ORIGINAL RESEARCH PAPER
Volume - 12 | Issue - 07 | July - 2023 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

ROLE OF RENAL NEPHROMETRY SCORE IN PREDICTING PERI-OPERATIVE OUTCOMES FOLLOWING PARTIAL NEPHRECTOMY.

Urology

Hussain Ishaque Shaikh Senior Registrar in Urology Jaslok Hospital and Research Centre, Mumbai

Amit Polara* Senior Registrar in Urology Jaslok Hospital and Research Centre, Mumbai *Corresponding Author

Ojas Vijayanand Potdar Senior Registrar in Urology Grant Medical College and J.J. group of hospitals, Mumbai.

ABSTRACT

Introduction: Renal cell carcinoma is 13th most common malignancy in the world.1 The prevalence of disease is more common in western countries compared to Asian countries, with prevalence of disease ranging between 1.1 and 6 per 100000 in Asian population.2 RCC is more common in males than in females.3 **Aim:** To study usefulness of RENAL nephrometry score in predicting peri-operative outcomes in patients with renal masses undergoing partial nephrectomy. **Materials and Methods:** A prospective single centre observational study was carried out at a tertiary care centre in western suburbs of India for a period of 18 months where all patients of renal masses satisfying inclusion and exclusion criteria undergoing Nephron sparing surgery were enrolled into study and data was collected and analysed. **Results:** In our study, renal masses with RENAL Nephrometry Score above 9 had greater tendency for open surgical approach, greater warm ischemia time and total operative time, greater blood loss and longer hospital stay with increased post-operative complications. **Conclusions:** Our study demonstrated that RENAL Nephrometry score is a useful tool in predicting surgical approach, warm ischemia time, total operative time, estimated blood loss, length of hospital stays, progression to total nephrectomy and post-operative complications.

KEYWORDS

INTRODUCTION:

Renal cell carcinoma is 13th most common malignancy in the world.[1] The prevalence of disease is more common in western countries compared to Asian countries, with prevalence of disease ranging between 1.1 and 6 per 100000 in Asian population.[2] RCC is more common in males than in females.[3] In a study done from India, mean age of presentation of RCC was around 52 years, which is a decade earlier than that seen in western countries.

Most common risk factors associated with RCC are smoking, hypertension and obesity. Other risk factors associated with RCC are diet, occupational exposure, genetic and environmental factors. The typical clinical presentation of RCC is haematuria, pain and palpable abdominal mass, but due to widespread use of imaging modalities most of asymptomatic individuals are even detected at an earlier stage. RCC detection rate in asymptomatic individuals is approximately 9.3% in Asian population, while it reaches up to 60% in western population. This difference in detection rate is attributed to higher socioeconomic status, demographic factors and widespread use of imaging modalities. [3,4]The imaging modalities such as ultrasound, CT or MRI are routinely used. In the patients with history of allergy, MRI is preferred modality. The imaging modalities are useful in detection, characterization and staging of renal mass.

The various treatment strategies available are excision of mass by radical or partial nephrectomy, thermal/Cryoablation and active surveillance. Radical nephrectomy has been standard of treatment for RCC in the past and is overutilized. Radical nephrectomy (RN) is associated with risk of chronic kidney disease and cardiovascular disease. Latest trend is towards nephron sparing surgeries considering comparable oncological outcomes and preservation of functional renal parenchyma. The final choice between the nephron sparing surgery and radical nephrectomy is subjective which depends on tumour anatomic complexity and surgeon's experience.[5]

To decide the renal tumour anatomic complexity, various nephrometry scoring were used such as R.E.N.AL., P.A.D.U.A., C-index, Contact surface area (CSA) and Arterial based complexity (ABC) score to quantify anatomic characteristic of renal tumours and thus assess feasibility of Nephron sparing surgeries in an objective manner.

R.E.N.A.L nephrometry scoring system consists of 5 reproducible features. i.e.(R)adius, (E)xo/endophytic, (N)earness to collecting system or renal sinus, (A)nterior/posterior and (L)ocation in relation to polar lines.[6]

Out of R.E.N.A.L., P.A.D.U.A., D.A.P. score and C- index, R.E.N.A.L. nephrometry score reveals maximum interobserver correlation according to the study done by Okhunov et al.[7] The scoring system objectifies renal masses and allows comparison in clinical practice.[8]

AIMS AND OBJECTIVES:

AIM:

To study usefulness of RENAL nephrometry score in predicting peri-operative outcomes in patients with renal masses undergoing partial nephrectomy.

OBJECTIVES:

- To assess peri-operative outcomes and complications in patients with Renal masses undergoing partial nephrectomy.
- To classify Renal masses according to Renal Nephrometry Score and find out its clinical correlation and its impact on surgical decision making viz. surgical access, conversion to total nephrectomy
- To compare outcomes and peri-operative complications in patients classified as per Renal Nephrometry Score

MATERIALS AND METHODS:

A prospective single centre observational study was carried out at a tertiary care centre in the western suburbs of India for a period of 18 months wherein all patients of renal masses undergoing Nephron sparing surgery were enrolled into the study.

The inclusion and exclusion criteria were:

Inclusion Criteria:

1. Age >18 years
2. Benign renal masses necessitating removal due to symptoms such as persistent pain or complications such as haematuria / recurrent infection.
3. Complex cystic lesions (Bosniak grade III/IV)
4. Clinically malignant tumour (Any T N0 M0)

Exclusion Criteria:

1. Age < 18 years
2. Pregnancy.
3. History of previous renal or abdominal surgeries, renal tuberculosis.
4. chronic kidney disease
5. Nephrolithiasis
6. Congenital Renal abnormalities.

7. Presence of Lymph node spread (Any T N1 M0) or metastasis (Any T Any N M1).
8. Renal tumour presenting along with Venous thrombus
9. Patients unwilling for nephron sparing surgery because of fear of residual tumour

After obtaining their informed consent, detailed patient history and demographic variables and thorough general and systemic examination was done. Renal Masses were assigned Renal Nephrometry Score, and tumour-node-metastasis staging of clinically malignant tumours was done. Patients were divided into three groups depending on complexity scores (low, moderate, high). Intra-operative details such as surgical access, clamping of hilar vessels, warm ischemia time, total operative time, blood loss, need for blood transfusion, conversion to open, opening of pelvi-calyceal system and placement of DJ Stent, conversion to total nephrectomy and complications and post-operative data such as blood transfusions and length of hospital stay were recorded and also final histopathology report was taken into account.

RESULTS:

A total of 60 patients were enrolled into study. Mean age of presentation was 56.38 years. Maximum patients were in age group 51-60 (40%). There were 50 male and 10 female patients. The most common clinical presentation was vague Flank pain observed in 16 cases (26.67%) followed by Haematuria in 12 cases (20%). However, majority of cases, 32 (53.33%) were diagnosed incidentally on radiological examination. 36 patients (60%) tumours had right sided and 24 patients (40%) had left sided renal tumours.

The mean tumour size was 5.46 cm. Mean tumour size in Low, Moderate and High Complexity group was 4.3, 5.878 and 7.5 cm respectively. 23 (38.33%) tumours were > 50% exophytic in nature, 31 (51.67%) tumours were <50% exophytic and 6 (10%) tumours were purely endophytic in nature. Nearness to Pelvicalyceal system: 24 (40%) tumours were located at a distance of >7 mm, 30 (50%) tumours were located at a distance 4 to 7 mm, 6 (10%) tumours were located at a distance < 4 mm from the Pelvi-calyceal system. 14 (23.33%) tumours were situated in anterior upper pole, 17 (28.33%) tumours were in anterior lower pole, 13 (21.67%) tumours were in posterior upper pole, 9 (15%) tumours were in posterior lower pole and 7 (11.67%) tumours were interpolar tumours. 32 (53.33%) tumours were located entirely above the upper or lower polar lines, 18 (30%) tumours were located crossing either of the upper or the lower polar lines and 10 (16.67%) tumours were located either completely i.e., 100% or more than 50% of the mass between the two polar lines or crossing the renal axial midline.

RENAL Nephrometry Score classification: Low (4-6) Complexity group - 22 (36.67%) tumours, Moderate (7-9) Complexity group - 32 (53.33%) tumours, High (10-12) Complexity group - 6 (10%) tumours. Surgical Access: 22 cases (100%) in Low, 28 cases (87.5%) in Moderate and 4 cases (66.67%) in High Complexity group were approached through a minimally invasive (robotic/laparoscopic) route while 4 cases (12.5%) in Moderate and 2 cases (33.33%) in High Complexity group were pre-emptively approached through an open approach.

Hilar clamping with resultant warm ischemia time was required in 17 cases (77.27%) in Low, 32 cases (100%) in Moderate and 6 cases (100%) in High Complexity group while 5 cases (22.72%) in Low complexity group did not require any hilar clamping.

The mean Warm Ischemia Time was 24.02 minutes. Mean warm ischemia time in Low, Moderate, High Complexity group was 20.35 minutes, 24.563 minutes, 31.5 minutes respectively.

The mean Operative Time was 180.58 minutes. Mean Operative time in Low, Moderate, High Complexity group was 156.136 minutes, 190 minutes, 220 minutes respectively.

The Mean Estimated Blood Loss was 309.33 ml. Mean Estimated Blood Loss in Low, Moderate, High Complexity group was 250 ml, 350 ml, 310 ml respectively.

The opening of Pelvicalyceal system was observed in 21 (35%) cases which were repaired intraoperatively and Double J Stent was placed in 22 (36.67%) cases.

Conversion to Open Nephrectomy occurred in 6 (10%) cases. Progression to Total / Radical Nephrectomy occurred in 2 cases (6.25%) in Moderate and 4 cases (66.67%) in High Complexity group.

The mean Length of Hospital Stay in in Low, Moderate and High Complexity group was 3.72 days, 5 days, 6 days respectively. Major intraoperative bleeding was seen in 4 cases (12.5%) in Moderate Complexity group and 2 cases (33.33%) in High Complexity group.

The rate of blood transfusion was 16.67%. Post-operative urinary leak was seen only in 1 case (1.67%) and it was managed with DJ stenting. Post-operative positive surgical margin was seen only in 1 case (1.67%).

There were no vascular / bowel / adjacent visceral injuries.

Clavien Dindo classification: 6 cases (10%) had Clavien grade 2, 1 case (1.67%) had Clavien grade 1 and 1 case (1.67%) had Clavien grade 3b. Majority of tumours 42 (70%) were Clear Cell carcinoma on histopathology report.

Table 1: Comparison of PERI-OPERATIVE OUTCOMES amongst RENAL Nephrometry Score Study groups

Peri-operative Outcomes	Low (n=22)	Moderate (n=32)	High (n=6)	P value
Age (years)	54.09	57.156	60.667	0.3380
Tumor Size (cm)	4.3 cm	5.878 cm	7.5 cm	<0.0001
Surgical Access	Minimal Invasive (22) Open (0)	Minimal Invasive (28) Open (4)	Minimal Invasive (4) Open (2)	0.04293
Warm Ischemia Time (min)	20.35 min	24.563 min	31.5 min	<0.01
Operative Time (min)	156.136 min	190 min	220 min	<0.01
Estimated Blood Loss (ml)	250 ml	350 ml	310 ml	<0.01
Length of Hospital Stay (days)	3.7273	5	6	<0.05
Progression to Total Nephrectomy	0	2	4	<0.01
Post-op Complication	0	4	4	<0.01

Table 2: Distribution of POST-OPERATIVE COMPLICATIONS among study groups

Complication	Low (n=22)	Moderate (n=32)	High (n=6)
Major Intraoperative Bleeding	0	4	2
Urine Leak	0	0	1
Positive Surgical Margin	0	0	1
Injury to Hilar Vessels	0	0	0
Visceral Injury	0	0	0
Nil	22	28	2

Table 3: Distribution of cases as per HISTOPATHOLOGY

Histopathology	Low (n=22)	Moderate (n=32)	High (n=6)
Clear cell carcinoma	15	23	4
Papillary carcinoma	3	4	1
Chromophobe carcinoma	2	2	1
Oncocytoma	1	2	0
Angiomyolipoma	1	1	0

DISCUSSION:

Renal cell carcinoma is 3rd most common urinary malignancy and accounts for approximately 5% and 3% of all adult malignancies in male and female population respectively.[9] Approximately 66% of renal masses are detected incidentally with greatest increase in renal tumours between 2 to 4cm and is attributed to recent advances in cross sectional imaging.[10,11]

Localized renal masses are amenable to various treatment options such as excision by partial or radical nephrectomy, ablative therapies or

active surveillance. [12] Due to increase in incidental tumour detection at an earlier stage, latest trend is towards performing nephron sparing surgeries (NSS) wherever feasible. The growing use of nephron sparing surgery avoids morbidity and mortality resulting from renal insufficiency. [13]

RENAL nephrometry scoring system is used in both CT and MRI. CT is most commonly employed in the evaluation of renal masses, while MRI is usually done in patients with allergy to iodinated contrast media. RENAL Nephrometry Scoring System is useful in quantifying complexity of renal masses, predicting surgical approach, perioperative outcomes and complications after partial nephrectomy for complex renal tumours and also predicting tumour upgrading between core biopsies and surgical specimen. [13-15]

Gender:
Out of 60 patients, 50 (83.33%) patients were males and 10 (16.67%) patients were females. In Woldrich et al[16] study out of 236,930 patients, 147687 (62.3%) were male and 89,243 (37.7%) were females.

Clinical Presentation:
Out of 60 patients, 16 patients (26.67%) presented with flank pain, 12 patients (20%) presented with haematuria, 32 patients (53.33%) were diagnosed incidentally. Similar to study conducted by Escudier et al[17], >50% of RCCs were detected incidentally, making the classical triad of flank pain, gross haematuria and palpable abdominal mass less frequent than in past. The most common clinical presentation was vague flank pain followed by haematuria in 26.67% and 20% patients respectively.

Tumor Characteristics:
In our study, the distribution of side of tumour was fairly well distributed with 36 (60%) tumours being right sided and 24 (40%) being left sided. In our study, overall mean size of tumour was 5.46 ± 1.43 cm with maximum being 8.2 cm & minimum 3 cm. In Low, Moderate, High Complexity group, Mean tumour size was 4.3 ± 0.81 cm, 5.878 ± 1.219 cm, 7.5 ± 0.4817 cm respectively. In Basu et al study,[9] mean tumour size in Low, Moderate and High Complexity group were 3.03, 6.18 and 9.16 cm respectively.

In our study, 23 (38.33%) tumours were > 50% exophytic, 31 (51.67%) tumours were <50% exophytic and 6 (10%) tumours were purely endophytic in nature. In Gupta et al study,[18] 10.5% tumours were ≥ 50% exophytic, 79 % were < 50% exophytic and 10.5% were purely endophytic.

In our study, tumours located at a distance of >7 mm, 4-7 mm, <4 mm from PCS were 24 (40%), 30 (50%), 6 (10%) respectively. In Gupta et al study,[18] tumours located at distance of >7 mm, 4-7 mm, <4 mm from PCS were 10.5%, 47.5%, 42% respectively.

In our study, 14 (23.33%) tumours were situated in anterior upper pole, 17 (28.33%) tumours were located in anterior lower pole, 13 (21.67%) tumours were located in posterior upper pole, 9 (15%) tumours were located in posterior lower pole and 7 (11.67%) tumours were interpolar tumours. In our study, 32 (53.33%) tumours were located over superior pole above upper polar line or over inferior pole below lower polar line, 18 (30%) tumours were located crossing either of upper or lower polar line and 10 (16.67%) tumours were located either completely i.e., 100% or more than 50% of the mass between two polar lines or crossing renal axial midline. In Gupta et all study,[18] 26% tumours were located involving superior pole above upper polar line or inferior pole below lower polar line, 21% tumours were located crossing either of upper or lower polar line and 53% tumours were located either completely i.e., 100% or more than 50% of mass between two polar lines or crossing renal axial midline.

Renal Nephrometric Score:
Tumour with 7a score was most common amounting to 8 (13.33%). 7p tumours were second most common amounting to 6 (10%). 6a tumours were third most common amounting to 5 (8.33%). No. of patients with Low (4-6), Moderate (7-9), High (10-12) RENAL score were 22 (36.67%), 32 (53.33%), 6 (10%) respectively. In the Gupta et al[18] study, tumours with Low, Moderate, High RENAL score were 5.3%, 63.1%, 31.6% respectively. In Basu et al[9] study; tumours with Low, Moderate, High RENAL score were 20%, 55%, 25% respectively. RENAL nephrometry scoring system represents first method introduced to attempt to standardize reporting of salient anatomy of an enhancing renal mass as well as provide a platform to objectify treatment decision making, minimizing individual subjectivity and judgement. [8]

Surgical Access:
In our study, 54 (90%) tumours were approached through a minimally invasive (robotic / laparoscopic) while remaining 6 (10%) tumours were approached through an open route. Amongst tumours classified as per RENAL score, 22 cases (100%) in Low, 28 cases (87.5%) in Moderate and 4 cases (66.67%) in High Complexity group were approached through a minimally invasive route while 4 cases (12.5%) in Moderate and 2 cases (33.33%) in High Complexity group were directly approached through an open approach owing to increasing complexity of renal tumour. Thus, RENAL score was helpful in surgical access decision making. In Matos AC et all[10] study, 63.38% tumours were approached through minimally invasive (robotic / laparoscopic) while remaining 36.62% tumours were approached pre-emptively through open route.

Hilar Clamping Of Renal Vessesls:
Out of 60 tumours, Hilar clamping was done for 55 (91.67%) tumours whereas no clamping was done in 5 (8.33%) tumours. In cases with multiple arteries, all arteries were clamped. Amongst tumours classified as per RENAL score, 17 cases (77.27%) in Low, 32 cases (100%) in Moderate and 6 cases (100%) in High Complexity group required hilar clamping with resultant warm ischemia time and 5 cases (22.72%) in Low complexity group did not require any hilar clamping. In Basu et al study ,[9] hilar clamping was done in 25% tumours only in High complexity group whereas no hilar clamping was done in remaining 75% tumours belonging to Low and Moderate complexity group.

Warm Ischemia Time:
In our study, overall mean warm ischemia time was recorded to be 24.02 ± 4.245 minutes. Minimum was 13 minutes and maximum time was 34 minutes. Warm Ischemia has potentially deleterious renal effects during partial nephrectomy. There is no known safe threshold of warm ischemia time since each minute sequentially contributes to risk of developing acute kidney injury and renal function decline. The RENAL Nephrometry score and its individual components can help predict longer WIT during partial nephrectomy.

Operative Time:
In our study, mean total operative time was noted to be 180.58 ± 28.18 minutes. Minimum was 130 minutes & maximum was 240 minutes. Operative time was more owing to tumour complexity and surgeon to surgeon variability.

Estimated Blood Loss:
In our study, mean blood loss was observed to be 309.33 ± 53.20 ml. Minimum loss was 220 ml & maximum was 400 ml.

Opening Of Pelvicalceal System And Placement Of Double J Stent:
Opening of PC system was considered an intraoperative event. In our study, 21 cases (35%) had opening of PCS, all of which repaired with vicryl 3-0. In remaining 39 (65%) cases PCS was intact. All cases with PC system opening and deeply placed tumours had DJ stent placed. Double J stent (DJ stent) was placed in 22 (36.67%) cases and 38 (63.33%) cases were without DJ stents. In Benway et al[19] study, PC system opening was done in 52.1% cases and in Mottrie et al[20] study PC system opening was done in 53% cases which were higher than our study.

Conversion To Open:
In our study, 6 cases (10%) were converted to open nephrectomy. In Kallingal et al study[21] and Castillo et al[22] ,no conversion was reported. Conversion was reported in 2% cases in Wang et al[23] study.

Progression To Total Nephrectomy:
In our study, we observed slightly greater conversion to Total Nephrectomy owing to greater tumour complexity and surgeon to surgeon variability.

Length Of Hospital Stay:
In our study, length of hospital stay was different in different complexity groups similar to Basu et al[9] study with a statistically significant difference.

Major Intraoperative Bleeding:

In our study, major intraoperative bleeding was seen in 4 cases (12.5%) in Moderate Complexity group and 2 cases (33.33%) in High Complexity group and blood transfusion was required in 10 (16.67%) cases while no blood transfusion was required in remaining 50 (83.33%) cases.

Urinary Leak:
In our study out of 60 cases, post-operative urinary leak was seen only in 1 case (1.67%) and it was managed with DJ stenting without the need for re-exploration. There were no cases of Urine leak in Low and Moderate Complexity group but only 1 case (16.67%) in High Complexity group. In the study conducted by Basu et all,[9] urine leak was observed in 1 case (9.09%) in Moderate and 2 cases (40%) in High Complexity group.

Positive Surgical Margin:
In our study out of 60 cases, positive surgical margins were seen only in 1 case (1.67%). There were no cases of positive surgical margin in Low and Moderate Complexity group but only 1 case (16.67%) in High Complexity group. In study conducted by Basu et al,[9]positive surgical margin was observed in 1 case (9.09%) in Moderate and 1 case (20%) in High Complexity group.

Injury To Hilar Vessels:
In our study, there were no reported cases of major vessel injury during surgery. In the study conducted by Rogers et al[24], injury to major vessel was reported in 1 case (0.67%) and 1 case in study conducted by Vitorri [25] and Wang et al[26].

Injury To Adjacent Viscera:
In our study, no visceral injury was noted. Bowel injury during partial nephrectomy can be serious complication, particularly if unrecognized. The degree of bowel injury varies from superficial abrasion to small enterotomies to frank perforation. For extensive injuries and contamination, bowel diversion may be necessary.[27]

Clavien Dindo Grade Of Complications:
Post-operative complications were classified according to the Clavien Dindo classification. In our study, 6 cases (10%) had Clavien grade 2, 1 case (1.67%) had Clavien grade 1 and 1 case (1.67%) had Clavien grade 3b. In Pang et al [14] study, 6 cases (7.2%) had Clavien grade 1, 2 case (2.4%) had Clavien grade 2, 2 case (2.4%) had Clavien grade 3a and 1 case (1.2%) had Clavien grade 4a.

Histopathology Of Resected Specimen:
42 (70%) tumours had histopathology report as clear cell carcinoma followed by papillary cell carcinoma 8 (13.33%), 5 (8.33%) tumours as chromophobe cell carcinoma, 3 (5%) as oncocytoma and 2 (3.33%) as other histology as angiomyolipoma and adenoma. In Ener et al study,[13] 52.3% cases were reported as clear cell carcinoma histologically, whereas remaining 47.6% cases were divided between chromophobe cell carcinoma, papillary cell carcinoma, oncocytoma and other histology which was nearly similar to our study.

CONCLUSIONS:

RENAL Nephrometry scoring system is simple, reproducible method of objectifying anatomic complexity of localized renal tumours. RENAL Nephrometry Score (RNS) divides lesions into low, moderate and high complexity groups and also assigns "h" suffix indicating hilar location. Based on these preoperative imaging features surgical management is usually decided (Radical v/s Nephron Sparing Surgery).

In our study, renal masses with RENAL Nephrometry Score above 9 had a greater tendency for open surgical approach, greater warm ischemia time and total operative time, greater blood loss and longer hospital stay with increased post-operative complications.

Our study demonstrated that RENAL Nephrometry score is a useful tool in predicting surgical approach, warm ischemia time, total operative time, estimated blood loss, length of hospital stays, progression to total nephrectomy and post-operative complications.

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