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Original Article

The utility of modified RENAL nephrometry score in predicting the perioperative outcomes following open partial nephrectomy

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Abstract

The RENAL nephrometry score (RNS) is a standardized approach for grading the complexity of renal masses, although it does not have a strong correlation with the perioperative outcomes of open partial nephrectomy. To address these issues, a modified RENAL has been proposed. The study's goal is to determine the usefulness of a modified RENAL nephrometry score in predicting perioperative outcomes after open partial nephrectomy. This interventional multicentric trial included 47 adult patients with T1N0M0 renal masses of 7 cm or less, which were appropriate for open partial nephrectomy. Salah et al. presented a modified R.E.N.A.L classification system, which was used to assess renal complexity. Demographics, anthropometrics, prior medical history, renal mass features, histological diagnosis, and perioperative data were all collected for examination. Logistic regression and receiver operator characteristic curve analysis were used to predict perioperative problems. The patients' average age was 52.0 ± 13.1 years, with a male-to-female ratio of 1.24:1. The modified R.E.N.A.L score averaged 9.6 ± 1.8. Perioperative problems occurred in 42.6% of cases. The moderate complexity group experienced a lengthier hospital stay (2.7 ± 0.6 days) than the mild complexity group (2.3 ± 0.5 days, p = 0.008). The R.E.N.A.L. score was identified as an independent predictor of perioperative complications (OR: 1.48; 95% CI: 1.03-2.26, p = 0.046), with an acceptable cut-off point of 8.7 (AUC = 0.68). The modified RENAL is an important tool for identifying renal malignancies based on their anatomic characteristics, which aids in the prediction of perioperative complication rates.

Keywords: Modified RENAL score, Open partial nephrectomy, Perioperative complications

1. Introduction

Kidney cancer is one of the top ten most prevalent malignancies in the United States, with renal cell carcinoma accounting for 90% of all kidney cancers [1]. In 2016, RCC deaths accounted for over 2% of total cancer deaths, or nearly 14,000 deaths [1]. Men are about twice as likely as women to develop RCC, with black men having a higher prevalence [2]. Most RCC cases are detected between the ages of 60 and 70 [3]. Renal masses encompass a wide range of malignancies, including benign masses, indolent cancers, and aggressive cancers [4]. While systemic medicines have advanced, surgical excision of localized kidney tumors remains the primary treatment option, either through radical nephrectomy (RN) or partial nephrectomy (PN) [5]. Over the last two decades, the use of PN has grown dramatically, owing to variables such as the increasing prevalence of smaller tumors, advances in surgical technology, and a better knowledge of the influence of renal surgery on functional kidney outcomes [6]. PN attempts to preserve healthy kidney tissue while offering oncological management similar to RN [7]. Initially, the maximum diameter for resectable tumors was determined at 4 cm (Stage T1a), but recent studies have increased this limit to 7 cm (Stage T1) and, in certain circumstances, 10 cm (Stage T2) [8]. Despite its benefits, PN is associated with an elevated risk of problems, hence assessing these risks is critical for optimum patient treatment [9]. Nephrometry scoring systems, such as the RENAL nephrometry score, standardize the description of renal masses, making it easier to compare outcomes and schedule surgeries [10]. The RENAL score assesses tumor complexity using size, location, and depth of penetration into the renal parenchyma [10]. Salah et al.'s modified R.E.N.A.L classification system contains additional factors such as hilar involvement and renal pelvic score, which improves its predictive accuracy for perioperative outcomes [11]. The study's goal

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is to determine the usefulness of the modified RENAL nephrometry score in predicting perioperative outcomes after open partial nephrectomy.

2. Materials and Methods

2.1. Study Design and Settings

This pre-post interventional study was conducted at Shar Teaching Hospital and Sulaymaniyah University Hospital over a 15-month period from October 1, 2022, to January 1, 2024. A total of 47 patients with a diagnosis of renal mass who underwent partial open nephrectomy were included, and selected by convenience sampling.

2.2. Ethical Considerations

Ethical and scientific approval for the research was obtained from the Scientific Committee at the Department of Urology.

2.3. Inclusion Criteria

Adults aged over 18 years with T1N0M0 renal masses of size 7 cm or smaller suitable for partial nephrectomy were included. Criteria for opting for partial nephrectomy included the presence of a solitary kidney, chronic kidney disease, or potential risk of renal impairment such as in cases of hypertension or diabetes [12].

2.4. Exclusion Criteria

Patients with a history of coagulopathy or recurrent renal mass were excluded from the study.

2.5. Surgical Protocol

Preoperative Preparation: Patients underwent a comprehensive assessment including detailed history, clinical examination, and laboratory investigations (CBC, coagulation profile, and renal function test). Preoperative imaging (contrast-enhanced CT or MRI) was conducted to assess tumor size, location, depth of invasion, and relationship to hilar structures [13].

Intraoperative Procedure: Patients were positioned in the lateral decubitus position, and open partial nephrectomy was performed with a flank incision. The mass was excised with a rim of normal parenchyma, and hemostatic materials were used for renal bed reconstruction [14].

Postoperative Follow-up: Follow-up appointments were scheduled for the first and fourth weeks post-surgery, including physical examination, serum creatinine assessment, and ultrasound evaluation for complications [15].

2.6. Data Collection and Analysis

Data included demographic information, renal mass characteristics, and perioperative outcomes. Statistical analyses were performed using logistic regression and receiver operator characteristics curve analysis. Continuous variables were expressed as means and standard deviations, while categorical variables were expressed as frequencies and percentages. Spearman's rank correlation was used to study the correlation between study parameters [16].

3. Results

In this prospective analysis involving 47 participants, the demographic and clinical characteristics of individuals undergoing open partial nephrectomy for renal masses were systematically evaluated. The study cohort, with a mean age of the patients, was 52.0 ± 13.1 years (range: 21-71), with a male-female ratio of 1.24:1. The mean BMI was 27.2 ± 3.2 kg/m². The majority of individuals were classed as ASA I (59.6%) or II (34.0%). A sizable proportion of the population had a history of smoking (31.9%) and a variety of comorbidities, including hypertension (38.3%) and type 2 diabetes mellitus (23.4%). Tumor characteristics indicated a somewhat higher incidence on the right side (59.6%), with placements classified as anterior (36.2%), posterior (19.1%), and indeterminate (44.7%). The modified RENAL score was 9.6 ± 1.8, with 51.1% classed as light and 48.9% as moderate complexity Table 1.

The perioperative parameters, complications, and follow-up have been shown in Table 2.

The average duration of surgery was 2.5 ± 0.5 hours, with an average hospital stay of 2.5 ± 0.6 days. Hemoglobin loss occurred in 57.4% of patients, with an average drop of 1.8 g/dL. Preoperative eGFR was 91.8 ± 13.7, while postoperative eGFR was slightly lower at 88.1 ± 23.9. Complications were reported in 42.6% of patients, with the most common being PCS injury (36.2%) and blood transfusion (29.8%). Warm ischemia accounted for 97.9% of the cases, with an average duration of 11.5 ± 3.9 minutes. Positive surgical margins were found in 4.3% of the cases.

The modified RENAL score showed a significant positive correlation with hospitalization duration (rho=0.36, p=0.013), ischemia time (rho=0.42, p=0.003), and a negative correlation with post-op eGFR (rho=-0.33, p=0.02)

Table 1. Baseline Characteristics and Renal Mass Characteristics.

Characteristic	N = 47
Age (years)	52.0 ± 13.1 (21-71)
Male-to-Female Ratio	1.24:1
BMI (kg/m²)	27.2 ± 3.2
ASA Classification	I (59.6%), II (34.0%), III (4.3%), IV (2.1%)
Smoking Exposure	31.9%
Co-morbidities	Hypertension (38.3%), T2DM (23.4%)
Tumor Side	Right (59.6%), Left (40.4%)
Position of the Mass	Anterior (36.2%), Posterior (19.1%), Indeterminate (44.7%)
Modified RENAL Score	9.6 ± 1.8 (5-13)
Complexity	Mild (51.1%), Moderate (48.9%)

Table 3.

The logistic regression analysis revealed that the modified RENAL score was an independent predictor of perioperative complications, with an odds ratio (OR) of 1.48 (95% CI: 1.03-2.26, p = 0.046). Furthermore, patients with intermediate complexity renal masses were substantially more likely to experience perioperative problems than those with mild complexity (OR: 4.34; 95% CI: 1.26-16.5, p = 0.024) (Tables 4 and 5).

The study found that a modified RENAL score cut-off point of 8.7 provides the optimum balance for predicting perioperative problems, with a sensitivity of 95%, specificity of 37%, and an area under the curve (AUC) of 0.68 (Fig. 1).

4. Discussion

The modified RENAL nephrometry score (MRNS) is a valuable tool for predicting perioperative outcomes in patients undergoing open partial nephrectomy. The study demonstrates that MRNS effectively classifies renal tumors based on their anatomic characteristics and correlates well with perioperative complications [17]. Higher MRNS scores were associated with longer hospital stays, increased warm ischemia times, and higher complication rates, emphasizing its clinical utility in surgical planning [18].

The incorporation of additional parameters like hilar involvement and renal pelvic score in MRNS enhances its predictive accuracy compared to the original RENAL nephrometry score (RNS) [19]. This study's findings align

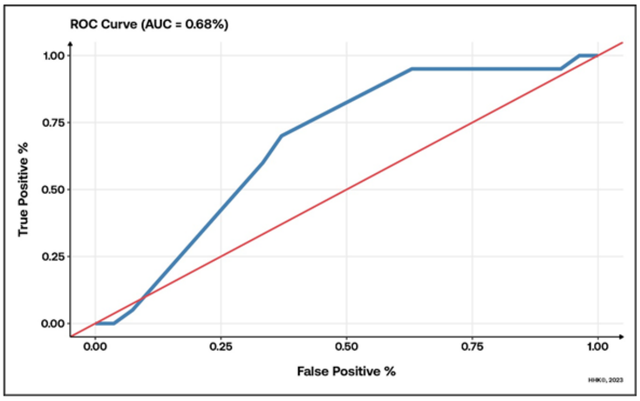

Fig. 1. ROC curve for the prediction of perioperative complications for the modified R.E.N.A.L. score.

Table 2. Perioperative Parameters, Complications, and Follow-up.

Characteristic	N = 47
Duration of Operation (hours)	2.5 ± 0.5
Duration of Hospital Stay (days)	2.5 ± 0.6
Hemoglobin Loss	57.4%
Amount (g/dL)	1.8 (0.8 - 4.0)
Pre-Op eGFR	91.8 ± 13.7
Post-Op eGFR	88.1 ± 23.9
Deterioration of RFT Post-Op	17.0%
Incidence of Complications	42.6%
PCS Injury	36.2%
Blood Transfusion	29.8%
Fever	12.8%
Urinoma	6.4%
Ischemia Type	Warm Ischemia (97.9%), Zero Ischemia (2.1%)
Warm Ischemia Time (min)	11.5 ± 3.9
Positive Surgical Margin	4.3%

Table 3. Correlation Analysis Between Modified RENAL Score and Perioperative Outcomes.

Outcome	Correlation Coefficient (rho)	p-value
Duration of Hospitalization	0.36	0.013
Ischemia Time	0.42	0.003
Post-op eGFR	-0.33	0.02

Table 4. Logistic Regression Analysis for Predicting Perioperative Complications.

Characteristic	OR (95% CI)	p-value
Modified RENAL Score	1.48 (1.03-2.26)	0.046
Complexity (Moderate vs. Mild)	4.34 (1.26-16.5)	0.024

Table 5. Optimal Cut-off Points for Predicting Perioperative Complications.

Characteristic	Cut-off Point	Sensitivity	Specificity	AUC
Modified RENAL Score	8.7	95%	37%	0.68

with previous research highlighting the importance of nephrometry scores in predicting surgical outcomes. For instance, Salah et al. demonstrated that MRNS outperforms RNS in predicting perioperative complications, further validating the utility of the modified score in clinical practice [20].

The findings of this study are consistent with previous literature. Kamath et al. reported similar associations between higher nephrometry scores and increased perioperative complications, longer ischemia times, and extended hospital stays [21]. Additionally, the correlation between MRNS and perioperative outcomes aligns with the results from Liu et al., who found significant associations between nephrometry scores and postoperative complications such as bleeding and urine leak [7].

One of the key advantages of MRNS is its ability to provide a more nuanced assessment of tumor complexity by incorporating hilar involvement and renal pelvic score. This modification addresses some of the limitations of the original RNS, particularly in cases where the tumor's proximity to critical structures like the renal artery or vein complicates surgical planning [22]. This enhanced predictive capability makes MRNS a valuable tool for preoperative risk stratification and surgical decision-making.

Despite the strengths of this study, there are some limitations to consider. The relatively small sample size and single-center design may limit the generalizability of the findings. Additionally, the study's retrospective nature could introduce selection bias, although efforts were made to mitigate this through robust statistical analyses. Future research with larger, multi-center cohorts and prospective designs is necessary to validate these findings and further refine the MRNS [23].

The study's findings have important clinical implications. By providing a reliable tool for predicting perioperative complications, MRNS can help clinicians tailor surgical approaches to individual patients' needs, potentially improving outcomes and reducing the risk of complications. For instance, patients with higher MRNS scores may benefit from more intensive preoperative planning, including consideration of alternative surgical techniques or adjunctive therapies to mitigate risks [24].

The use of MRNS in clinical practice also supports shared decision-making between clinicians and patients. By providing a clear, quantifiable assessment of tumor complexity and associated risks, MRNS can help patients better understand their treatment options and make informed decisions about their care. This approach aligns with the principles of patient-centered care, emphasizing transparency and collaboration in treatment planning [25].

Future research should focus on external validation of MRNS in larger, diverse patient populations and its applicability in minimally invasive procedures. Additionally, longitudinal studies with extended follow-up periods are needed to assess the long-term impact of MRNS on recurrence-free survival and overall survival. Such studies could provide valuable insights into the utility of MRNS in guiding long-term management strategies for patients with renal tumors [26].

Furthermore, exploring the integration of MRNS with other prognostic tools and biomarkers could enhance its predictive accuracy and clinical utility. For instance, combining MRNS with genetic or molecular markers of tumor aggressiveness could provide a more comprehensive assessment of individual patient risk, facilitating personalized treatment approaches.

5. Conclusion

The modified RENAL nephrometry score is a valuable tool for predicting perioperative outcomes in patients undergoing open partial nephrectomy. Its incorporation into preoperative assessments can enhance clinical decision-making and patient management. Clinicians should consider using the modified RENAL score, particularly in cases categorized as moderate complexity, to guide personalized risk assessments.

Conflict of Interests

The authors declare that they have no competing interests related to this study.

Consent for publications

The author read and approved the final manuscript for publication.

Ethics approval and consent to participate

The Department of Urology, College of Medicine, University of Sulaimani's ethical committee accepted the study with reference number HR033,37.

Informed Consent

The study was carried out in conformity with local legislation and institutional guidelines. All study participants provided consent for publishing.

Availability of data and material

Authors declare that all relevant data are included in the article and/or its supplementary information files will be available upon request.

Author Contributions

Shakhawan Hama Amin Said, planned the study, created the technique, and carried out the surgical procedures. Goran Friad was in charge of data curation, and writing the manuscript. Mzhda Sahib Jaafar carried out the imaging analysis and interpretation. The histological study was done by Lusan Abdulhameed Arkawazi. Mohammed Fahad Raheem handled patient recruiting and data gathering. Ismaeel Aghaways supervised and critically examined the manuscript. Mohammed I. M. Gubari carried out the data analysis, and oversaw the project administration. All authors revised and approved the final manuscript.

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