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Complications of The Stone Score: A Preoperative Assessment Tool to Predict Stone Free Rate Following Ureterolithotripsy

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ABSTRACT

Introduction: *Ureteroscopic lithotripsy (URSL) is a widely accepted and minimally invasive procedure for the treatment of ureteric stones. While the STONE scoring system has been validated primarily for predicting stone-free rates based on preoperative radiological parameters, its role in anticipating procedure-related complications remains less clearly defined. This study was conducted to assess the relationship between STONE scores and the incidence of complications following URSL.*

Methods: *This hospital-based quasi-experimental study took place in the Department of Urology, NIKDU (National Institute of Kidney Disease and Urology), Sher-E-Bangla Nagar, Dhaka, Bangladesh, from January 2020 to June 2020. A total of 30 subjects were included in the study by a purposive sampling technique. Statistical analyses were carried out by using the Statistical Package for Social Sciences version 23.0.*

Result: *In this study of 30 patients, those with lower STONE scores (5–8) achieved a 100% stone-free rate with no or minimal complications, while higher scores (12–13) were associated with reduced stone clearance (50%) and increased complications. Logistic regression showed a significant negative association between STONE score and stone-free status (OR = 0.448, P = 0.043), although no statistically significant correlation was found between STONE score groups and overall complication rates (P = 0.223).*

Conclusion: *Patients with lower STONE scores (5–8) demonstrated a 100% stone-free rate with minimal or no complications, whereas higher scores (≥11) were associated with reduced stone clearance and a greater incidence of complications. Although the overall correlation between STONE score categories and complication rates was not statistically significant, the trend suggests increasing risk with higher scores. Thus, the STONE score can effectively guide surgical planning and patient counseling by anticipating procedural success and potential complications.*

Keywords: *Ureterolithotripsy, Complications, Stone Score, Preoperative Assessment Tool*

I. INTRODUCTION

Urolithiasis, the formation of stones within the urinary tract, is a prevalent condition that affects a significant portion of the global population, with a lifetime incidence of up to 15% in developed countries and increasing trends in developing nations due to dietary and lifestyle changes [1]. Ureteric stones, a common subtype of urolithiasis, frequently necessitate active intervention when conservative management fails or complications such as obstruction or infection arise. Ureteroscopic lithotripsy (URSL) has emerged as one of the most widely adopted minimally invasive procedures for the treatment of ureteric stones due to its high stone clearance rate and safety profile [2]. Despite the widespread use and effectiveness of URSL, the procedure is not without variability in outcomes. One of the key determinants of successful treatment is the stone-free rate (SFR), which refers to the complete clearance of calculi from the urinary tract after intervention. Predicting the likelihood of achieving stone-free status preoperatively is crucial in optimizing treatment decisions, improving patient counseling, and minimizing the risk of complications and unnecessary procedures [3]. Consequently, several scoring systems and nomograms have been developed to predict SFR following ureteroscopic interventions, among which the STONE score has gained prominence. The STONE score—an acronym derived from Size, Topography (location), Obstruction (degree of hydronephrosis), Number of stones, and Evaluation of Hounsfield units—was introduced as a validated preoperative assessment tool to predict SFR after ureteroscopic management of ureteral and renal calculi [4]. Each component of the score represents a measurable radiological parameter that has been shown to influence procedural outcomes. For instance, larger stone size, proximal location, severe hydronephrosis, multiple calculi, and high Hounsfield units (HU) have been associated with lower SFRs and increased procedural complexity [5]. However, while the STONE score offers a standardized method for outcome prediction, its clinical utility is also influenced by patient-specific and procedural factors that may not be fully captured in the score. Moreover, there has been growing interest in understanding whether the STONE score correlates with the likelihood of intraoperative and postoperative complications, which are significant determinants of patient morbidity and healthcare burden [6]. Complications such as ureteral injury, infection, bleeding, residual fragments, and the need for auxiliary procedures can affect patient outcomes and extend recovery times [7]. Some studies have reported a positive correlation between higher STONE scores and increased incidence of complications, likely due to the higher procedural difficulty in patients with more complex stone characteristics [8]. For example, proximal ureteral stones and those with higher density on CT scans tend to require longer operative times and increased laser energy, which may predispose to thermal injury or ureteric perforation [9]. Additionally, patients with large, multiple stones often require staged procedures, increasing their exposure to anesthesia and hospital stays. Therefore, while the STONE score was initially designed to predict stone-free outcomes, its potential to anticipate perioperative risk is gaining attention in urological practice. Incorporating the STONE score into routine preoperative assessment allows for better patient stratification and informed consent discussions. Surgeons can use the score to decide whether to proceed with URSL, consider alternative interventions such as shockwave lithotripsy (SWL) or percutaneous nephrolithotomy (PCNL), or plan for adjunctive measures like stenting or staged operations. Furthermore, identifying high-risk patients in advance may prompt proactive measures such as perioperative antibiotics, meticulous procedural planning, and use of protective devices to minimize complications [10]. This study aims to assess the relationship between the STONE score and the occurrence of complications following ureteroscopic lithotripsy.

II. METHODS

This hospital-based quasi-experimental study took place in the Department of Urology, NIKDU (National Institute of Kidney Disease and Urology), Sher-E-Bangla Nagar, Dhaka, Bangladesh, from January 2020 to June 2020. Patients with renal &ureteric stone undergoing URS stone removal in the Urology department of the National Institute of Kidney Diseases & Urology were considered as the study population. A total of 30 subjects were included in the study by a purposive sampling technique. The inclusion criteria for this study comprised patients aged 16 years and above, presenting with radio-opaque renal stones measuring between 8 mm and 20 mm in size. Only those meeting all three criteria were considered eligible for enrollment in the study. The exclusion criteria for the study included patients with any degree of ureteral stricture distal to the stone, those with radiolucent stones, and cases where ureteric injury occurred during the procedure. Patients meeting any of these conditions were excluded from the study to ensure uniformity in the analysis and outcomes. All patients underwent thorough evaluation, including history, physical examination, and relevant investigations such as urine analysis, CBC, serum creatinine, coagulation profile, USG KUB, x-ray KUB, and non-contrast CT KUB. X-ray KUB was repeated on the day of surgery. Documented UTIs were treated, and comorbidities were optimized preoperatively. STONE scores were assigned before surgery. Ureteroscopy was performed under spinal anesthesia using an 8 Fr semi-rigid or flexible ureteroscope (Storz FLEX-XC), advanced via a UAS. In lithotomy position, the ureteroscope was guided by a 0.035-inch wire. Stone fragmentation was done using a pneumatic lithoclast, with low-pressure irrigation for visibility, and fragments were extracted using a stone grasper. Statistical analyses were carried out by using the Statistical Package for Social Sciences version 23.0 for Windows (SPSS Inc., Chicago, Illinois, USA). The numerical data were expressed as mean ±SD and were compared via the Student's t test. A logistic regression model was applied to evaluate data for stone stone-free rate. $P < 0.05$ was considered statistically significant. The result was presented in tables, figures, and diagrams. The 95 % confidence intervals (CI) were calculated for these values. Ethical clearance for the study was obtained from the ethical committee of the National Institute of Kidney Diseases and Urology, Sher-E-Bangla Nagar, Dhaka, Bangladesh. Written consent was obtained from each subject.

III. RESULTS

Table 1: Age Distribution (n=30)

Age	frequency	Percentage
16-25	7	23.33%
26-35	10	33.33%
36-45	8	26.67%
46-55	1	3.33%
>56	4	13.34%
Mean	35.83±12.71	
Range	19-59 years	

Table 1 shows that out of 30 patients maximum of 33.33% belonged to the age group 26-35 years, followed by 26.67% in the 36-45 years age group. The mean age was 35.83±12.71 years (Age range: 19-59 years). [Table 1]

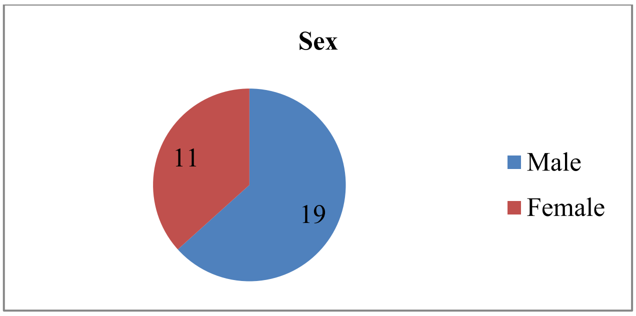

Figure 1: Sex Distribution (n=30)

Figure 1 shows that out of 30 patients 19963.33%), patients were male, and 11(36.67%) patients were female. The male-to-female ratio was 1.7:1.

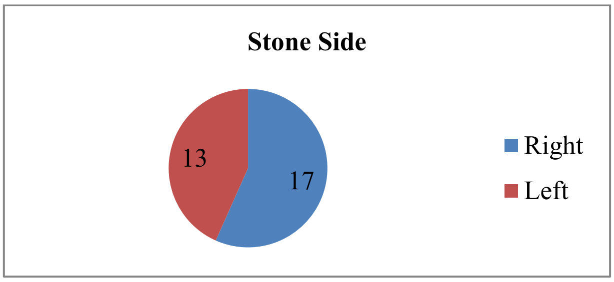

Figure 2: Distribution of patients by stone side (n=30)

Figure 2 shows that 17(56.67%) patients presented with right-sided ureteric stones, whereas 13(43.33%) patients had left-sided ureteric stones.

Table 3: STONE score in score in stone-free patients & patients with residual calculi (n=30)

	Stone free	Residual calculi	P value
STONE score	9.39±1.86	12.33±1.03	0.000125^{s}
(mean±SD)			

P-value was calculated by a paired 't' test

S; Significant

The table shows mean STONE score in stone-free patients is 9.39±1.86 & 12.33±1.03, respectively ($p<0.05$). [Table 3]

Table 4: Patient distribution, stone free status & complications according to STONE scoring system (n=30)

The STONE scoring	Number of patients (%)	Number of stone-free patients (%)	Number of complications 1 2
5	2 (6.67%)	2 (100%)	0 0
6	2 (6.67%)	2 (100%)	0 0
7	3 (10%)	3 (100%)	0 0
8	4 (13.33%)	4 (100%)	1 0
9	4 (13.33%)	3 (75%)	0 0
10	6 (20%)	5 (83.33%)	1 0
11	3 (10%)	2 (66.67%)	1 1
12	4 (13.33%)	2 (50%)	1 1
13	2 (6.67%)	1 (50%)	0 1
14	0	0	0 0
15	0	0	0 0

Patients with lower STONE scores (5–8) achieved a 100% stone-free rate with minimal to no complications. As the STONE score increased, the stone-free rate gradually declined, dropping to 50% for scores 12 and 13. Notably, complications, including one or two events per group, were observed only in patients with scores 8 and above, with the highest complication frequency seen in scores 11 to 13. No patients had scores of 14 or 15 in this cohort. [Table 4]

Table 5: Effect of STONE scoring system on stone free status, operative time, and length of stay (n=30)

STONE scoring system	B- coefficient	OR	95%CI	P value
Stone free	-0.80	0.448	0.20–0.97	0.043^{ts}
Operative time	0.109	1.11	0.93–1.34	0.244^{ns}
Length of Hospital stay (days)	-1.24	0.288	0.008–10.08	0.493^{ns}

Binary logistic regression was done to analyze the data.
S = significant

Logistic regression analysis showed an odds ratio (OR) of the STONE score to be 0.448 (P = 0.043), which was significantly associated with stone-free rates. [Table 5]

Table 6: Complication rate with STONE scoring system stratified into groups

Complication	Low (5–8)	Moderate (9–12)	High (13–15)	P value
Group 1	1	3	0	0.223^{ns}
Group 2	0	2	1	
Group 3a	0	0	0	
Group 3b	0	0	0	
Group 4a	0	0	0	
Group 4b	0	0	0	
Group 5	0	0	0	

Fisher's exact test was used to analyze the data.
NS = not significant

A correlation between STONE score stratified into low, moderate, and high score risk groups (low scores 5–8, moderate scores 9–12, high scores 13–15) and complication was not found significant (P = 0.223). [Table 6]

IV. DISCUSSION

Preoperative nomograms can prove to be very helpful tools for preoperative prediction of the success rate and complication rate of any procedure. For a nomogram to be ideal, it should be easy to apply, should have good inter-observer reproducibility, and should correlate with the success and complication rate of the procedure.

The best scoring system would be one that would help in unifying reporting for research, training purposes, and also for proper patient counseling. Several published nomograms have been generated to predict stone-free status with URS. The STONE score is a scoring system to predict the stone-free status of a patient from preoperative characteristics available on the CT scan of KUB. In our study, the mean age was 35.83±12.71 years (range 19-59years). There were a total of 19(63.33%) male &11 (36.67%) female patients & male to male-to-female ratio was 1.7:1. The mean body mass index (BMI) of the patients in the study was 24.52±3.49. The success rate in our study was 80%. The mean stone size (mm) in this study was 10.93±2.75 mm. The mean STONE score was 9.23±2.35. In our study, we found a 100% stone clearance rate in patients scoring up to a, and then the stone clearance rate gradually declined as the STONE score increased. Patients with scores 12 & 13 had a stone clearance rate of 50%. Patients with stone-free status had a mean STONE score of 9.3911.86, and those with residual calculi were 12.33±1.03 ($p<0.05$). Regression binary logistics showed the stone-free rate was significantly associated with STONE score, with OR 0.448(95%CI 0.20-0.97) with a p-value of 0.043. This means a single score increase in the STONE scoring system reduces the stone clearance rate by 0.448 times. Lower stone clearance rate with high STONE score may be associated with increased stone size, impacted stone, increased stone number, increased HU, and location. We found no significant association of STONE score with operative time and length of hospital stays (p value was 0.244 and 0.493respectively). Our findings were similar to the work done by Molina et al. [11]. They found stone stone-free rate to be correlated to the STONE score & as the score increased, the SFR decreased with a logical regression trend ($p<0.001$). Score ≤9 points obtains stone free rates >90% and typically fall off by 10%per point thereafter. The stone location is one of the most important factors regarding the stone clearance rate. In our study, we found that proximal ureteral and lower calyceal stone has a lower clearance rate. Bagley DH [12] found a success rate for treating proximal ureteral stones with small rigid and flexible ureteroscopes and the holmium laser is well over 90%. Lower pole renal calculi can also be treated with a success rate of approximately 80%. Stones in mid ureter to the vesico-ureteric junction have a clearance rate of >95%. Impacted stones are also associated with poor stone clearance. They may reduce visibility by mucosal edema & obstruction. Increased stone density measured in HU also affects stone fragmentation and clearance rate. In our study, we found a mean HU of 992.62±263.75. Amin MA et al. [13] evaluated the usefulness of measuring stone density in Hounsfield Units by Low-dose Non Contrast Computed Tomography scan in predicting the outcome of extracorporeal shockwave lithotripsy for renal stone clearance. They found 78.8% of the patients with stone density ≤750 HU exhibited complete clearance of stone as opposed to 37.5% of those with stone density>750 HU. The chance of having complete stone clearance is 6-fold (95% CI = 1.9-19.4) higher in patients with low-density stone (≤750 HU) than in patients with high-density stone (>750HU)(p=0.002). Intra- and post-operative complications were graded according to the modified Clavien grading system [14]. Out of 30 cases, 7 patients (23.33%) experienced complications. Grade 1 complication was seen in 4 patients, most common being postoperative nausea and vomiting, followed by pain, which were treated by antiemetics & analgesics. Grade 2 complication was seen in 3 patients. Among them, one patient had mucosal injury and required only stenting. Others needed a change of antibiotics due to infection. We did not come across any case of Grade 3, 4, or 5 complications in our study. STONE score can be stratified into low, moderate, and high score risk groups (low scores 5-8, moderate scores 9-12, high scores 13-15). But no significant correlation was found between stone scores and complications (P=0.223).

Limitations of The Study

The study was conducted in a single hospital with a small sample size. So, the results may not represent the whole community.

V. CONCLUSION

Patients with lower STONE scores (5–8) demonstrated a 100% stone-free rate with minimal or no complications, whereas higher scores (≥11) were associated with reduced stone clearance and a greater incidence of complications. Although the overall correlation between STONE score categories and complication rates was not statistically significant, the trend suggests increasing risk with higher scores. Thus, the STONE score can effectively guide surgical planning and patient counseling by anticipating procedural success and potential complications.

VI. RECOMMENDATION

It is recommended that the STONE scoring system be routinely utilized in preoperative evaluations for patients undergoing ureterolithotripsy. Its ability to predict stone-free rates can aid in surgical planning, patient selection, and risk stratification, thereby enhancing clinical decision-making and optimizing patient outcomes.

Further large-scale, multicenter studies are encouraged to validate its predictive value for complications and refine its clinical applicability.

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Conflict of interest: None declared

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