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ORIGINAL PAPER

The association of anatomical renal mass complexity with surgical approach, Hb drop, and the rate of blood transfusion

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Summary ***Introduction:*** *The third most prevalent malignant neoplasm involving the urinary tract is renal cell carcinoma (RCC), encompassing nearly 3.5% of the entire cancers afflicting the body. The aim of this research was to explore how the R.E.N.A.L. nephrometry score relates to the decisions made regarding surgery in individuals with localized RCC.*
Methods: *This prospective study, assessed patients with localized parenchymal renal masses (stages I and II) tentatively diagnosed as RCC. Utilizing preoperative multiphasic renal CT scans and MRI, the R.E.N.A.L. score categorized masses for nephrometry values. Inclusion criteria involved collecting patient data, and data collection utilizing a structured format focusing on the nephrometry grading system.*
Results: *The study included 64 patients aged (Mean ± SD) 49.78 ± 12.35 yrs. Undergoing renal mass surgery, there were 17 (26.5%) low, 28 (43.8%) moderate and 19 (29.7%) high-complexity lesions. All patients with a low Nephrometry score (n = 17) underwent partial nephrectomy, and all cases with a high score (n = 19) underwent radical nephrectomy. For those with a moderate Nephrometry score (n = 28), 13 (46.4%) underwent partial nephrectomy, while the remaining 15 (53.6%) cases underwent radical nephrectomy. Morbidity was low, and no mortality occurred at 180 days. Patients who had lesions fully above or below polar lines were less likely to need blood transfusions. A trend towards higher Fuhrman grades in patients receiving transfusions suggests a potential link between tumor aggressiveness and bleeding risk*
Conclusions: *Our findings provide insight on the utilization of the R.E.N.A.L. nephrometry score in forecasting perioperative, post-surgical, and oncological results. Such data might help optimize surgical methods and pre-operative patient counseling.*

KEY WORDS: R.E.N.A.L. nephrometry score; Renal mass complexity; Surgical approach; Hemoglobin drop; Blood transfusion prediction.

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INTRODUCTION

The third most prevalent malignant neoplasm involving the urinary tract is *renal cell carcinoma* (RCC), encompassing nearly 3.5% of the entire cancers afflicting the body (1). As a result of the extensive utilization of the more available and higher precision imaging techniques, the prevalence of renal cell carcinoma is on the rise, particularly notable in tumors ranging between 2 to 4 cm (2, 3). The RCC's biology is intricate, and although nearly 33% of all kidney masses first present signs of systemic disease, yet a significant number of localized renal masses show a tendency to progress slowly (4). Surgical management is still the primary treatment option. Due to the ongoing evolution of imaging technologies, particularly the enhancements seen in ultrasonography, there has been a discernible augmentation in the identification of RCCs at an early stage (5). There are numerous therapeutic options for kidney tumors, including excision via *partial nephrectomy* (PN) or *radical nephrectomy* (RN), ablative procedures, or active observation (6). The determination of surgical approaches is substantially impacted by factors such as the volume and precise anatomical location of the neoplasm. Further considerations shaping the chosen surgical approach and intervention include the skillset and experience of the surgeon, the capabilities of the operating facility, and established procedural norms within the medical practice (7). Increasing evidence implies a link connecting the pathological and anatomical characteristics of the renal tumors (8-10), however objective measurements of renal mass anatomy have only recently been described (7, 11-13). In recent times, there has been a discernible demand for precise anatomical characterization of renal masses, prompting the emergence of new scoring systems tailored to offer objective guidance in surgical decision-making processes. Two predominant systems have garnered widespread attention: the *RENAL nephrometry score* (RNS) which was established by *Kutikov and Uzzo* (2009) and objectively quantifies relevant kidney tumor anatomy characteristics using a scoring system; the *Preoperative Aspects and Dimensions Used for Anatomical Classification* (P.A.D.U.A.) approach which was proposed by *Ficarra et al.* (2009) and closely resembles the RENAL score, offering an alternative anatomical assessment (7, 14, 15). Scoring algorithms have been created and verified to appropriately evaluate the likelihood of postsurgical adverse events and to reflect the complexity of renal tumors (16). The aim of this research was to explore how the R.E.N.A.L. nephrometry score relates to the decisions made regarding surgery in individuals with localized RCC.

Methods

Study design

This prospective study design was approved by the *Institutional Research Ethics Committee*, and all patients were granted informed consent. Preoperative multiphasic renal CT scans with intravenous contrast injection were performed on all patients, with *magnetic resonance imaging* (MRI) serving as additional imaging. R.E.N.A.L. score was used to assess the kidney tumor. Masses with nephrometry values of 4 to 6 were categorized as to be mildly complicated for resection, those with scores ranging from 7 to 9 were classed as moderate complexity, and those with scores between 10 to 12 were labeled high complexity. The nephrometry score of a kidney tumor might vary from 4a (1+1+1+a+1) to 12ph (3+3+3+ph+3) [1]. In this investigation, the R.E.N.A.L. score was utilized to evaluate patients with renal tumors managed at our hospital with radical nephrectomy or partial nephrectomy, conducted through both open and laparoscopic approaches.

Inclusion and exclusion criteria

Data for inclusion criteria regarding clinical features, histopathological specimens, and cross-sectional images, as well as surgical and postsurgical outcomes, were gathered from the medical database.

Sample size & sampling procedures

This study was done prospectively on 64 patients who had localized parenchymal renal mass (stages I and II) that was tentatively diagnosed as RCC and were planned for surgery.

Data collection procedures

A structured data abstraction format with items targeting the nephrometry grading system was applied. The R.E.N.A.L. score was established in 2009 (7) and is based on the five most repeatable aspects of a solid renal mass's anatomy: (R)adius (the largest diameter of the tumor in centimeters) to which points were assigned as 1 (≤ 4 cm), 2 (> 4 but < 7 cm), and 3 (≥ 7 cm); (E)xophytic/endophytic properties (points were designated as 1 in cases where 50% or more of the tumor exhibited exophytic growth, 2 when less than 50% of the tumor demonstrated exophytic characteristics, and 3 in instances where the tumor displayed entirely endophytic characteristics); (N) component (nearness) of the tumor to the collecting system or sinus and for which points were assigned as 1 (≥ 7 mm), 2 (> 4 but < 7 mm), and 3 (invading, touching, or within 4 mm); (A) indicates the anterior or posterior location of the tumor which was designated as a non-numerical suffix that describes the location of the tumor with respect to the kidney midline plane as assessed on axial images (the tumor is designated with the suffix "x" when it cannot be specified as either anterior or posterior; (L) designates the location of tumor in relation to polar lines. Standardized points (1-3 points per descriptor) were given to each parameter, excluding the anterior or posterior component. An additional suffix "h" is used to highlight a hilar tumor.

The literature review was done by carefully selecting papers from reputable journals and omitting those from predatory sources based on predetermined criteria of Kscien's list (17).

Results

In this study, a total of 64 patients were included, encompassing 28 males and 36 females. The patients had the surgery through an open approach except for five (7.8%)

Table 1.
Presents clinical characteristics of the 64 patients enrolled in this study.

Variables Demographics	N. patients (%)
Age (Mean ± SD)	49.78 ± 12.35 yrs.
Sex	
Male	28 (43.8%)
Female	36 (56.2%)
Tumors side	
Right	28 (43.8%)
Left	36 (56.2%)
Past medical history	
No	38 (59.4%)
HTN	16 (25%)
DM	4 (6.3%)
HTN+DM	6 (9.4%)
BMI	
< 18.5	0 (0%)
18.5-24.9	20 (31.3%)
25-29.9	30 (46.9%)
> 30	14 (21.9%)
Blood transfusion	
Yes	16 (25%)
No	48 (75%)
Type of management	
Radical	34 (53.1%)
Partial	30 (46.9%)
Presentation on symptomatic	
Incidental	41 (64.1%)
Symptomatic	23 (35.9%)
Symptom of presentation	
Asymptomatic	39 (60.9%)
Right loin pain	8 (12.5%)
Left loin pain	10 (15.6%)
Anemia	2 (3.1%)
Hematuria	5 (7.8%)
ASA	
1	29 (45.3%)
2	25 (39.1%)
3	9 (14.1%)
4	1 (1.6%)
Stage	
1	50 (78.1%)
2	14 (21.9%)
Nephrometry score	
Low	17 (26.5%)
Middle	28 (43.8%)
High	19 (29.7%)

Table 2.
Surgical approach stratified by nephromtery score and relationships between Hb-drop and postoperative creatinine change with Nephrometery score.

Variables	Nephromtery score - N (%), SD, Mean			P-value
Types of management	Low	Moderate	High	
Partial	17 (56.6%)	13 (43.3%)	0 (0%)	< 0.001
Radical	0 (0%)	15 (44.1%)	19 (55.8%)	
Post-operative value				
Hb drop	1.02 ± 0.65	1.5 ± 0.83	1.53 ± 0.78	0.093
Postoperative creatinine change	0.14 ± 0.19	0.12 ± 0.20	0.08 ± 0.21	0.705

patients who had laparoscopic surgery. Among them 30 (46.9%) patients underwent partial nephrectomy, while 34 patients (53.1%) underwent radical nephrectomy. Among these patients, 41 (64.1%) had an incidental finding of a renal tumor, while 23 (35.9%) presented with symptoms. Of these, 28 (43.8%) had a right-sided renal tumor, while 36 (56.2%) had a left-sided renal tumor. Most of our patients were diagnosed with clear-cell RCC on final histopathology (n = 60). The remaining cases consisted of multilocular cystic RCC (n = 1), renal oncocytoma (n = 2), and renal angiomyolipoma (n = 1). Sixteen patients (25%) received perioperative blood transfusions, while 48 (75%) did not (Table 1). The general 180-day morbidity in the current investigation was low, including pleural injury (n = 3), urinary leakage (n = 1), and patients requiring postoperative blood transfusion (n = 6). The mortality rate was zero after 180 days of follow-up.

There were 17 (26.5%) low, 28 (43.8%) moderate and 19 (29.7%) high-complexity lesions (Table 1). All patients with a low Nephrometry score (n = 17) underwent partial nephrectomy, and all cases with a high score (n = 19) underwent radical nephrectomy. For those with a moderate Nephrometry score (n = 28), 13 (46.4%) underwent partial nephrectomy, while the remaining 15 (53.6%) cases underwent radical nephrectomy (Table 2). Additionally, Table 2 provides post-operative follow-up data, examining the connections between Hb-drop and postoperative creatinine change with different nephrometry scores. The Nephrometry scores were categorized as low, moderate, and high, and the data are reported as mean ± SD. For the variable "*Hb drop*", the following values were observed: for low Nephrometry score: 1.02 ± 0.65, for moderate Nephrometry score 1.50 ± 0.83; for high Nephrometry score 1.53 ± 0.78 (with a p-value of 0.093).

For the variable "*postoperative creatinine change*", the data aer as follows: for low Nephrometry Score 0.14 ± 0.19; for moderate Nephrometry score 0.12 ± 0.20; for high Nephrometry score 0.08 ± 0.21 (with a p-value of 0.705) (Table 2).

The anatomical location data based on the nephrometry score reveals important details about the renal masses under study. The mean maximum dimension and *standard deviation* (SD) was measured at 1.96 ± 0.73. The nature of the masses is described in terms of endophytic and exophytic characteristics, with 37.5% of the masses being predominantly exophytic, 48.5% showing a 50% exophytic nature, and 14.1% being primarily endophytic (Table 3). Regarding their location, 31.3% of the masses are prioritized anteriorly [designated as 'Priority (a)'], while the same percentage is located posteriorly ['Priority (p)']. An additional 37.4% of the masses are categorized as 'Uncertain (x).' The proximity of the masses to the renal hilum is also noted, with 12.5% located at or above 7 units away, 15.6% situated between 4 and 7 units, and the majority, 71.9%, being located within 4 units of the hilum (Table 3).

Polar relationships further characterized the masses, with 53.1% positioned exclusively under or upwards of the polar lines. Another 20.3% of the masses crossed the polar line, while the remaining 26.6% were distributed such that 50% of the mass either crosses the polar line, extends across the axial renal midline, or is fully situated amidst the polar lines. These factors collectively provide insights into the lesion's size, endophytic or exophytic nature, its specific location, proximity to the hilum, and its relationship to the polar lines. This data distribution is detailed in Table 3.

A comparative analysis was conducted between patients who received blood transfusions and those who did not. The mean maximum diameter for patients receiving blood transfusions was 2.25 ± 0.77, while those who did not receive transfusions had a mean diameter of 1.87 ± 0.70 (p = 0.077). Patients with tumors ≥ 50% exophytic nature received transfusion in 4/24, those with < 50% exophytic nature tumors received in 7/32, and patients with endophytic tumors on 5/9 (p = 0.065). Patients with tumors in anterior location had transfusion in 5/20, patients with tumors in posterior location in 5/20 and patients with tumors in unknown location in 6/24 (p =1.00). In regards to the nearness with hilum, patients with a distance ≥ 7 units received blood in 1/8, and those with distances > 4 but < 7 units in 1/10, and for distances ≤ 4 units, 14/46 received blood (p = 0.274). In regard to polar relation, the

Table 3.
Anatomical characteristics of dimension nephrometry scores.

Variables	N (%)
Maximum diameter (Mean ± SD)	1.96 ± 0.73
Endophytic/exophytic	
>= 50% exophytic	24 (37.5%)
< 50% exophytic	31 (48.5%)
Endophytic	9 (14.1%)
Location	
Anterior (a)	20 (31.3%)
Posterior (p)	20 (31.3%)
Unknown (x)	24 (37.4%)
Nearness to Hilum	
>= 7	8 (12.5%)
>4 BUT < 7	10 (15.6%)
<= 4	46 (71.9%)
Polar relation	
Entirely above the upper or below the lower polar	34 (53.1%)
lesion crosses polar line	13 (20.3%)
> 50% of mass is across polar line, or mass crosses the axial renal midline, or mass is entirely between the polar lines	17 (26.6%)

Table 4.
Comparison of clinical features in blood transfusion groups.

Blood transfusion	Yes	No	P-value
Maximum diameter (Mean ± SD)	2.25 ± 0.77	1.87 ± 0.70	0.077
Endophytic/exophytic			0.065
>= 50% exophytic	4 (16.6)	20 (83.4)	
< 50% exophytic	7 (21.9)	25 (78.1)	
Endophytic	5 (55.5)	4 (44.5)	
Location			1.000
Anterior (a)	5 (25)	15 (75)	
Posterior (p)	5 (25)	15 (75)	
Unknown (x)	6 (25)	18 (75)	
Nearness to Hilum			0.274
>= 7	1 (6.3)	7 (14.6)	
> 4 BUT < 7	1 (6.3)	9 (18.8)	
<= 4	14 (87.4)	32 (66.7)	
Polar Relation			0.042
Entirely above the upper or below the lower polar	5 (14.7)	29 (85.3)	
lesion crosses polar line	3 (23)	10 (77)	
> 50% of mass is across polar line, or mass crosses the axial renal midline, or mass is entirely between the polar lines	8 (47.1)	9 (52.9)	

Table 5.
Surgical approach of renal cell carcinoma.

Blood transfusion	Yes	No	P-value
Maximum diameter (Mean ± SD)	1.53 ± 0.57	2.35 ± 0.64	< 0.001
Endophytic/exophytic			< 0.001
>= 50% exophytic	19 (63.3%)	5 (14.7%)	
< 50% exophytic	11 (36.7%)	20 (58.8%)	
Endophytic	0 (0%)	9 (26.5%)	
Location			0.199
Anterior (a)	10 (33.3%)	10 (29.4%)	
Posterior (p)	12 (40%)	8 (23.5%)	
Unknown (x)	8 (26.7%)	16 (47.1%)	
Nearness to Hilum			< 0.001
>= 7	8 (26.7%)	0 (0%)	
> 4 BUT < 7	10 (33.3%)	0 (0%)	
<= 4	12 (40%)	34 (100%)	
Polar Relation			< 0.001
Entirely above the upper or below the lower polar	25 (83.3%)	9 (26.5%)	
lesion crosses polar line	3 (10%)	10 (29.4%)	
> 50% of mass is across polar line, or mass crosses the axial renal midline, or mass is entirely between the polar lines	2 (6.7%)	15 (44.1%)	

Table 6.
Relationship between Nephrometry score and Hb drop with blood transfusion and Relationship of blood transfusion with Fuhrman grade.

P-value	Blood transfusion N (%)		Variables
	No	Yes	
0.093			Nephrometry score
	15 (31.3%)	2 (12.5%)	low
	22 (45.8%)	6 (37.5%)	moderate
	11 (22.9%)	8 (50%)	high
0.479	1.34 ± 0.79	± 0.80 1.50	Hb drop (Mean ± SD)
0.094			Furhman grade
	28 (60.9%)	5 (31.2%)	1
	17 (37%)	11 (68.8%)	2
	1 (2.1%)	0 (0%)	3

analysis showed that 5/34 of the cases with mass entirely above or below the polar lines received a blood transfusion, whereas transfusion were received in 3/13 of those with lesions that crossed polar lines (p = 0.042). The results from this comparative evaluation are summarized (Table 4).
The number of patients by type of management, radical or partial, revealed that the type of surgery was based on the anatomical scores (Table 5).
An investigation was conducted to explore the association between nephrometry scores and hemoglobin decline in the context of blood transfusion. The transfusion rate was correlated with Nephrometry score (Table 6). Patients with low, moderate, and high nephrometry scores had transfusions in 2/15, 6/28, and 8/19, respectively (p = 0.093. Additionally, mean ± SD values for Hb drop for those who received a blood transfusion or not are presented in (Table 6). Furthermore, Table 6 delved into the investigation of the relationship between blood transfusion and Fuhrman grade, with information presented as counts and percentages (N%). For patients who did not receive blood, Fuhrman Grade 1 accounted for 60.9% (28 cases), Fuhrman Grade 2 for 37% (17 cases), and Fuhrman Grade 3 for 2.1% (1 case). Patients who received blood were 5/33 in Fuhrman grade 1 group, 11/28 in Fuhrman grade 2 group and 0/1 in Fuhrman grade 3 group (p = 0.094). These findings are comprehensively presented in (Table 6), contributing to the insight into the interplay between nephrometry scores, hemoglobin decline, and Fuhrman grade in the studied cohort.

Discussion

The third most prevalent malignant neoplasm involving the urinary tract is RCC, encompassing nearly 3.5% of the entire cancers afflicting the body (1). An approximate 54.390 new diagnoses and 13.010 mortalities in 2008 were attributed to RCC (18). Most diagnoses nowadays are unintentional. In the past, symptoms such as weight loss, hematuria, or a palpable flank bulge would indicate the condition. The reason for this change is because more cross-sectional diagnostic imaging is being used. As a result, at least 48-66% of RCC diagnoses have been established based on asymptomatic, incidental renal masses

(19). Both the incidence of RCC and the rate of RCC therapies have risen consistently over the last three decades with lower-stage migration (20). The treatment of localized RCC is a therapeutic challenge due to the diversity of tumor appearances and unique patient circumstances. Surgical management, such as PN and RN, is the main treatment option for localized RCC. A number of factors, including the size, location, and intricacy of the tumor, influence the decision to perform a particular surgery (21). The R.E.N.A.L. nephrometry score employs imaging-derived characteristics of kidney tumors to measure tumor complexity objectively, facilitating decisions regarding the selected technique and strategy.

Postoperative results in individuals receiving open or minimally invasive PN have been correlated with the R.E.N.A.L score. The current study underscores the effectiveness of the R.E.N.A.L nephrometry score in forecasting surgical complexity and postsurgical morbidity.

The results of this investigation correspond with past studies that have highlighted the connection between surgical technique selection and tumor architecture. One standardized and objective tool for preoperative decision-making is the R.E.N.A.L-NS. It gives urologists a useful tool for determining the optimal surgical approach and evaluating the complexity of renal masses. These findings provide credence to the hypothesis that anatomically-based tailored renal mass surgery might lead to improved clinical outcomes (22). According to this study, anatomic tumor features like size and location have a profound effect on preoperative outcomes and the prognosis that follows surgery. According to our findings, renal masses' preoperative radiographic and anatomic characteristics can predict the mass's pathologic characteristics. The R.E.N.A.L. Nephrometry score, as the primary rating algorithm established to gauge renal tumor architecture concerning surgical resectability, was utilized in this study.

Excision is the usual course of treatment for individuals with a solid renal tumor. Active observation, operative excision, and thermal ablative procedures are all effective therapeutic options for suitably chosen individuals with a clinical stage T1 kidney tumor, as new American Urological Association guidelines have shown (23).

R.E.N.A.L nephrometry scores range through 4 to 12 points. Lesions that have a collective score of 4, 5, or 6 on nephrometry are classified as low complexity. Meanwhile tumors with cumulative points of 7 to 9 points are considered intermediate complexity, and masses scored between 10 to 12 are classified as high complexity lesions. A suffix of a or p, and x adds a descriptive component to the system, signifying the anterior or posterior location of the mass, whereas a h is used for hilar tumors (7). Of the 68 patients in the current study, 34 (53.1%) underwent RN and 30 (46.9%) underwent PN based on their nephrometry scores: 17 (26.5%) were low complexity, followed by 28 (43.8%) intermediate complexity and 19 (29.7%) high complexity.

Haidar et al. found a relationship connecting R.E.N.A.L score and surgical technique choice. PN was done in 75.6% of cases with low score, 54.6% of instances with moderate level ($p = 0.004$), and only 11.7% of those with high score ($p < 0.001$) (24). In our study, 46.9% of 68 patients underwent partial nephrectomy, with 56.6% having a low score and 43.3% having a moderate score. The remaining patients underwent radical nephrectomy, with 44.1% and 55.8% having intermediate and high scores, respectively.

To define the anatomical aspects of a kidney mass, another approach called *Preoperative Aspects and Dimensions Used for an Anatomical* (PADUA) was established. With the exception of defining the sinus lines and assessing the physical connection between the tumor and the renal sinus, or urine collecting system, this system is comparable to the nephrometry score. The C-Index Method was finally presented to ascertain the centrality of a tumor. The distance separating the mass and the kidney centers must be calculated using a sophisticated geometric approach utilizing cross-sectional imaging (25, 26).

Whenever medically feasible, most globally recognized standards recommend doing a partial nephrectomy for T1a tumors. Approaches to solid renal tumor care include deciding whether to remove the entire kidney or only the tumor with a clean surgical margin, as well as whether to use an open or laparoscopic surgical technique. It was demonstrated that tumor volume increases the likelihood of malignant vs benign pathology, high-grade versus low-grade illness, and clear cell versus papillary histology (27). In our study, all patients with a low Nephrometry score got partial nephrectomy, while all patients with a high score had radical nephrectomy. Those with a moderate score (46.4%) got partial nephrectomy, while the rest (53.6%) had radical nephrectomy.

One of the most difficult components of RCC therapy is preventing perioperative problems while maintaining patient safety (28). The study identified just a few cases of pleural injury, urinary incontinence, and the need for postoperative blood transfusions. The lack of mortality throughout the 180-day follow-up period is reassuring, showing that anatomically complex surgical decisions do not threaten patient safety.

In terms of perioperative blood transfusions, the study revealed that a quarter of the patients needed them, although the rest did not. This study stresses the need of accurately calculating perioperative blood loss, which can affect surgical technique and postoperative therapy. In challenging cases, efforts to decrease blood loss and the need for transfusions, such as precision surgical techniques and advanced hemostatic therapies, should be considered. *Haider et al.* revealed that individuals with an elevated R.E.N.A.L. score experienced more adverse perioperative results in comparison to those with a lower score. Subjects with a high R.E.N.A.L score (19.4% *vs* 6.3%, $p = 0.018$) were three folds more likely to get blood transfusions than those with a low score (24). Out of the 68 patients in the current study, 16 had blood transfusions, the majority, 8 (50%) had high scores, followed by 6 (37.5%) with moderate scores and 2 (12.5%) with low scores.

There is ongoing debate regarding the ability of the R.E.N.A.L. nephrometry scoring technique to reliably forecast malignancy and high histopathological grades in small kidney tumors. Osawa et al. found that despite the fact that R.E.N.A.L. nephrometry scores were effective in distinguishing the benign and malignant kidney masses, as well as low- and high-grade kidney tumors, histopathological examination yielded superior performance in this regard (29). Further investigations have demonstrated a profound relationship between the R.E.N.A.L. score and both tumor grade ($p < 0.0001$) and histology ($p < 0.0001$). This suggests that as tumor volume rises, there is a higher probability of malignancy, particularly high-grade and clear-cell tumors, upon histological examination (30). The consequence of RCC tumor complexity on oncologic results remains to be definitively made. This current research revealed that the R.E.N.A.L. score played a predictive role in key oncologic outcomes. For instance, individuals exhibiting lower R.E.N.A.L. scores demonstrated markedly higher survival rates in contrast to those presenting higher nephrometry scores. Similarly, tumors with elevated R.E.N.A.L. scores showed more likelihood of experiencing recurrence and progression.

Conclusions

The R.E.N.A.L. nephrometry scoring system offers a versatile, advantageous, and replicable tool for quantifying the key aspects of renal anatomy. The cumulative nephrometry score was shown to be linked with operative decision-making. Specifically, the anatomical characteristics of a kidney tumor foretell the utilization of different surgical approaches.

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