coll Med J* 2023; **19(2)**:185-9.
17. Shin SJ, Ko KJ, Kim TS, Ryoo HS, Sung HH, Jeon HG, *et al*. Trends in the use of nephron-sparing surgery over 7 years: An analysis using the R.E.N.A.L. nephrometry scoring system. *PLoS One* 2015; **10(11)**:e0141709. doi: 10.1371/ journal.pone.0141709.
18. Soeroto AA, Mochtar CA, Umbas R, Hamid AR. The role of renal nephrometry score to predict perioperative outcome following partial nephrectomy in a national referral hospital. *Indonesian J Urol* 2022; **29(3)**:190-5. doi: 10.32421/juri. v29i3.800.
19. Abou Heidar N, Hakam N, El-Asmar JM, Najdi J, Khauli MA, Degheili J, *et al*. The RENAL score's relevance in determining perioperative and oncological outcomes: A Middle Eastern tertiary care center experience. *Arab J Urol* 2022; **20(3)**:115-20. doi: 10.1080/2090598X.2022. 2064041.
20. Takagi T, Yoshida K, Wada A, Kondo T, Fukuda H, Ishihara H, *et al*. Predictive factors for recurrence after partial

nephrectomy for clinical T1 renal cell carcinoma: A retrospective study of 1227 cases from a single institution. *Int J Clin Oncol* 2020; **25(5)**:892-8. doi: 10.1007/s10147-020-01632-x.

21. Shvero A, Zilberman D, Mor Y, Kaver I, Fridman E, Portnoy O, *et al*. MP41-19 local recurrence after partial nephrectomy for primary rUP. *J Urol* 2016; **195(4S)**:e1-192. doi: 10.1016/j.juro.2016.02.186.
22. Basu S, Khan IA, Das RK, Dey RK, Khan D, Agarwal V, *et al*. RENAL nephrometry score: Predicting perioperative outcomes following open partial nephrectomy. *Urol Ann* 2019; **11(2)**:187-92. doi: 10.4103/UA.UA_93_18.
23. Marszalek M, Carini M, Chlosta P, Jeschke K, Kirkali Z, Knuchel R, *et al*. Positive surgical margins after nephron-sparing surgery. *Eur Urol* 2012; **61(4)**:757-63. doi: 10.1016/j.eururo.2011.11.028.