MAK HILL Publications Research Journal of Medical Sciences

Research Article
doi: 10.59218/makrjms.2024.6.551.555

Evaluation of Guy's and S.T.O.N.E. Scoring Systems for Predicting Success and Complications After Percutaneous Nephrolithotomy: A Prospective Study

[1]Pushpendra Kumar Shukla, [2]Kumar Deepak, [3]Atul Kumar Singh, [4]Vivek Sharma, [5]Vijay Kumar Shukla, [6]Padma Shukla and [7]Varsha Shukla

[1,4,5]Department of Urology, Shyam Shah Medical College, Rewa, Madhya Pradesh, India

[2,3,7]Department of Surgery, Shyam Shah Medical College, Rewa, Madhya Pradesh, India

[6]Department of Obstetrics and Gynaecology, Shyam Shah Medical College, Rewa, Madhya Pradesh, India

Abstract

Percutaneous nephrolithotomy (PCNL) is the preferred treatment for renal calculi larger than 20 mm due to its higher stone-free rates and reduced need for additional procedures. The most common nephrolithometry scoring systems to predict the outcome of PCNL are Guy's Stone Score (GSS) and S.T.O.N.E. score. The present study is aimed to evaluate the Guy's & S.T.O.N.E. scoring systems for predicting success and complications after percutaneous nephrolithotomy. This prospective study was conducted in the Department of Surgery and Urology Shyam Shah Medical College, Rewa (M.P.). One hundred fifty patients with renal stones were included in the study. The patients were given S.T.O.N.E. score and Guy's Stone Score (GSS) grades based on computerised tomography (CT) scans. The PCNL were done using a standard technique in the prone position. Outcomes were assessed based on the stone-free rate (SFR) and complications during and after the procedure. Both scoring systems were compared with the outcome. After statistical analysis, p-value < 0.05 was taken as the significance level. The average age was 39.46±15.79 years, the mean GSS was 1.75±0.67, and the S.T.O.N.E. score was 6.98±2.04. The average operating time was 60.82±22.4 minutes, and the average hospital stay was 4.88±1.12 days. Out of 150 patients, 126 (84%) were free of stones after the procedure, which was significantly decreased with an increase in both scoring systems (p-value <0.00001). A total of 50 complications were observed in 41(27.33%) patients according to the modified Clavien grading. The number and severity of complications significantly increased with an increase in both scoring systems (p-value <0.00001). Both the GSS and S.T.O.N.E. Scoring systems are easy to use, reproducible, and comparable in predicting the outcome of PCNL in terms of SFR and postoperative complications. These scores can be used for surgical decision-making and patient counseling.

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Key Words
Percutaneous nephrolithotomy, guy's stone score, S.T.O.N.E. Score, modified clavien grading

Corresponding Author
Vivek Sharma,
Department of Urology, Shyam Shah Medical College, Rewa, Madhya Pradesh, India
viveksharma123@outlook.com

Author Designation
[1,3,4,6]Associate Professor
[2]Resident Surgical Officer
[5,7]Assistant Professor

Received: 14 May 2024
Accepted: 18 June 2024
Published: 22 June 2024

Citation: Pushpendra Kumar Shukla, Kumar Deepak, Atul Kumar Singh, Vivek Sharma, Vijay Kumar Shukla, Padma Shukla and Varsha Shukla, 2024. Evaluation of Guy's and S.T.O.N.E. Scoring Systems for Predicting Success and Complications After Percutaneous Nephrolithotomy: A Prospective Study. Res. J. Med. Sci., 18: 551-555, doi: 10.59218/makrjms. 2024.6. 551.555

INTRODUCTION

The global prevalence of urolithiasis varies widely, ranging from 1% to 13%[1]. A range of procedures are currently used to manage kidney stones, including extracorporeal shockwave lithotripsy (ESWL), retrograde intrarenal surgery (RIRS), and percutaneous nephrolithotomy (PCNL). Among these, PCNL is the preferred treatment for renal calculi larger than 20 mm due to its higher stone-free rates and reduced need for additional procedures[2]. Renal stones are a common reason for patient visits to urology clinics worldwide, and percutaneous nephrolithotomy (PCNL) has become the treatment of choice for large and complex renal stones[2,3]. The success of PCNL depends on various factors, such as patient-related clinical and anatomical factors, stone-related factors, and technical factors. This success is measured in terms of stone-free rate and complications. The primary goal of this innovative surgery is to achieve maximum stone clearance with minimal morbidity[4]. These factors have been incorporated into different nomograms and scoring systems to standardise outcome comparisons and to facilitate proper surgery planning and patient counselling in advance. In 2011, Thomas K. and Smith et al. developed the Guy's Stone Score (GSS), which categorises renal stones into four grades based on stone number, location, and renal unit abnormalities (Table 1)[5].

Similarly, the S.T.O.N.E. score was created in 2013 using five variables abbreviated as "S. T.O.N.E." for stone size, tract length (skin-to-stone distance), degree of obstruction (presence of hydronephrosis), number of involved calyces, and stone essence (Hounsfield Unit) (Table 2)[6]. Multiple studies have validated these scores; however, there are fewer cross-comparative studies. The present study is aimed to evaluate the Guy's and S.T.O.N.E. scoring systems for predicting success and complications after percutaneous nephrolithotomy.

MATERIALS AND METHODS

This research was conducted at the Department of Surgery and Urology at Shyam Shah Medical College in Rewa (M.P.) from April 2021 to June 2022. Ethical approval was obtained from the institutional ethical board before the study began. The study included newly diagnosed cases of renal calculus with an indication for PCNL, patients over 18 years of age, and those who provided written consent. Patients with a history of previous renal stone surgery, BPH, stricture urethra, bladder outlet obstruction, bleeding disorders, co-morbidities, pregnancy, and blood coagulopathies were excluded from the study. A total of 150 patients were enrolled in the study. All patients underwent basic investigations such as renal function tests, urine cultures, ultrasound examinations, and CT urogram. The stone burden was defined as the maximum diameter of the stone on CT urogram.

Additionally, all patients were graded with the GSS and S.T.O.N.E. score. PCNL was performed using standard techniques. Each patient's demographic profile, preoperative clinical parameters, and intraoperative findings were noted. Intraoperative and postoperative complications were graded according to the modified Clavien grading system. The outcome was assessed based on the stone-free rate and complications during and after the procedure. Follow-up of the patients was done on 15 days, one month, and three months. Stone-free status was defined as the absence of residual stones or the presence of clinically asymptomatic residual fragments = 4mm on non-contrast CT scan at three months follow up. Both scoring systems were compared with the outcome. Statistical analysis was performed using the statistical software IBM-SPSS, version 22.0. Chicago, IL, USA., for data entry and evaluation. The chi-square test was used to analyse Guy's stone score and S.T.O.N.E. score and their effect on the outcome of PCNL. A p-value of less than 0.05 was considered statistically significant.

RESULTS AND DISCUSSIONS

The baseline characteristics of the patients are summarised in (Table 3). The average age was 39.46±15.79 years, the average operating time was 60.82±22.4 minutes, and the average hospital stay was 4.88±1.12 days. Out of 150 patients, 126 (84%) were free of stones after the procedure. The stone-free rate was 98.74% in the S.T.O.N.E. 5–6 score, 90.47% in the S.T.O.N.E. 7–8 score, and significantly decreased to 34.48% in the S.T.O.N.E. 9–13 score. Similarly, stone-free rates were 98.31% and 96.59% in Guy's I and II scores, respectively, but dropped to 46.67% and 26.56% in Guy's III and IV scores, respectively (Table 4). The results in Table 5 indicate that the procedure time and hospital stay were similar for patients in Guy's I and II categories. However, they significantly increased for those in categories III and IV. The S.T.O.N.E. scores also followed similar patterns, with significant increases observed for scores greater than nine compared to scores less than nine. According to the modified Clavien grading system, 50 complications were observed in 41 (27.33%) patients. Most of the complications were classified as grade 2 and grade 1. Of the 50 complications, 29 were grade 2 and 16 were grade 1. The most common complication was intraoperative bleeding requiring blood transfusion (Type 2), followed by fever above 38°C (Type 1). Table 6 demonstrates that the number and severity of complications increased with higher scores in both scoring systems.

Table 1: Guy's Stone score

Score	Description
1	A solitary stone in the mid-/lower pole with simple anatomy or a solitary stone in the pelvis with simple anatomy
2	A solitary stone in the upper pole with simple anatomy or multiple stones in a patient with simple anatomy or any solitary stone in a patient with abnormal anatomy.
3	Multiple stones in a patient with abnormal anatomy or stones in a calyceal diverticulum or partial staghorn calculus.
4	Staghorn calculus or any stone in a patient with spina bifida or spinal injury

Table 2: S.T.O.N.E. Score

Variables	Scores			
	1	**2**	**3**	**4**
Stone size(mm2)	0-399	400-799	800-1599	>1600
Tract length(mm)	<100	>100	-	-
Obstruction	No or mild hydronephrosis	Moderate or severe hydronephrosis	-	-
Calyces	1-2	3	Staghorn	-
Essence	<950HU	>950HU	-	-

Table 3: Baseline characteristic of Patients

Patient's Characteristics	Number (%)
Male	91(60.67)
Female	59((39.33)
Age (Years)	39.46±15.79
Mean operating time (Minutes)	60.82±22.4
Mean hospital stay (Days)	4.88±1.12
Mean Guy's stone score	1.75±0.67
Grade I	59 (39.33)
Grade II	59 (39.33)
Grade III	15 (10%)
Grade IV	17 (11.33)
Mean S.T.O.N.E. Score	6.98±2.04

Table 4: Stone free status and their correlation with Guy's and S.T.O.N.E. score

Scoring system	No of stone free/ Total no	Percentage	p– value
STONE Scoring			
5–6	78/79	98.74	0.000017-8
	38/42	90.47	
9–13	10/29	34.48	
Guy's Scoring			
I	58/59	98.31	
II	56/59	96.59	0.00001
III	7/15	46.67	
IV	5/17	26.56	

Table 5: Procedure time and hospital stay and their correlation with Guy's and S.T.O.N.E. score

Scoring System /Grade	Procedure Time (Mean operating time 60.82±22.4)	p– value	Length of hospital stay (Mean hospital stay 4.88±1.12)	p– value
S.T.O.N.E. Scoring				
5–6	52.28 ± 13.14	0.00001	4.81±0.99	0.0254
7–8	58.27±22.31		4.99±0.94	
9–13	87.75±14.65		4.89±1.18	
Guy's Scoring				
I	53±16.06	0.00001	4.77± 0.82	0.0013
II	55.16±19.97		4.86±1.11	
III	84.66±22.55		5.26±1,53	
IV	86.58±16.23		5.1±1.54	

Table 6: Correlation of Modified Clavien Grading System with Guy's and S.T.O.N.E. score

sScoring System/	Modified Clavien Grading System								p– value
	Grade								
Grade	**1**	**2**	**3a**	**3b**	**4a**	**4b**	**5**	**Total**	
S.T.O.N.E. Scoring									
5–6 (n= 65)	4	5	0	0	0	0	0	9	0.00001
7–8 (n=70)	7	10	0	0	0	0	0	17	
9–13 (n=15)	5	14	2	1	1	1	0	24	
Guy's Scoring									
I (n=59)	3	7	0	0	0	0	0	10	0.00001
II (n=59)	5	11	0	0	0	0	0	16	
III (n=15)	4	6	1	0	0	0	0	11	
IV (n=17)	4	5	1	1	1	1	0	13	

The American Urological Association strongly recommends clinicians obtain a non-contrast CT scan of patients before performing PCNL[7]. C.T. scans provide high-resolution spatial imaging for accurately characterising stone size and distribution, stone composition in Hounsfield Units, pelvicaliceal anatomy,

anomalies, and anatomical relationships with surrounding organs. Based on preoperative CT scans, nephrolithometry scores are developed to assess the complexity of stones for proper surgical planning and preoperative patient counselling. The ideal nephrolithometry score, which should be simple to use, repeatable, and capable of accurately predicting complications and stone-free status, was the focus of our prospective comparison of two nomograms, Guy's score and STONE score.

In the present study, the mean GSS was 1.75±0.67, and the S.T.O.N.E. score was 6.98±2.04, which aligns closely with the findings of Kumar et al. (GSS:1.82±0.9, S.T.O.N.E.score 6.93±2.81) and Noureldin *et al*. (G.S.S.: 2.3 ± 0.7, S.T.O.N.E.score:7.67 ± 0.1)[8,9], underscoring the consistency and reliability of these scoring systems. In a study by Thomas *et al*. in 2011, 81%, 72.4%, 35%, and 29% success rates were reported for GSS 1, 2, 3, and 4, respectively[5]. Another study by Khan *et al*. in 2020, which included 190 patients, found mean S.T.O.N.E. and GSS to be 8.76 ± 2.29 and 2.70 ± 1.0, respectively. The study also revealed that stone-free patients had significantly lower mean Guy's score (2.58 ± 1.01 vs. 3.23 ± 0.77 [P < 0.001]) and S.T.O.N.E. scores (8.44 ± 2.24 and 10.17 ± 2.0 [P < 0.001]), compared to those with residual stones[10]. Additionally, Kumar *et al*. (2018) study involving 445 patients found significant associations between the GSS and S.T.O.N.E. scores with the procedure's success rate. The success rate reported in the study was 86.29%[8]. The present study also observed similar trends, where stone-free rates decreased with increased GSS and S.T.O.N.E. scores.

We have categorised the complications using the modified Clavien grading system and identified complications in 27.33% of the patients. Mandal S *et al*. reported a higher complication rate of 41.72%, while Roset *et al*. and Vicentini *et al*. reported lower complication rates of 20.5% and 18.7%, respectively[11,4,12]. In our current study, we discovered a correlation between GSS and S.T.O.N.E. scores and the complication rate, similar to the observations made by Khan *et al*.[9,10]. Vicentini *et al*.[12] and Mandal *et al*.[11] identified a correlation between GSS and the complication rate, whereas Thomas *et al*.[5], Noureldin *et al*.[9], and Kumar *et al*.[8] did not find this correlation.

Our study also significantly associated these scoring systems with operative time and postoperative hospital stay. An increase in nephrolithometry scores is directly associated with increased operative time and prolonged hospital stay. This is similar to the findings of the studies by Kumar *et al*., Khan *et al*., and Labadie *et al*.[8,10,13],

According to a systematic review by Mazon *et al*. in 2023, they initially examined 549 abstracts and subsequently chose 18 papers for inclusion. Of these 18 papers, 11 focused on traditional nephrolithometric nomograms to predict specific complications. GSS correlated with complications in five studies, while S.T.O.N.E. score correlated in four studies[14]. The review concluded that conducting more rigorous validations with larger prospective patients' series in the future is advisable.

The limitations of the present study are the small number of patients, single-center study, and the multiple surgeons with different expertise levels operated on cases. Our study's results demonstrate the equal effectiveness of both GSS and S.T.O.N.E. scoring systems in predicting stone-free status, a finding that has significant implications for clinical decision-making.

CONCLUSION

Both Guy's and S.T.O.N.E. scoring systems are easy to use, reproducible, and comparable in predicting the outcome of PCNL in terms of SFR and postoperative complications. These scores can be used for surgical decision-making and patient counselling.

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