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S.T.O.N.E. Score in Prediction of Stone Clearance in PCNL

Sudeep Raj K.C,[1] Bhushan Timilsina,[1] Dipesh Kumar Kushwaha,[1] Saroj Giri[1]

[1]Department of Urology, College of Medical Sciences and Teaching Hospital, Bharatpur, Chitwan, Nepal.

ABSTRACT

Introduction

S.T.O.N.E. score has been considered as standard scoring system for prediction of complication and to state the clearance of the stone. The objective of this research is to find out S.T.O.N.E. score in predicting percutaneous nephrolithotomy (PCNL) success in stone free rate.

Methods

An analytical cross-sectional study was conducted from March - 2022 to February - 2023 in the department of urology in College of Medical Sciences and Teaching Hospital. Seventy five cases of patients who underwent PCNL were included in the study and S.T.O.N.E. score was gathered like stone size, tract length (skin-to-stone distance), degree of obstruction (presence of hydronephrosis), number of involved calyces and stone essence (stone density). Collected data was entered and analyzed using SPSS.

Results

Among the total of 75 patients, 40% (with 95% CI as 28.91% to 51.08%) had residual stone while remaining had no residual stone. 90.7% patients had 0-399 mm stone size, 97.3% had less than 100 mm tract length and likewise 29.3% had moderate to severe dilatation. Majority (68%) had 2-3 calyces involment and 72% had more than 950 HU stone density.

Conclusions

S.T.O.N.E. nephrolithometry is highly predictive of stone free status in patients undergoing PCNL and provides a quick, easy-to-apply method for grading the complexity of PCNL

Keywords: PCNL; STONE Clearance; stone density.

INTRODUCTION

There has been a marked increase in the prevalence of kidney stone disease.[1] Urinary stone disease is a prevalent problem throughout the world, with an incidence of 5–10% in the general population and of which 15–20% of patients with renal stones require invasive intervention.[2] Almost one-third of the surgical workload is related to the treatment of patients with urinary calculi.[3] Before the development and widespread adoption of less invasive treatments, most patients with symptomatic

Correspondence: Dr. Sudeep Raj K.C, Department of Urology College of Medical Sciences and Teaching Hospital, Bharatpur, Chitwan, Nepal. Email: sudeeprkc786@gmail.com. Phone: +977-9851030974.

renal calculi underwent open surgical lithotomy.[4] Percutaneous nephrolithotomy (PCNL) has been recommended as the first-line treatment option for kidney stones that are either refractory to extracorporeal shock wave lithotripsy (ESWL) or are >2 cm in diameter according to the guidelines of the European Association of Urology (EAU).[5] Despite continuous refinements in surgical techniques and technology, the overall complication rates for PCNL have increased.[6] There are many scoring system developed for prediction of complication and state the clearance of the stone. Attempts by many authors with the use of clinico-radiological parameter came up with various scoring system but till date none of these scoring systems has been considered standard. These Scoring System are useful to inform the patients about the success and complication rates of the operation prior to surgery.[7] S.T.O.N.E [stone size(S), tract length (T), obstruction (O), number of involved calices (N), and essence or stone density (E)] nephrolithometry score is one of the commonly practiced scoring system.[8] Aim of this study was to find out S.T.O.N.E. score in predicting percutaneous nephrolithotomy (PCNL) success in stone free rate.

METHODS

An analytical cross-sectional study was conducted from March - 2022 to February - 2023 in the department of Urology of College of Medical Sciences and Teaching Hospital. Ethical approval was taken from Institutional Review Committee of College of Medical Sciences (Ref No. COMSTH-IRC/2022-010). All patients undergoing PCNL were included in this study except for patients having previous renal surgery, PCNL done for migratory stone during URSL and patients younger than 18 years old. Sample size was calculated using $Z\alpha^2*p*(1-p)/d^2$ formula. Prevalence of nephrolithiasis in Asia ranges from 1-5%. Selecting the upper limit of this prevalence range for the sample size calculation, prevalence (p) = 5% =0.05, with 95% confidence interval ($Z\alpha$ = 1.96) and Margin of error (d) = 5% = 0.05, which came out to be 72.33 which was increased to 75. Data collection, entry and analysis was done using MS excel and SPSS. Mean and standard deviation for continuous variables while frequency and percentage for categorical variables. In the inferential Statistics Student's t-test and ROC curves with sensitivity and specificity were used. All PCNLs were performed under spinal anesthesia by urologist.

Plain CT-KUB was done in post-operative period to see for residual stone. Stone size greater than 4 mm was considered as a residual stone and stone less than that was considered as stone free status. Before discharge information of S.T.O.N.E. score was gathered like 'stone size, tract length (skin-to-stone distance), degree of obstruction (presence of hydronephrosis), number of involved calyces, and stone essence (stone density). The stone size is estimated by combining the measures of length and width in square millimeters. The stone size is scored from 1 to 4 according to a calculated area of 0-399, 400-799, 800-1599, and more than or equal to 1600 mm^2, respectively. The tract length evaluates the skin-to-stone distance. The skin-to-stone distance is defined as the mean vertical distance from the center of the stone to the skin measured on a supine non contrast-enhanced CT film at 0, 45, and 90 degrees. The tract length is scored according to a mean length of 100 mm. The third variable, obstruction, evaluates the degree of hydronephrosis and is scored according to the severity of dilation of the collecting system. No obstruction or mild dilation is assigned 1 point and moderate to severe dilation 2 points. The fourth component assesses the number of calyces containing stones. If only a single calyx is involved, a score of 1 is assigned. If 2 or 3 calices are affected, a score of 2 is assigned. A maximum score of 3 is assigned if a full staghorn calculus is present. The last variable is the stone essence, which evaluates the stone density. This is measured on preoperative CT imaging and

is assigned a score according to a radio density threshold of >950 or <950 Hounsfield units. The scores from each variable are summed to determine the S.T.O.N.E. nephrolithometry score. The score can vary from a minimum of 5 to a maximum of 13. A score of 5 denotes the least complex stone and a score of 13, the most complex scenario.

RESULTS

This research was conducted among 75 patients. Regarding age majority of the patients were in the age group 30-50years with Mean±SD as 40±13.6 years. Majority of the patients (64%) were male by gender. Also, 90.7% patients had 0-399 mm stone size, 97.3% had less than 100 mm tract length and likewise 70.7% had no or mild dilatation. Majority (68%) had 2-3 calyces involvement and 72% had more than 950 HU stone density (Table 1).

Table 1. Cinco social characteristics of the patients (n=75).

Variables	Frequency	Percent
Age (years)		
<30	21	28
30-50	36	48
>50	18	24
Mean±SD	40±13.6 years	
Gender		
Female	27	36
Male	48	64
Stone size		
0-399 mm	68	90.7
400-799 mm	6	8
800-1599 mm	1	1.3
Tract		
Less than 100 mm	73	97.3
More than 100 mm	2	2.7
Obstruction		
Moderate to severe dilatation	22	29.3
No or mild dilatation	53	70.7
Calyx involvement		
1 calyx involved	19	25.33
2-3 calyces involved	51	68
Full staghorn calculus	5	6.67
Stone density		
Less than 950 HU	21	28
More than 950 HU	54	72

Among the total patients, 40% (with 95% CI as 28.91% to 51.08%) had residual stone while remaining had no residual stone (Table 2).

Table 2. Prevalence of residual Stone (n=75).

Residual Stone	Frequency	Percent	95% CI	
			Lower	Upper
Present	30	40.0	28.91%	51.08%
Absent	45	60.0	48.91%	71.08%

Regarding age and residual stone, 61.1% patients in the age group 30-50 years had residual stone. There is no statistically significant association between age and residual stone (p-value >0.05). Majority of the female patients had residual stone and have no statistically significant association with gender (p-value >0.05). Patients who had 0-399 mm^2 stone size, 64.7% of them had residual stone. There is statistically significant association between stone sizes with residual stone (p-value <0.05). Majority of the patients who had less than 100 mm tract length had residual stone. There is no statistically significant association between tract length with residual stone (p-value>0.05). Majority of the patients who had no or mild dilatation as obstruction had residual stone. There is statistically significant association between obstruction with residual stone (p-value<0.05). Majority of the patients who had one calyx involved had residual stone. There is statistically significant association between Calyx involvement with residual

stone (p-value<0.05). Most of the patients who had less than 950 HU had residual stone. There is no statistically significant association between Calyx involvement with residual stone (p-value<0.05) (Table 3).

Table 3. Association between residual Stone with selected variables (n=75).

Variables	Stone free n(%)	Not stone free n(%)	Chi-square	p-value
Age (years)				
<30	15(71.4)	6(28.6)		
30-50	22(61.1)	14(38.9)	2.97	0.226
>50	8(44.4)	10(55.6)		
Gender				
Female	17(63)	10(37)	0.15	0.69
Male	28(58.3)	20(41.7)		
Stone size				
0-399 mm^2	44 (64.7%)	24 (35.3%)	6.68	0.02
400-799 mm^2	1 (16.7%)	5 (83.3%)		
800-1599 mm^2	0 (0.0%)	1 (100.0%)		
Tract				
Less than 100 mm	43 (58.9%)	30 (41.1%)	1.37	0.51
100 mm or more	2 (100.0%)	0 (0.0%)		
Obstruction				
No or mild dilatation	38 (71.7%%)	15 (28.3%)	10.3	<0.01
Moderate to severe dilatation	7 (31.8%)	15 (68.2%)		
Calyx involvement				
1 calyx involved	15 (78.9%)	4 (21.1%)	6.38	0.04
2-3 calyces involved	29 (56.9%)	22 (43.1%)		
Full staghorn calculus	1 (20.0%)	4 (80.0%)		
Stone density				
Less than 950 HU	13 (61.9%)	8 (38.1%)	0.04	0.84
950 HU or more	32 (59.3%)	22 (40.7%)		

DISCUSSIONS

PCNL is the first choice of treatment for the renal stone larger than 2cm and for the stone located in the lower pole larger than 1.5cm as recommended by the European Association of Urology Urolithiasis Guidelines.[9] As the incidence and prevalence of renal disease increases dramatically, the burden to use PCNL to treat large stones has continued to increase.[10] This study showed higher percentage of stone clearance when the stone is located in the lower pole followed by middle and least when the stone is located in the upper pole. Other studies also have similar results as mentioned above. It may be because most of surgeons prefer the lower pole puncture though the clearance from

the upper pole puncture has higher percentage of stone clearance. Upper pole puncture can be challenging and technically difficult in inexperienced hands. This may be the reason why the clearance rate of upper pole stone is less compared with other. Gucuk et al., investigated the effects of certain parameters, including HU, on the outcome of 179 PCNL patients, and concluded that the HU value was an independent factor that affected the success of PCNL. Specifically, an HU value < 677.5 reduced the success of PCNL by 2.65-fold. Labadie et al., did a study in 246 patients in three different academic institute which failed to find a positive correlation of HU units with the stone free status. [10] In this study 54 patients had harder stone with HU greater than 950 of which 59.3% had stone free status. Softer stones were 21 in numbers and 61.9% had stone free status, p value was not significant. The stone clearance is directly affected by the direct visualization of stone and locating the stone in fluoroscopy. Low density stone is not located easily with fluoroscopy and once the stone are fragmented and hide in any of the calyx the chance of residual stone increases. Noureldin et al., studied total of 185 patients, the overall stone-free rate was 71.9 %, When compared to patients with residual fragments, stone-free patients had significantly lower S.T.O.N.E. score (7.4 vs. 8.3; p = 0.004).[11] Kumar et al in 2018 studied total of 445 patient and based on S.T.O.N.E. score, higher the score more the chance of residual stone (8.81 ± 2.50) and lower the score, higher the stone free rate (7.57 ± 1.88) with a p value of 0.0002.[12] Rathee et al., studied 100 patients in 2017 where they found that the stone-free rate was 90%, stone-free patients had S.T.O.N.E. score (7.5 vs 9.1; p = 0.023).[13]

CONCLUSIONS

S.T.O.N.E. nephrolithometry is highly predictive of stone free status in patients undergoing PCNL

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