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"Prospective Evaluation of Stone Free Rate and Complications of Percutaneous Nephrolithotomy Using the 'STONE' Nephrolithometry Score"

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***Abstract**: Percutaneous nephrolithotomy (PCNL) is the minimally invasive treatment modality for complex kidney calculi and considered as the standard treatment for large and complex renal stones. New predictive tools have recently emerged to systematically and quantitatively assess kidney stone complexity to predict outcomes following PCNL.*
***Aims and objective:** To prospectively evaluate the ability of 'stone nephrolithometry score in predicting stone clearance rate and complications rate by modified clavien classification (within 30 days of the procedure).*
***Materials and Methods:** A Prospective observational study done in the duration from January 2017 to June 2018. All patients having renal stone admitted for PCNL in Urology department, of a tertiary care hospital in eastern part of India.*
***Results:** A total 100 patients fulfilled the inclusion and exclusion criteria for undergoing the PCNL for this study. Ninety patients had total clearance . In complete clearance group average stone size is 810 mm^2 , Avg tract length was 87.61mm and average calyces involved was 1.1 with density of stone of 1024.9 HU.*
***Conclusion:** The STONE score is a simple and easy to apply system for predicting the complexity of the stone for PCNL, and stone clearance rate.*
***Key words:** STONE NEPHROMETRY SCORE , PCNL, Modified Clavien, Dindo*

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I. Introduction

Percutaneous nephrolithotomy (PCNL) is the minimally invasive treatment modality for complex kidney calculi**[1].** With the marked increase in the incidence and prevalence of renal stones, the use of percutaneous nephrolithotomy (PCNL) is now considered as the standard treatment for large and complex renal stones [2,3]. New predictive tools have recently emerged to systematically and quantitatively assess kidney stone complexity to predict outcomes following PCNL: the Guy's Stone Score, the CROES nomogram, S.T.O.N.E. nephrolithometry, and S-ReSC score. An ideal scoring system should include variables that both influence surgical planning and are predictive of postoperative outcomes. This review discusses the strengths, weaknesses, and commonalities of each of the above scoring systems. Recently, Okhunov et al. [4] proposed a novel quantitative scoring system which integrates five components measured from non-contrast-enhanced CT (NCECT) images before surgery to provide a picture of the complexity that can affect the percutaneous management of renal calculi. The stone score is calculated using five variables, abbreviated as an acronym 'STONE'. These include stone size, tract length (skin-to-stone distance), degree of obstruction, number of calyces involved and stone essence (density). Each feature from the NCCT KUB was graded on a 1-3 point scale. The scoring system can be used as a standard method for predicting the stone-free rate (SFR) after PCNL, and help in preoperative patient counselling, surgical planning and uniform academic reporting of the outcome. By this scoring system to assess peri-operative complications which will be measured by modified clavien classification of surgical complications. In this study we will try to evaluate it's efficacy of 'STONE' nephrolithometry score in grading stone free rate and perioperative complications by modified clavien system.

New predictive tools have recently emerged to systematically and quantitatively assess kidney stone complexity to predict outcomes following PCNL: the Guy's Stone Score, the CROES nomogram, S.T.O.N.E. nephrolithometry, and S-ReSC score. An ideal scoring system should include variables that both influence surgical planning and are predictive of postoperative outcomes. This review discusses the strengths, weaknesses, and commonalities of each of the above scoring systems.

II. Aims & Objectives

To prospectively evaluate the ability of 'stone nephrolithometry score in predicting.

1. Stone clearance rate.
2. Complications rate by modified clavien classification (within 30 days of the procedure).

III. Materials And Methods

A Prospective observational study done in the duration from January 2017 to June 2018. All patients having renal stone admitted for PCNL in Urology department, of a tertiary care hospital in eastern part of India. Renal stone ≥ 2 cm in largest diameter were included in the study , in some situation stone ≥1.5 (in largest diameter) in lower pole stone or any stone that was not favourable for RIRS or ESWL were also included.

Radiolucent stone, bilateral renal stone, presence of a ureteric stent, presence of nephrostomy tube, Active UTI, Skeletal deformity or special/abnormal anatomy of upper tract (i.e., horshoe kidney, PUJ obstruction, bifid system, etc) were excluded from the study.

In preoperative period nephrolithometric score is measured from the variables from NCCT of KUB region. The CT variables stone size, tract length, degree and presence ofobstruction (hydronephrosis), number of involved calyces and stone essence (density) is measured. Each of the variables is scored according to the predefined system and the STONE nephrolithometry score calculated using the sum of individual variable scores. All procedures are performed with the patient prone, using single-tract dilatation with Alken dilators under fluoroscopic guidance. Stones arefragmented using either the pneumatic Lithoclast, or simultaneous combined therapy with the Lithoclast and Holmium - YAG laser lithotripter. The procedure is continued until no stone could be identified by both nephroscopic and fluoroscopic inspection. Antegrade double 'J' is placed in majority of patients. Nephrostomy tube is inserted at the end of procedure in case of perforation of pelvicalyceal system, suspected residual fragments, incomplete clearance or bleeding from the tract. Str. X ray KUB are routinely performed on 3^{rd} post-op day. S.T.O.N.E. nephrolithometry wasdeveloped via a literature review ofEnglish language studies from 1976 to 2012 on Medline to identify the most clinically relevant and reproducible variables that had been shown to impact outcomes following PCNL. Its components are stone size, PCNL tract length, presenceof obstruction, number of involved calyces, and stone density,measured from preoperative CT.A cohort of 117 PCNL patientswas used to evaluate the predictivevalue of the S.T.O.N.E. nephrolithometry.A "low" score of 3 to5 demonstrated a correlation withSF rates of 94% to 100%, a "moderate"score of 6 to 8 correlated witha SF rate of 83% to 92%, and "high"scores of 9 to 13 correlated with SFrates ranging from 27% to 64%.

S.T.O.N.E. Nephro-lithometry[c]	Scoring based on 5 variables from preoperative noncontrast computed tomography stone size: **S** = stone size 1: 0-399 mm^2 2: 400-799 mm^2 3: 800-1599 mm^2 4: > 1600 mm^2 **T** = tract length 1: < 100 mm 2: > 100 mm **O** = Obstruction 1: no or mild dilatation 2: moderate to severe dilatation **N** = Number of involved calyces 1: 1 calyx involved 2: 2-3 calyces involved 3: full staghorn calculus **E** = Essence (stone density) 1: < 950 HU 2: > 950 HU

IV. Results And Analysis

STUDY GROUP :

A total 100 patients fulfiled the inclusion and exclusion criteria for undergoing the PCNL for this study. Fifty five patients are male with average age 41 years and 45 patients are female with average age is 41 years. Out of 100 patients 90 patients had complete clearance and 10 patients had incomplete clearance.

	COMPLETE CLEARANCE	INCOMPLETE CLEARANCE	TOTAL	P value
STONE SIZE(mm^2)	810.58	967.6	826.28	< 0.05

In complete clearance group average stone size is 810 mm^2 and incomplete group average stone size is 967 mm^2 and which is statistially significant that is if stone size is increased stone clearance rate decreases.

	COMPLETE CLEARANCE	INCOMPLETE CLEARANCE	TOTAL	P value
SKIN TO STONE DISTANCE	87.61 mm	90.2 mm	87.87	> 0.05

As P value is more than 0.05 so Skin to stone distance does not change the operative success rate.

	COMPLETE CLEARANCE	INCOMPLETE CLEARANCE	TOTAL	P value> 0.05
DEGREE OF HYDRONEPHROSIS	1.4	1.6		

Degree of hydronephros is not related to stone clearance rate.

	COMPLETE CLEARANCE	INCOMPLETE CLEARANCE	TOTAL	P value 0.02
NO. OF CALYCES	1.1	1.7	1.16	

In complete clearance group average number of calyx involved are 1.1 and incomplete group average number of calyx is involved is 1.7 and which is statistially significant that is if stone is found in multiple calyces then success rate decreases.

	COMPLETE CLEARANCE	INCOMPLETE CLEARANCE	TOTAL	P value > 0.05
ESSENCE OF STONE	1024.9	1089.7	1031.4	

In complete clearance group average stone density is 1024.9 HU and incomplete group average stone density is 1089.7 HU and which is statistially not significant that is if stone density is increased stone clearance does not change.

	COMPLETE CLEARANCE	INCOMPLETE CLEARANCE	TOTAL	P value 0.002
‘STONE’ SCORE	7.21	8.6	7.35	

In this chart P value is statistically significant so NEPHROMETRIC RENAL SCORE is significantly correlated with operative success rate.

Intraoperative time was documented and compared between the patients group of different stone score.

STONE SCORE	GROUP A	GROUP B	P value = 0.011
Operative time(min)	56	72	

Group A – NEPHROMETRIC SCORE 6, 7, 8
Group B – NEPHROMETRIC SCORE 9, 10, 11
Likewise Clavein Dindo score was noted and compared .

STONE SCORE	GROUP A	GROUP B	P value = 0.021
MODIFIED CLAVIEN SCORE	0.82	1.8	

Group A – NEPHROMETRIC SCORE 6, 7, 8
Group B – NEPHROMETRIC SCORE 9, 10, 11
It obvious from the table that clavien score significantly correlated with NEPHROMETRIC RENAL SCORE.

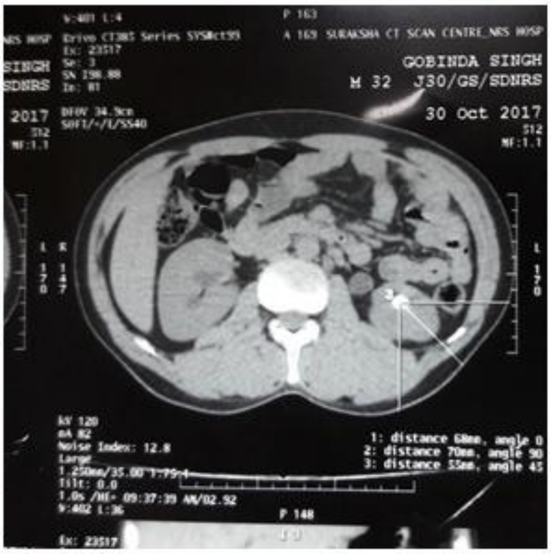

FIG: showing stone size **FIG: showing skin to stone distance**

FIG INSTRUMENT TROLLEY FOR PCNL

V. Discussion

In the general population the incidence of urolithiasis is 5–10% and nearly 30% of the workload in an active urology department is related to treating urinary stones [5,6]. For large and complex kidney stones PCNL is an important surgical intervention, and its success depends on several variables. Some of these can be predicted before surgery, i.e., stone burden and upper tract anatomy, but success also depends on surgical experience[7]. To establish an accurate diagnosis and to determine the optimum treatment and surgical planning, preoperative imaging is a critical step [8]. CT has become the leading imaging method for urolithiasis, providing high-resolution spatial imaging along with multiplanar reconstruction for the accurate determination of stone complexity i.e. size and distribution, pelvicalyceal anatomy and anatomical relationship with other structures, hence contributing to surgical planning [9,10]. Several scoring systems have been developed for predicting the SFR after shock-wave lithotripsy, retrograde intrarenal surgery and PCNL [11,12]. These have incorporated different variables that can influence success rates, but the imaging methods on which these systems are developed show some inconsistencies [13]. The scoring systems in contemporary use for predicting the outcome of PCNL are Guy's stone score, the STONE nephrolithometry score, the Clinical Research Office Of Endo-

Urological Society (CROES) nephrolithometric nomogram, and staghorn morphometry. These have attempted to incorporate important variables in an efficient and simple manner to quantify renal stone complexity [13]. An optimal scoring system should be quick, simple, reproducible and easily implemented and must have a good correlation with SFRs and complications [14].

Several scoring systems have been developed for predicting the SFR after shock-wave lithotripsy, retrograde intrarenal surgery and PCNL [11], [12]. These have incorporated different variables that can influence success rates, but the imaging methods on which these systems are developed show some inconsistencies.

Okhunov et al. developed and validated the STONE score from preoperative NCECT, based on a Medline review of English-language studies from 1976 to 2012 and identifying clinically relevant variables affecting the outcomes of PCNL. This scoring system was externally validated in a multi-institutional study with 850 patients, and showed that the model was significantly associated with the SFR, overall complication rate, estimated blood loss, operative duration and length of hospital stay. In contrast to the other scoring systems, the STONE score uses variables that are easy to calculate, derived from NCECT (most common diagnostic method used for evaluating patients with stone) and requires no specialised software.

All patients with radiolucent stone, bilateral renal stone, presence of a ureteric stent and presence of nephrostomy tube, active UTI, skeletal deformity or special/abnormal anatomy of upper tract (i.e. horshoe kidney, PUJ obstruction, bifid system, etc), pregnancy, patients who are unfit for surgery, untreated coagulopathy are excluded from study.

In our study total number of patients are 100 and overall complete clearance rate 90%. Residual stone (stone> 4 mm in size on KUB radiography at one month postoperative film) found in 10% patients.

Fifty five patients are male with average age 41 years and 45 patients are female with average age is 41 years with similar success rate.

In complete clearance group average **stone size** is 810 mm^2 and incomplete group average stone size is 926 mm^2 and which is statistially significant that is if stone size is increased stone clearance decreases.

As P value is less than 0.05 so **Skin to stone distance** does not change the operative success rate.

As shown in the table in complete clearance group average **stone density** is 1024.9 HU and incomplete group average stone density is 1089.7 HU and which is statistially not significant that is if stone density is increased stone clearance does not change. **Degree of hydronephrosis** not related to stone clearance rate according to my data.

As shown in this graph in complete clearance group average number of calyx is involved is 1.1 and in incomplete group average number of calyx is involved is 1.7 and which is statistially significant that is **if stone is found in multiple calyces then success rate decreases.** According to the graphs number of access is correlated with NEPHROMETRIC SCORE as P value is less than 0.5. So **stone is found in multiple calyces and NEPHROMETRIC SCORE are corelated with multiple puncture.**

Operative time is significantly increases with incomplete clearance group and when nephrometric score increases.

It obvious from the table and graph that **clavien score** significantly correlated with NEPHROMETRIC RENAL SCORE.

In the present study, tract length, stone density and the degree of obstruction were not associated with a lower SFR. Others have reported that patients with a greater stone density and consequently longer tract (skin-to-stone distance) will be technically challenging, and this could affect the peri-operative variables.

We did not determine the accuracy of the score, nor did we assess the inter-observer reliability, but we found this scoring system to correlate with the SFR, with lower scores predicting the likely probability of stone clearance. Although the difference between mean STONE score of the stone-free and residual-stone group was significant, it was small (<1 point). Similarly, a higher STONE score, with a more complex procedure, was correlated with a longer operation; it was not reflected in a greater likelihood of complications.

The stone score is calculated using five variables, abbreviated as an acronym ‘STONE’. These include stone size, tract length (skin-to-stone distance), degree of obstruction, number of calyces involved and stone essence (density) will be measured. Each of the variables will be scored according to the predefined system and the STONE nephrolithometry score calculated using the sum of individual variable scores. All procedures will be performed with the patient prone, using single-tract dilatation with Alken dilators under fluoroscopic guidance. Stones will be fragmented using either the pneumatic Lithoclast, or simultaneous combined therapy with the Lithoclast and Holmium - YAG laser lithotripter. The procedure has to be continued until no stone could be identified by both nephroscopic and fluoroscopic inspection. For heavy stone burden and multiple calyceal stone involvement multiple session may be required. Antegrade double ‘J’ has to be placed in majority of patients. Nephrostomy tube will be inserted at the end of procedure in case of perforation of pelvicalyceal system, suspected residual fragments, incomplete clearance or bleeding from the tract. Str. X ray KUB are routinely performed on 3rd post-op day.

VI. Conclusion

The STONE score is a simple and easy to apply system for predicting the complexity of the stone for PCNL, and stone clearance.

Prospective studies with a larger sample are required to further confirm these findings.

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