Predictors of Stone Free Rate and Application of the Size, Topography, Obstruction, Number and Evaluation of Hounsfield Units (S.T.O.N.E) Scoring System in Predicting the Outcome in Patients Undergoing Semi-rigid Ureteroscopic Lithotripsy for Ureteric Calculi at a University Hospital of Nepal

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ABSTRACT

Background

Ureteric colic is common urological emergency in patients with urinary stone disease. Semi rigid ureteroscopic lithotripsy is a widely acceptable treatment modality for ureteric calculi.

Objective

To evaluate the predicting factors of stone free rate (SFR) and application of the Size, Topography, Obstruction, Number and Evaluation of Hounsfield units (S.T.O.N.E) scoring system in predicting success rate of ureteroscopiclithotrisy (URSL) for ureteric calculi.

Method

This was a prospective hospital based observational study conducted at the Department of Surgery, Dhulikhel Hospital, Kathmandu University Hospital from October 2021 to September 2022. Patients undergoing ureteroscopiclithotripsy using laser and/or pneumatic lithotripsy for ureteric calculi were included in the study. Informed consent was taken from each patient and data collection was done by filling the proforma.

Result

A total of 82 patients were included in the study. Mean age of patients was 35.89 ± 11.51 years. Overall stone free rate was 80.5%. Stone free rate were 96.67% and 71.15% in moderate (6-9) and high (10-13) S.T.O.N.E score groups respectively. Stone size and S.T.N.O.E score were found to be significantly high in patients with retained stone following ureteroscopiclithotrisy (p value < 0.05). Duration of surgery was significantly high in high S.T.O.N.E score group (p<0.05). However no significant correlation was found between patient characters like age, sex, Body mass index and Hounsfield units of stone with stone free rate in this study. The area under the curve of the receiver operating characteristic curve for the S.T.O.N.E score and stone size were 0.693 and 0.660 respectively in this study.

Conclusion

Stone size and S.T.O.N.E score can be used as predictors of success following semi-rigid ureteroscopic lithotripsy. The value of S.T.N.O.E score has good predictive value for SFR and duration of surgery. There was no significant impact of patient's age, sex, Body mass index and Hounsfield units of stone in stone free rate following ureteroscopic lithotrisyin this study.

KEY WORDS

Body mass index, Lithotripsy, Receiver operating characteristic curve, Ureteroscopy

INTRODUCTION

Urinary stone disease has become a major burden to the health care service across the globe.[1] The prevalence of stone disease is increasing worldwide, with rates ranging from 1% to 5% in Asia and 7% to 13% in North America.[2,3] Ureteric calculus descends from the kidney.[4] Ureteric calculi of > 6 mm size have < 5% chance of spontaneous passage. Location of stone in the ureter can predict the chances of spontaneous passage, 50%, 25% and 10 % for stone located at distal, mid and upper ureter respectively.[5] Ureteric colic is a urological emergency causing severe pain, nausea, vomiting and anxiety to the patient, most commonly occurring in male patients from 30 years to 60 years.[1] The treatment of ureteral stones has undergone a remarkable evolution.[6] Ureterorenoscopy (URSL) and Extracorporeal shock wave lithotripsy (ESWL) are the two most favored methods for the treatment of Ureteric calculus.[7] ESWL may require multiple sessions and repeated follow-up visits to achieve complete stone clearance.[8] Semi-rigid ureteroscopy has been reliable and widely accepted treatment modality for the management of ureteral stones with advantage of better stone clearance.[9]

Ureterorenoscopy is more reliable with better stone free rate. A scientific model to help predict treatment success is vital for optimal decision making and patient counseling. Size, Topography, Obstruction, Number, and Evaluation of Hounsfield units (S.T.O.N.E.) score has been devised as a novel assessment tool to predict stone free rate in patients undergoing URS.[10,11]

We aim to investigate different factors responsible in predicting the stone free status and application of S.T.O.N.E score in predicting the outcome among patients undergoing semirigidureterooscopy for ureteric calculi at a University Hospital of Nepal.

METHODS

This was a prospective hospital based observational study conducted at Department of Surgery, Dhulikhel Hospital, Kathmandu University Hospital from October 2021 to September 2022, after approval of Institutional review committee. Sample size of 73 was calculated with estimated prevalence of 5% with 95% confidence interval. However, considering possible dropouts, we took 82 patients admitted to Surgery Ward of Dhulikhel Hospital, Kathmandu University hospital who underwent URSL using laser/pneumatic lithotripsy for ureteric calculus in the study. Patients under the age of 18 years, patients lacking preoperative computed tomography (CT) scan, patients who underwent URS without lithotripsy were excluded from the study. The S.T.O.N.E. score was calculated from its five parameters. Scores given to these five parameters were as follows: size of stone (S): 1 point for stones less than 5 mm, 2 points for stones equal to or more than 5 mm but less than 10 mm, and 3 points for stones more than 10 mm. For topography or location of stone (T): 1 point for distal and mid-ureteric stones, 2 points for proximal ureter, mid-pole, and upper pole stones, and 3 points for lower pole stones. Obstruction (O) is evaluated by degree of hydronephrosis: 1 point for no hydronephrosis, 2 points for mild to moderate hydronephrosis (grade 1-2), and 3 points for severe hydronephrosis (grade 3-4). Number of stones (N): 1 point for 1 stone, 2 points for 2 stones, and 3 points for 3 stones or more. Evaluation (E) of the Hounsfield unit (HU): 1 point for less than 750 HU, 2 points for between 750 and 1000 HU, and 3 points for equal to or more than 1000 HU. The grades were summed to give a final S.T.O.N.E. score (5 to 15 points).[9]

Informed consent was taken from each participant. URSL was performed using standard protocol followed by the department under either general or regional anaesthesia. A single dose of prophylactic intravenous antibiotic was given prior to the procedure and continued for total 5-7 days postoperatively.

Patients were placed in the dorsal lithotomy position. Rigid cystoscopy was done to visualize the urinary bladder and identify the ureteric orifice, followed by introduction guide wire. A semi rigid ureteroscopy was conducted (7.5/9.5 Fr, Karl Stroz, Tuttlingen, Germany) and visualized stone fragmented using laser/pneumatic lithotripsy. During the lithotripsy, a holmium YAG laser (200 or 272 micron fibers) or Swiss Lithoclast Pneumatic Lithotripter (Electro Medical Systems, Le Sentier, Switzerland) was used. Fragmented stones were either actively flushed using Normal saline or left without retrieval depending upon their size. At the end of the procedure, a double J stent was placed as per the patient's clinical condition and the surgeons judgment.

A successful URSL was determined by the clinical status of stone free, which was defined as no evidence of a stone or clinically insignificant residual fragment stones less than 2 mm, as demonstrated by postoperative imaging or by meticulous endoscopic inspection and simultaneous fluoroscopy.[9]

Patient was called for double J stent removal 4-6 weeks after the procedure. Double J stent removal was performed under local anesthesia and patients were discharged on the same day.

SPSS 20.0 (SPSS Inc., Chicago,IL,USA) was used for data analysis. Frequency analysis was performed for scalar and ordinal variables. For nominal variables, descriptive analysis was performed with calculation of mean, range, standard deviation. Independent sample t-test was performed for comparison of parametric scalar variables between two groups. For non parametric categorical variables, Chi square test was performed. The p value of less than 0.05 was considered significant.

RESULTS

This study comprised of 82 patients who underwent URSL using laser/pneumatic lithotripsy for ureteric calculus. Complete stone clearance was obtained in 66 (80.5%) patients (Group A) while 16 (19.5%) patients (Group B) had retained stones after the procedure. The mean age of patients was 35.89± 11.51 years. 45(54.87%) patients were male and 37(45.12%) were female.

As shown in table 1, there is no significant difference between male and female patients in Group A and Group B (p=0.902).

Table 1. Comparison of gender between Group A and Group B.

	Male	Female	p-value
Complete stone clearance (Group A)	36	30	0.902
Retained stone (Group B)	9	7	

As shown in table 2, there is no significant difference in side of stone between Group A and Group B (p=0.0.544).

Table 2. Comparison of side of stone between Group A and Group B

	Right	Left	Bilateral	p-value
Complete stone clearance (Group A)	34	32	1	0.544
Retained stone (Group B)	8	7	1	

As shown in table 3, laser lithotripsy is a reliable mode of lithotripsy for good stone free status.

Table 3. Comparison of instrument used between Group A and Group B

	Laser lithotripsy	Pneumatic lithotripsy	Both (laser and pneumatic lithotripsy)	p-value
Complete stone clearance (Group A)	65	1	0	0.000
Retained stone (Group B)	8	3	5	

As shown in table 4, Stone size, S.T.O.N.E score and duration of surgery are significantly high in patients with retained stones (Group B). However there is no significant difference between Age, Hounsfield Units (H.U) and Body mass index(BMI) in patients with complete stone clearance(Group A) and Retained stone (Group B).

As shown in table 5, patients were divided into three groups according to S.T.O.N.E Score, low (5), moderate (6-9) and high (10-13). There were no patients in low S.T.O.N.E score group. Thirty patients were in moderate S.T.O.N.E Score group and 52 in high S.T.O.N.E Score group with SFR 96.67% and 71.15% respectively.

Table 4. Comparison of Age, stone size, Hounsfield units (H.U), Body mass index (BMI), S.T.O.N.E score and duration of surgery between Group A and Group B.

	Group	Mean	S.D	p-value
Age	Complete stone clearance(Group A)	35.55	10.88	0.585
	Retained stone (Group B)	37.31	14.16	
Stone size (mm)	Complete stone clearance(Group A)	10.58	2.49	0.015
	Retained stone (Group B)	12.55	4.07	
Hounsfield units (H.U)	Complete stone clearance(Group A)	1037.21	203.59	0.257
	Retained stone (Group B)	1103.44	226.7	
Body mass index (BMI)	Complete stone clearance(Group A)	26.17	3.28	0.199
	Retained stone (Group B)	24.93	3.94	
S.T.O.N.E score	Complete stone clearance(Group A)	9.82	1.14	0.016
	Retained stone (Group B)	10.56	0.72	
Duration of surgery (minutes)	Complete stone clearance(Group A)	25.03	7.78	0.000
	Retained stone (Group B)	43.75	19.79	

Table 5. S.T.O.N.E Score group and SFR

S.T.O.N.E Score Group	Number of Patients	Stone Free Rate (SFR)
Low (5)	0	
Moderate (6-9)	30(36.6%)	96.67%
High (10-13)	52(63.4%)	71.15%
Total	82(100%)	

As shown in table 6, duration of surgery is significantly high in high S.T.O.N.E Score group (p=0.019).

Table 6. S.T.O.N.E Score group and Duration of Surgery.

S.T.O.N.E Score group	Number of patients	Duration of Surgery (Mean ± S.D minutes)	p- value
Moderate (6-9)	30	24.17 ± 9.65	0.019
High (10-13)	52	31.29 ± 14.45	

Among the complications, hematuria was the most common complication which was noted in 22 (26.82%) patients followed by post dural puncture headache(PDPH) in 2 (2.4%) and ureteric stricture in 1 (1.2%) patient. Hematuria was transient and subsided after few days. Patients with PDPH were managed with analgesics and adequate hydration. Patient who developed ureteric stricture was managed with ureteric balloon dilatation and DJ stenting. The patient was asymptomatic and follow-up URS and RPG done revealed adequate ureteric lumen admitting easy passage of 8.5 Frureteroscope.

Stone free rate declined with increase in S.T.O.N.E Score. Stone free rate was 72.7% and 68% for patients with S.T.O.N.E Score 10 and 11 respectively (fig. 1).

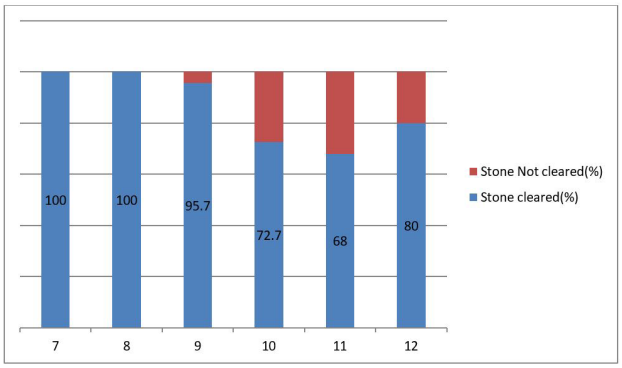

Figure 1. Effect of S.T.O.N.E Score on Stone free rate.

Our study showed an AUC of 0.693 regarding the accuracy of S.T.O.N.E scoring system in predicting stone free status following URSL (fig. 2).

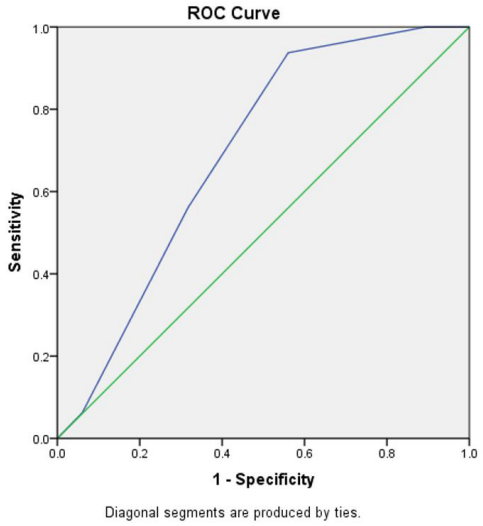

Figure 2. ROC Curve of S.T.O.N.E Score (AUC=0.693)

Our study showed an AUC of 0.660 regarding the accuracy of stone size in predicting stone free status following URSL (fig. 3.

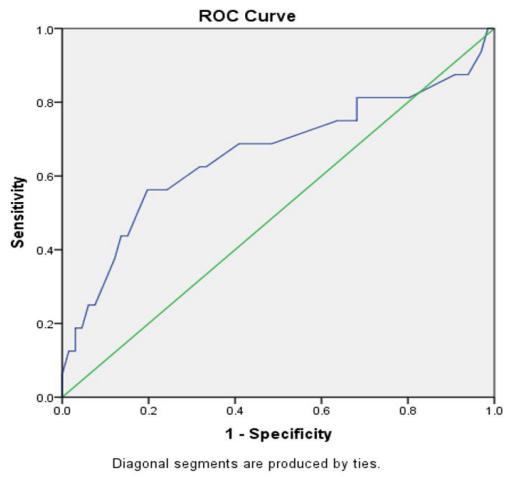

Figure 3. ROC Curve of stone size. (AUC= 0.660)

DISCUSSION

Urolithiasis is a common condition of urinary tract. Ureteric calculus generally forms in kidney and comes down to ureter. Ureteral stones are significant health problems throughout the world, most of whom present to Emergency room or urology clinic mostly with severe colic. Chances of spontaneous passage of ureteric calculus depends upon size and location of calculus. Ureteric calculus > 6 mm are most likely to require surgical treatment. Ureteroscopic lithotripsy (URSL) is one of the established treatment modality for treatment of ureteric calculus. The main benefit of URSL is immediate relief of symptoms and good stone free rate. ESWL is an alternative method available, however this method may require multiple sessions and might take lengthy time for stone free status.Various known factors affecting the success rate of URSL are age, sex, BMI, stone and ureteral characteristics, degree of hydronephrosis along with available equipments and surgeon's expertise.[11-14]

Okcelik et al. has shown stone free rate following semi-rigid ureterorenoscopy to be 78.8%.[15] Sancak et al. has reported SFR to be 81.7% and Giulianelli et al. have given 86.1% overall SFR with 68.13% for upper ureteric stone, 84.8% for mid ureteric stone and 96.4% for distal ureteric stone respectably following URSL.[16,17] The overall stone free rate (SFR) following URSL for ureteric calculi was 80.5% in our study which is comparable to other studies.[15-17]

Patient characters like age, sex and BMI did not show any significant impact on stone clearance which is similar to the result of other study.[18] Unlike the correlation shown by Mishra et al. there is no correlation between BMI and SFR in this study.[14] The study by Kim et al revealed that the HU value did not affect the success of treatment using URSL which is similar to the finding of our study.[19] The usefulness of Hounsfield unit as a determinant of URSL success is still to be established.[20] The mean overall stone size in our study was 10.96 mm (Range 5-22, S.D 2.94). The stone size has shown to be a significant factor for stone clearance following URSL in our study (p value = 0.016). However a study by Mishra et al. has shown no association of stone size with stone free status following URSL.[21]

The duration of surgery was found to be significantly more in patients with retained stones following URSL in our study (p value= 0.000) The reason for prolonged operative time in this group could be larger impacted stone with significant mucosal oedema. The overall operative duration was 28.68 ± 13.29 minutes in our study. This is comparable to the finding of other study by Mishra et al. who has found the operative time to 32.86 ± 16.94 minutes.[21] Holmium Laser lithotripsy has achieved good stone free rate in our study. Teichman et al. has also concluded that out of all available methods it is the holmium laser that breaks up stones into the smallest fragments.[22] The use of laser is costly and may not be available everywhere. However, we recommend the use of holmium laser for ureteroscopic lithotripsy wherever possible.

The development of statistical models and score systems can help surgeons with new insight into patient planning and counseling regarding the possible outcomes following a procedure. The S.T.O.N.E Score is a newly developed user friendly model to predict stone free rate post URS. A S.T.O.N.E Score ≤ 9 points can yield stone free rates > 90% and typically decrease by 10% per point thereafter.[10] The average S.T.O.N.E Score of overall patients was found to be 9.96 in our study. Our study has shown significant association between S.T.O.N.E Score and Stone Free rate (SFR) (p value= 0.016). On dividing the patients according to S.T.O.N.E Score Group, SFR was found to be 96.67% for moderate S.T.O.N.E Score Group and 71.15% for high S.T.O.N.E Score Group. Duration of surgery is found to be high in the later group. Our results are comparable to those reported by similar study which has shown SFR 97.83% and 77.42% respectively.[11]

Regarding S.T.O.N.E scoring system accuracy, this study had an AUC of 0.693 in predicting stone free status following URSL. Likewise, Molina et al. reported an AUC of 0.764 and Sirirak et al. reported an AUC of 0.815 for the S.T.O.N.E Score.[10,11] Similarly, the predictive accuracy of stone size for stone free rate was comparable to S.T.O.N.E Scoring system with an AUC of 0.660. Sirirak et al. has shown similar finding with AUC of 0.774.[11] Increasing S.T.O.N.E Score and Stone size are negative predictors of stone free status following URSL for ureteric calculi.

This study was a single-center study which can be a limitation of the study, a multiple-center study with a larger patient population would yield better outcomes at national level.

CONCLUSION

Stone size and S.T.O.N.E score can be used as predictors of success following semi-rigid ureteroscopic lithotripsy (URSL). The value of S.T.N.O.E score has good predictive value for SFR and duration of surgery. Hence, Stone size and S.T.O.N.E Score can be used as simple yet valuable tools in clinical management plan and counseling for every patient undergoing semi-rigid ureteroscopic lithotripsy for management of ureteric calculi. However no significant correlation was found between patient characters like age, sex, Body mass index (BMI) and Hounsfield units (HU) of stone with stone free rate (SFR).

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