Utility of S.T.O.N.E Score to Predict Stone Clearance After Percutaneous Nephrolithotomy

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ABSTRACT

Objective — *To determine the utility of S.T.O.N.E score in predicting the stone free rate (SFR) after percutaneous nephrolithotomy (PCNL).*

Study design — *Cross sectional study.*

Place & Duration of study — *Department of Urology, Jinnah Postgraduate Medical Centre (JPMC) Karachi, from January 2019 to November 2019.*

Methodology — *Patients, who had renal calculus of more than 1.5cm were included in this study. All patients had pre-procedure non contrast enhanced CT scan to determine the stone characteristics. S.T.O.N.E score was calculated using CT findings. In all patients, PCNL was performed by using rigid nephroscope in prone position. After three months of PCNL, CT scan was performed to determine stone free rate (SFR).*

Results — *Total of 120 patients were included in this study. The mean age of the patients was 39.2±11.2 year. There were 83 (69.2%) males and 37 (30.8%) females. After PCNL, 98 (81.7%) patients were stone free. In 22 (18.3%) patients residual stones found on follow up. Patients with residual stones had higher mean S.T.O.N.E score when compared to patients who had complete stone clearance which was significant (p <0.001). Binary logistic regression showed significant regression co-efficient (B=-0.40) and p-value <0.001. On ROC analysis, area under the curve (AUC) was 0.781 with 0.697 lower and 0.871 upper limits, which shows that S.T.O.N.E. score can clearly predict unsuccessful stone clearance.*

Conclusion — *S.T.O.N.E score can successfully predict risk of failure of PCNL in patients with renal stone disease. S.T.O.N.E. score is easy to calculate and can effectively help to predict high risk patients.*

Key words — *Urolithiasis, S.T.O.N.E. score, Stone free rate, Renal calculus.*

INTRODUCTION:

Urolithiasis is a common disease that has an unusual impact on quality of life. The prevalence of urolithiasis is rising around the world regardless of age and gender.[1] the prevalence rate of the nephrolithiasis varies from 1% to 5% in Asia,[2] and 16 % in Pakistan (7.4% in northern Pakistan and 28% in west of Pakistan).[3] Percutaneous nephrolithotomy is an established method of stone disease management since decades with minimum complication rate.[4,5] PCNL has varying success rate from 56% to 76% according to published studies which can be increased by using adjuvant treatments such as shockwave lithotripsy (SWL) and adding multiple nephrostomy tracks.[6] This adds to the overall cost and procedural complications as well.[7]

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By determining the factors that can correlate with post-PCNL success rate, a better preoperative selection of the treatment options can be made. Different factors such as type and composition of stones, ethnicity and gender are reported to predict stone free rate (SFR) after PCNL by using different scoring system but none of them is regarded as the accurate score.[8] S.T.O.N.E. score is one of the scoring systems developed to predict SFR. This is based on computed tomography findings and uses five stone parameters, the stone size, location, obstruction, number and Hounsfield units (HU).[9] The utility of this soring system has not been reported widely in literature. The aim of the present study was to determine the role of S.T.O.N.E. score in predicting the SFR after PCNL.

METHODOLOGY:

This cross sectional study was conducted on 120 patients who underwent PCNL in the Department of Urology JPMC Karachi, from January 2019 to November 2019. Patients who had renal stones of size=15 mm and age >18 years were included. Patients with previous renal stone surgery, radiolucent stones, ureteral stones, skeletal deformity or anatomic kidney variations and positive urine cultures, were excluded. Purpose of the study was explained to the patients and informed written consent taken. Detailed history and clinical examination were done in all patients. Routine baseline investigations including urine culture, ultrasound KUB, non-contrast CT Kidney, ureter and bladder (NCCT KUB) and x-ray KUB were done in all patients before surgery. NCCT KUB was used to calculate S.T.O.N.E score findings as given in table I.

All procedures were performed in prone position. Tract dilatation was done with Alken dilators under fluoroscopic guidance after puncturing of the desired calyx. Pneumatic lithoclast was used to fragment the stone. At the end of the procedure, fluoroscope and nephroscope were used to look for the residual stone. Post PCNL nephrostomy catheter was placed in each patient that was removed before the discharge. At follow up, x-ray KUB was used to find out the presence of residual stone. At the end of third month post-procedure, NCCT KUB was performed for assessing stone free status of the patients. All patients who had no stone or fragments less than 1-2 mm were considered as stone free.

Data analysis was performed with SPSS version 23 software. Independent sample t-test was applied to compare the mean S.T.O.N.E. score among stone free patients with those having residual stones. Logistic regression was applied to calculate the regression co-efficient of S.T.O.N.E. score on residual stones. ROC curve was made to calculate AUC of the S.T.O.N.E. score for predicting residual fragments.

Table I: S.T.O.N.E. Score

Category	Characteristic	Score
Size	<5 mm	1
	5-10 mm	2
	> 10 mm	3
Topography	Distal to Mid-Ureter	1
	Proximal Ureter (Mid to Upper Pole)	2
	Lower Pole	3
Obstruction	Preoperative Stent or No Hydronephrosis	1
	Grade 1-2	2
	Grade 3-4	3
Number of Stones	1	1
	2	2
	>3	3
Evaluation of HU	<750	1
	750-1000	2
	> 1000	3

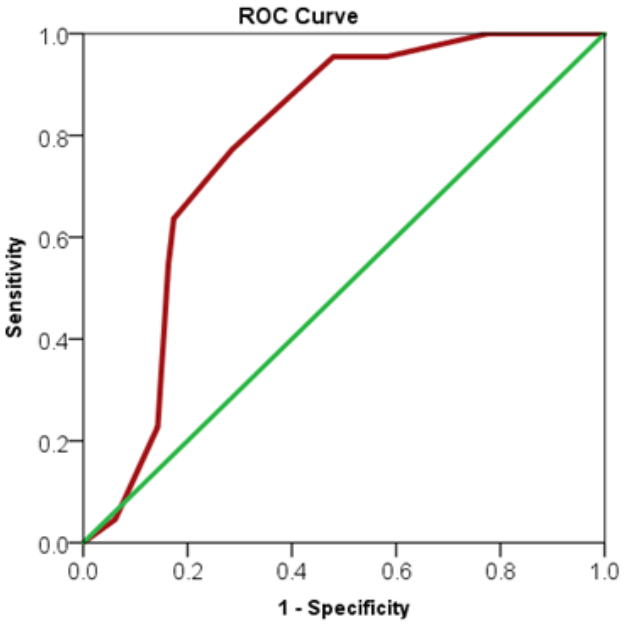

Fig I: ROC Curve Characteristics for Prediction of Residual Stones

RESULTS:

A total of 120 patients were enrolled in this study with 83 (69.2%) males and 37 (30.8%) females. The mean age of the patients was 39.2±11.2 year. Fifty-three (44.2%) stones were on left side and 67 (55.8%) on right side. Mean stone size was 17.2±6.9 mm. A total of 1.33±0.59 nephrostomy tracts were used. The overall SFR was of 81.7%. There were 22 (18.3%) patients who were diagnosed with significant residual stones. Patients with residual stones after the procedure had large stone burden (23.69+12.69 mm) compared to the patients with stone free outcome (15.88+3.63 mm). The mean S.T.O.N.E. score was significantly higher in patients with residual fragments, 10.04±1.74 versus 7.19±2.55 which was statistically significant ($p < 0.001$).

Binary logistic regression was applied to determine the effect of S.T.O.N.E. score on residual stones and significant regression co-efficient (B=-0.40) with odds ratio (OR=1.49 - 1.21-1.84) and $p < 0.001$. Thus each point increase in S.T.O.N.E. score can increase 0.40 times chances of unsuccessful stone clearance. On ROC analysis, area under the curve was 0.781 with 0.697 lower and 0.871 upper limits. This shows that S.T.O.N.E. score can clearly predict unsuccessful stone clearance (Fig - I).

DISCUSSION:

PCNL is considered as a gold standard procedure for renal calculi with good outcome, even with large and complex stones, the success of which is determined by several factors.[10] Most of these can be taken into consideration before surgical intervention. This include stone burden, its location and upper tract anatomy. Experience of surgeon also plays role in successful outcome of PCNL.[11] There has been an increasing interest in looking for factors that can easily predict stone free rate before PCNL that can be helpful in pre-procedural counseling of patients about the possible outcomes.

Statistical models help to designs prediction scores on the basis of patients and stone related characteristics. An ideal scoring system should be user friendly, reproducible with simple implications, and good in determining SFR and procedure related complication.[12] Such scoring system may be used for audit, and comparison of results among different centers and with different approaches by being consistent and acceptable for reporting.[13,14] This study also aimed to validate one such scoring system, the S.T.O.N.E score. It is used in comparison to other scoring systems such as Guy's score and S-ReSC scoring systems that are based on stone characteristics such as stone size, number, anatomy of kidney and collecting system and therefore, difficult to calculate.[9,15,16] S.T.O.N.E score uses stone related parameters and does not involve collecting system and kidney anomalies thus it can be calculated using CT scan findings.

In this study NCECT for S.T.O.N.E score calculation was found useful as has been reported by others.[17] A scoring system has been used in a mutli-institutional study that showed significant association of SFR with estimated blood loss, total operative time, complication rate and hospital stay duration. In present study these parameters as well as postoperative complications were not recorded.[18]

In present study, we found that S.T.O.N.E. score is a valuable tool and can predict the risk of failure of primary PCNL procedure. With increase in score the chances of SFR decreases as significantly higher mean S.T.O.N.E. score value was found in residual stones group in comparison with stone free group. A study by Kumar et al also reported similar outcomes.[19] Another study by Choi et al also reported similar findings. These authors also compared S.T.O.N.E score with Guy's score and CROES score nomogram and did not find any significant difference in accuracy of these three scoring systems and concluded that all of these scores are equally effective in determining the risk of residual stone fragments after PCNL.[20]

The sample size of our and other conducted studies

Table I: Area Under the Curve

Test Result Variable(s): S.T.O.N.E. Score

Area	Std. Error[a]	Asymptotic Sig.[b]	Asymptotic 95% Confidence Interval	
			Lower Bound	Upper Bound
.784	.044	.000	0.697	.871

are small due to which the ideal cut-off value of S.T.O.N.E. score for predicting the risk of failure is still not decided. There is a need to conduct a large study with sufficient sample size so that the ideal cut-off value of S.T.O.N.E. score can be defined.

CONCLUSION:

S.T.O.N.E. score can successfully predict risk of failure of PCNL or need of additional procedures in patients with renal stone disease. The score can be easily calculated from CT parameters. It can predict high risk patients and help to develop strategy in preoperative planning to increase SFR in this group.

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