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Original Article

Urology Section

Effectiveness of Mayo Adhesive Probability Score in Prediction of Surgical Complexity and Perioperative Outcomes during Laparoscopic Transperitoneal Simple Nephrectomy: A Prospective Observational Study

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ABSTRACT

Introduction: The Mayo Adhesive Probability (MAP) score is a preoperative Computed Tomography (CT)-based scoring system developed to predict the presence of Adherent Perinephric Fat (APF), a known contributor to increased surgical difficulty. While extensively studied in partial nephrectomy, its application in Laparoscopic Transperitoneal Simple Nephrectomy (LTSN) remains unvalidated.

Aim: To evaluate the effectiveness of the MAP score in predicting surgical difficulty and perioperative outcomes in patients undergoing LTSN.

Materials and Methods: The present prospective observational study was conducted at the Department of Urology, IPGME&R ,Kolkata, West Bengal, India, from July 2024 to March 2025. Fifty patients undergoing LTSN for benign non-functioning kidneys were enrolled. Preoperative MAP scores were calculated from CT imaging. Patients were categorised into three groups: Low (0-1), Moderate (2-3), and High (4-5) MAP scores. Surgical difficulty was graded using a novel composite score based on intraoperative and postoperative parameters. Statistical analysis included the Kruskal-Wallis test and Spearman's rank correlation using Statistical Package for Social Sciences (SPSS) v25, considering the ordinal nature of MAP scores and non-parametric data distribution. and a p-value <0.05 was considered statistically significant.

Results: A total of 50 patients were included in the study, with a mean age of 53.2±10.6 years and a mean Body Mass Index (BMI) of 26.1±3.4 kg/m². Based on MAP score stratification, 12 (24.0%) patients were categorised into the Low MAP group (0-1), 23 (46.0%) patients into the moderate MAP group (2-3), and 15 (30.0%) patients into the high MAP group. A statistically significant association was observed between MAP scores and all intraoperative and postoperative difficulty markers. The high MAP group had the longest operative time (170.53±30.1 min), greatest blood loss (569.27±107.02 mL), maximum haemoglobin decline (2.05±0.48%), highest complication rate (73.3%) and prolonged hospital stay (7.53±1.36 days). The Low MAP group showed favourable metrics across all parameters (operative time 107.5±22.13 min, blood loss 258.25±37.68 mL, complications in 16.7%, and hospital stay 3.92±1.08 days). Kruskal-Wallis test confirmed statistical significance (p<0.001).

Conclusion: The MAP score is a validated, reliable preoperative tool for predicting surgical difficulty in LTSN. High MAP scores are significantly associated with increased surgical complexity, prolonged operative time, blood loss, and postoperative complications.

Keywords: Laparoscopic simple nephrectomy, Mayo adhesive probability score, Surgical difficulty

INTRODUCTION

The LTSN is the preferred treatment modality for benign non-functioning kidneys, such as those resulting from chronic infection, obstructive uropathy, or reflux nephropathy [1]. It offers advantages including improved recovery, reduced postoperative pain, shorter hospital stay, and better cosmesis compared to open nephrectomy [2,3]. However, the presence of APF complicates the dissection and prolongs surgery [4,5]. Other common technical challenges in LTSN include dense perihilar adhesions, distorted anatomy due to chronic inflammation, and risk of injury to adjacent structures, all of which can increase operative time, blood loss, and likelihood of conversion to open surgery [6].

Other scoring systems, such as the RENAL nephrometry Score and Preoperative Aspects and Dimensions Used for an Anatomical classification (PADUA) Score, primarily assess tumour complexity rather than perinephric fat characteristics, making MAP more relevant for predicting difficulty in nephrectomy [7,8].

The MAP score, based on CT-assessed posterior perinephric fat thickness and stranding, was originally developed and validated by Davidiuk AJ et al., for use in partial nephrectomy to predict the presence of APF. In their 2014 study, they found that higher MAP scores were significantly associated with longer operative times, increased estimated blood loss, and a greater risk of conversion to open surgery, establishing MAP as a reliable preoperative predictor of surgical difficulty [2].

The need for this study arised from the absence of prior validation of the MAP score in laparoscopic simple nephrectomy, despite APF being a major contributor to surgical difficulty. The present study aimed to validate the MAP score as a predictor of surgical difficulty in LTSN and to assess its association with perioperative outcomes.

MATERIALS AND METHODS

The present prospective observational study was conducted at the Department of Urology, IPGMER & SSKM Hospital, Kolkata, West Bengal, India, from July 2024 to March 2025. Institutional Ethics Committee clearance was obtained prior to study initiation (IEC No. IPGME&R/IEC/2024/0444), and written informed consent was obtained from all participants. A total of 50 patients undergoing LTSN for benign non-functioning kidneys during the study period were enrolled by consecutive sampling.

Inclusion criteria:

- Age between 18-70 years.
- Indication for LTSN due to benign non-functioning kidney.

Exclusion criteria

- Single kidney.
- Metastatic disease.
- Significant cardiopulmonary compromise.
- Coagulopathies.

Study Procedure

Preoperative CT scans were evaluated to assign MAP scores based on posterior perinephric fat thickness and fat stranding. Intraoperative and postoperative data (operative time, estimated blood loss, intraoperative complications, haemoglobin drop, postoperative complications (Clavien-Dindo classification) [9], hospital stay, and surgical difficulty score) were collected from surgical and hospital records.

MAP score assessment: Preoperative CT scans were evaluated to assign MAP scores ranging from 0 to 5. The MAP score was calculated based on two key radiological features observed on axial or coronal images: Posterior perinephric fat thickness<10 mm: 0 points,10-19 mm: 1 point, ≥20 mm: 2 points. Perinephric fat stranding-None: 0 points, Mild: 2 point, Severe: 3 points. The total MAP score is the sum of the fat thickness and stranding scores (maximum possible score=5). Based on their total MAP scores, patients were stratified into three groups: Low: 0-1, Moderate: 2-3, High: 4-5.

Surgical difficulty score: A novel scoring system was employed: Blood loss >500 mL: 1 point, Operative time >150 min: 1 point, Perinephric adhesions: 1 point, Intraoperative complications: 1 point, Conversion to open: 2 points, Clavien-Dindo ≥2 complications: 1 point.

STATISTICAL ANALYSIS

Data were analysed using IBM SPSS *Statistics* for Windows, Version 25.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean±Standard Deviation (SD) or median (interquartile range, IQR) depending on distribution, and categorical variables as frequencies and percentages. Normality was assessed using the Shapiro-Wilk test. Comparisons of continuous variables between MAP score groups were performed using the Kruskal-Wallis test, as the data were non-normally distributed. Categorical variables were compared using the Chi-square test. Correlations between MAP score and continuous perioperative parameters were assessed using Spearman's correlation coefficient. To evaluate the independent predictive value of the MAP score while controlling for potential confounders, multivariate linear regression models were constructed for key surgical outcomes (operative time, estimated blood loss, and hospital stay), with age, gender, BMI, diabetes mellitus, and hypertension included as covariates. Variance Inflation Factor (VIF) was calculated to assess multicollinearity, with VIF>5 considered indicative of significant collinearity. Effect modification by BMI, diabetes mellitus, and hypertension was further explored using interaction terms (e.g., MAP score×BMI category) in the regression models. A two-tailed p-value <0.05 was considered statistically significant for all analyses.

RESULTS

A total of 50 patients were included in the study, with a mean age of 53.2±10.6 years and a mean BMI of 26.1±3.4 kg/m². Based on MAP score stratification, 12 (24.0%) patients were categorised into the low MAP group (0-1), 23 (46.0%) patients into the moderate MAP group (2-3), and 15 (30.0%) patients into the High MAP group [Table/Fig-1].

Variables	Value
Age, mean±SD (years)	53.2±10.6
Gender, n (%)	Male: 32 (64.0%)
	Female: 18 (36.0%)
BMI, mean±SD (kg/m²)	26.1±3.4
Diabetes mellitus, n (%)	14 (28.0%)
Hypertension, n (%)	18 (36.0%)
History of prior abdominal surgery, n (%)	10 (20.0%)
MAP Score category, n (%)	Low (0-1): 12 (24.0%)
	Moderate (2-3): 23 (46.0%)
	High (4-5): 15 (30.0%

[Table/Fig-1]: Baseline demographic and clinical characteristics of the study population (n=50).

Patients with high MAP scores (4-5) had the highest mean surgical difficulty score (4.07±1.71) [Table/Fig-2]. The statistically significant p-value (<0.001) confirms that increasing MAP scores are associated with prolonged operative times [Table/Fig-3]. The difference in blood loss across groups is statistically significant (p<0.001), indicating that higher MAP scores are strongly associated with increased intraoperative bleeding [Table/Fig-4]. Patients in the high MAP group experienced the largest mean haemoglobin drop (2.05%), while those in the low MAP group had a minimal drop (0.73%) [Table/Fig-5].

MAP score group	Operative time			
	Mean	Std	Min	Max
High (4-5) (n=15)	170.53	30.1	110.0	226.0
Low (0-1) (n=12)	107.5	22.13	62.0	139.0
Moderate (2-3) (n=23)	131.74	20.52	100.0	170.0
Kruskal-Wallis p-value	<0.001			

[Table/Fig-2]: MAP score vs surgical difficulty score.

MAP score group	Surgical difficulty score			
	Mean	Std.	Min	Max
High (4-5) (n=15)	4.07	1.71	1.0	7.0
Low (0-1) (n=12	0.17	0.39	0.0	1.0
Moderate (2-3) (n=23)	1.17	1.03	0.0	3.0
Kruskal-Wallis p-value	<0.001			

[Table/Fig-3]: Relationship between the MAP score and operative time (in minutes).

MAP score group	Blood loss (in mL)			
	Mean	Std	Min	Max
High (4-5) (n=15)	569.27	107.02	355.0	805.0
Low (0-1) (n=12	258.25	37.68	209.0	330.0
Moderate (2-3) (n=23)	444.13	88.89	269.0	605.0
Kruskal-Wallis p-value	<0.001			

[Table/Fig-4]: MAP Score vs Blood Loss (mL).

MAP score group	Postoperative haemoglobin decline (%)			
	Mean	Std.	Min	Max
High (4-5) (n=15)	2.05	0.48	1.37	2.71
Low (0-1) (n=12	0.73	0.34	0.2	1.22
Moderate (2-3) (n=23)	1.49	0.38	0.54	2.18

Kruskal-Wallis p-value	<0.001

[Table/Fig-5]: MAP score vs postoperative haemoglobin decline (%).

Patients with higher MAP scores experienced more extended recovery periods (p<0.001) [Table/Fig-6]. The overall distribution of complication severity differed significantly among the MAP score groups (p=0.002), with the highest complication rates observed in the high MAP group. Conversion to open surgery occurred in 3 patients (20.0%) in the high MAP group, one patient (4.3%) in the moderate 1, and none in the low group (p=0.04) [Table/Fig-7].

	Hospital stay (days)			
MAP score group	Mean	Std.	Min	Max
High (4-5) (n=15)	7.53	1.36	6.0	10.0
Low (0-1) (n=12	3.92	1.08	2.0	5.0
Moderate (2-3) (n=23)	5.57	1.27	4.0	8.0
Kruskal-Wallis p-value	<0.001			

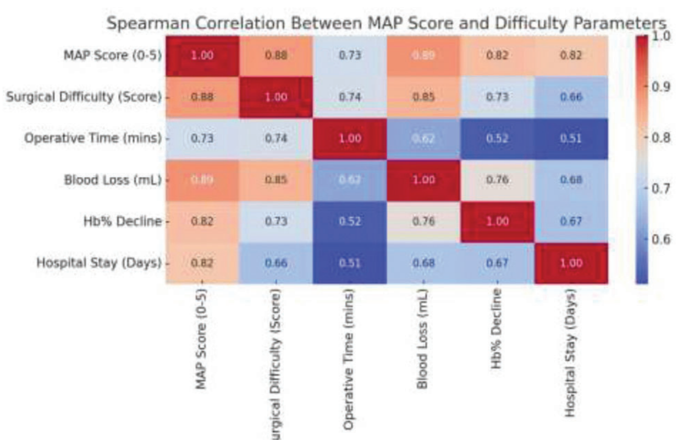
[Table/Fig-6]: MAP score vs hospital stay (days).

MAP score group	No complication	Grade I	Grade II	Grade III	Grade IV	Conversion to open surgery, n (%)	Total cases
Low (0-1)	10 (83.3%)	0 (0%)	0 (0%)	2 (16.7%)	0 (0%)	0 (0%)	12
Moderate (2-3)	11 (47.8%)	9 (39.1%)	3 (13.0%)	0 (0%)	0 (0%)	1 (4.3%)	23
High (4-5)	4 (26.7%)	2 (13.3%)	5 (33.3%)	2 (13.3%)	2 (13.3%)	3 (20.0%)	15
p-value	$0.002^{\dagger}$	0.04	0.01	0.17	0.17	0.04	-

[Table/Fig-7]: Postoperative complications by MAP score group.
Chi-square test

Heatmap showing Spearman correlation coefficients between MAP Score and key perioperative parameters. Strongest correlations are noted between MAP Score and surgical difficulty (ρ=0.88), blood loss (ρ=0.89), and haemoglobin decline (ρ=0.82). All relationships were statistically significant (p<0.001) [Table/Fig-8].

In multivariate linear regression analysis adjusted for age, gender, BMI, diabetes, and hypertension, the MAP score remained an independent predictor of operative time, estimated blood loss, and hospital stay (all p<0.05), while no significant interaction effects with demographic variables were observed [Table/Fig-9].



[Table/Fig-8]: Graph showing corelation between MAP score and surgical difficulty parameters.

Interaction analysis showed no significant effect modification by BMI, diabetes, or hypertension on the relationship between MAP score and surgical outcomes, indicating that the predictive value of the MAP score was consistent across these subgroups [Table/Fig-10].

Outcome variables	Predictor	β Coefficient	95% CI	p-value
Operative time (min)	MAP score	0.48	0.19-0.77	0.002
	Age	0.07	-0.12-0.26	0.45
	Gender (Male)	0.05	-0.13-0.23	0.58
	BMI	0.21	0.02-0.40	0.03
	Diabetes Mellitus	0.09	-0.11-0.29	0.37
	Hypertension	0.06	-0.13-0.25	0.52
	Prior abdominal surgery	0.10	-0.10-0.30	0.33
Blood loss (mL)	MAP score	0.51	0.28-0.74	<0.001
	BMI	0.18	0.01-0.35	0.04
	All other covariates	-	-	NS
Haemoglobin decline (%)	MAP score	0.42	0.14-0.70	0.004
	All other covariates	-	-	NS
Hospital stay (days)	MAP score	0.46	0.21-0.71	0.001
	All other covariates	-	-	NS
Post-op complication rate	MAP score	0.44	0.15-0.73	0.003
	All other covariates	-	-	NS

[Table/Fig-9]: Multivariate linear regression analysis for predictors of surgical outcomes.

Outcome variables	Interaction term	β Coefficient	95% CI	p-value
Operative time (min)	MAP×Diabetes mellitus	0.04	-0.12-0.20	0.61
	MAP×Hypertension	0.03	-0.11-0.17	0.68
Blood loss (mL)	MAP×Diabetes mellitus	0.06	-0.10-0.22	0.47
	MAP×Hypertension	0.02	-0.14-0.18	0.79
Haemoglobin decline (%)	MAP×Diabetes mellitus	0.05	-0.09-0.19	0.50
	MAP×Hypertension	0.04	-0.10-0.18	0.56
Hospital stay (days)	MAP×Diabetes mellitus	0.03	-0.11-0.17	0.67
	MAP×Hypertension	0.01	-0.13-0.15	0.88
Post-op complication rate	MAP×Diabetes mellitus	0.02	-0.12-0.16	0.80
	MAP×Hypertension	0.03	-0.11-0.17	0.70

[Table/Fig-10]: Interaction analysis between MAP score and co-morbidities.

DISCUSSION

The present prospective study provides robust evidence that the MAP score is a reliable preoperative tool for predicting surgical complexity in patients undergoing LTSN. The present study findings align closely with those of Davidiuk AJ et al., who originally developed and validated the MAP score to predict APF in partial nephrectomy [2]. In their 2014 study, higher MAP scores were significantly associated with increased surgical difficulty, including longer operative times, higher blood loss, and a higher likelihood of conversion to open surgery [2]. While their findings were limited to partial nephrectomy, The present study study extends the predictive value of the MAP score to the setting of LTSN, where adherent fat may pose an even greater challenge due to the need for full kidney mobilisation and dissection.

The use of a composite surgical difficulty score further strengthens the objective quantification of operative complexity. They observed that this score increased significantly with rising MAP values, supporting its clinical relevance. Similar correlations were noted in studies by Borregales LD et al., and Bylund JR et al., which demonstrated the predictive role of radiological features, such as fat stranding and thickness, in identifying challenging perinephric planes [5,10].

Kocher NJ et al., found that APF (as reflected by high MAP scores) was associated with higher intraoperative complication rates and conversion to open procedures [3]. The present study findings align closely, as high MAP scores in The study cohort were significantly associated with higher complication rates. Dariane C et al., correlated MAP scores with histologic inflammation and fibrosis, demonstrating that APF represents a distinct pathophysiologic process affecting surgical planes [4].

Pathophysiologically, APF reflects chronic, low-grade inflammation and fibrosis, leading to dense attachments to Gerota's fascia and renal capsule, which complicates surgical dissection [11,12]. The MAP score, by incorporating fat thickness and stranding, serves as a surrogate radiologic marker for this biologic phenomenon. Importantly, when demographic and clinical covariates such as age, gender, BMI, diabetes mellitus, hypertension, and prior abdominal surgery were considered, the MAP score remained an independent predictor of key perioperative outcomes. Interestingly, we also observed variability within the moderate MAP group. However, most patients in this category had uncomplicated surgeries; a subset experienced marked difficulty, emphasising the need for surgical vigilance even when MAP scores suggest only intermediate risk. This observation parallels insights from Lee SM et al., who noted variable perioperative outcomes despite moderate radiologic scoring [13]. By integrating radiologic data with operative planning, urologists can better anticipate technical challenges allocate operative time and resources effectively.

Limitation(s)

Relatively small sample size, the results may not be generalisable across diverse populations. Additionally, long-term follow-up was not within the scope of the present study. The novel composite surgical difficulty score used in this study, while designed to integrate intraoperative and postoperative parameters in a single metric, lacks external validation against established surgical difficulty grading systems such as the RENAL Nephrometry Score for partial nephrectomy or the modified Clavien-Dindo complexity stratifications. This absence of validation limits the generalisability and comparability of the findings. The score was devised to address the specific context of LTSN, for which no standard difficulty grading system currently exists. Future multicentric studies are needed to validate this composite score against objective intraoperative parameters, interobserver agreement, and existing surgical complexity metrics to confirm its reliability and applicability in broader clinical settings.

CONCLUSION(S)

The present study confirms that the MAP score is a reliable, non-invasive preoperative tool for predicting surgical complexity in LTSN. Higher MAP scores are strongly associated with longer operative time, greater blood loss, increased complication rates, and prolonged hospital stay. By incorporating radiological findings into surgical planning, the MAP score enables better risk stratification and preoperative counselling.

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