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RESEARCH ARTICLE

STUDY ON RENAL MASSES WITH RENAL NEPHROMETRY SCORE FOR STANDARDISED REPORTING SYSTEM USING MDCT

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Abstract

Background: The nephrometry score, which is determined from cross-sectional imaging, categorizes renal masses into low, intermediate, and high complexity.
Objective: The purpose of this article is to understand how the score is determined and review the five key features that contribute to the nephrometry score.
Methods: Prospective study on patients referred from urology departm ent of Mysore medical college and research institute (April 2023- April 2025) after the initial ultrasound revealed a renal tumour that seemed to be RCC with requisition of contrast enhanced CT scan.
Results: The R.E.N.A.L. Nephrometry Score evaluates renal tumors based on several factors: (R)adius, which refers to the tumor's size as the maximum diameter; (E)xophytic/endophytic characteristics, indicati ng whether the tumor grows outward or inward; (N)earness, describing how close the tumor's deepest part is to the collecting system or renal sinus; (A)nterior (a) or posterior (p) location; and (L)ocation in relation to the polar line. Tumors that are near the main renal artery or vein are designated with an "h" for hilar. This nephrometry system effectively classified the complexity of tumors undergoing excision at our institution.
Conclusions: The scoring system has implications for surgical planning and has been widely adopted by urologists but is less familiar to radiologists. The nephrometry score provides a useful tool for objectively describing renal mass characteristics and enhancing better communication for the operative planning directed at renal masses.
Contribution: This article demonstrates the value of nephrometry score in guiding and improving surgical management and outcome.

Introduction:-

Renal cell carcinoma's (RCC) morphology is quite intricate. Although about one-third of all renal masses exhibit systemic illness, many localised renal masses seem to have a clinical trajectory that involves very gradual growth. Partial laparoscopic nephrectomy (PLN) would be a useful option for low complexity renal tumours, while higher grades require a radical nephrectomy or a partial open nephrectomy (PON), ablation, or active surveillance (AS) in old or sick patients[1].Imaging is essential for the diagnosis, characterization, staging of patients with renal cell carcinoma (RCC). The ability to measure tumour size, the detailed visualisation of most important landmarks for T staging, the non-invasive nature of imaging for clinical staging, the wide availability of CT and MRI, and the ability to assist in the detection of pathologic lymph nodes, venous invasion, and distant metastases are the main strengths of imaging for clinical staging[2].

Numerous nephrometry scores (NS) have been proposed [3], most of which are based primarily on renal imaging. Their main goal is to create a reliable method for categorising renal masses and characterising architecture with an emphasis on the characteristics including tumor size, nearness to the sinus, endophyticity, polar location, inside description and hilar designation that are most important for surgery. The R.E.N.A.L nephrometry score system, PADUA [4] and the centrality index (C-index) [5] have been studied, although there are few reports on which system is more dominant. The choice of surgical treatment could potentially be influenced by these scores, which were intended to predict surgical results. The R.E.N.A.L nephrometry scoring system and PADUA use similar components and methodologies.

They provide a comprehensive report that includes information on the tumor's size, proximity to the renal collecting system, polar placements, and posterior or anterior locations. Each of these factors is given a score. Depending on the ratio of the distance between the kidney centre and the tumour as well as the tumour radius, Centrality score measures and depicts the centrality of the renal mass. The renal masses are classified into three complexity levels by the renal nephrometry grading system, which is based on cross sectional imaging (CT/MRI). It is most frequently employed because it is simpler to use, has been demonstrated to provide significant pre-operative information, such as surgical planning and significant peri-operative information, such as operative complication rates, operative ischemia period, and post-operative complications. [6] This study sought to evaluate renal tumour characteristics and its complexity to calculate the renal nephrometry score and include this number in diagnostic reports.

Materials and Methods:-

This prospective study conducted on patients referred from Urology department of Mysore medical college and research institute after the initial ultrasound revealed a renal tumour that seemed to be RCC with requisition of contrast enhanced CT scan. This study was conducted between April 2023 to April 2025. Written informed consents were obtained from all participants, the study was approved by the research ethical committee of Mysore medical college and research institute.

Inclusion criteria Adult patients with initial ultrasound examinations showing renal mass suggestive of RCC.Patients had CT with contrast for staging.

Exclusion Criteria
Renal impairment, an allergy to the contrast medium, a single kidney, multiple tumours, and prior partial open or laparoscopic nephrectomy.

Methods:-

The Nephrometry scoring system was developed using CECT images obtained from 128 slice twin beam single source dual energy CT scanner (Somatoform Definition Edge, Siemens Health care, Germany). Our standard CT protocol consists of a three-phase examination that includes unenhanced, nephrographic phase, and excretory phase imaging. Nephrographic phase imaging occurs at approximately 100 seconds and excretory phase imaging at 5 minutes after contrast administration. The scanning parameters are as follows: 240 mAs and 120 kVp; slice thickness, 5 mm; increment, 5 mm; and pitch, 0.8. Coronal and sagittal reconstructions are obtained with 1.5 × 0.8 mm thickness.

TABLE 1: RENAL Nephrometry Scoring System

	Score		
Component	1 Point	2 Points	3 Points
R (radius, maximal diameter) (cm)	≤ 4	> 4 but < 7	≥ 7
E (exophytic/endophytic)	≥ 50 % exophytic	< 50% exophytic	Completely endophytic
N (nearness to collecting system/renal sinus) (mm)	≥ 7	> 4 but < 7	≤ 4
A (anterior/posterior	No points given.		

locator)	Descriptor of "a," "p," or "x" assigned to describe mass location.		
L (location relative to polar lines)	Entirely below lower polar or above upper polar line	Mass crosses polar line	50% of mass is across polar line or mass is entirely between polar lines or mass crosses axial midline

Imaging Classification

The Nephrometry Score Grading

Using the scoring system, tumor complexity is determined: low complexity (nephrometry score = 4–6), moderate complexity (nephrometry score = 7–9), and high complexity (nephrometry score = 10–12) (Figs. 10a to19).

Review Findings:

The nephrometry score is most easily remembered using the acronym R.E.N.A.L., where:

- R stands for radius, referring to the size of the tumor as its maximal diameter in any plane.
- E refers to the exophytic or endophytic nature of the tumor, which indicates whether the tumor is growing outward (exophytic) or inward (endophytic) in relation to the kidney.
- N quantifies the nearness of the tumor to the renal sinus or collecting system.
- A represents the tumor's position relative to the coronal plane, where 'a' indicates an anterior position, 'p' indicates posterior, and 'x' is used when the tumor spans across the coronal plane.
- L refers to the location of the tumor in relation to the kidney's polar lines (upper or lower).

Tumor size (R), or its radius, is the primary factor when assessing a renal mass and is the most reproducible and relevant characteristic when staging localized lesions. The tumor size is measured as the maximum diameter in any single plane, using a scale consistent with the 2002 American Joint Committee on Cancer TNM staging system. Tumors smaller than 4 cm receive 1 point, those between 4 and 7 cm receive 2 points, and tumors 7 cm or larger are assigned 3 points. It's important to consider alternative views, such as coronal or sagittal, if the largest diameter isn't apparent on axial images.

The exophytic or endophytic characteristics (E) of the tumor are evaluated on a 3-point scale. Tumors that are more than 50% exophytic receive 1 point, those less than 50% exophytic are given 2 points, and tumors that are entirely endophytic receive 3 points. This assessment is based on the tumor's predominant feature, which may not always be symmetrical or spherical. It's recommended to measure the tumor's most exophytic and endophytic components relative to where the normal renal cortex would be without the tumor.

Proximity to the renal sinus or collecting system (N) is assessed by measuring the distance from the deepest portion of the tumor to these structures. Tumors more than 7 mm away receive 1 point, those between 4 and 7 mm receive 2 points, and tumors touching or less than 4 mm away from the renal sinus or collecting system are given 3 points. This measurement is easily reproducible with digital imaging.The anterior or posterior location (A) of the tumor is assessed based on its position relative to the kidney's axial midline. This component is described using non-numerical suffixes (a for anterior, p for posterior, and x when the tumor spans across the coronal plane).

Lastly, the location relative to the polar lines (L) determines how close the tumor is to the kidney's upper or lower polar lines. Tumors located entirely above or below the polar lines receive 1 point, tumors crossing the polar line receive 2 points, and those that span more than 50% of the diameter across the polar line or cross the renal axial midline are assigned 3 points. Tumors touching the main renal vessels are given an additional suffix "h" for hilar location.

The R.E.N.A.L. score is used to assess the complexity of a renal tumor, with lower scores (4-6) indicating low complexity, moderate scores (7-9) indicating moderate complexity, and higher scores (10-12) indicating high complexity. These scores help guide surgical decision-making, with low and moderate complexity tumors more often undergoing minimally invasive partial nephrectomy, while high complexity tumors may require open partial nephrectomy or laparoscopic radical nephrectomy.

RENAL REPRESENTATIVE IMAGES

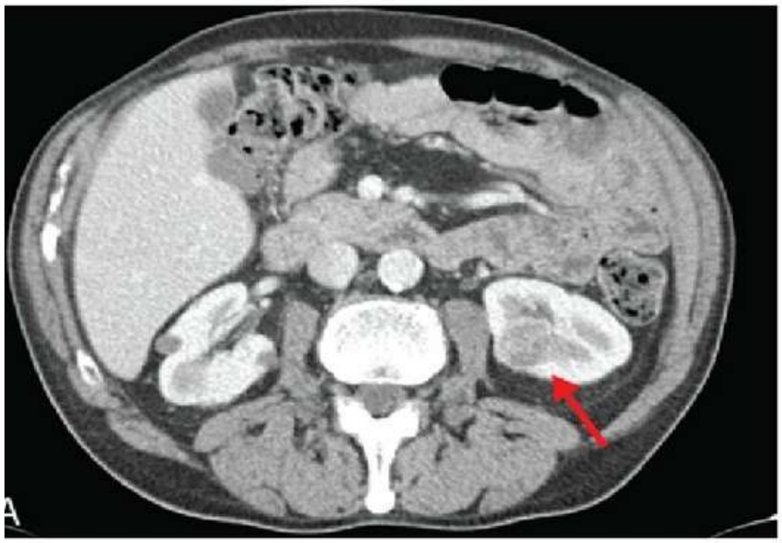


Figure 1- Endophytic mass

Figure 2- Exophytic mass

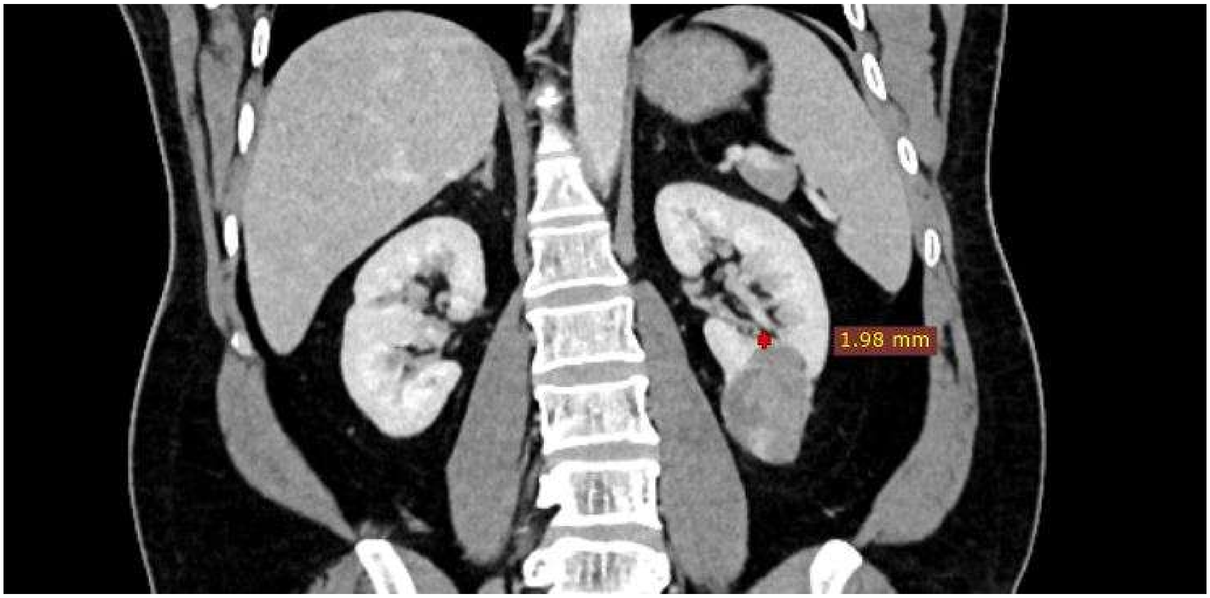


Figure 3- Nearness to collecting system

Figure 4- Radius (Maximum diameter in cm)

Figure 5- Posterior lesion

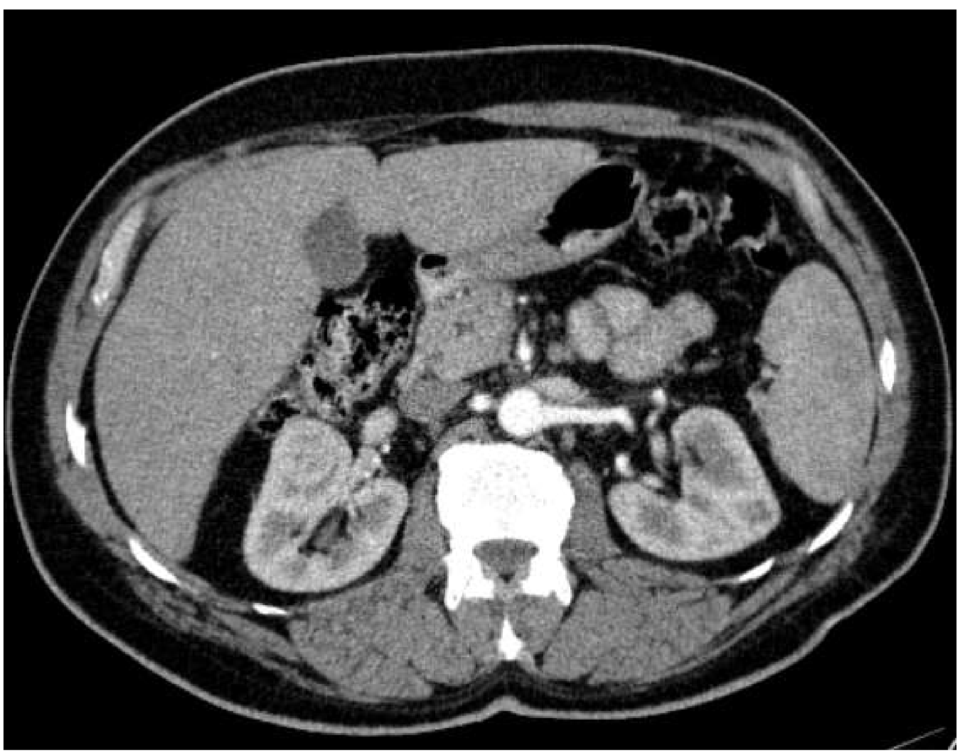


Figure 6- Anterior lesion

CROSSING POLAR LINES

Figure 7- Mass crossing polar line

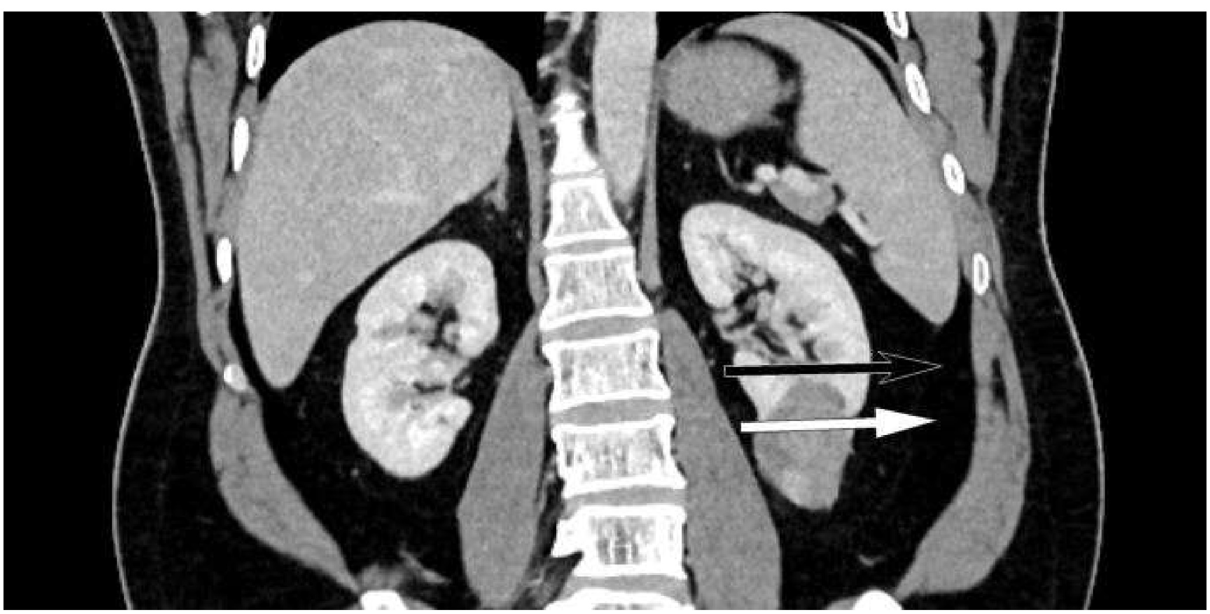


Figure 8- Mass completely below lower polar line

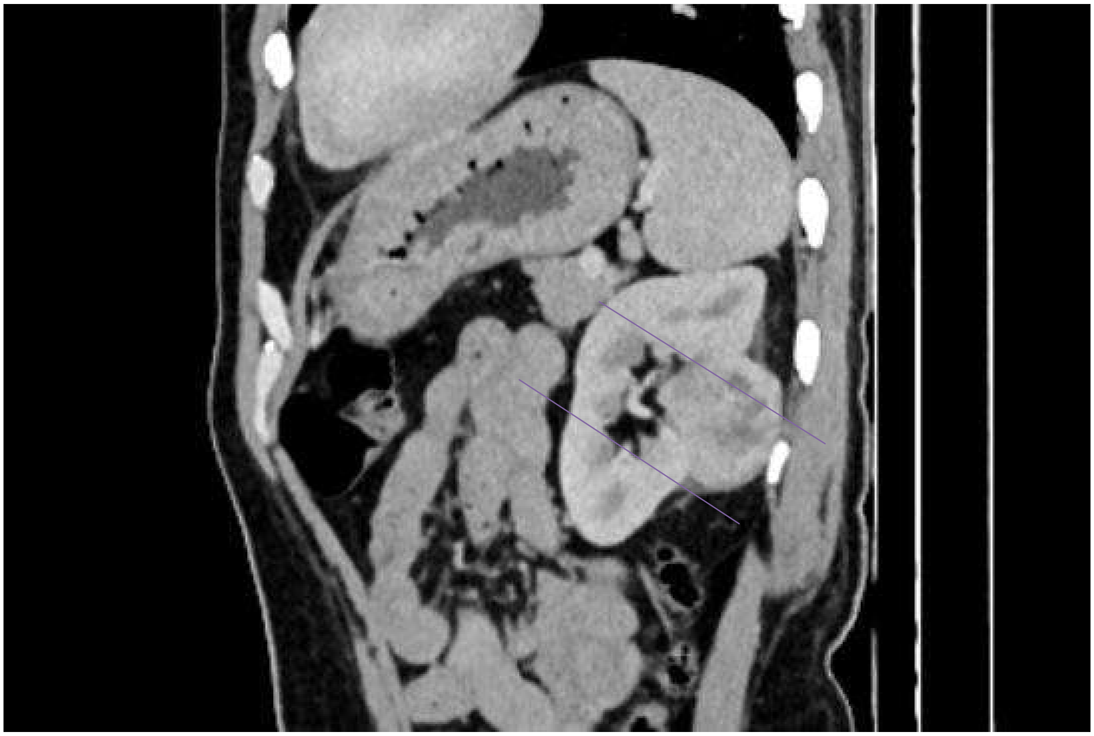
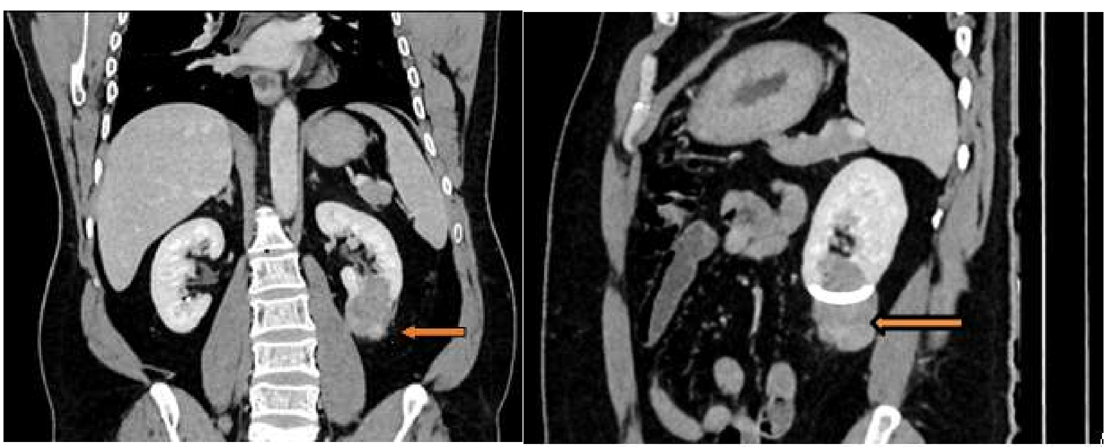
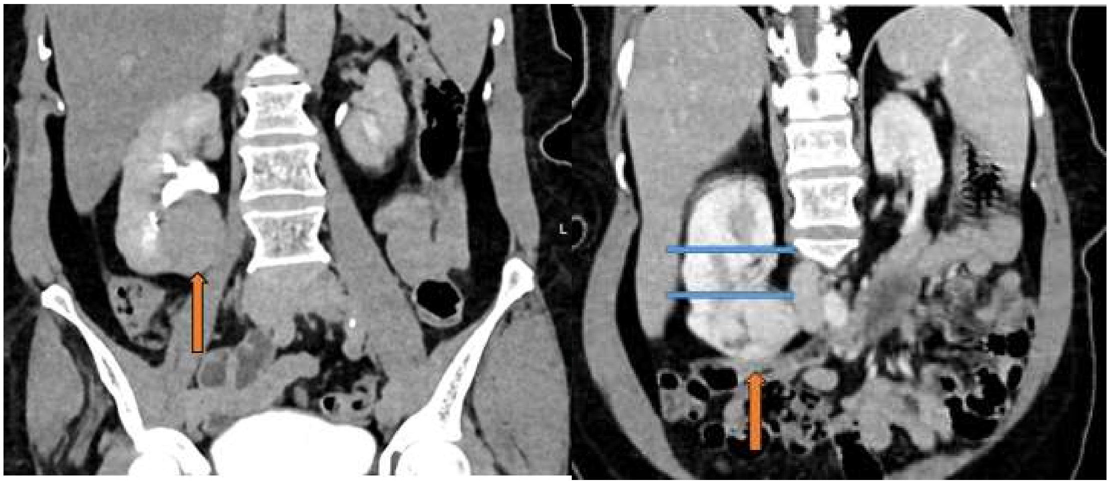


Figure 9- >50% mass within polar lines



10a **10b**

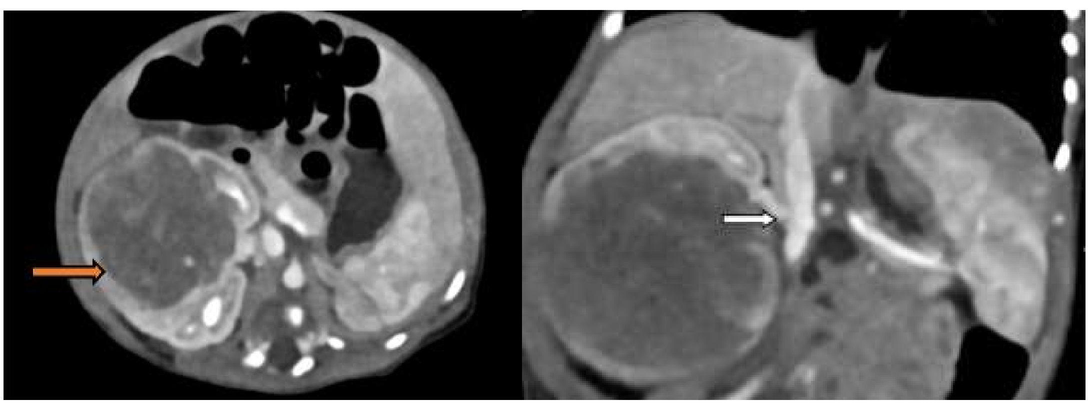
Figure 10a and 10b (reformatted coronal and sagittal CT images) 52-year-old male with a 4.5-cm papillary renal cell carcinoma (orange arrow) of the left kidney. The "E" exophytic/endophytic attribute is determined by looking at the white curved solid line, which represents the predicted renal shape. When a tumor extends more than 50% outside of the renal cortex, it should receive a "E" score of 1. The score for nephrometry is 2+1+3+x+1 =7x



11a **11b**

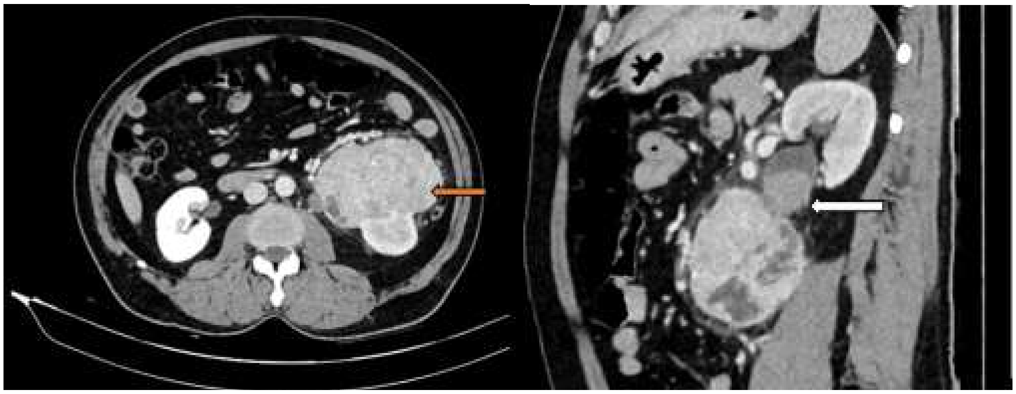
Figure 11a and 11b (coronal reformatted images)

The patient is a 52-year-old woman who has been diagnosed with anteriorly placed right clear cell renal cancer (orange arrow). The tumor is classified as "a" due to its anterior location, and further it is classified as "h" due to its contact with the major renal vasculature. If the tumor is next to the main renal artery or vein, an additional suffix "h" is added to indicate the location of the hilar tissue. The tumor crosses the inferior polar line, and the polar lines are indicated by blue solid lines. Nephrometry score is 2 + 1 + 3 + a + 2h = 8ah.



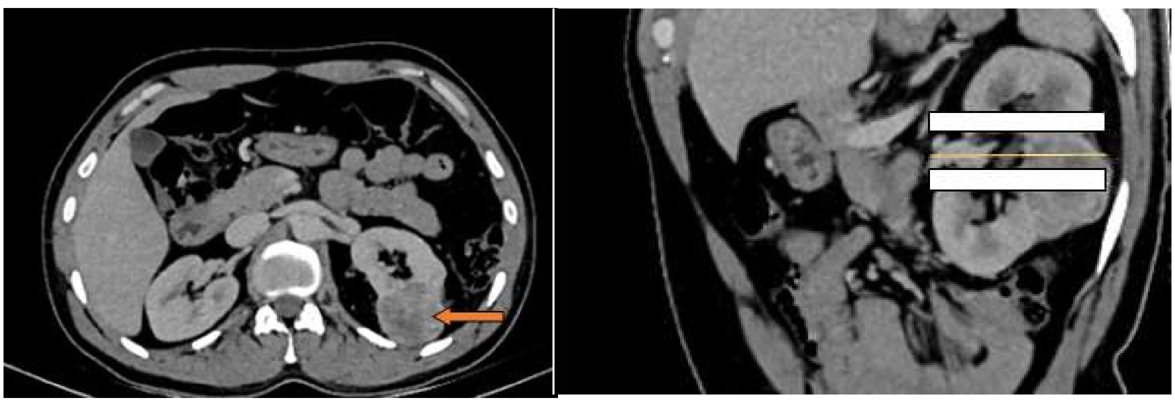
12a **12b**

Figure 12a and 12b (axial contrast enhanced CT image and reformatted coronal image) shows a 3 months old female child with an endophytic mesonephric blastema involving the inter and lower pole of right kidney causing enlargement of right kidney. The tumour is classified as ‘x’ as its location is not defined and further classified as ‘h’ since the lesion touches the hilum (white arrow). The nephrometry score is 3+1+3+x+3h=10xh



13a **13b**

Figure 13a and 13b Axial and sagittal reformatted contrast enhanced CT images show 60 years old male with left high complex renal cell tumour (orange arrow). The tumour is classified with a suffix ‘a’ as the lesion is in anterior location and further classified as ‘h’ since the tumor touches hilum (white arrow).Nephrometry score is 3+1+3+a+1=8ah.



14a **14b**

Figure 14a and 14b (axial and reformatted sagittal contrast enhanced images)

55-year-old female patient with 4.4-cm left highly complicated clear cell renal carcinoma in the mid pole (orange arrow). The two solid white lines represent the polar lines while renal midline is shown by the thin yellow line and the tumour crosses the renal midline, hence assigned a score of 3. Due to its posterior location, the lesion is categorized with a suffix "p." Nephrometry score is 2+1+3+p+3= 9p

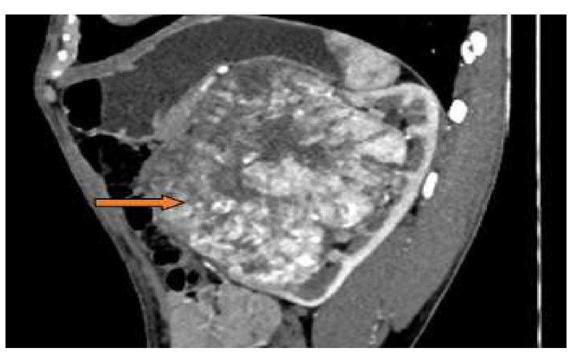


Figure 15 (reformatted sagittal contrast enhanced images)

51-year-old man with high-complexity left clear cell carcinoma (arrow).The white curved line indicates the predicted normal contour of the right kidney with less than 50% endophytic component. Nephrometry score is 3+ 2 + 3 + x+ 3xh = 10xh.

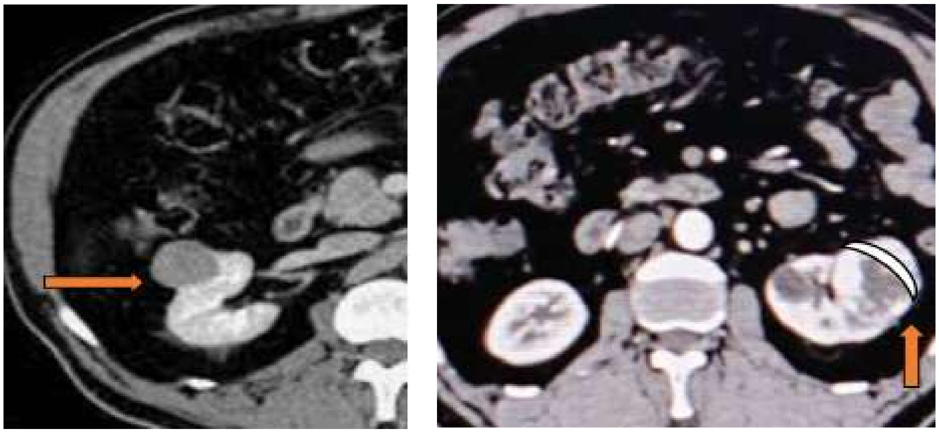
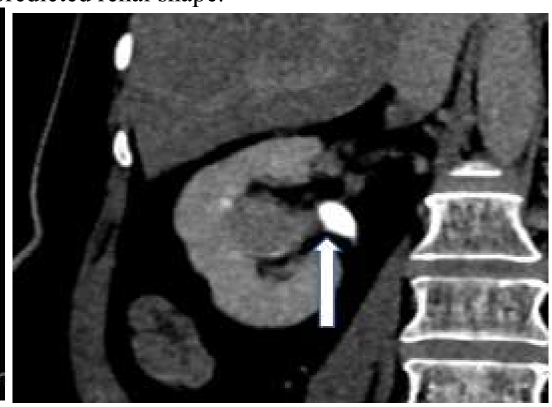


Figure 16- axial contrast enhanced image

45-year-old man with small clear carcinoma of left kidney (arrow) that is < 50% exophytic with “E” score of 2. Nephrometry score is 1 + 2 + 1 + a + 1 = 5a. The "E" exophytic/endophytic feature of the nephrometry score is determined by the solid, curved white line, which depicts the predicted renal shape.

17a



17b

54 years old female with right low complex tumour. Figure 17a and 17b (axial and reformatted coronal images) shows centrally located tumour (orange arrow) , endophytic in nature and the tumour is less than 4mm from collecting system (white arrow).Nephrometry score is 1+3+3+a+3 = 10p

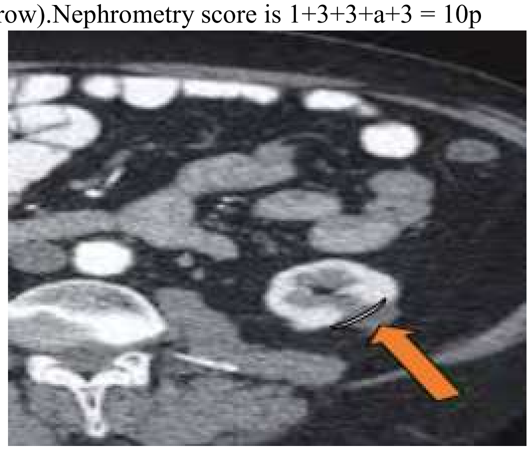


Figure 19- Axial CT image

44-year-old man with left papillary renal cancer. Figure shows exophytic low-complexity cancer (arrow) with N score is 1 as the tumour is >7mm away from the collecting system. The "E" exophytic/endophytic attribute is determined by looking at the white curved solid line, which represents the predicted renal shape. When a tumor extends more than 50% outside of the renal cortex, it should receive a "E" score of 1. Nephrometry score is 1 + 1 + 1 + p + 1 = 4p

IMPLICATIONS AND RECOMMENDATIONS

More than half of RCCs are discovered accidentally and frequently diagnosed at an early stage, thanks to the widespread use of cross-sectional imaging techniques. Although the tumours are often solitary, they can occasionally be multifocal (6-25%), and bilateral RCC can develop at any moment during a patient's lifetime in 4% of cases[6] This might make it possible to create more cautious treatment plans. The preferred procedure for identifying and staging RCC is Computed Tomography [7]

Clinically localised kidney tumours can only be cured surgically by excision [1]. Traditionally, this entails a total nephrectomy, but new research has shown that partial or "nephron-sparing" nephrectomy is just as beneficial in some populations. A tumour less than 4 cm in size, a peripheral position, the absence of the contralateral kidney, bilateral renal tumours, and renal insufficiency are all criteria for partial nephrectomy. The possibility of future renal function impairment due to another ailment or the possibility of bilateral renal tumours are additional factors to take into account[3,4]. Results for both partial and radical nephrectomy for low complex tumours have been demonstrated to be equal [8, 9]. In spite of these facts, partial nephrectomy is still undervalued. Recent data show that nephron-sparing surgery is used to treat about 27% of all patients with localised renal tumours, regardless of anatomical characteristics. [11]

The characteristics of tumor resected using Partial Nephrectomy or complete nephrectomy had been reported in many studies, but few studies mentioned the features affecting decision of Urologist for partial nephrectomy or complete nephrectomy, or the cut-off value determining the choice for both processes. Hence, to regulate and standardise the treatment protocol and to help the surgeons in choosing the appropriate surgery, nephrometry score was developed.

The selection and preoperative assessment of patients for partial nephrectomy heavily relies on imaging. The choice to conduct a partial nephrectomy is arbitrary, and prior to the creation of the nephrometry score, there was no accepted way to assess the complexity of the renal mass. The essential anatomical components of the renal mass are captured by the five features R (radius), E (exophytic/endophytic), N (nearness), A (anterior), and L (location), which can be used to categorise the surgical complexity into low, middle, and high categories.

The comparability of research examining the therapy of renal masses has increased because of nephrometry. A nephrometry scoring system must perform well in predicting negative outcomes and be simple to use in order to be used preoperatively in every instance in order to become popular among urologists and radiologists[12].

However, there are certain pitfalls in nephrometry score system. The RENAL nephrometry score has been the subject of interobserver variance research. In a retrospective analysis by Vilaseca et al [13], two independent radiologists evaluated 46 patients with renal masses who had undergone imaging tests between 2008 and 2012. They used the RENAL nephrometry score. For the total score as well as each component score, the interobserver agreement was determined. The agreement was determined to be 98%, 80%, 100%, 89%, and 85% for each component of the RENAL score, with the closest agreement for the nearness, radius, and total score, and the lowest agreement for the hilar location and the highest agreement for the total score. No significant ramifications for surgical planning were seen for the cases where there was debate over the final score.In a study conducted by cost et al [14]on 69 patients of varying groups it has been understood that the Renal nephrometry score is beneficial for assesing the complexity of RCC and other masses in older children because the authors discovered that it did not substantially correspond with blood loss, operating time, blood transfusion, positive surgical margins, or tumour rupture in older age groups.

The patient's unique traits are not taken into account by nephrometry scoring systems, which solely take into account the aspects of the masses. The outcome of the procedure may be negatively impacted by factors such as perirenal fat, age, previous surgeries, architecture, and an underlying disease

Comparing the complication rates following partial nephrectomy is challenging due to the subjective nature of assessing surgical complexity before to surgery. For open laparoscopic or robotically assisted partial nephrectomy, the reported complication rates vary from 4.5% to 10.6% [15]. Lesions with scores between 12 and 14 were five times more likely to have a postoperative urologic problem, while patients with low-complexity nephrometry scores are less likely to have a postoperative bleed or urinary fistula than those with moderate-complexity masses. It has been demonstrated that a higher nephrometry score is associated with a longer ischemia duration during partial nephrectomy and a higher risk of urinary fistula development after surgery [16, 17]. In addition to greater surgical complications, higher nephrometry scores have also been demonstrated to be correlated with pathologic stage, nuclear grade, and mortality.

The RENAL nephrometry scoring system, in conclusion, offers a simple way for classifying the complexity of renal tumours, assisting in treatment selection and counselling and offering a platform for standardised academic reporting. The nephrometry score appears to be correlated with long-term outcomes, albeit the findings are preliminary.

The scoring system excludes renal anomalies like fusion and duplication that could increase surgical morbidity, and if nephrometry is more frequently used, adjustments may be required. Assigning a nephrometry score will be easy for the interpreting radiologists, and doing so will make sure that the key characteristics of a renal carcinoma are recorded for operation planning.

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Competing interests:

The author(s) declare that they have no financial or personal relationship(s) that may have inappropriately influenced them in writing this article.

Authors' contributions

P.N.H contributed to the conceptualization of the initial idea. N.P.S, S.G.P and K.R contributed to the article creation. N.P.S and K.R assisted in review analysis, implications and recommendations and article preparation.

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Data availability

The data that support the findings of this study are available from the corresponding author, N.P.S, upon request.

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