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Original Research Article

PROGNOSTIC UTILITY OF MODIFIED SMART SCORING IN UROLITHIASIS: EVALUATING ASSOCIATIONS OF ENDOSCOPIC FINDINGS WITH DISEASE SEVERITY AND STONE CLEARANCE DURING URETEROSCOPIC LITHOTRIPSY (URSL)

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ABSTRACT

Background: Urolithiasis is often treated with ureteroscopic lithotripsy (URSL). Unlike the S.T.O.N.E. score, the Modified SMART score includes intraoperative factors, enhancing prognostic accuracy by evaluating scope visibility, mucosal status, anatomy, fragmentation response, and tissue integrity. This study assessed the Modified SMART scoring system, which includes intraoperative endoscopic findings, to predict disease severity and stone clearance. **Materials and Methods:** This prospective observational study included 120 adults with unilateral ureteric stones undergoing URSL at Government Madurai Medical College between February and December 2024. The STONE score was calculated preoperatively. Intraoperative features, such as mucosal oedema, mucosa-stone adherence, and distal ureteric tightness, were graded using the Modified SMART score. Outcomes, including fever, haematuria, and residual stones, were recorded and statistically analysed. **Result:** Of the 120 patients (mean age 47.13±14.64 years; 55% male), 10–20 mm stones accounted for 93.3% of the cases, mostly in the upper ureter (45%). Postoperative fever occurred in 8(6.7%), haematuria in 18(15%), and residual calculi in 8(6.7%). Patients with fever had significantly larger stones (17.00±6.14 mm vs 11.15±4.10 mm, $p<0.0001$) and longer intervention delay (43.00±19.10 vs 24.93±11.71 days, $p<0.0001$). Haematuria was associated with stones >20 mm (27.8% vs 1%, $p<0.0001$) and higher obstruction (38.9% severe obstruction, $p<0.0001$). Residual stones were associated with stones >20 mm (62.5% vs. 0.9%, $p<0.0001$) and severe mucosal oedema (62.5% vs. 9.8%, $p<0.0001$). Severe mucosa-stone adherence and distal ureteric tightness were also strongly correlated with complications ($p<0.01$). Modified SMART scores correlated better with residual stones than STONE scores. **Conclusion:** The Modified SMART scoring system, which incorporates intraoperative endoscopic findings, enhances the prediction of URSL outcomes and supports better surgical planning.

INTRODUCTION

Urolithiasis, a condition characterised by the formation of stones within the urinary tract, remains a significant clinical challenge worldwide. Ureteroscopic lithotripsy (URSL) has become a standard minimally invasive approach to manage ureteral stones.[1] Surgeons typically rely on a range of preoperative factors such as stone size, location, density, and anatomic considerations to estimate procedural difficulty and the likelihood of complete stone clearance.[2] One widely used preoperative tool is the S.T.O.N.E. score, which incorporates stone Size, Topography, Obstruction, Number, and Evaluation of Hounsfield units, offering a valuable means to predict operative complexity and outcomes.[3] However, reliance exclusively on preoperative assessments overlooks a key dimension of URSL: the real-time endoscopic findings encountered during surgery.[4]

As the procedure unfolds, intraoperative conditions such as ureteral mucosal oedema, urothelial integrity,

degree of stone impaction, ureteral narrowing or tortuosity, bleeding visibility, and tactile feedback through the ureteroscope may substantially affect operative flow, fragmentation efficiency, complication risk, and residual stone presence. These dynamic changes are not captured by preoperative scoring.[5] Despite their potential importance, there is no universally accepted or widely applied system for classifying and quantifying intraoperative endoscopic findings.

Surgeons often describe such observations descriptively, mentioning, for example, "severe mucosal abrasion," "stone embedded within mucosa," or "narrow ureteral lumen", but without a standard framework for comparison.[6] This variability limits the ability to systematically evaluate how these intraoperative factors influence outcomes such as operative time, intraprocedural complications, stone clearance, and postoperative recovery.[7] A formalised intraoperative classification system would allow more precise prognostication, improve communication among surgical teams, and may guide intra-procedure decision-making, such as whether to proceed with fragmentation or switch strategy, when to place a stent, or how aggressively to navigate tight or inflamed segments.[8] It would also facilitate research by enabling consistent data collection across studies and institutions, allowing outcomes to be correlated more robustly with surgical visibility, tissue response, and stone burden observed in real time.[9]

The "Modified SMART scoring system" was proposed to fill this gap. By integrating intraoperative endoscopic findings into a structured, quantifiable framework, Modified SMART aims to reflect the actual operative milieu and potentially enhance prognostic accuracy over preoperative systems alone. SMART stands for Scope visibility, Mucosal status, Anatomy, Response to fragmentation, and Tissue integrity, each component addressing a critical aspect of what the surgeon sees and experiences during URSL.[10]

This study aimed to assess the prognostic utility of the Modified SMART scoring system based on intraoperative endoscopic findings by evaluating its association with disease severity and stone clearance outcomes during ureteroscopic lithotripsy and comparing its predictive effectiveness with the established preoperative S.T.O.N.E. score.

MATERIALS AND METHODS

This prospective observational study was conducted with 120 patients admitted with unilateral ureteric stones who were scheduled for URSL at the Department of Urology, Government Madurai Medical College, Madurai, over a period of ten months from February 2024 to December 2024. The study was approved by the Institutional Ethics Committee, and written informed consent was obtained from all patients before enrolment.

Inclusion Criteria

The study included adult patients aged > 18 years of either sex who had unilateral ureteric stones involving a single ureteric segment. Only patients who underwent primary URSL with pneumatic lithotripsy were considered.

Exclusion Criteria

Patients with anatomical abnormalities, such as duplicated ureters, horseshoe kidneys, or ureteral strictures, were excluded. Patients with active urinary tract infection or sepsis, bleeding diathesis, or a history of previous ureteric interventions, including ureteral stenting, URSL, percutaneous nephrostomy (PCN), percutaneous nephrolithotomy (PCNL), or open nephrostomy, were also excluded.

Methods

All eligible patients were admitted and clinically evaluated with a detailed history and physical examination. Routine preoperative investigations included complete blood count, renal function tests, urinalysis, and urine culture. Radiological evaluation consisted of ultrasound, X-ray KUB, and non-contrast computed tomography (NCCT), where indicated. The preoperative risk profile of each patient was assessed using the STONE score, which was calculated based on stone size, location, degree of obstruction, number of stones, and Hounsfield unit.

Surgical procedures were performed under spinal or general anaesthesia using standard semi-rigid ureteroscopes, including Richard Wolf 4 Fr, 6/7.5 Fr, and Karl Storz 8/9.5 Fr models. Pneumatic lithotripsy was used in all cases for stone fragmentation. During the procedure, intraoperative endoscopic findings were carefully observed and graded according to the Modified SMART Scoring system (S – Scope-in Time, reflecting duration of surgery; M – Mucosal oedema at the stone-impacted site; A – Adherence between stone and mucosa; R – Resistance, indicating distal ureteric tightness; T – Trauma, representing ureteric injury during the procedure). The parameters assessed included mucosal oedema, presence of polyps, mucosa-stone adherence, degree of mucosal injury, and distal ureteral tightness. These findings were entered into a customised Google AppSheet-based form for real-time scoring and risk stratification.

Stone clearance was confirmed intraoperatively and reassessed postoperatively using radiography or ultrasonography before stent removal, which was usually performed in the third postoperative week. A stone-free state was defined as complete clearance or the presence of residual fragments smaller than 4 mm.

Statistical Analysis

Statistical analyses were performed using IBM SPSS (v21). Continuous variables are expressed as mean ± standard deviation, and categorical variables are presented as frequencies and percentages. Comparisons between continuous variables were performed using the independent sample t-test, and categorical variables were analysed using the Pearson

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chi-square test. Statistical significance was set at $p < 0.05$.

RESULTS

The mean age was 47.13 ± 14.64 years, the mean stone size was 11.54 ± 4.48 mm, and the mean time to intervention was 26.13 ± 13.04 days. Patients with fever had larger stones (17.00 ± 6.14 mm vs. 11.15 ± 4.10 mm, $p < 0.0001$) and longer delays (43.00 ± 19.10 vs. 24.93 ± 11.71 days, $p < 0.0001$) than those without fever. Those with hematuria showed stone size 16.22 ± 6.63 mm vs. 10.72 ± 3.42 mm ($p < 0.0001$) and delay 34.94 ± 19.34 vs. 24.58 ± 11.00 days ($p = 0.002$). Residual calculi cases had stone size 20.50 ± 7.80 mm vs. 10.90 ± 3.39 mm ($p < 0.0001$) and delay 45.13 ± 18.95 vs. 24.78 ± 11.48 days ($p < 0.0001$). Age differences were not significant in any of the comparisons ($p > 0.05$) [Table 1].

Table 1: Association of stone size and intervention delay with postoperative complications

Parameter	Fever (Mean ± SD)		P value	Hematuria (Mean ± SD)		P value	Residual Calculi (Mean ± SD)		P value
	No	Yes		No	Yes		No	Yes	
Age (years)	46.74 ± 14.59	52.63 ± 15.27	0.274	46.58 ± 14.71	50.28 ± 14.23	0.325	46.89 ± 14.46	50.50 ± 17.71	0.503
Exact size (mm)	11.15 ± 4.10	17.00 ± 6.14	<0.0001	10.72 ± 3.42	16.22 ± 6.63	<0.0001	10.90 ± 3.39	20.50 ± 7.80	<0.0001
Time until intervention (days)	24.93 ± 11.71	43.00 ± 19.10	<0.0001	24.58 ± 11.00	34.94 ± 19.34	0.002	24.78 ± 11.48	45.13 ± 18.95	<0.0001

Footnotes: All values are expressed as mean ± Standard Deviation (SD). Millimetres = mm. Statistical comparisons between groups were performed using the Independent Student's t-test, and statistical significance was set at $p < 0.05$.

Postoperative fever occurred in eight patients, with no significant differences according to sex or side ($p = 0.769$ and 0.922, respectively). Larger stones (>20 mm) were more frequent in patients with fever (37.5% vs. 2.7%, $p < 0.0001$). Obstruction severity was higher among patients with fever, with 37.5% having severe obstruction versus 4.5% without fever ($p = 0.004$). The number of calculi and Hounsfield units showed no significant association. A longer scope time (>30 min) was more common in patients with fever (62.5% vs. 9.8%, $p < 0.0001$). Severe mucosal oedema (62.5% vs. 9.8%), severe mucosa-stone adherence (75% vs. 15.2%), and strong distal ureteric tightness (50% vs. 10.7%) were significantly associated with fever (all $p \leq 0.004$). Ureteric injury, especially mucosal (62.5% vs. 21.4%) and fat injury (12.5% vs. 1.8%), was more frequent in patients with fever ($p = 0.003$). Patients with fever underwent more second interventions (62.5% vs. 2.7%, $p < 0.0001$). Topography and scope size showed no significant differences ($p > 0.05$) (Table 2).

Table 2: Factors associated with postoperative fever

Variable	Category	Fever N (%)		P value
		No	Yes	
Sex	Female	50 (44.6%)	4 (50%)	0.769
	Male	62 (55.4%)	4 (50%)	
Side	Left	58 (51.8%)	4 (50%)	0.922
	Right	54 (48.2%)	4 (50%)	
Size group (mm)	< 5	2 (1.8%)	0	<0.0001
	5-10	55 (49.1%)	0	
	10-20	52 (46.4%)	5 (62.5%)	
	> 20	3 (2.7%)	3 (37.5%)	
Topography	DU	40 (35.7%)	1 (12.5%)	0.4
	MU	23 (20.5%)	2 (25.0%)	
	UU	49 (43.8%)	5 (62.5%)	
Obstruction	Mild	61 (54.5%)	3 (37.5%)	0.004
	Moderate	34 (30.4%)	2 (25%)	
	Severe	5 (4.5%)	3 (37.5%)	
	No	12 (10.7%)	0	
Number of calculi	1	100 (90.1%)	6 (85.7%)	0.71
	2	11 (9.9%)	1 (14.3%)	
Hounsfield unit	< 400	6 (5.4%)	1 (12.5%)	0.277
	400-700	35 (31.3%)	0	
	700-1000	43 (38.4%)	4 (50%)	
	> 1000	28 (25%)	3 (37.5%)	
Scope size (Fr)	6-7.5	12 (10.7%)	2 (25%)	0.224
	8-9.5	100 (89.3%)	6 (75%)	
Scope in time (mins)	< 15	40 (35.7%)	1 (12.5%)	<0.0001
	15-30	61 (54.5%)	2 (25%)	
	> 30	11 (9.8%)	5 (62.5%)	
Mucosal edema	Mild	48 (42.9%)	2 (25%)	<0.0001
	Severe	11 (9.8%)	5 (62.5%)	

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	No	53 (47.3%)	1 (12.5%)	
Mucosa stone adherence	Mild	47 (42%)	1 (12.5%)	<0.0001
	Severe	17 (15.2%)	6 (75%)	
	No	48 (42.9%)	1 (12.5%)	
Distal ureteric tightness	Mild	43 (38.4%)	3 (37.5%)	0.004
	Strong	12 (10.7%)	4 (50%)	
	No	57 (50.9%)	1 (12.5%)	
Ureteric injury	Fat	2 (1.8%)	1 (12.5%)	0.003
	Mucosal	24 (21.4%)	5 (62.5%)	
	No	86 (76.8%)	2 (25%)	
Second intervention	No	109 (97.3%)	3 (37.5%)	<0.0001
	Yes	3 (2.7%)	5 (62.5%)	

Footnotes: Values are expressed as frequencies and percentages [N (%)]. DU = Distal Ureter; MU = Mid Ureter; UU = Upper Ureter; Fr = French (scope size). Statistical analysis was performed using the chi-square test or Fisher's exact test, wherever applicable. Statistical significance was set at $p < 0.05$.

Haematuria was observed in 18 patients. There was no significant difference between sex or side ($p = 0.136$ and 0.72, respectively). Larger stones were significantly associated with haematuria, with 61.1% and 27.8% of patients having stones 10–20 mm and >20 mm compared to 45.1% and 1% of patients without haematuria ($p < 0.0001$). Obstruction severity was higher in patients with haematuria, with 38.9% and 38.9% of patients having moderate and severe obstruction, respectively, versus 28.4% and 1% without haematuria ($p < 0.0001$). A Hounsfield unit >1000 was more frequent in patients with haematuria (55.6% vs. 20.6%, $p = 0.006$). A larger scope size (6–7.5 Fr) and longer scope time (>30 min) were significantly more common in patients with haematuria (33.3% vs. 7.8%, $p = 0.002$; 55.6% vs. 5.6%, $p < 0.0001$). Severe mucosal oedema (55.6% vs. 5.9%), severe mucosa-stone adherence (72.2% vs. 9.8%), and strong distal ureteric tightness (61.1% vs. 4.9%) were significantly associated with the presence of haematuria (all $p < 0.0001$). Ureteric injury (fat and mucosal) occurred more often in patients with haematuria (16.7% and 72.2% vs. 0 and 15.7%, $p < 0.0001$, respectively). Patients with haematuria required more second interventions (38.9% vs. 1%, $p < 0.0001$). The number of calculi and topography were not significantly associated with the occurrence of haematuria ($p > 0.05$) [Table 3].

Table 3: Association of clinical and procedural factors with hematuria

Variable	Category	Hematuria N (%)		P value
		No	Yes	
Sex	Female	43 (42.2%)	11 (61.1%)	0.136
	Male	59 (57.8%)	7 (38.9%)	
Side	Left	52 (51%)	10 (55.6%)	0.72
	Right	50 (49%)	8 (44.4%)	
Size group (mm)	< 5	2 (2%)	0	<0.0001
	5-10	53 (52%)	2 (11.1%)	
	10-20	46 (45.1%)	11 (61.1%)	
	> 20	1 (1%)	5 (27.8%)	
Topography	DU	33 (32.4%)	8 (44.4%)	0.446
	MU	23 (22.5%)	2 (11.1%)	
	UU	46 (45.1%)	8 (44.4%)	
Obstruction	Mild	60 (58.8%)	4 (22.2%)	<0.0001
	Moderate	29 (28.4%)	7 (38.9%)	
	Severe	1 (1%)	7 (38.9%)	
	No	12 (11.8%)	0	
Number of calculi	1	91 (90.1%)	15 (88.2%)	0.814
	2	10 (9.9%)	2 (11.8%)	
Hounsfield unit	< 400	7 (6.9%)	0	0.006
	400-700	34 (33.3%)	1 (5.6%)	
	700-1000	40 (39.2%)	7 (38.9%)	
	> 1000	21 (20.6%)	10 (55.6%)	
Scope size (Fr)	6-7.5	8 (7.8%)	6 (33.3%)	0.002
	8-9.5	94 (92.2%)	12 (66.7%)	
Scope in time (mins)	< 15	40 (39.2%)	1 (5.6%)	<0.0001
	15-30	56 (54.9%)	7 (38.9%)	
	> 30	6 (5.9%)	10 (55.6%)	
Mucosal edema	Mild	43 (42.2%)	7 (38.9%)	<0.0001
	Severe	6 (5.9%)	10 (55.6%)	
	No	53 (52%)	1 (5.6%)	
Mucosa stone adherence	Mild	43 (42.2%)	5 (27.8%)	<0.0001
	Severe	10 (9.8%)	13 (72.2%)	
	No	49 (48%)	0	
Distal ureteric tightness	Mild	40 (39.2%)	6 (33.3%)	<0.0001
	Strong	5 (4.9%)	11 (61.1%)	

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	No	57 (55.9%)	1 (5.6%)	
Ureteric injury	Fat	0	3 (16.7%)	<0.0001
	Mucosal	16 (15.7%)	13 (72.2%)	
	No	86 (84.3%)	2 (11.1%)	
Second intervention	No	101 (99%)	11 (61.1%)	<0.0001
	Yes	1 (1%)	7 (38.9%)	

Footnotes: Values are expressed as frequencies and percentages [N (%)]. DU = Distal Ureter; MU = Mid Ureter; UU = Upper Ureter; Fr = French (scope size). Statistical analysis was performed using the chi-square test or Fisher's exact test, where appropriate. Statistical significance was set at $p < 0.05$.

Residual calculi were observed in 8 patients. Sex and side did not show any significant associations ($p = 0.769$ and 0.526, respectively). Larger stones (> 20 mm) were more common in patients with residual calculi (62.5% vs. 0.9%, $p < 0.0001$). Moderate-to-severe obstruction was significantly higher in the residual calculi group (87.5% vs. 33.1%, $p = 0.012$). The number of calculi and Hounsfield units showed no significant differences. A longer scope time (>30 min) was more frequent in residual cases (50% vs. 10.7%, $p = 0.003$). Severe mucosal oedema (62.5% vs. 9.8%, $p < 0.0001$), severe mucosa-stone adherence (62.5% vs. 16.1%, $p = 0.003$), and distal ureteric tightness (mild or strong) were significantly associated with residual calculi ($p = 0.01$). Mucosal ureteric injury was more common in residual cases (75% vs. 20.5%, $p = 0.002$). Patients with residual calculi underwent more secondary interventions (75% vs. 1.8%; $p < 0.0001$) [Table 4].

Table 4: Factors associated with residual calculi after ureteroscopy

Variable	Category	Residual Calculi N (%)		P value
		No	Yes	
Sex	Female	50 (44.6%)	4 (50%)	0.769
	Male	62 (55.4%)	4 (50%)	
Side	Left	57 (50.9%)	5 (62.5%)	0.526
	Right	55 (49.1%)	3 (37.5%)	
Size group (mm)	< 5	2 (1.8%)	0	<0.0001
	5-10	54 (48.2%)	1 (12.5%)	
	10-20	55 (49.1%)	2 (25%)	
	> 20	1 (0.9%)	5 (62.5%)	
Topography	DU	39 (34.8%)	2 (25%)	0.583
	MU	24 (21.4%)	1 (12.5%)	
	UU	49 (43.8%)	5 (62.5%)	
Obstruction	Mild	63 (56.3%)	1 (12.5%)	0.012
	Moderate	31 (27.7%)	5 (62.5%)	
	Severe	6 (5.4%)	2 (25%)	
	No	12 (10.7%)	0	
Number of calculi	1	100 (90.1%)	6 (85.7%)	0.71
	2	11 (9.9%)	1 (14.3%)	
Hounsfield unit	< 400	7 (6.3%)	0	0.353
	400-700	34 (30.4%)	1 (12.5%)	
	700-1000	44 (39.3%)	3 (37.5%)	
	> 1000	27 (24.1%)	4 (50%)	
Scope size (Fr)	6-7.5	14 (12.5%)	0	0.287
	8-9.5	98 (87.5%)	8 (100%)	
Scope in time (mins)	< 15	41 (36.6%)	0	0.003
	15-30	59 (52.7%)	4 (50%)	
	> 30	12 (10.7%)	4 (50%)	
Mucosal edema	Mild	47 (42%)	3 (37.5%)	<0.0001
	Severe	11 (9.8%)	5 (62.5%)	
	No	54 (48.2%)	0	
Mucosa stone adherence	Mild	45 (40.2%)	3 (37.5%)	0.003
	Severe	18 (16.1%)	5 (62.5%)	
	No	49 (43.8%)	0	
Distal ureteric tightness	Mild	41 (36.6%)	5 (62.5%)	0.01
	Strong	13 (11.6%)	3 (37.5%)	
	No	58 (51.8%)	0	
Ureteric injury	Fat	3 (2.7%)	0	0.002
	Mucosal	23 (20.5%)	6 (75.0%)	
	No	86 (76.8%)	2 (25%)	
Second intervention	No	110 (98.2%)	2 (25%)	<0.0001
	Yes	2 (1.8%)	6 (75%)	

Footnotes: Values are expressed as frequencies and percentages [N (%)]. DU = Distal Ureter; MU = Mid Ureter; UU = Upper Ureter; Fr = French (scope size). Statistical analysis was performed using the chi-square test or Fisher's exact test, where appropriate. Statistical significance was set at $p < 0.05$.

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DISCUSSION

This prospective observational study evaluated the prognostic role of the Modified SMART scoring system, which incorporates intraoperative endoscopic findings, in patients undergoing URSL. Unlike conventional preoperative tools such as the STONE score, which are based solely on radiological parameters, the SMART score reflects dynamic tissue changes encountered during surgery, thereby offering a more comprehensive assessment of procedural complexity and outcome prediction.[11]

One of the key strengths of this system is its ability to grade findings in real time. The structured proforma used in this study ensured that mucosal oedema, mucosal stone adherence, distal ureteric tightness, and ureteric injuries were objectively documented during surgery. Grading allows these qualitative impressions to be translated into reproducible, numerical values. By applying this grading system, intraoperative changes could be recorded uniformly, allowing meaningful comparisons across cases and correlations with outcomes such as operative time, postoperative fever, haematuria, and stone-free status.

Mucosal oedema emerged as one of the most relevant intraoperative findings. Severe oedema reflects chronic obstruction and inflammatory alterations of the ureteral wall. In our study, higher oedema grades were clearly linked to prolonged operative time because of reduced endoscopic visibility and the need for careful scope manoeuvring. Patients with severe oedema also had a greater risk of postoperative fever and residual fragments. Thus, oedema was not only a marker of chronic impaction but also a practical determinant of surgical difficulty and recovery.[12,13]

Mucosal stone adherence is another important factor. Stones firmly embedded in the mucosa require more extensive manipulation for dislodgement, prolonging the procedure. Severe MSA was associated with haematuria and postoperative fever in our cohort, indicating that strong adherence increases tissue trauma. Importantly, severe adherence also reduced the chance of complete clearance, making secondary intervention more likely. This finding supports the notion that stone impaction is not only a radiological concept but also an intraoperative reality with direct clinical consequences.[12,14]

Distal ureteric tightness significantly influenced the surgical success. The strong DUT restricted scope advancement and limited access to the stone site. These cases require longer procedures and often carry a higher risk of incomplete clearance. Importantly, grading of the DUT during surgery also provided the surgeon with immediate decision-making support; in patients with very narrow ureters, a staged approach or stent placement could be considered to avoid ureteric injury. This reflects the practical value of the SMART score beyond prognosis; it can actively guide intraoperative judgement.[14,15]

The cumulative impact of these findings is clear. Patients with higher intraoperative grades consistently had longer operative times, more complications, and lower stone-free rates. The structured grading system made it possible to quantify this relationship, moving beyond the subjective impressions. Our results reinforce that preoperative imaging alone cannot account for tissue changes induced by obstruction; real-time assessment is essential for accurate prognostication.[13,16]

From a clinical perspective, the Modified SMART score also provides significant value in post-procedure counselling. By documenting ureteral changes, surgeons can explain to patients why a surgery may have taken longer, why a stent was placed, or why residual fragments may remain after surgery. Patients with higher SMART scores can be counselled about the possibility of postoperative fever or haematuria and the need for closer follow-up or secondary intervention. This structured communication improves patient understanding, sets realistic expectations, and supports shared decision-making.[17]

Compared with the STONE score, the SMART score demonstrated superior predictive ability, particularly for residual fragments and postoperative complications. The correlation index in our study showed that SMART correlated more strongly with surgical outcomes than STONE. Nonetheless, the two systems are complementary rather than mutually exclusive: the STONE score remains valuable for preoperative risk stratification, whereas the SMART score adds an intraoperative dimension that reflects the true operative environment.[16,18] Together, they provide a more holistic approach to risk assessment, surgical planning, and patient care.

The Modified SMART scoring system fills an important gap in current urolithiasis management. By formally grading intraoperative findings, it not only improves prognostic accuracy but also supports intraoperative decision-making and enhances patient communication. Incorporating this system alongside conventional preoperative scores has the potential to refine surgical strategies, reduce complications, and improve patient-centred outcomes.

Limitations: This study was conducted at a single centre, which may limit the generalisability of the findings. Additionally, the follow-up period was short, preventing the assessment of long-term outcomes and complications.

CONCLUSION

The Modified SMART scoring system effectively correlated severe endoscopic findings with greater disease severity, longer surgery times, higher postoperative complications, and increased residual stones after URSL. It showed better prediction of stone clearance than the preoperative STONE score alone. Incorporating real-time endoscopic data can

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improve surgical planning and patient counselling. Further multicentre studies with longer follow-up periods are needed to validate these results.

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