Section: Radiodiagnosis

Original Research Article

STUDY OF RENAL MASSES WITH COMPUTED TOMOGRAPHY (CT) NEPHROMETRY SCORING SYSTEM

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ABSTRACT

The increasing diagnosis of renal cell carcinoma (RCC), the most common kidney cancer, is largely due to the widespread use of advanced imaging techniques like CT and MRI scans, which are highly effective at detecting small kidney tumors.1 Similar to BI-RADS and LI-RADS, the RENAL nephrometry score offers an objective and reproducible method for describing kidney tumors. This system (R.E.N.A.L.: Radius, Exophytic/Endophytic, Nearness, Anterior/posterior, Location Relative to polar lines) facilitates consistent evaluation and better communication between healthcare professionals.7 The study aims to evaluate preoperative and perioperative information to predict long-term outcomes by using RENAL Nephrometry scoring system A prospective study was conducted at a tertiary care hospital involving 60 patients. The evaluation included imaging in arterial, portal, and delayed phases. The RENAL nephrometry score is determined by assessing 5 highly reproducible characteristics that describe the anatomy of a solid renal mass using contrast-enhanced cross-sectional imaging. Application of R.E.N.A.L. nephrometry scoring preoperatively may be used as a guide to the complexity and choice of surgery in patients with solid renal masses. It also serves as a tool for patient counselling, with reference to postoperative outcomes.

Keywords: CT, MRI, RCC.

INTRODUCTION

The increasing diagnosis of renal cell carcinoma (RCC), the most common kidney cancer, is largely due to the widespread use of advanced imaging techniques like CT and MRI scans, which are highly effective at detecting small kidney tumors.[1]
It's noteworthy that a large proportion of these newly diagnosed RCC cases are found by chance. These incidental findings occur when imaging tests done for unrelated medical conditions reveal a suspicious, enhancing mass in the kidney, potentially indicating a tumor.[2]
Surgical procedures, including either partial nephrectomy or total nephrectomy, emerged as a highly effective treatment approach in 2010 with remarkable 99.2% recurrence-free survival rate.[3]
Partial nephrectomy is increasingly favored over total nephrectomy for small kidney tumors (under 4 cm). Its use has risen from about 27% in 2005, indicating a shift towards kidney preservation.[4]
More than 65% of patients with small renal tumors (less than 4 cm) now receive partial nephrectomy, highlighting a strong preference for kidney-sparing surgical approaches.[5,6]
Similar to BI-RADS and LI-RADS, the RENAL nephrometry score offers an objective and reproducible method for describing kidney tumors. This system (R.E.N.A.L.: Radius, Exophytic/Endophytic, Nearness, Anterior/posterior, Location Relative to polar lines) facilitates consistent evaluation and better communication between healthcare professionals.[7]
Unlike PADUA and CI, the RENAL scoring system is preferred for its objective and quantifiable assessment of kidney tumor complexity, offering a more precise evaluation.[8,9]
The RENAL scoring system has quickly become popular for its valuable information before and

during kidney tumor surgery, aiding in long-term prognosis prediction and leading to its increasing use in clinical trials, similar to RECIST guidelines.[10]

Although CT scans can identify renal masses, they aren't always diagnostic for RCC. While nephrectomy is often performed, a biopsy is necessary for a definitive RCC diagnosis and to determine further treatment.

The rise in imaging has increased the detection of incidental renal masses. While surgery provides a definitive diagnosis, it risks overtreating benign cases. Although biopsy can help, its invasive nature necessitates exploring alternative diagnostic approaches.

Aims and Objectives

1. To evaluate the treatment patterns of solid renal masses according to the quantifiable anatomic features using nephrometry in surgical planning.
2. To evaluate preoperative and perioperative information to predict long-term outcomes by using RENAL Nephrometry scoring system.
3. To find the prognosis in post-operative patients using MDCT.

MATERIALS AND METHODS

Study design: Descriptive Study

Study setting: Department of Radiodiagnosis, Tertiary care centre

Study duration: 18 months (Data collection –12 months and analysis 6 months)

Sample size: Sample size of 60 is chosen.

The patients referred for Triple Phase CT on clinical suspicion of renal masses are clinically examined, relevant history taken, prior radiological investigations if done are noted. Exclusion criteria is applied and if the patient is not excluded the patient is taken for Triple Phase CT by properly preparing the patient and informed consent. Patients were kept nil orally 6-8 hours prior to CT scan to avoid complications while administrating contrast medium. Details of the study protocol was explained to the subjects. Risks of contrast administration were explained to the patients and consent was obtained prior to the contrast study. Routine antero-posterior topogram of the abdomen was initially taken in all patients in the supine position. Kilovolt peak: 120–140 kVP, Milliampere second: 200-250 mAs for an average-sized patient (increased values for an oversized patient). Pitch: 1.5, Field of view: 240–350 mm; Collimation: 2.5 mm, Time for scan: 4-5 seconds. If there are no renal imaging abnormalities, such patients are not included in the study, only the patients who have renal masses are taken into study and data is analyzed. Triple Phase CT is an imaging technique in which the I.V. contrast is injected and phases of CT scan is taken to study the entire excretory system. In this study Single contrast media bolus Triple Phase CT technique is used. Patient is asked to drink 1L water 15 minutes before the procedure.

Patient is asked to empty the urinary bladder immediately before the procedure except in suspected urinary bladder neoplasms. First a non-enhanced phase is taken without contrast, then I.V. contrast Iohexol (non-ionic iodinated contrast) of 70-100ml with concentration of 300 mg/100 ml is injected by using a power injector at a rate of 3 ml/sec., nephrogenic phase is taken approximately 100 seconds after the start of contrast administration.

Patient lying down on gantry table. From the level of the xiphisternum to pubic symphysis, data acquisition is uninterrupted. The patient shall be instructed against moving or talking during scanning.

RESULTS

The RENAL nephrometry score is determined by assessing 5 highly reproducible characteristics that describe the anatomy of a solid renal mass using contrast-enhanced cross-sectional imaging. These characteristics are identified as

(R) radius (maximum tumor diameter),

(E) exophytic/endophytic nature of the tumor,

(N) proximity of the tumor's deepest part to the collecting system or renal sinus,

(A) anterior (a)/posterior (p) orientation, and

(L) location relative to the polar line. If the anterior or posterior orientation cannot be determined, the tumor is given the suffix "x." Additionally, a suffix "h" is applied if the tumor is located at the hilum, in close contact with the main renal artery or vein.

All elements, with the exception of the (A) descriptor, are rated on a scale from 1 to 3.

Imaging Classification [Table 1 and Figure 1]

The "R" descriptor indicates the maximum diameter of the mass. A radius of 4 cm is the threshold that distinguishes a T1a lesion from a T1b lesion and was traditionally viewed as the upper limit for performing a partial nephrectomy. Masses that are 4 cm or smaller are given 1 point, those greater than 4 cm but less than 7 cm are given 2 points, and those 7 cm or larger are given 3 points.

The "E" descriptor identifies the exophytic or endophytic nature of the tumor. Predominantly endophytic tumors are more challenging to surgically remove compared to exophytic ones. Tumors that extend more than 50% outside the renal cortex are assigned 1 point, those extending less than 50% receive 2 points, and entirely endophytic tumors are assigned 3 points.

The "N" descriptor reflects the tumor's proximity to the collecting system, measured in millimeters, and is best assessed using excretory phase images. Similar to the "R" descriptor, the point scale is divided using thresholds of 4 and 7 millimeters. Tumors are classified into three categories: those 7 mm or more away from the collecting system or renal sinus are given 1 point, those greater than 4 mm but less than 7 mm receive 2 points, and tumors 4 mm or closer to the collecting system are assigned 3 points.

The "A" descriptor indicates whether the tumor is located on the anterior or posterior side of the kidney and does not carry a point value. The "a/p" designation is determined based on axial imaging. Tumors primarily on the ventral surface of the kidney are labeled as anterior (a), while those on the dorsal surface are labeled as posterior (p). Tumors that do not fit neatly into these categories, such as purely lateral or central apical lesions, are designated with an "x",

The "L" descriptor specifies the tumor's position relative to the polar lines. The superior and inferior polar lines, defined by the renal vascular pedicle, can be identified on either axial or coronal images. Tumors located entirely above or below these polar lines are assigned a score of 1. If the tumor crosses the polar line, it receives a score of 2. If more than 50% of the mass crosses the polar line, or if the mass is entirely situated between the polar lines, a score of 3 is assigned. Tumors that abut the main renal vein or artery are given the suffix "h" to denote a hilar location, though this "h" designation does not affect the point score.

Table 1: Description of the RENAL Nephrometry Score

Components	**Score**		
	1 point	**2 points**	**3 points**
(R)adius (maximal diameter in cm)	≤4	>4 but < 7	≥ 7
(E)xophytic/endophytic properties	≥ 50%	<50%	Entirely endophytic
(N)earness of the tumor to the collecting system or sinus (mm)	≥ 7	>4 but <7	≤4
(A)nterior/Posterior	No points given. Mass assigned a descriptor of a, p, or x		
(L)ocation relative to the polar lines* * suffix "h" assigned if the tumor touches the main renal artery or vein	Entirely above the upper or below the lower polar line.	Lesion crosses polar line.	>50% of mass is across polar line (a) or mass crosses the axial renal midline (b) or mass is entirely between the polar lines (c)

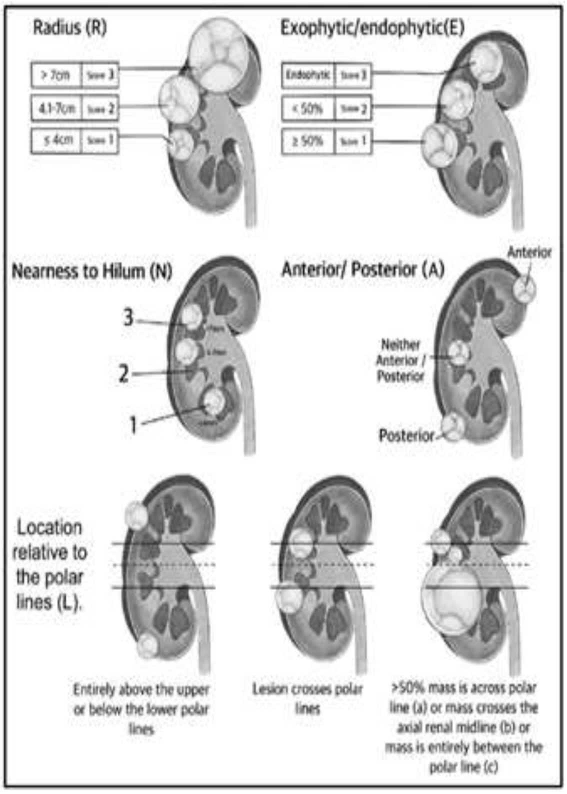

Figure 1: Description of the RENAL Nephrometry Score

Figure 1: A. Axial CECT image left renal mass.

Figure 2: B: Coronal reconstruction

The Nephrometry Score Grading

Using the scoring system, tumor complexity is determined:

- Score of 4-6: Low complexity
- Score of 7-9: Moderate complexity
- Score of 10-12: High complexity

Illustration of Cases

Case 1: 62 year old male with renal mass measuring 2.5 cm at lower pole of left kidney.

Enhancing renal mass with low (4 to 6) complexity R.E.N.A.L. - NS: 1 + 1 + 1 + a + 1 = 4a.

Case 2: 51 year old male with renal mass measuring 3.6 cm at upper pole of right kidney.

Enhancing renal mass with intermediate (7 to 9) complexity R.E.N.A.L- NS: 1 + 2 + 3 + p + 2 = 8p.

Figure 3

Case 3: 73-year-old man with centrally located left renal mass.

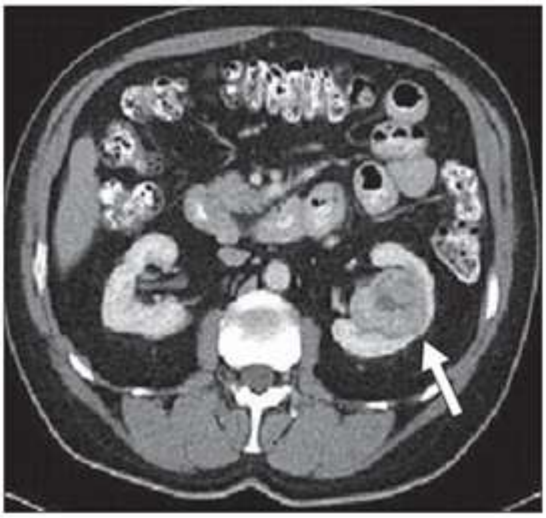

Figure 4: Axial CECT image of left renal mass.

Enhancing renal mass with high (10 to 12) complexity R.E.N.A.L. - NS: 2 + 3 + 3 + x + 3 = 11x.

DISCUSSION

The standard treatment for solid kidney tumors is surgical removal (excision). For smaller tumors (T1a RCCs), partial nephrectomy is the preferred method and is now commonly used even for larger tumors up to 7 cm (T1b). International guidelines generally recommend partial nephrectomy for T1a tumors when technically possible.

Partial nephrectomy for kidney tumors appears to have similar cancer outcomes as removing the entire kidney, while also reducing the risk of kidney failure needing dialysis, cardiovascular issues, and death. Managing these tumors involves deciding between removing the whole kidney or just the tumor with clear margins. The chosen surgical method (open, laparoscopic, or robotic) has specific complications and requires experienced surgeons for the best results.

The choice of kidney tumor surgery and approach depends on many factors, including hospital resources, surgeon experience, patient preference, and primarily, tumor characteristics. Historically, hospital resources were the main driver, leading to inconsistent decisions and outcomes. Even when considering only tumor characteristics, varying definitions made comparing study results difficult.

Nephrometry was introduced as an objective method to assess the complexity of kidney tumors. Three main systems, R.E.N.A.L., PADUA, and C-index, are used to evaluate tumor location relative to kidney structures, primarily for partial nephrectomy. These systems aim to predict the difficulty of surgery and are intended to guide surgical decisions, improve reporting, assess risks, and predict outcomes. The R.E.N.A.L. score is a widely studied system that was initially designed to standardize reporting and link tumor characteristics with pathology and prognosis.

Summary

In our study we used Triple Phase CT as a technique for evaluation of renal masses. We studied total 60 patients of renal masses who were presented to our department after proper inclusion and exclusion criteria and their consent. We used Triple Phase CT findings in classifying renal masses into gradings according to R.E.N.A.L. nephrometry scoring system (NSS).Amongtotal60 casesstudied12(20%)werelow complexity [nephrometryscore=4–6], 27 (45%) were moderate complexity[nephrometryscore=7–9], and21(35%)were high complexity [nephrometryscore=10–12]. Mean age of the group in years was 51.7 years. Overall,therewas male preponderance with 40 (66.7%) male and 20 (33.3%) with male to femaleratio 2:1. Of the renal masses, 46 were clear cell, 9 were chromophobe, 3 were metanephric and oncocytoma and AML were 1 each in our study. Of total 60 patients, the patients having partial surgery were 39 (65%) and radical surgery were 21(35%). Of 39 patients undergone partial surgery, the patients having NSS low complexity undergone were 12 (30.76%), moderate complexity were 23 (58.97%) and high complexity 4 (10.25%) while of 21 patients undergone radical surgery the patients having NSS low complexity undergone were none, moderate complexity were 4 (19.04%) and high complexity 17 (80.95%).

Application of R.E.N.A.L. nephrometry scoring preoperatively may be used as a guide to the complexity and choice of surgery in patients with solid renal masses. It also serves as a tool for patient counselling, with reference to postoperative outcomes.

CONCLUSION

Using the R.E.N.A.L. nephrometry score and its sum to report radiographic and surgical data allows for standardized communication about the anatomical features of solid renal masses. Although the scoring system may not encompass every possible detail unique to the complexities of renal mass anatomy and excision, we believe it effectively captures the most relevant characteristics in a consistent way. We anticipate that the adoption of this novel scoring system in both literature and practice will enable meaningful comparisons across studies and help standardize clinical care practices.

The R.E.N.A.L. nephrometry score for a solid renal mass is strongly linked to our surgical choices (partial vs radical) and the surgical approach (open versus minimally invasive), especially in cases where partial nephrectomy is performed. This score serves as a valuable tool for objectively characterizing a renal mass, supporting clinical decision-making, and improving communication among professionals involved in the management of solid renal masses.

The RENAL nephrometry score was found to correlate with warm ischemia time, estimated blood loss, and length of hospital stay. This indicates that the RENAL nephrometry score effectively represents the technical complexity involved in performing surgery.

The RENAL nephrometry scoring system offers a straightforward approach to categorizing the complexity of renal tumors, which assists in treatment planning, patient counseling, and provides a basis for standardized academic reporting. While the current data are preliminary, the nephrometry score seems to be associated with long-term outcomes. However, the scoring system does not account for renal abnormalities that could increase surgical risks, such as fusion or duplication. As the use of nephrometry becomes more widespread, modifications to the system may be necessary. Radiologists will find that assigning a nephrometry score is easy and ensures that the key characteristics of renal carcinoma are reported for surgical planning.

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