Original Article

Grading the complexity of percutaneous nephrolithotomy using the Guy's stone score based on intravenous urography

Bimal Krishna Sahay, Sharad Seth, Rishi Agarwal

Department of General Surgery, Rohilkhand Medical College and Hospital, Bareilly, Uttar Pradesh, India

Corresponding Author:
Bimal Sahay,
Department of General Surgery, Rohilkhand Medical College and Hospital, Bareilly, Uttar Pradesh, India. E-mail: bimalsahay27@gmail.com

Received: 11-03-2020
Accepted: 15-04-2020
Published: 29-05-2020

How to cite this article:
Sahay BK, Seth S, Agarwal R. Grading the complexity of percutaneous nephrolithotomy using the guy's stone score based on intravenous pyelogram. Int J Adv Integ Med Sci 2020;5(2):57-61.

Source of Support: Nil,
Conflicts of Interest: None declared.

Introduction: Since the introduction of percutaneous nephrolithotomy (PCNL), it has been well acknowledged that PCNL has varying grades of complexities that affect stone clearance and post-operative complications. There is, thus, a need to standardize the success and the perioperative complexity associated with the procedure. Such a purpose can be achieved using scoring system which can generalize the criteria for stratification of the complexity of PCNL. The "Guy's Stone Score" (GSS) which was validated in 2011 by Thomas *et al*. is a valuable tool that can be used in the stratification of the complexity of PCNL into four grades depending on the stone burden along with the anatomy of both the patient and the renal tract. **Objective:** The objective of the study was to evaluate GSS in patients undergoing PCNL in predicting the complexity of the procedure. **Materials and Methods:** The study design was a prospective observational study which was conducted on 80 patients who underwent PCNL at Rohilkhand Medical College and Hospital, Bareilly, Uttar Pradesh, between November 2018 and October 2019. The GSS was determined preoperatively for each patient using intravenous urography (IVU). All patients underwent PCNL as per the standard protocol. Stone-free status was determined using X-ray kidneys, ureters, and bladder on the 2nd post-operative day. **Results:** Out of 80 patients, 37 patients (46.3%) belonged to Grade I, 26 patients (32.5%) belonged to Grade II, eight patients (10%) belong to Grade III, and nine patients (11.3%) belonged to Grade IV. Overall Stone-free status was accomplished in in 73 patients (91.25%). A complete stone-free rate (100%) was achieved among patients belonging to Grades I and II, while 7 (87.5%) out of eight patients belonging to Grade III had a complete stone-free status and only three patients (33.3%) belonging to Grade IV had complete stone-free status. **Conclusion:** GSS based on IVP is a simple and useful tool which can stratify the complexity of PCNL preoperatively and can help in counseling of patients preoperatively regarding the outcome of PCNL.

KEY WORDS: GSS, PCNL, IVU

INTRODUCTION

Since time immemorial, mankind has been afflicted by renal calculi. Prevalence rates range from 7% to 13% of the population in North America, about 5–9% of the population in Europe, and only 1–5% of the population in Asia.[1] In India, the incidence of kidney stones was lower than 40/100,000 population during the 1960's, but over span of three decades, it has grown to about 930/100,000 population.[2,3]

Access this article online	
Website: www.ijaims.net	Quick Response code

Since the introduction of percutaneous nephrolithotomy (PCNL) by Fernström and Johansson,[4] neoteric advancements have been made in the procedure. PCNL accounts for about 5% of all renal stone surgeries worldwide.[5,6] It is now well acknowledged that PCNL has varying grades of complexities that affect stone clearance and post-operative complications.

There is, thus, a need to standardize the success and perioperative complexity associated with the procedure. Such a purpose can be achieved using a scoring system which can generalize criteria for stratification of complexity of PCNL.

In 2009, Smith *et al*.[7] from Guy's and St. Thomas' NHS Foundation Trust, London, United Kingdom proposed the Guy's stone score (GSS) and was validated in 2011 by Thomas *et al*.[8] The GSS is a valuable tool that can be used in the stratification of the complexity of PCNL into four grades, depending on the stone burden along with the anatomy of both patient and the renal tract.

- Grade I: Solitary stone in mid/lower pole with simple anatomy or, solitary stone in pelvis with simple anatomy.
- Grade II: Solitary stone in upper pole with simple anatomy or, multiple stones in a patient with simple anatomy or, solitary stone in a patient with abnormal anatomy.
- Grade III: Multiple stones in a patient with abnormal anatomy or, stones in calyceal diverticulum or, partial staghorn calculus.
- Grade IV: Staghorn calculus or, any stone in patient with spina bifida/spinal injury.

The GSS can be determined using a preoperative intravenous pyelogram (IVP)[9] or more recently using a non-contrast computed tomography (NCCT) scan of the kidneys, ureters, and the bladder (KUB). Meanwhile, a digital X-ray KUB can be obtained on 2nd post-operative day to ascertain the stone-free status after the procedure. Although various scoring systems have been proposed for the stratification of complexity of PCNL, disagreement still remains in the comparative efficiency and efficacy of these scoring systems. This study was undertaken to predict whether the GSS which is easily reproducible and a quicker scoring system can preoperatively predict the complexity of PCNL and help in optimizing operative planning and facilitate in counseling the patient regarding the outcome of PCNL.

MATERIALS AND METHODS

This was an observational study which was conducted on 80 patients who underwent PCNL at Rohilkhand Medical College and Hospital, Bareilly, Uttar Pradesh, between November 2018 and October 2019. The study was done after approval from the ethical committee of our institution. All patients aged 18 or above, who were admitted and diagnosed as a case of renal calculi and underwent PCNL, were included in the study after consenting for the same. Exclusion criteria for the study were – patients with bleeding diathesis or infection/sepsis, patients belonging to American society of anesthesiologists (ASA) Grades 4, 5, and 6, and patients who underwent bilateral PCNL. All the surgeries were performed by a single experienced surgeon. For each patient, a pre-operative IVP was done and GSS was determined. All patients were counseled preoperatively regarding the expected outcome of the procedure in terms of the stone-free rate (SFR) and complications of PCNL.

Patients underwent PCNL according to the standard technique after ensuring sterile urine. Cystoscopy was the initial step with the insertion of a ureteral catheter in lithotomy position. Following which the patients were placed in prone position and percutaneous access was obtained under the guidance of C-arm fluoroscopy with or without contrast dye. Tract was dilated using Alkens serial dilator and an Amplatz sheath ranging from 24 Fr to 28 Fr. was then placed as per the surgeon's preference. Once the tract was dilated, nephroscopy was performed using a rigid 21 Fr Nephroscope (Wolf). After identification of the calculi, fragmentation was done with a pneumatic lithoclast. Stone clearance was confirmed intraoperatively using fluoroscopy. If multiple punctures were required, they were done before dilating the first tract and the guidewire was then secured. Antegrade placement of a Double J stent was performed at the end of the procedure. If a relook PCNL was anticipated in any patient, an external urethral catheter was left in situ. In all the patients a 16 Fr nephrostomy tube was placed at the end of the procedure, either in the renal pelvis or the punctured calyx. Operative time was calculated from the time of percutaneous needle access to the completion of nephrostomy tube placement. All complications were noted and graded as per the Clavien Dindo system.[10] On the 2nd post-operative day, X-ray KUB was done to assess SFR. In this study, the SFR was defined as no visible stone or presence of clinically insignificant fragment <4 mm on X-ray KUB. Those with clinically significant residual stone (>4 mm) underwent ancillary procedure which included re look PCNL and extracorporeal shock wave lithotripsy (ESWL). For each patient, pre-operative GSS, intra- and post-operative clinical parameters and SFR (based on post-operative X-ray KUB) was recorded and analysis was performed to determine the association between GSS and treatment outcomes (SFR and procedural complications).

Statistical analysis was performed using SPSS software version 23 (SPSS Inc, Chicago, USA). Qualitative data were represented in the form of frequency and percentage. Quantitative data were represented using Mean ± SD and Median and Interquartile range. The area under curve (AUC), calculated by receiver operating characteristic (ROC) curve, was used to assess the predictive ability of GSS. All *P*-value were two-tailed with statistical significance set at 0.05 and confidence intervals (CIs) were calculated at the 95% level.

RESULTS

The study was conducted on 80 patients, 47 (58.8%) were male and 33 (41.2%) were female with mean age of 36.25 ± 13.6 years. There was no statistical significance ($P = 0.667$) in the distribution of patients according to body mass index among GSS grades. Out of 80 patients, 37 patients (46.3%) belonged to Grade I, 26 patients (32.5%) belonged to Grade II (out of these 19 [73.1%] had multiple calculi and seven [26.9%] had solitary upper calyceal stone), eight patients (10%) belonged to Grade III, and nine patients (11.3%) belonged to Grade IV.

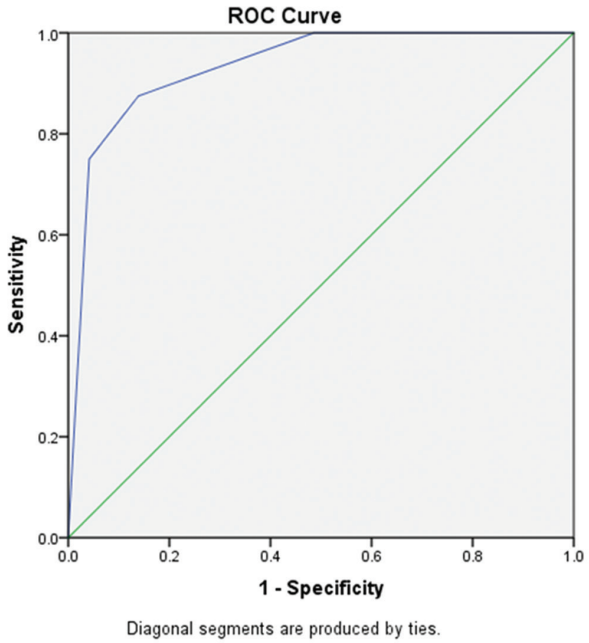
Out of 80 patients, 67 (83.8%) belonged to ASA Grade 1, remaining 13 (16.2%) belonged to ASA Grade 2. The preferred

surgical approach was subcostal access accounting for 49 cases (61.3%) while supracostal access accounted for 31 cases (38.8%). Most patients – 76 (95.0%) required only one needle tract for percutaneous access meanwhile only four patients (5.0%) required two needle tracts. Mean operative time was 56.69 ± 29.66 min [Table 1].

Overall stone-free status was achieved in 73 patients (91.25%), out of 80 patients who underwent PCNL. A complete SFR (100%) was achieved among patients belonging to Grades I and II, while seven (87.5%) out of eight patients belonging to Grade III had a complete stone-free status and only three patients (33.3%) belonging to Grade IV had complete stone-free status. Mean post-operative stay at hospital was 5.08 ± 1.74 days. Among patients with residual stone, re look PCNL was done for six patients (one belonged to Grade III and five belonged to Grade IV) and only one patient belonging to Grade IV required ESWL [Table 2]. One patient (belonging to Grade IV) with residual stone did not opt for any ancillary procedure. Out of 80 patients considered for this study, only one patient (belonging to Grade IV) required blood transfusion with one unit of packed red blood cell.

Logistic regression analysis [Table 3] was performed to assess the predictor value of SFR (as independent variable) against dependent variables – GSS, number of calyx involved, and number of stones, which suggested that there was no such significant association between number of stones (solitary or multiple) and number of calyx involved (solitary or multiple) with the SFR. There is a significant positive association between GSS and SFR with a p-value of 0.039

ROC curve and AUC were used to determine the predictive ability of GSS.



Area under curve	*P*-value	95% Confidence interval range
0.934	<0.001	0.854–1.000

DISCUSSION

In this study, among 37 patients belonging to Grade I, 20 patients (25%) had solitary pelvic calculi with normal renal anatomy, nine patients (11.25%) had solitary calculi in middle calyx, and eight patients (10%) had solitary calculi in lower calyx with normal renal anatomy. All of the Grade III patients had partial staghorn calculi and none had diverticular stone or abnormal anatomy. Similarly, all the Grade IV patients had staghorn calculi and none had spinal abnormality.

The procedure adopted the use of supracostal or subcostal access as the need warranted. For staghorn calculi, preferred approach is through upper or middle calyx preferably with a supracostal puncture.[11] In this study, most supracostal access (32.5%) were done in patients belonging to Grade II which is in disagreement with the study done by Lojanapiwat *et al*.[9] in 2016, where most patients (50.6%) requiring supracostal access belonged to Grade IV. However, there was concordance with respect to most preferred percutaneous access site which was subcostal access being 64.3% as compared to 61.3% in the present study. In the present study, the most of the patients (95%) required only one needle tract for percutaneous access while only four patients (5%) required two needle tracts. This is similar to the study by Thomas *et al*.[8] in 2011, where 90% patients required only one needle tract, while 5% patients required two needle tracts and 1% required three needle tracts. The need for extra needle tract was required for the removal of displaced fragmented stones into other calyces intra operatively. Higher grades may require multiple needle tract for better clearance, as more calyces are involved in higher grades, also there is ease in performing the procedure as manipulation of instruments is reduced due to an alternative access for lithotripsy and retrieval of fragmented stones.

The average operating time of the present study was 56.69 ± 29.66 min and showed an increasing trend as the grade increased ($P < 0.001$) which is consistent with the study by de Souza Melo *et al*.[12] where the mean operating time was 108.45 ± 48.25 min ($P < 0.001$). Higher grades have more calyceal involvement and the chances of displacement of fragmented stones are more. Hence, to achieve a complete clearance, operative time required is more as the grades increase.

A total of 13 patients developed complications which included fever among nine patients, hematuria among three patients and a single patient developed fever along with hematuria. Complications were graded based on Clavien–Dindo grading. Most complications were noted in Grade IV which is in agreement with the conclusion made by Bozkurt *et al*.[13] (2015), in their study, in which more complications were encountered as the grading increased ($P < 0.001$).

Leakage from nephrostomy site is noted to be higher in patients with higher grades as the increase in operative time and greater manipulation of instruments during surgery predisposes to persistent leak. However, leakage of nephrostomy site can also occur due to displaced DJ stent or obstruction in DJ stent irrespective of GSS grade.

Table 1: Distribution of patients according to GSS based on intra operative parameters

GSS	GSS I	GSS II		GSS III	GSS IV	*P*-value
		Multiple stone	Solitary upper calyceal stone			
Number of patients, *n* (%)	37 (46.3)	19 (23.7)	7 (8.7)	8 (10)	9 (11.3)	
Surgical access, *n* (%)						
Supracostal	0	9 (34.6)	7 (26.9)	7 (87.5)	8 (88.9)	<0.001
Subcostal	37 (100)	10 (38.4)	0	1 (12.5)	1 (11.1)	
Number of needle tracts, *n* (%)						
1	37 (100)	18 (69.2)	7 (26.9)	8 (100)	6 (66.7)	<0.001
2	0	1 (3.84)	0	0	3 (33.3)	
Operative time (in min)	34.32±3.94	61.32±12.0	47.14±17.04	89.38±9.8	117.22±18.8	<0.001

GSS: Guy's stone score

Table 2: Distribution of patients according to GSS based on post-operative parameters

GSS	GSS I	GSS II		GSS III	GSS IV	*P*-value
		Multiple stones	Solitary upper calyceal stone			
Leakage from nephrostomy site >12 h, *n* (%)	0	3 (11.5%)		3 (37.5%)	6 (66.7%)	<0.001
Stone-free rate, %	100	100	100	87.5	33.3	<0.001
Post-operative stay (in days)	4.03±1.07	5.42±1.43	4.57±1.13	6.88±1.64	7.44±1.33	<0.001
Ancillary procedure, *n* (%)						
Re look percutaneous nephrolithotomy	0	0	0	1 (12.5%)	5 (55.6%)	<0.001
Extracorporeal shock wave lithotripsy	0	0	0	0	1 (11.1%)	
Clavien Dindo grading, *n* (%)						
1	37 (100%)	23 (88.5%)		5 (62.5%)	5 (55.5%)	
2	0	3 (11.5%)		3 (37.5%)	4 (44.4%)	
3a	0	0		0	1 (11.1%)	

GSS: Guy's stone score

Table 3: Logistic regression analysis

Parameter	*P*-value	Odds ratio	95% Confidence interval	
			Lower bound	Upper bound
Guy's stone score	0.039	1.71	0.774	0.881
Number of stones	0.464	0.163	0.661	0.943
Number of calyx involved	0.998	0.001	0.741	0.988

Different modalities and timing have been utilized by various studies for assessing SFR, ranging from X-ray KUB to CT KUB. Studies which employed X-ray KUB defined SFR as no stone or any residual stone <4 mm; meanwhile, studies based on CT scan defined SFR as being free of stone on CT scan. In the study by Ingimarsson *et al*.,[14] in 2014, concluded a SFR of 95–97% for Grades I and II, respectively, which is similar to the observations noted in the present study where Grade I and II had a SFR of 100% each. However, Grade III had a SFR of 95% and Grade IV had 75%, which is much better compared to 87.5–33.3% noted among Grade III and Grade IV patients of the present study. This discrepancy could be attributed to the use of NCCT KUB on 1st post-operative day by Ingimarsson *et al*. for determining stone-free status. Ingimarsson *et al*.[14] also concluded that GSS offers good inter rater concordance and is associated with rigorous endpoints of stone clearance.

Using binary logistic regression analysis, only GSS was noted to be the predictor for SFR ($P = 0.003$) which is in concordance with the conclusion made by Sfoungaristos *et al*.[15] in 2015. Efficacy of the test was done using ROC analysis which revealed an AUC of 0.934 for a 95% CI between 0.854 and 1.000 ($P < 0.001$). This suggests high predictability of SFR and high efficacy of GSS for all grades. The results of this study suggest a better outcome than other studies which include the study by Bozkurt *et al*.[13] in 2015 which revealed a AUC of 0.77 for 95% CI between 0.73 and 0.82, meanwhile a study by Sfoungaristos *et al*.[15] in 2015 reported an AUC of 0.796 for 95% CI between 0.72 and 0.87 ($P < 0.001$).

CONCLUSION

The conclusion of this study is that GSS based on IVU is a simple and useful tool which can be used to stratify the complexity of PCNL preoperatively and can help in counseling of patients preoperatively regarding the outcome of PCNL.

REFERENCES

1. Sorokin I, Mamoulakis C, Miyazawa K, Rodgers A, Talati J, Lotan Y. Epidemiology of stone disease across the world. World J Urol 2017;35:1301-20.
2. Liu Y, Chen Y, Liao B, Luo D, Wang K, Li H. Epidemiology of urolithiasis in Asia. Asian J Urol 2018;5:205-14.
3. Kale SS, Ghole VS, Pawar NJ, Jagtap DV. Inter-annual variability of urolithiasis epidemic from semi-arid part of Deccan Volcanic Province, India: Climatic and hydrogeochemical perspectives. Int J Environ Health Res 2014;24:278-89.
4. Fernström I, Johansson B. Percutaneous pyelolithotomy: A new extraction technique. Scand J Urol Nephrol 1976;10:257-9.
5. de la Rosette JJ, Laguna MP, Rassweiler JJ, Conort P. Training in percutaneous nephrolithotomy a critical review. Eur Urol 2008;54:994-1003.
6. Alken P, Bellman G, Flam T, Fuchs G, Gallucci M, Gautier JR. Treatment of renal stones. In: Segura J, Conort P, Khoury S, Pak C, Preminger GM, Tolley D, editors. International Consultation on Stone Disease, Paris 2001, July 4-5. Proc Ed 2003;21:173-210.
7. Smith NC, Hegarty N, Glass J, Thomas K. 824 novel system for grading complexity of PCNL procedures: The Guy's stone score. Eur Urol Suppl 2009;8:821-4.
8. Thomas K, Smith NC, Hegarty N, Glass JM. The Guy's stone score grading the complexity of percutaneous nephrolithotomy procedures. Urology 2011;78:277-81.
9. Lojanapiwat B, Rod-Ong P, Kitirattrakarn P, Chongruksut W. Guy's stone score (GSS) based on intravenous pyelogram (IVP) findings predicting upper pole access percutaneous nephrolithotomy (PCNL) outcomes. Adv Urol 2016;4:1-6.
10. Dindo D, Demartines N, Clavien PA. Classification of surgical complications: A new proposal with evaluation in a cohort of 6336 patients and results of a survey. Ann Surg 2004;240:205-6.
11. El-Karamany T. A supracostal approach for percutaneous nephrolithotomy of staghorn calculi: A prospective study and review of previous reports. Arab J Urol 2012;10:358-66.
12. de Souza Melo PA, Vicentini FC, Beraldi AA, Hisano M, Murta CB, de Almeida Claro JF. Outcomes of more than 1 000 percutaneous nephrolithotomies and validation of Guy's stone score. BJU Int 2018;121:640-6.
13. Bozkurt IH, Aydogdu O, Yonguc T, Yarimoglu S, Sen V, Gunlusoy B, *et al*. Comparison of guy and clinical research office of the endourological society nephrolithometry scoring systems for predicting stone-free status and complication rates after percutaneous nephrolithotomy: A single center study with 437 cases. J Endourol 2015;29:1006-10.
14. Ingimarsson JP, Dagrosa LM, Hyams ES, Pais VM Jr. External validation of a preoperative renal stone grading system: Reproducibility and inter-rater concordance of the Guy's stone score using preoperative computed tomography and rigorous postoperative stone-free criteria. Urology 2014;83:45-9.
15. Sfoungaristos S, Lorber A, Gofrit ON, Yutkin V, Landau EH, Pode D, *et al*. External validation and predictive accuracy assessment of Guy's stone score as a preoperative tool for estimating percutaneous nephrolithotomy outcomes. J Endourol 2015;29:1131-5.