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Evaluation of stone score for PCNL

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Abstract

Purpose: To evaluate the STONE score for success rate of PCNL.

Materials and methods: This study prospectively included 445 patients undergoing PCNL and STONE score was calculated using pre-operative NCCT. All the cases were done by standard technique in prone position and post-operative complications were classified according to modified Clavien grading system.

Results: The STONE score inversely correlated with the stone free rate, i.e. higher the STONE score, lower was the stone free rate (p value 0.0002). Among the individual components of the score, stone free rate correlated with the stone size (p value < 0.05) and number of calyces involved (p value < 0.05). The STONE score further correlated with the fluoroscopy time, operative duration and duration of post-operative hospital stay (p values <0.01). The STONE score grouped into low, intermediate and high further correlated with the complication rate (p value 0.03).

Conclusion: The STONE nephrolithometry score is a simple and easily reproducible system based on NCCT scan to classify the severity/ complexity of renal calculi and can be used for proper patient counseling about stone free status.

Keywords: adult, percutaneous nephrolithotomy, renal calculi

1. Introduction

In the present era, percutaneous nephrolithotomy (PCNL) is the main stay of treatment for both large and complex renal calculi [1, 2]. Several classification systems have been proposed to predict stone free rate after PCNL. Guy's scoring system [3] and Clinical Research Office of the Endourological Society (CROES) [4] nomogram were developed to grade PCNL stone-free rate. In 2013 Okhunov *et al*, [5] proposed STONE nephrolithometry scoring system to predict stone free rate and also the risk of perioperative complications following PCNL. This system includes various parameters assessed on Non Contrast CT Scan of Kidney Ureter and Bladder (NCCT of KUB) done preoperatively which includes Stone size (mm2), Tract length (mm), hydronephrosis or Obstruction, Number of involved calyces, and stone density or Essence (Hounsfield units, HU) for calculating the STONE score.

To the best of our knowledge, not much work has been done for prospective evaluation of the STONE score. We prospectively used this STONE score to evaluate its ability to predict stone free rate by applying the modified Clavien grading system.

2. Materials and Methods

This prospective study was conducted in our institute from July 2015 to December 2016. Ethical clearance was taken from our institute ethics committee. All the adult patients (>18 years) with renal calculi, undergoing PCNL in our department, were included in this study. Patients with history of renal surgery on the affected side, having comorbidities like hypertension, diabetes mellitus, renal insufficiency, coagulopathy, spinal deformity, anomalies of the Pelvi-Calyceal System (PCS) or having radiolucent calculi were excluded from the study. All the patients were preoperatively evaluated for Complete Blood Counts (CBC), bleeding profiles, Renal Function Tests (RFT), urine culture and NCCT KUB. Demographic, clinical and surgical details were collected. The individual parameters of the STONE score were reported by a senior radiologist of our institute and subsequently STONE nephrolithometry score was calculated.

The Stone score [5] used was as follows

Table 1

Variable	1	2	3	4
Stone size ($mm^{2)}$	0-399	400-799	800-1599	≥1600
Tract length(mm)	≤ 100	> 100	-	-
Obstruction	None/Mild	Moderate/Severe	-	-
Calyces	1-2	3	Staghorn	-
Essence(HU)	≤ 950	> 950	-	-

PCNL was performed in prone position by standard technique. The ureteric catheter was inserted on the affected side in lithotomy position using the semi rigid ureteroscope under fluoroscopy guidance. The patient was shifted to prone position and percutaneous puncture was made under fluoroscopy guidance using air or dye pyelogram. Alken's dilator, was used for tract dilatation and 24 Fr rigid nephroscope was used for nephroscopy. In cases requiring fragmentation of the stone, pneumatic lithoclast was used. Stone clearance was checked at the end, both using nephroscope and under fluoroscopy. Double J stent (DJ stent) was placed if there was need to fragment the calculi or the Pelvi Ureteric Junction (PUJ) was found oedematous.

Percutaneous Nephrostomy (PCN) tube was placed in every case at the end of the procedure. Operative time was defined as the time taken from delineation of the PCS and upto the completion of the procedure. Fluoroscopy time was defined as the total time for which fluoroscopy was used during each procedure.

All the patients were given pre-operative i.v. antibiotics which were continued post operatively. Post operatively the patients were given analgesics as and when needed. Routine blood investigations including CBC, RFT and an X-Ray KUB were done on the second post-operative day. The PCN tube was removed if there was no hematuria and no residual calculi or a very small residual fragment. The procedure was considered as successful if the patient had no residual fragment or had clinically insignificant residual fragments (CIRFs) [6] which is defined as < 4 mm, non-obstructing, non-infectious and asymptomatic residual fragments on X Ray KUB and Ultrasonography done at the fourth week of follow up. If needed, the patients with small residual fragments underwent Extra Corporeal Shockwave Lithotripsy (ESWL) 5 to 6 weeks after PCNL. Those who needed a second PCNL were considered as failure cases.

The statistical analysis was done using SPSS version 20 and t-test, chi-square test and Fisher exact test were used. P value <0.05 was considered statistically significant.

3. Results

A total of 445 cases were included in the study. The demographic and clinical data of the patients have been summarised in Table 2.

Table 2: Patient demographic and clinical data

Variable	Total,n(%)	Residual stone (61)	Stone free (384)	p value
Age (Years)	-	41.11±8.123	40.49±9.258	0.69 (t test)
Sex				
Male	298 (66.96%)	47 (15.77%)	251 (84.23%)	0.07 (chi square)
Female	147(33.03%)	14 (9.52%)	133 (90.48%)	
Side				
Right	243(54.61%)	29 (11.93%)	214 (88.07%)	0.23(chi square)
Left	201 (45.39%)	32 (15.84%)	170 (84.16%)	
BMI(mean)		24.37±1.42	24.69±1.61	0.14 (t test)
Stone score				
Low 4-5	164(36.85%)	0 (0%)	164 (100%)	< 0.01 (chi square)
Moderate 6-8,	201 (45.17%)	22 (10.95%)	179 (89.05%)	
High 9-13	80 (17.98%)	39 (48.75%)	41(51.25%)	
Mean	-	8.81±2.50	7.57±1.88	< 0.01 (t test)
Size ($mm^{2)}$				
0-399	136 (30.56%)	14 (10.29%)	122 (89.71%)	< 0.01 (chi square)
400-799	196 (44.04%)	23 (11.73%)	17388.27%)	
800-1599	86(19.33%)	6 (6.98%)	80 (93.02%)	
>1600	27 (6.07%)	18 (66.67%)	9 (33.33%)	
Mean (mm^2)		882.194±568.33	636.04±374.63	< 0.01 (t test)
Tract length (mm)				
<100	325 (73.03%)	40 (12.31%)	285 (87.69%)	0.16
>100	120(26.97%)	21 (17.5%)	99 (82.5%)	
Tract length (mean)		101.291±11.69	99.631±11.15	0.62 (t test)
Obstruction				
No /Mild	238(53.48%)	27 (11.34%)	211 (88.66%)	< 0.12
Moderate/ Severe	207 (46.51%)	34 (16.43%)	173 (83.57%)	
No. of Calyces involved				
0-2	294 (66.07%)	24 (8.16%)	270 (91.84%)	< 0.01
3	115 (25.84%)	17 (14.78%)	98 (85.22%)	
4-6	36 (8.09%)	20 (55.56%)	16 (44.44%)	
Essence				
<950	202 (45.39%)	28 (13.86%)	174 (86.14%)	0.94 (chi square)
>950	243 (54.61%)	33 (13.58%)	210 (86.42%)	
HU (mean)	-	1117.79±200.329	1064.56±208.396	0.06 (t test)
No of tracts made				
1	-	34 (11.11%)	272 (88.89%)	< 0.01 (chi square)
2	-	16 (13.45%)	103 (86.55%)	
3	-	11 (55%)	9 (45%)	
Operative time (mins)	-	81.41±28.548	69.60±26.53	0.01 (t test)
Fluoroscopy time (secs)	-	255.86±159.281	184.60±121.836	< 0.01(t test)
Post-operative Hospital stay (days)	-	4.11±1.166	3.42±0.822	< 0.01(t test)

This study had 298(66.96%) males and 147(33.04 %) females. The mean age and body mass index (BMI) of the males and females in stone free and residual groups were comparable. The total stone free rate after PCNL was 86.29%. The STONE score inversely correlated with the stone free rate, i.e, higher the STONE score, lower was the stone free rate (p value 0.0002). The STONE score for the stone free group was 7.57±1.88 and for the residual stone group was 8.81±2.50.

Among the individual components of the score, stone free rate correlated with stone size (p value < 0.05) and number of calyces involved (p value < 0.05). The mean stone size for

the stone free group was 636.04±374.63 mm^2 and for the residual stone group was 882.194±568.33 mm^2.

The STONE score further correlated with the fluoroscopy time, operative duration and the duration of post-operative stay in the hospital on correlation (p values <0.01) (Table 3).

Table 3: Pearson Correlation Coefficient

Variables	Stone score. R value	p value
OT time	0.3524	<0.01
Fluoroscopy time	0.4476	<0.01
Hospital stay	0.3188	<0.01

Table 4: Individual score with number of stone free and residual calculi patients

Stone score	Residual (%)	Stone free (%)
4	0 (0)	12 (100)
5	0(0)	48(100)
6	6 (7.69)	72 (92.30)
7	5 (6.41)	73 (93.59)
8	9 (11.39)	70 (88.61)
9	8 (12.5)	56 (87.5)
10	7 (22.58)	24 (77.42)
11	9 (30)	21 (70)
12	10 (55.55)	8 (44.44)
13	7 (100)	0 (0)

Among the components of the STONE score, tract length, presence or absence of hydronephrosis and essence of the stone did not correlate with the stone free rate. About 26.96% (120) patients had tract length >100 mm of which 82.5% (99) of the patients were rendered stone free as compared to 87.69% (285) of those having tract length <100mm (p value 0.157). 53.48% (238) patients had no to mild hydronephrosis of which 88.66% (211) were rendered stone free as compared to 83.57% (173) of the patients with moderate to severe hydronephrosis (p value 0.1201).Among the total patients, 45.39% (202) had softer stones (with HU < 950) with stone free rate of 86.14% (174) as compared to 86.42% (210) in those with harder stones (p value 0.9351). All the patients with STONE Score 13 (7 patients) needed second stage PCNL and were included in the residual stone group.

4. Discussion

PCNL is a well-established treatment for both complex and large stones. Many studies have been done to predict success rates of PCNL.[7-13] Very recently Okhunov *et al*. [5] proposed and validated the STONE nephrolithometry score based on the preoperative NCCT using Medline review of English literature studies from 1976 to 2012, and found that STONE score significantly correlated with postoperative stone-free status, overall complications, operative time and hospital stay [14]. In their retrospective study, Yasser A Noureldin *et al.* have shown that STONE score can accurately predict the stone free status [15].

For a scoring system to be widely acceptable, it should be simple and easily applicable. The scoring system should also correlate with stone free rate and complication rate [3]. The present study tried to prospectively validate the STONE nephrolithometry score to predict the stone free rate and complication rate.

In our study, the overall STONE Score correlated not only with the stone free rate but also operative duration, fluoroscopy time, length of hospital stay and also the complication rate. However, M Farhan *et al.* in their prospective study have shown STONE score to correlate with the stone free rate but did not find any correlation with the complication rate.[16] Among the individual variables, the stone size was significantly related to the stone free rate in our study, which correlates with other studies done in the past.[17,18,19,20] The variables that did not correlate with stone free rate in our study were tract length, presence or absence of hydronephrosis and essence of the stone as shown by other studies.[5,15]Zhu *et al*, in their paper on logistic regression model for prediction of success rate after minimally invasive PCNL, showed that stone burden, staghorn calculi and presence of moderate to severe hydronephrosis were associated with decreased stone-free rates.[18]Tract length did not affect the success rate in our study,probably because of our centre being a high volume stone centre with large number of PCNL done regularly and hence the surgical efficiency. Tract length depends on the site of entry in the PCS and the BMI of the patient. If proper calyx is chosen, then usually the tract length is short and it allows instrument manipulation in nearly all stone bearing areas of the PCS. Presence of hydronephrosis did not affect the stone free rate as hydronephrotic kidneys can be easily punctured and nephroscope can be manipulated more easily to visualise the PCS for stone fragment removal. However, gross dilatation of the PCS with thin parenchyma leads to difficult entry into the PCS and more punctures may be needed for complete clearance. In our study too, the success rate was higher in patients with no to mild hydronephrosis as compared to those with moderate to severe hydronephrosis, though it was not statistically significant (p value 0.12). Hence, gross hydronephrosis with multiple calculi can have higher failure rates. The overall Stone free rate in various series of PCNL have ranged from 80% to 89.2%, [16, 21] whereas, in our study it was 86.29%. The sample size was smaller in all the above mentioned studies as compared to our study in which the number of patients was almost 3 to 4 times.

In this study, we found that STONE Score is a simple and easy tool that can be used by the clinicians for grading stones for PCNL. In addition, it can also be helpful in counselling the patients preoperatively about the chances of residual calculi and the need for any secondary procedures.

5. Conclusion

The STONE nephrolithometry score is a simple and easily reproducible system to classify the severity of renal calculi. This system is based on a simple NCCT easily available at centres doing PCNL and being used for evaluation of stone disease. This scoring system can prove to be an excellent pre-operative tool for the urologist to predict stone free rate before PCNL and for proper counselling of the patients about the need for further staged procedure after surgery.

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