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A CLINICAL STUDY TO ASSESS THE COMPLEXITY OF NEPHRON SPARING SURGERY USING DIFFERENT SCORING SYSTEMS

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INTRODUCTION

Renal cell carcinoma accounts for about 3.5% of all malignancies in the body, and is ranked the third most common cancer of the urinary tract [(1)]. With increased use of imaging, most of the renal tumors are detected incidentally; incidentally detected small renal masses constitute 48% to 66% of overall renal cell carcinoma (RCC) diagnosis[(2)]. Surgical management of either partial or total nephrectomy results in a 99.2% recurrence-free survival rate [(3)]

Partial nephrectomy or nephron-sparing surgery (NSS) is considered the treatment of choice for localized small renal masses with oncological outcome comparable to radical nephrectomy (RN) [(4)]. The use of NSS has an advantage of preserving renal function with lower cardiovascular mortality and morbidity [(5, 6)]. Partial nephrectomy (PN) is the gold standard for T1a and T1b. Even for T2 masses, it should be given preference over radical nephrectomy if it is technically possible [(7, 8)]. Partial nephrectomy is also strongly preferred whenever preservation of renal function is potentially important. This is applicable in cases such as patients with pre-existing chronic kidney disease, those with an abnormal contra lateral kidney, or those with multifocal or familial renal cell carcinoma [(10)]. Partial nephrectomy can be performed by open partial nephrectomy, laparoscopic partial nephrectomy and robotic partial nephrectomy**.** A meta-analysis of 9 studies by Kim et al [(9)], revealed the following statistically significant results in favour of Partial Nephrectomy:

1. 61% risk reduction for the development of severe Chronic kidney disease
2. 19% risk reduction in overall mortality
3. 29% risk reduction in cancer-specific mortality.

With an overall complication rate of 15–30%, PN is still a challenging procedure, independent of the technique applied. Feasibility of NSS depends on experience of the surgeon and the complexity of tumour localization within the kidney, whereas size of the renal mass seems to be less important [(10)]. Several systems have been developed to assess the feasibility of nephron-sparing surgeries (NSS) in a rather objective manner [(11)]. The RENAL scoring system was initially described in 2009 by Kutikov and Uzzo [(12)]. RENAL system assesses (R)adius, (E)xophytic extent, (N)earness to the renal sinus, (A)nterior/posterior location, and (L)ocation relative to the polar lines.

Similarly, Preoperative Aspects and Dimensions Used for Anatomical Classification or 'P.A.D.U.A' system was reported in 2009 by Ficarra et al. [(13)]. This system is very close to RENAL methodology with a few notable differences. C-index system was reported in 2010 by Simmons et al. [(14)]. Unlike RENAL and P.A.D.U.A. systems, it provides a numerical score based on the combination of tumor diameter and distance from tumor edge to the kidney center.

Recently, Spaliviero et al [(15)] designed a novel nephrometry system, the arterial-based complexity (ABC) score. In brief, this system assigns a score of 1, 2, 3S, or 3H to tumors requiring transection of the interlobular and arcuate arteries, interlobar arteries, segmental arteries or in close proximity to the renal hilum, respectively. This classification should describe the invasiveness of the tumor and predict for vascular and urinary injuries, which are the major, events influencing surgical morbidity of PN.

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Goals for development of Nephrometry systems: Methodological analysis of tumor location and standardization of tumor data reporting. Predict success of partial nephrectomy, risk of postoperative complications, and functional & oncologic outcomes [16, 17].

Aim of this study is to provide a comprehensive comparison of the **RENAL, PADUA, C-index, and ABC** scores. The respective tools were compared regarding their inter-observer agreement as well as their significance in predicting peri-operative outcomes in open partial nephrectomy.

Methodology:

Study area & duration: Prospective Observational Study in Department of Surgical Oncology in a Tertiary Care Cancer Hospital

Study population: All patients presenting with renal masses during the study period according to the inclusion and exclusion criteria are included in the study.

Inclusion criteria: Tumor confined to the organ, T1a and T1b lesions.

Exclusion criteria: T2 and above tumors, with metastatic disease, who are not willing for nephron sparing Surgery, Patients undergoing minimally invasive surgery are not included in this study.

Sample size: Based on the results of **Aditya P Sharma et al** on comparative study of RENAL, PADUA and C- index scoring systems in predicting perioperative outcomes [103]

And using the formula

$$N = [(Z_\alpha+Z_\beta)/C]^2 + 3$$

$$C = 0.5 * \ln[(1+r)/(1-r)]$$

The standard normal deviate for $\alpha = Z_\alpha = 1.96$

The standard normal deviate for $\beta = Z_\beta = 0.84$

Considering correlation coefficient of r=0.40 [moderate correlation] exist between different scoring systems and perioperative parameters.

$$C = 0.5 * \ln[(1+r)/(1-r)] = 0.4236$$

$$\text{Total sample size} = N = [(Z_\alpha+Z_\beta)/C]^2 + 3 = 47$$

The final Sample size was rounded off to 50.

Study procedure: All patients are subjected to the pre-operative cross sectional imaging by multiphase CT / MRI, scans will be studied by two surgeons and two radiologists, and RENAL Nephrometry score, PADUA score , C-index and ABC score will be calculated independently by surgeons and radiologists. Each observer was blinded to the results of the other observer's assessments. The operative characters will be noted , Warm ischemia time (WIT), estimated blood loss (EBL), operative time(OT), postoperative complications in Clavien-Dindo format, length of hospital stay (LOS), percent change in hemoglobin and the need for blood transfusion, percent change in creatinine level and estimated glomerular filtration rate (e GFR) by Cockcroft-Gault Formula. This change in hemoglobin, creatinine and e GFR is calculated at immediate postoperative period and 15 days postoperatively at the time of suture removal. Histopathology will be reviewed for type of renal tumor, margin status, and Fuhrman grading. The trifecta outcomes were defined as negative surgical margins, WIT of <30 min and minimal postoperative complications (Clavien–Dindo grade 0- 2). The patients achieving trifecta outcomes will be computed. Comparison would be made for the predictive value of all four scores for 51 patients. Blood loss will be measured as a sum of suctioned fluids and weighed sponges. Duration of surgery defined from the time of skin incision to the closure of the skin incision. All complications will be defined as intra- or postoperative. Postoperative complications include those occurring during the same hospitalization or within 30 days following discharge.

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Statistical analysis: Statistical analyses were performed using SPSS v 22.0 (IBM, New York USA) and Microsoft Excel 2007. Descriptive analysis of all the explanatory and outcome parameters will be done using frequency and proportions for categorical variables, whereas in Mean & SD for continuous variables. Intra class Correlation test was performed to assess the Inter observer [2 surgeons & 2 radiologists] reliability for different scoring systems. Mann Whitney Test was used to compare the mean values of different study scoring systems based on Trifecta Outcomes, outcomes of Clavien-Dindo Classification and also Breach of pelvicalyceal system. Chi Square Test was used to compare the ABC-scores based on Trifecta outcomes, outcomes of Clavien-Dindo Classification and also Breach of pelvicalyceal system. Spearman's correlation test was performed to assess the relationship between perioperative outcomes and different scoring systems. Multiple linear regression analysis was performed to predict perioperative outcomes using different scoring systems among study patients. Wilcoxon Signed Rank Test was used to compare the mean percentage reduction in haemoglobin, creatinine & eGFR levels between day 1 and day 15 of postoperative period. The level of significance was set at $P<0.05$.

RESULTS

Age	**No of Patients**	**%**
< 40 years	2	3.9%
41-50 years	8	15.7%
51-60 years	18	35.3%
61-70 years	16	31.4%
> 70 years	7	13.7%

TABLE NO 1: AGE DISTRIBUTION

Gender	**No of Patients**	**%**
Males	34	66.7%
Females	17	33.3%

TABLE NO 2: GENDER DISTRIBUTION

Co morbidities	**No of Patients**	**%**
Diabetes	8	15.7%
HTN	13	25.5%
Diabetes + HTN	10	19.6%
Nil	20	39.2%

TABLE NO 3: DISTRIBUTION OF CO MORBIDITIES

Presentation	**No of Patients**	**%**
Abdominal Pain	13	25.5%
Hematuria	3	5.9%
No symptoms	35	68.6%

TABLE NO 4: DISTRIBUTION OF PRESENTATION AMONG STUDY POPULATION

Tumor Side	**No of Patients**	**%**
Right	20	39.2%
Left	31	60.8%

TABLE NO 5: DISTRIBUTION OF KIDNEY INVOLVEMENT

Tumor Type	**No of Patients**	**%**
Angiomyolipoma	2	3.9%
Chromophobe Ca	2	3.9%
Clear cell carcinoma	36	70.5 %
Leiomyoma	1	2.0%
Oncocytoma	3	5.8%
Papillary carcinoma	7	13.7 %

TABLE NO 6: DISTRIBUTION OF TUMOR HISTOLOGY

Grade	**No of Patients**	**%**
Grade 1	21	46.6 %
Grade 2	20	44.4 %
Grade 3	4	9.5%
Grade 4	0	0%

TABLE NO 7:DISTRIBUTION OF GRADE OF THE TUMOR

T Stage	**No of Patients**	**%**
T1a	22	48.8%%
T1b	23	51.1% %
T2	0	0%

TABLE NO 8: DISTRIBUTION OF STAGE OF THE DISEASE

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Most widely used system for grading of RCC is nuclear grading system described in 19782 by **Fuhrman et al.**[109] Describes the tumor from grade 1 to grade 4.in the current study most of the tumors belongs to Grade 1(46.6%) and Grade 2 (44.4%) followed by grade 3 (9.5%)

TABLE NO 9: RISK STRATIFICATION USING DIFFERENT SCORES

	Category	Scores	n	%
Renal Score	Low	4 - 6	27	52.9%
	Moderate	7 - 9	22	43.1%
	High	10 - 12	2	3.9%
Padua Score	Low	6 - 7	16	31.4%
	Moderate	8 - 9	16	31.4%
	High	10 - 14	19	37.3%
C-Score	Low	< 1	12	23.5%
	High	> 1	39	76.5%
ABC-Score	Low	1 - 2	30	58.8%
	High	3S	21	41.2%

TABLE NO 10: CORRELATION AMONG DIFFERENT OBSERVERS

Variable	ICC	95% CI		P-Value
		Lower	Upper	
Renal Scores	0.985	0.977	0.991	<0.001*
Padua Scores	0.957	0.934	0.974	<0.001*
C-Scores	0.994	0.991	0.996	<0.001*
ABC Scores	0.970	0.955	0.982	<0.001*

TABLE NO 11: CORRELATION BETWEEN SURGEON AND RADIOLOGIST

Variable	ICC	95% CI		P-Value
		Lower	Upper	
Renal Scores	0.976	0.953	0.986	<0.001*
Padua Scores	0.957	0.925	0.976	<0.001*
C-Scores	0.990	0.982	0.994	<0.001*
ABC Scores	0.965	0.938	0.980	<0.001*

TABLE NO 12: ISCHEMIA DISTRIBUTION

Type of ischemia	**No of patients**	**%**
No ischemia	5	9.8%
Warm ischemia only	33	64.7%
Both warm and cold ischemia	14	27.4%

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TABLE NO 13: DISTRIBUTION OF TRIFECTA OUTCOMES

Variable	Category	n	%
Trifecta outcomes	Positive	11	21.6%
	Negative	40	78.4%

TABLE NO 14: COMPARISON OF TRIFECTA OUTCOMES AMONG THE VARIOUS SCORES

Scoring Systems	Grading	Positive		Negative		χ^2 Value	P-Value
		n	%	n	%		
Renal Score	Low	1	9.1%	26	65.0%	13.064	0.001*
	Moderate	10	90.9%	12	30.0%		
	High	0	0.0%	2	5.0%		
Padua Score	Low	1	9.1%	15	37.5%	11.915	0.003*
	Moderate	1	9.1%	15	37.5%		
	High	9	81.8%	10	25.0%		
C-Score	Low	4	36.4%	8	20.0%	1.284	0.26
	High	7	63.6%	32	80.0%		
ABC-Score	Low	2	18.2%	28	70.0%	9.564	0.002*
	High	9	81.8%	12	30.0%		

TABLE NO 15: COMPARISON OF MEAN VALUES OF SCORES WITH TRIFECTA OUTCOMES

Scores	Trifecta outcomes	N	Mean	SD	Mean Diff	P-Value
Renal Score	Positive	11	7.73	0.91	1.50	0.003*
	Negative	40	6.23	1.54		
Padua Score	Positive	11	10.09	1.45	1.71	0.005*
	Negative	40	8.38	1.76		
C-Scores	Positive	11	1.28	0.46	-0.15	0.23
	Negative	40	1.43	0.33		

TABLE NO 16: DISTRIBUTION OF POSTOPERATIVE COMPLICATIONS

Variable	Category	n	%
Postop complications in Clavien-Dindo Classification	No Complications (grade 1)	45	88.2%
	Blood Transfusion & Wound Infection (grade2)	5	9.8%
	Dialysis (grade 4a)	1	2.0%

TABLE NO 17: COMPARISON OF VARIOUS SCORES WITH POSTOP COMPLICATIONS

Scoring Systems	Grading	No Complications		Blood Transfusion & Wound Infection		Dialysis		χ^2 Value	P-Value
		n	%	n	%	n	%		
Renal Score	Low	25	55.6%	1	20.0%	1	100.0%	3.877	0.42
	Moderate	18	40.0%	4	80.0%	0	0.0%		

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	High	2	4.4%	0	0.0%	0	0.0%		
Padua Score	Low	16	35.6%	0	0.0%	0	0.0%	4.943	0.29
	Moderate	13	28.9%	2	40.0%	1	100.0%		
	High	16	35.6%	3	60.0%	0	0.0%		
C-Score	Low	11	24.4%	1	20.0%	0	0.0%	0.363	0.83
	High	34	75.6%	4	80.0%	1	100.0%		
ABC-Score	Low	27	60.0%	2	40.0%	1	100.0%	1.457	0.48
	High	18	40.0%	3	60.0%	0	0.0%		

TABLE NO 18: COMPARISON OF MEAN VALUES OF VARIOUS SCORES WITH POSTOP COMPLICATIONS

Indices	Clavien-Dindo Classification	N	Mean	SD	Mean Diff	P-Value
Renal Score	No Complications	45	6.49	1.58	-0.51	0.41
	With Complications	6	7.00	1.41		
Padua Score	No Complications	45	8.64	1.87	-0.86	0.24
	With Complications	6	9.50	1.38		
C-Scores	No Complications	45	1.40	0.37	0.01	0.99
	With Complications	6	1.39	0.38		

TABLE NO 19: COMPARISON OF DIFFERENT SCORES WITH BREACH OF PELVICALYCEAL SYSTEM

Scoring Systems	Grading	Breach of pelvicalyceal system				χ^2 Value	P-Value
		Yes		No			
		n	%	n	%		
Renal Score	Low	19	70.4%	8	29.6%	3.752	0.15
	Moderate	20	90.9%	2	9.1%		
	High	2	100.0%	0	0.0%		
Padua Score	Low	11	68.8%	5	31.3%	2.377	0.31
	Moderate	13	81.3%	3	18.8%		
	High	17	89.5%	2	10.5%		
C-Score	Low	11	91.7%	1	8.3%	1.265	0.26
	High	30	76.9%	9	23.1%		
ABC-Score	Low	22	73.3%	8	26.7%	2.303	0.13
	High	19	90.5%	2	9.5%		

TABLE NO 20: COMPARISON OF DIFFERENT SCORES WITH BREACH OF PELVICALYCEAL SYSTEM

Indices	Breach	N	Mean	SD	Mean Diff	P-Value
Renal Score	Yes	41	6.66	1.62	0.56	0.31
	No	10	6.10	1.20		
Padua Score	Yes	41	8.85	1.87	0.55	0.40
	No	10	8.30	1.70		
C-Scores	Yes	41	1.38	0.37	-0.10	0.44
	No	10	1.48	0.32		

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TABLE NO 21: PERI OPERATIVE OUTCOMES AMONG STUDY POPULATION

Parameter	Mean	SD	Median	Min	Max
Warm Ischemia Time	18.12	13.59	23	0	42
Intra-operative Blood Loss (in ml)	165.2	130.57	100	25	600
Surgery Duration (in min)	145.2	23.4	138	120	180
Tumor Size (in cm)	4.82	1.82	7	1.6	8.5
Length of Hospital Stay (in days)	7.59	2.04	4.5	5	18

TABLE NO 22: MEAN VALUES OF PERIOPERATIVE OUTCOMES WITH VARIOUS GROUPS OF RENAL SCORE

Peri-operative Outcomes	Low [4 - 6]		Moderate [7 - 9]		High [10 - 12]		P-Value	Mann Whitney Post hoc Test		
	Mean	SD	Mean	SD	Mean	SD		L vs M	L vs H	M vs H
WIT	13.63	11.12	22.14	14.78	34.50	0.71	0.004*	0.008*	0.005*	0.22
IOBL	138.70	113.69	185.45	146.71	300.00	0.00	0.04*	0.22	0.04*	0.22
Surgery Duration	139.8	19.8	148.2	25.8	180	0.00	0.04*	0.43	0.04*	0.18
LHS	7.70	2.54	7.59	1.30	6.00	0.00	0.24	0.60	0.19	0.09
Tumor Size	4.08	1.33	5.43	1.89	8.00	0.00	0.004*	0.008*	0.01*	0.07

TABLE NO 23: MEAN VALUES OF PERIOPERATIVE OUTCOMES WITH VARIOUS GROUPS OF PADUA SCORE

Peri-operative Outcomes	Low [6-7]		Moderate [8 - 9]		High [10 - 14]		P-Value	Mann Whitney Post hoc Test		
	Mean	SD	Mean	SD	Mean	SD		L vs M	L vs H	M vs H
WIT	10.81	10.85	14.31	11.31	27.47	12.48	<0.001*	0.31	<0.001*	0.001*
IOBL	156.25	134.32	135.63	106.64	197.63	144.51	0.39	0.84	0.30	0.20
Surgery Duration	136.2	16.2	147	24.6	150.6	27	0.37	0.31	0.19	0.91
LHS	7.69	1.45	8.13	3.07	7.05	1.18	0.37	0.99	0.21	0.28
Tumor Size	4.12	1.28	4.27	1.53	5.87	2.00	0.008*	0.75	0.003*	0.07

TABLE NO 24: MEAN VALUES OF PERIOPERATIVE OUTCOMES WITH VARIOUS GROUPS OF C - INDEX

Peri-operative Outcomes	CI Score Grades	N	Mean	SD	Mean Diff	P-Value
WIT	Low [< 1]	12	27.25	12.92	11.94	0.003*
	High [> 1]	39	15.31	12.66		
IOBL	Low [< 1]	12	176.67	109.90	15.00	0.26
	High [> 1]	39	161.67	137.41		
Surgery Duration	Low [< 1]	12	166.8	20.4	0.48	0.001*
	High [> 1]	39	138.6	20.4		
LHS	Low [< 1]	12	7.17	1.12	-0.55	0.55
	High [> 1]	39	7.72	2.25		

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Tumor Size	Low [< 1]	12	5.78	1.76	1.25	0.04*
	High [> 1]	39	4.52	1.75		

TABLE NO 25: MEAN VALUES OF PERIOPERATIVE OUTCOMES WITH VARIOUS GROUPS OF ABC SCORE

Peri-operative Outcomes	CI Score Grades	N	Mean	SD	Mean Diff	P-Value
WIT	Low [1-2]	30	12.27	10.78	-14.21	<0.001*
	High [3S]	21	26.48	12.98		
IOBL	Low [1-2]	30	150.83	121.83	-34.88	0.35
	High [3S]	21	185.71	142.65		
Surgery Duration	Low [1-2]	30	142.2	21.6	-0.12	0.53
	High [3S]	21	149.4	26.4		
LHS	Low [1-2]	30	8.00	2.42	1.00	0.08
	High [3S]	21	7.00	1.14		
Tumor Size	Low [1-2]	30	4.24	1.41	-1.40	0.009*
	High [3S]	21	5.64	2.04		

TABLE NO 26:CORRELATION OF DIFFERENT SCORES WITH PERIOPERATIVE OUTCOMES

Perioperative outcomes	Values	Renal Score	Padua Score	C-Score	ABC-Score
WIT	rho	0.53	0.56	-0.31	0.63
	P-Value	<0.001*	<0.001*	0.03*	<0.001*
IOBL	rho	0.22	0.09	-0.18	0.14
	P-Value	0.13	0.55	0.21	0.32
Operative time	rho	0.28	0.19	-0.44	0.06
	P-Value	0.04*	0.19	0.001*	0.66
LOS	rho	-0.26	-0.28	0.03	-0.31
	P-Value	0.07	0.07	0.83	0.03*
Tumor Size	rho	0.57	0.50	-0.31	0.32
	P-Value	<0.001*	<0.001*	0.03*	0.02*

TABLE NO 27: PREDICTION OF PERIOPERATIVE OUTCOMES

Perioperative Outcomes	Independent Variables	Unstd. Coefficients		t	P-Value	R^2
		□	Std. Error			
WIT (in min)	Constant	10.28	7.71	1.333	0.189	0.41
	ABC Score	9.57	1.92	4.981	<0.001*	
	C-Score	-9.31	4.19	-2.223	0.03*	
Operative time (in hrs)	Constant	3.07	0.20	15.350	<0.001*	0.19
	C-Score	-0.47	0.14	-3.386	0.001*	
Tumor Size (in cm)	Constant	0.42	0.92	0.456	0.65	0.33
	Renal Score	0.67	0.14	4.912	<0.001*	
	Padua Score	0.50	0.12	4.054	<0.001*	

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TABLE NO 28: COMPARISON OF PERCENTAGE CHANGE IN HB, CREATININE AND E GFR

Parameters	Time	N	Mean	SD	Mean Diff	P-Value
Hb	Day 1	51	14.92	8.63	4.79	0.002*
	Day 15	51	10.13	9.10		
Creatinine	Day 1	51	-35.92	36.90	-27.98	<0.001*
	Day 15	51	-7.93	34.88		
e-GFR	Day 1	51	22.44	16.67	23.18	<0.001*
	Day 15	51	-0.74	29.35		

DISCUSSION

Several anatomy-based nephrometry scores have been developed to improve risk stratification of renal masses prior to nephron sparing surgery (NSS).A number of studies have assessed the various scoring systems for their role in predicting perioperative outcomes after nephron sparing surgery [12, 13, 14, and 15]. However, there is paucity of studies comparing the efficacy of RENAL, PADUA, ABC and C – index scores in predicting perioperative outcomes in nephron sparing surgery. This study was aimed at comparing the RENAL, PADUA, ABC and C-index scores in predicting trifecta outcomes and perioperative outcomes after open partial nephrectomy, which included 51 consecutive patients from May 2018 to August 2020. For all the patients who are included in the study, all four scores were calculated by two surgeons and two radiologists to evaluate the predictive value of these SS in predicting trifecta outcomes and perioperative outcomes and to assess inter observer reliability among the four observers.

In the current study, most of the population are in the age group of 51- 60 years (35.3%) followed by 61- 70 years (31.4%) with male to female ratio of 2:1 similar to **Decastro et al**. [16] According to **Hollingsworth et al[17]**and **Leone et al. [18]**majority of the tumors are incidentally detected due to widespread use of imaging. In our series 68.6% had incidentally detected renal masses; other presentations include abdominal pain (25.5%) and haematuria (5.9%). Left side (60.8%) is more commonly involved than the right side (39.2%).39.2% of population are not having any co morbidities followed by 13 patients (25.5%) are having Hypertension and 19.6% are having both Diabetes Mellitus and Hypertension.

Aditya P Sharma et al. [19]80% of tumors are stage T1 tumors, in our series majority were stage T1 tumors (94%) and only three patients presented with tumor size of more than 7 cm (6.1%). clear-cell carcinoma (70.5%) is the most common histology followed by papillary carcinoma (13.7%) similar to **Reuter et al**. **[20]** This finding is in line with multiple other studies reported from India. Most of the population belongs to low complexity group in RENAL (52.9%), ABC (58.8%) score and C- index (76.45%), high complexity (37.3%) followed by low and intermediate (31.4% each) group in PADUA score.

Spaliviero et al. [21] included 90 CT scans read by 5 observers [22] to rate C‑index, PADUA, and RENAL score. They found that agreement using C‑Index method (ICC = 0.773) was higher than with PADUA (ICC = 0.677), or RENAL (ICC = 0.660). There is good interobserver reliability for RENAL score in studies by **Okhunov *et al*.[23]** and **Aditya P Sharma et al. [24]** In the current study, there was an excellent concordance between the four observers in scoring RENAL, PADUA ,ABC and C- index scores with ICC of 0.985 , 0.957, 0.970 and 0.994 at p value of <0.001 . Out of these C – index shows high reliability. Probably with maturation of utilizing these SS, our study and probably subsequent studies evaluating these SS will start reporting higher ICC rates compared to previous studies.

Trifecta outcomes: The trifecta outcomes were defined as negative surgical margins, WIT of <30 min and minimal postoperative complications (Clavien–Dindo grade 0- 2). Among the 51 patients none of

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the patients had positive surgical margins, 11 patients had prolonged warm ischemia of more than 30 min, only one patient had Clavien–Dindo grade 4a (dialysis) postoperativelyIn our series 78.4% of population had achieved Trifecta outcomes.

Aditya P Sharma et al[24]prospectively evaluated the RENAL, PADUA, and C –index scores in 50 patients. 72% population had achieved trifecta outcomes in their study and C-index was significantly associated with trifecta outcomes. Trifecta achievement rates were significantly higher for low complexity than for high complexity tumors in the current study, similar to retrospective studies by **Borgmann *et al***[25] and **Alessandro Antonelli et al.** [26] The mean RENAL score of patients who had achieved Trifecta outcome (6.23 ± 1.54) was significantly (0.003) lower than the individuals who does not achieve Trifecta outcome (7.73 ± 0.91). The mean PADUA score of patients with Trifecta outcome (8.38± 1.76) was significantly (0.005) lower than that of patients without Trifecta outcome (10.09± 1.45). The mean C –INDEX score of patients with Trifecta outcome was 1.43 ±0.33, is little higher than those without Trifecta outcome 1.28 ± 0.46, but it is not statistically significant. (P value 0.23) 81.8% of patients with score of 3S had not achieved trifecta outcomes in ABC score. In the present study, RENAL, PADUA and ABC scores are significantly correlated with trifecta achievement.

Complications:

Early studies showed that complications of PN were highest among those with imperative indications. [22].**Vivek Venkatramani et al**[27]had 3.2 % of Clavien 3 or higher complications. In our series, 2% had Clavien–Dindo grade 4a (dialysis), 88.8%of population had no complications, 9.8% had Clavien–Dindo grade 2 complications. No significant correlation was observed between the scoring systems with complications by **Aditya P Sharma et al**[24] **Alessandro Antonelli et al**[26] **and Borgmann et al**[25] and **Zhang et al**[28]

Opening of the pelvicalyceal system is another important surgical event in NSS as it increases the likelihood of urinary leakage**.** 41 out of 51 patients had of breach of pelvicalyceal system intra operatively and underwent subsequent repair.In the current study, the mean RENAL, PADUA and C- score (6.66±1.62 , 8.85± 1.87, 1.38± 0.37) for the individuals with a breach of pelvicalyceal system was higher than the individuals without breach of pelvicalyceal system (6.10±1.20 , 8.30± 1.70, 1.48± 0.32) at p value of 0.31, 0.40 and 0.44. In ABC score patients with score 3S (46.3%) and score 2(36.6%) had more injury to PCS than score1 (17.1%) at 0.08 p value.

As the complexity of tumor increases, there are increased chances of developing postoperative complications and breach of pelvicalyceal system; however there is no any statistically significant correlation exists between various scoring systems with these outcomes, similar to previous studies.

Warm ischemia time:

Alessandro Antonelli et al. [26]retrospectively evaluated 234 patients with RENAL, PADUA, ABC & C INDEX scoring systems and found that all scores are significantly related with WIT. **Okhunov *et al*** [23]. Retrospectively evaluated 50 patients with RENAL, PADUA and C INDEX scoring systems, noticed a significant correlation of WIT with C- index rho of C-Index -0.44 at 0.001 followed by RENAL (rho=0.32 at 0.001)and PADUA scores (rho=0.25 at 0.016) **Aditya P Sharma etal** [24]identified no significant correlation of WIT with RENAL, PADUA and C- index scores. **Schiavina et al**[29] retrospectively evaluated 277 patients with RENAL and PADUA scores in RAPN, found significant correlation of both scores with WIT.

In a retrospective analysis of 162 patients **Bylund et al**.[30] evaluated the correlations between nephrometric scores and surgical outcomes after PN: the PADUA score, R.E.N.A.L. score and C-index showed a statistically significant correlation with WIT ($P < 0.001$), PADUA score performed slightly better than the other systems for WIT. In the present study, there was a significantly increased WIT as the tumors are becoming more complex with all the scoring systems, similar to **Alessandro Antonelli et al**

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[26]The mean warm ischemia time (WIT) in our study was 18.12 ± 13.59 with minimum of zero minutes to maximum of 42 min. It demonstrates strong significant correlation with ABC score where rho = 0.63 at p <0.001, moderate significant correlation with RENAL and PADUA scores with correlation coefficient of 0.53 and 0.56 at p value <0.001 respectively. However the WIT shows a weak correlation with C score which was significant at p= 0.03 with rho value of -0.31.out of all these ABC score had high correlation with WIT in the current study. On multiple linear regression analysis to predict WIT, for every 1 score increase in ABC-Score, the warm ischemia time will significantly increase by 9.57 mins at P<0.001 .This variability in Warm Ischemia Time caused by ABC scores can be attributed to 0.41 or 41%.

Length of hospital stay and estimated blood loss:

Alessandro Antonelli et al [26]retrospectively evaluated 234 patients, observed an increase in IOBL and LHS as the complexity increases in RENAL, PADUA, ABC & C INDEX scoring systems, with significant correlation of RENAL, PADUA with IOBL (p 0.008 and 0.003). **Aditya P Sharma et al**[24]no significant correlation of RENAL, PADUA and C – index scores with EBL and LHS. No significant correlation was found by **Okhunov et al**[23]between the PADUA, RENAL and C –index scoring system with IOBL .However, C-Index showed a significant relationship with LOS. In the current study Mean intra operative blood loss was165.2 ± 130.57 ml and length of hospital stay was 7.59 ± 2.04 days. As the tumor complexity increases there are increased chance of IOBL and LHS. Intra operative blood loss demonstrates weak correlation with RENAL score (rho= 0.28), and very weak correlation with PADUA (rho=0.09), ABC score (0.14) and C –index score (rho= -0.18), which is statistically insignificant. LHS shows a significant weak correlation with ABC score with rho of -0.31(p =0.03).However the RENAL, PADUA and C- index shows weak correlation which is statistically insignificant. Plausible reason for this poor correlation of IOBL may be association of vascular anomalies and surgeons experience. LHS not significantly correlated with any of the scoring systems probably because of most of the patients wants to stay one or two days longer as they are coming from outside the city in our study group.

Operative time:

Alessandro Antonelli et al. [26] Shows an increase in OT as the tumors are becoming more complex with RENAL, PADUA, ABC and C – index scores. PADUA and RENAL scores are significantly associated when compared to others. At p =<0.001 and 0.002. C-index had significant correlation with OT (*P* = 0.02) in **Aditya P Sharma et al**[24] when compared to RENAL and PADUA scores. No significant correlation of OT with RENAL, PADUA and C scores by **Okhunov et al** [23] Mean operating time (OT) was 2.42 ± 0.39 hours. There was a significant moderate correlation with C score at p= 0.001 with rho of -0.44 and weak correlation with RENAL score (rho= 0.28 at p =0.04).PADUA and ABC score shows very weak correlation at rho of 0.19 and 0.06 with insignificant p values (0.19, 0.66).On multiple linear regression analysis to predictoperative time, for every 1 score increase in C-Score, the duration of surgery will decrease by 28.2 min this variation in OT can be attributed to 0.19 or 19%. In our study, C – index is more correlated similar to **Aditya P Sharma et al**[24]

Tumor size:

The mean tumor size was 4.82 ± 1.82 cm. There was a moderate significant correlation with RENAL and PADUA scores with correlation coefficient of 0.57 and 0.50 at p value <0.001 and very weak significant correlation with C score (rho of -0.31 at 0.03) and ABC score (rho = 0.32 at p value 0.02).on linear regression analysis, for every 1 score increase in RENAL and PADUA scores the tumor size increase by 0.67 and 0.50 cm at p value of <0.001 with a variation of 33% similar to the results of **Aditya P Sharma et al**[24] In the present study we evaluated the percent change in hemoglobin and estimated glomerular filtration rate (e GFR) by Cockcroft-Gault Formula at immediate postoperative period and 15 days postoperatively at the time of suture removal. There was a significant improvement in hemoglobin and e GFR at 15 days postoperatively when compared with immediate postop, at p values of 0.002 and <0.001 respectively

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ONCOLOGICAL OUTCOME:

In our study none of the patients had PSM(positive surgical margin). In the current literature, Overall rates of PSMs range from 0% to 7 %[63].In our study there was no tumor recurrence identified among the 51 patients during our study period.

CONCLUSIONS

All four scoring systems demonstrated good reliability among observers and represent novel methods of quantitatively describing renal tumors. From our study we conclude that RENAL score was best in predicting trifecta outcomes followed by PADUA and ABC scores. ABC score was best in predicting warm ischemia time when compared to other scores. For operative time C score is best and for tumor size RENAL and PADUA score is better when compared to other scores. Postoperative complications, IOBL and LHS could not be predicted reliably based on any of these scoring systems.

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