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ORIGINAL ARTICLE

Guy's stone score as a predictor for stone free rate and complications related to PCNL – A retrospective study

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Abstract
Renal stones and their management forms bread and butter for a practising urologist. Percutaneous Cystolithotripsy (PCNL) forms the workhorse in the management of large renal stones with size greater than 2 cm. Many score predictors have been described to determine stone free rates and complications related to PCNL surgery.

Key words: staghorn calculus, guy's scoring system, success and complications

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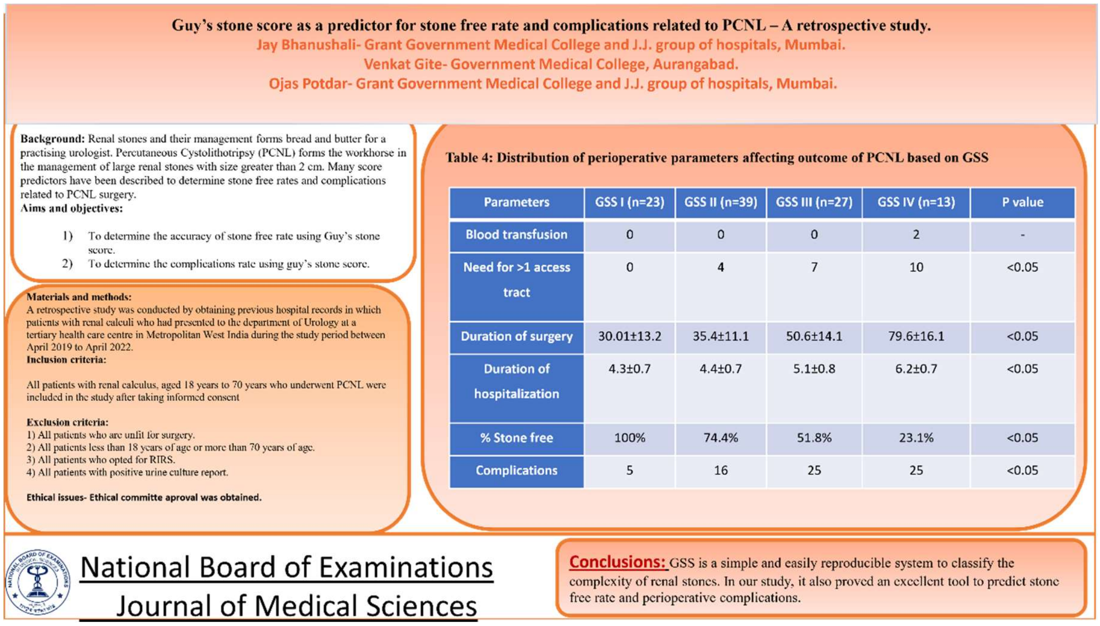
Graphical Abstract



Parameters	GSS I (n=23)	GSS II (n=39)	GSS III (n=27)	GSS IV (n=13)	P value
Blood transfusion	0	0	0	2	-
Need for >1 access tract	0	4	7	10	<0.05
Duration of surgery	30.01±13.2	35.4±11.1	50.6±14.1	79.6±16.1	<0.05
Duration of hospitalization	4.3±0.7	4.4±0.7	5.1±0.8	6.2±0.7	<0.05
% Stone free	100%	74.4%	51.8%	23.1%	<0.05
Complications	5	16	25	25	<0.05

Introduction

Over the past 20 years, kidney stone illness has become much more commonplace worldwide. The utilization of Percutaneous Nephrolithotomy (PCNL) for the treatment of massive stone burden has increased in tandem with the sharp rise in the incidence and prevalence of stone illness. Even with ongoing advancements in technology and surgical methods, PCNL still has a higher overall complication rate [1,2].

The degree of hydronephrosis, positional distribution, calyceal and anatomical complexity, stone burden and density, and secondary alterations all appear to be significant factors in the outcome of PCNL [3].

After PCNL, the Stone Free Rate (SFR) has been observed to range from 56% to 76% [4]. Comparing different studies, however, is challenging for two reasons. –

1) There is no standard grading scheme to classify the difficulty of stones.
2) The definition and methodology for evaluating stone clearance are not standardized [5].

Despite being regarded as a minimally invasive surgery, PCNL carries a considerable risk of complications and does not guarantee that the patient will be clear of stones. There are guidelines for PCNL indications, and the Clavien system has been adjusted to grade problems [6].

Moreover, there isn't a widely recognized standard for grading stone complexity that would enable relevant study comparisons. A validated, user-friendly stone score would be helpful for outcome comparison and possibly for informing patients about their chances of achieving a "Stone Free" outcome after surgery.

In 2007 UK National PCNL audit by British Association of Urological Surgeons (BAUS) identified 'inability to stratify stone complexity' as a significant barrier towards derivation of meaningful audit conclusions [7].

Two major scoring system categories that attempt to be connected to SFR following PCNL have been described [8-10].

First, Ordinal Scoring Systems were developed from single institution analysis. They classified calculi into "Ordered" classes of increasing difficulty, primarily based on characteristics that experts believed (with the help of historical data) determined SFR. These grades were then further tested statistically.

Thomas et al. (2011) [8] described Stone Scoring System, “Guy’s Stone Score” (GSS), which comprises 4 grades based upon renal anatomy, number of stone and patient factors. Okhunov et al. (2013) [14] proposed S.T.O.N.E. [stone size (S), tract length (T), obstruction (O), number of involved calices (N), and essence or stone density (E)]. It provides an overall view of the surgical procedure's complexity by integrating five components measured from preoperative CT imaging and quantitatively characterizing the stone state [9].

The second type, Smith et al. (2013) [10] proposed CROES (Clinical Research Office of the Endourological Society) nomogram for PCNL success. Regression modeling produced from many institutions serves as the foundation for the statistically determined data-driven risk estimator model known as CROES. With the explanatory variables of stone burden, case volume, previous stone treatment, staghorn stone, stone placement, and stone count, it provides a continuous score that can "predict" the dependent result of SFR. The greatest indicator of the stone-free rate was stone burden (Chi-square =30.27, p =0.001) [10].

With the use of high resolution spatial imaging provided by CT, it is possible to accurately characterize the size and distribution of stones, the anatomy of the pelvic floor, abnormalities, and anatomical linkages that may determine the viability and risks of various treatment methods. With these quantifiable stone and patient characteristics, the GSS [8], S.T.O.N.E. nephrolithometry [4] and the CROES nephrolithometry nomogram [10] were implemented in order to evaluate kidney stones in a methodical and quantitative manner. These models consider co-morbidities that influence the course of the disease in addition to imaging features [8-10]. In order to enhance patient counseling and surgical planning, the surgeon can more precisely predict PCNL outcomes by using the score systems as disease stratification tools [8-10].

Standardized reporting across several series is another possible benefit of scoring systems. Due to a lack of generally recognized guidelines, comparison testing of urolithiasis treatments has not yet been possible and user-friendly stone scoring standardization system [5]. This was a retrospective study which evaluated the Guy’s scoring system not only in predicting the stone free rate and complications, but also in evaluation of the intraoperative events during PCNL.

Aims and objectives:

1) To determine the accuracy of stone free rate using Guy’s stone score.
2) To determine the complications rate using guy’s stone score.

Materials and methods

A retrospective study was conducted by obtaining previous hospital records in which patients with renal calculi who had presented to the department of Urology at a tertiary health care centre in Metropolitan West India during the study period between April 2019 to April 2022.

Inclusion criteria

All patients with renal calculus, aged 18 years to 70 years who underwent PCNL were included in the study after taking informed consent.

Exclusion criteria

1) All patients who are unfit for surgery.
2) All patients less than 18 years of age or more than 70 years of age.
3) All patients who opted for RIRS.
4) All patients with positive urine culture report.

Information was obtained from hospital previous records which included basic demographic data like age and sex, detailed clinical history on basis of symptoms and its duration, associated co-morbidities, past calculus history, previous surgical intervention (especially urological) and family history of calculus disease, diabetes, hypertension, malignancy and clinical examination findings. Investigations included basic preoperative investigations and imaging in the form of Non contrast Computerised Tomography of Kidney, Ureter and Bladder (NCCT KUB).

This radiological imaging provided for details of stone location, site, size, number, stone density, calyceal involvement, dilated system and associated congenital & anatomical abnormalities.

In all study cases, Guy's stone score was calculated as follows:

PCNL had been performed in all these patients and their operative details were obtained from the previous records and noted.

Peri-operative variables included Operative side (Laterality of stones), Stone location, Stone size, Number of calyces involved, Anatomy of kidney (normal or abnormal) operative time, analgesic and blood requirement, length of hospital stay were noted and surgical complications (intraoperative and postoperative) according to modified Clavien system were also obtained from the records. Post operatively Stone Free Status was assessed by X-Ray KUB on the first postoperative day and findings were recorded.

A patient was considered to be in a stone-free status if there were no stones at all or clinically insignificant residual fragments (CIRF) that were smaller than 4 mm and did not indicate an obstruction, infection, or need for additional care.

The postoperative complications of PCNL were assessed using the **modified Clavien grading** scale [5].

All the data obtained was tabulated and results analysed.

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This radiological imaging provided for details of stone location, site, size, number, stone density, calyceal involvement, dilated system and associated congenital & anatomical abnormalities.

In all study cases, Guy's stone score was calculated as follows (Table 1):

Table 1. Guy's Stone Score

Grade	Description
Grade I	A solitary stone in the mid/lower pole with simple anatomy OR A solitary stone in the pelvis with simple anatomy
Grade II	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
Grade III	Multiple stones in a patient with abnormal anatomy OR Stones in a calyceal diverticulum OR Partial Staghorn Calculus
Grade IV	Staghorn Calculus OR Any stone in a patient with spina bifida or spinal injury

PCNL had been performed in all these patients and their operative details were obtained from the previous records and noted.

Peri-operative variables included Operative side (Laterality of stones), Stone location, Stone size, Number of calyces involved, Anatomy of kidney (normal or abnormal) operative time, analgesic and blood requirement, length of hospital stay were noted and surgical complications (intraoperative and postoperative) according to modified Clavien system were also obtained from the records. Post operatively Stone Free Status was assessed by X-Ray KUB on the first postoperative day and findings were recorded.

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The **modified Clavien grading system** was used to evaluate postoperative complications of PCNL [5].

All the data obtained was tabulated and results analysed.

Results

The study included a total of 102 patients in which 62 were males and 40 were females. The mean age of patients was 43.2 (±13.2) years. The age distribution of patients is depicted in Table 2.

Table 2. Distribution of age groups based on gender of patients

Age groups (Years)	Males (n_1/%)	Female (n_2/%)	Total no. of patients (N/%)
18-30	8 (7.8%)	7 (6.9%)	15 (14.7%)
30-39	10 (9.8%)	5 (4.9%)	15 (14.7%)
40-49	24 (23.6%)	13 (12.7%)	37 (36.3%)
50-59	11 (10.8%)	9 (8.8%)	20 (19.6%)
>60	9 (8.8%)	6 (5.9%)	15 (14.7%)
Total	**62 (60.8%)**	**40 (39.2%)**	**102 (100%)**
Mean ±SD	**50.6±14.1**	**41.6±15.3**	**43.2±13.2**
Min-Max	**18-70 years**	**P value**	**0.07^{NS}**

Out of 102 patients studied, majority belonged to the age group 40 to 49 years old (37 cases, 36.3%), followed by 20 patients (19.6%) aged between 50 to 59 years of age and 15 patients (14.7%) each of age between 18 to 30, 30 to 39 and above 60 years old.

Youngest patient admitted was 18 years old male while oldest patient admitted was 70 years old female.

Mean age of male and female patients was 50.6±14.1 years and 41.6±15.3 years respectively. Mean age of patients was found to be 43.2±13.2 years. It can be seen that mean age of male and female patients did not differ significantly (p=0.07) (Figure 1 and Table 3).

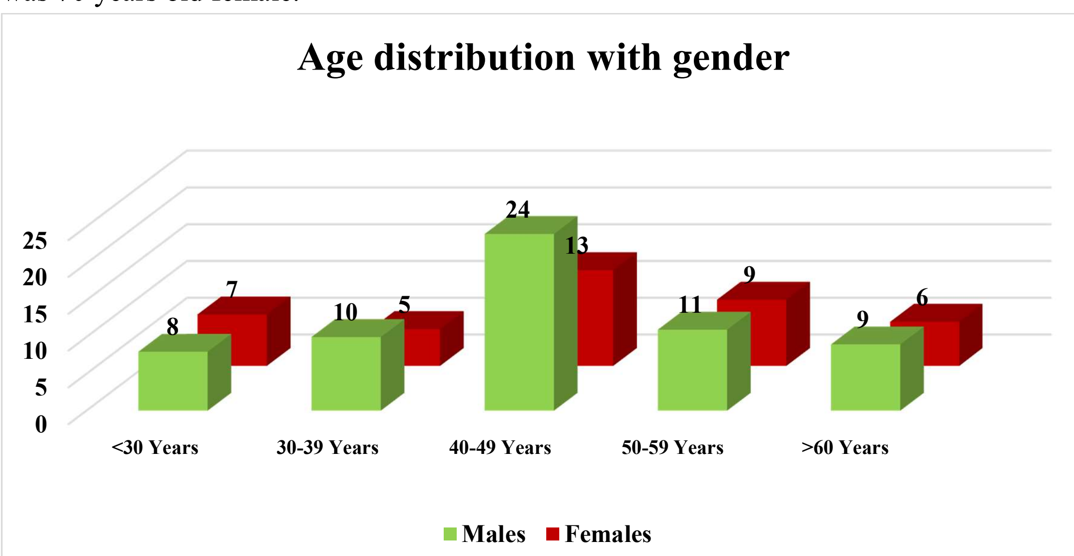

Figure 1. Distribution of age groups based on gender of patients

Table 3. Distribution of stone free rate based on Guy Stone's Score

Guy Stone's Score	Stone free (n_1/%)	Residual stone (n_2/%)	Total (N/%)	% Free
I	23 (22.6%)	0	23 (22.6%)	100%
II	35 (34.3%)	4 (3.9%)	39 (38.2%)	89.7%
III	20 (19.6%)	7 (6.9%)	27 (26.5%)	74.1
IV	5 (4.9%)	8 (7.8%)	13 (12.7%)	38.7%
Total	**83 (81.4%)**	**19 (18.6%)**	**102 (100%)**	**P<0.05***

According to the GSS there were 23 (22.6%), 39 (38.2%), 27 (26.5%) and 13 (12.7%) patients in GSS I, II, III and IV groups, respectively. GSS I (n=23) included 13 pelvic, 2 mid-pole and 8 inferior pole calculi. GSS II (n=39) included 30 multiple calculi, 4 upper-polar calculi and single pelvic calculus with pelviureteric junction obstruction in 5 renal unit. All GSS III (n=27) included 27 partial staghorn calculi. All renal units in GSS IV (n=13) had complete staghorn calculus.

About 19 (18.6%) patients still had residual stones while 83 patients (81.4%) were stone free. For renal units with GSS I, II, III and IV, 100%, 89.7%, 74.1% and 38.7% of renal units respectively were stone-free. There was a significant inverse correlation between GSS grade and Stone free rate ($p < 0.05$) (Figure 2 and Table 4).

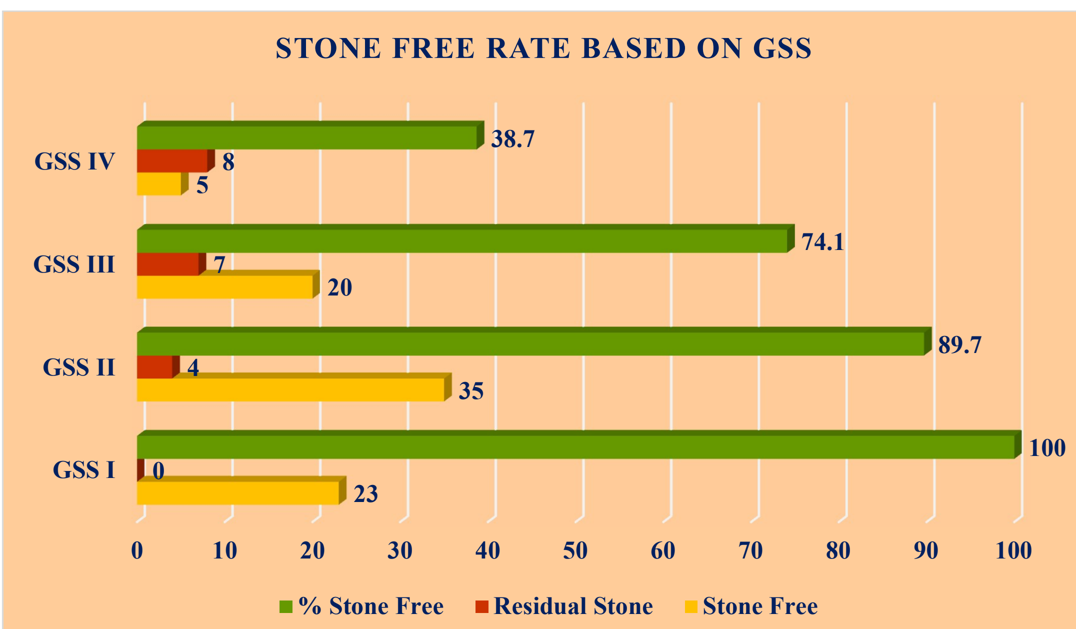

Figure 2. Distribution of stone free rate based on Guy Stone's Score

Table 4. Distribution of complications based on Clavien Dindo grading system among GSS groups

Clavien grading	GSS I	GSS II	GSS III	GSS IV	Total complications (N/%)
1	4 (5.6%)	11 (15.6%)	13 (18.3%)	9 (12.7%)	37 (52.2%)
2	1 (1.4%)	1 (1.4%)	3 (4.2%)	5 (7%)	10 (14%)
3a	0	4 (5.6%)	7 (9.9%)	8 (11.3%)	19 (26.8%)
3b	0	0	1 (1.4%)	2 (2.8%)	3 (4.2%)
4a	0	0	1 (1.4%)	1 (1.4%)	2 (2.8%)
4b	0	0	0	0	0
5	0	0	0	0	0
Total	**5 (7%)**	**16 (22.6%)**	**25 (35.2%)**	**25 (35.2%)**	**71 (100%)**

A total 71 complications were seen in 102 patients studied. The occurrence of complications in patients with various GSS grades was compared and is shown in above table. Majority of complications were seen in grade III and grade IV (25 cases each, 35.2%). All grades of complications were more common in patients with GSS III and IV (P <0.05) (Figure 3 and Table 5).

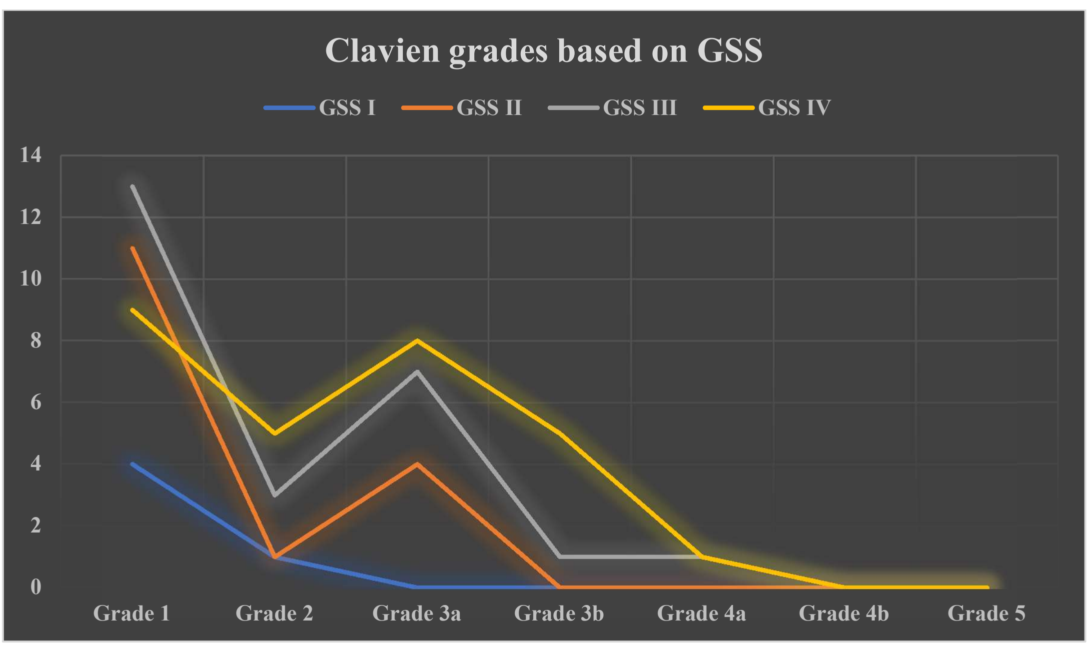

Figure 3. Distribution of complications based on Clavien grading system among GSS groups

Table 5. Distribution of perioperative parameters affecting outcome of PCNL based on GSS

Parameters	GSS I (n=23)	GSS II (n=39)	GSS III (n=27)	GSS IV (n=13)	P value
Blood transfusion	0	0	0	2	-
Need for >1 access tract	0	4	7	10	<0.05
Duration of surgery	30.01±13.2	35.4±11.1	50.6±14.1	79.6±16.1	<0.05
Duration of hospitalization	4.3±0.7	4.4±0.7	5.1±0.8	6.2±0.7	<0.05
% Stone free	100%	74.4%	51.8%	23.1%	<0.05
Complications	5	16	25	25	<0.05

Blood transfusion was needed in 2 patients with GSS IV. In 4 patients of GSS II, 7 patients with GSS III and 10 patients with GSS IV more than one access tract was needed to complete the procedure. Duration of surgery and hospitalisation in GSS I was 30.01±13.2 and 4.3±0.7, in GSS II was 35.4±11.1 and 4.4±0.7, in GSS III was 50.6±14.1 and 5.1±0.8 and that of in GSS IV was 79.6±16.1 and 6.2±0.7 respectively. Stone free rate in GSS I, GSS II, GSS III and GSS IV was 100%, 89.7%, 74.1% and 38.7%. Complications were seen in 5, 16, 25 and 25 patients with GSS I, GSS II, GSS III and GSS IV respectively.

The GSS grade and Stone free rate had a significant inverse connection ($p < 0.05$). GSS grades III and IV had a considerably increased rate of problems using the Clavien grading system ($p < 0.05$). The frequency of blood transfusions, the requirement for more than one access tract, and the duration of surgery and duration of hospitalization.

Discussion

Over the previous forty years, there has been a threefold increase in kidney stone incidence and prevalence. Researchers have worked hard to build a standard system that can identify patients who may require a staged procedure or other alternative procedure, be more susceptible to complications, or have residual stone burden following PCNL. This will aid in patient counseling and clinical decision-making.

In 2008, Tefekli et al. attempted to establish a connection between the rate of complication and stone complexity, but they were unable to produce any meaningful results.

In their investigation, De la Rosette et al. discovered a significant correlation between operative time and stone burden, although they did not identify any relationship between stone burden and complications.

A noteworthy correlation between stone size and problems was discovered by Michel et al.

Standardization of the preoperative data was lacking in all earlier studies and subsequent ones on preoperative variables to predict the stone free rate and outcome following PCNL.

The S.T.O.N.E. score system was created by Okhunov et al. [16] and is based on non-contrast CT (NCCT). A lower number indicates a higher rate of stone clearance. The score ranges from 5 to 13, taking into account several factors.

Increased estimated blood loss (EBL), longer operating times (OT), and longer lengths of stay (LOS) are among the major problems that are linked to higher S.T.O.N.E. scores. Smiths et al.'s CROES nomogram was derived from a global database analysis involving 5830 patients. This nomogram has six characteristics: stone burden, number, location, multiple, staghorn, and institute-level case volume. It is cucumber-sized and requires a lot of work, yet it achieved an impressive 76% prediction accuracy.

Numerous research works have contrasted these scoring systems' prognostic abilities in post-PCNL SFR. The majority of research has looked at how well these scoring systems function in terms of SFR prediction, but not in terms of complications prediction.

Every scoring system has limitations or drawbacks. For instance, the term "partial staghorn stone" was ambiguous in Guy's scoring system. Preoperative CT is the only source of data used in the S.T.O.N.E. Score scoring system.

The CROES nomogram requires data (case volume and treatment history) that may not be easily accessible.

Percutaneous Nephrolithotomy (PCNL) has become the accepted standard treatment of choice for large and difficult kidney stones. It is a minimally invasive procedure with a good safety record and success rate. Variable outcomes related to renal anatomy, the number of stones, calcification involvement, stone burden, complexity, and other variables are also linked to PCNL. A number of Stone Scoring Systems have been implemented to evaluate and validate predictive nomograms, which can greatly improve patient counseling and preoperative treatment planning.

Higher grades are linked to lower SFR. Thomas et al. (2011) [4] established the GSS per grading to predict SFR based on stone complexity. Ingimarson et al. (2014) [16] verified the GSS.

The calyceal diverticulum, aberrant renal architecture, and the quantity of stones are included in the Guy's Score. A stone complexity metric is included in each grading system. Staghorn or partially staghorn stone formation is a variable in the GSS that is primarily used to highlight a stone's intricacy [13,15]. Subjective interpretations of stone burden and position can lead to variances in scores for certain grading systems [13,16].

For comprehensive reporting and comparison, the ideal scoring system must be easily implementable, reproducible, and sufficiently detailed. The sole assessment needed to determine the GSS score is renal imaging, which may be completed at facilities with CT access. Complication prediction is linked to GSS. In comparison, it is less laborious.

Numerous published studies have confirmed the GSS as having good inter-rater concordance [16].

In our study, we found direct correlation between GSS and increased complication rate. This may be attributable to higher stone burden leading to need for multiple punctures and higher technical complexity and longer intraoperative time [17].

Conclusion

The GSS is a straightforward and repeatable method for grading the difficulty of kidney stones. In our study, it also proved an excellent tool to predict stone free rate and perioperative complications. Ultimately, meticulous pre operative planning aided by a thorough evaluation of patients using GSS and radiological investigations accompanied by preoperative counselling is key to success in management of renal stone disease and obtain favourable outcome while minimising morbidity of the patient.

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Conflict of Interest

The authors have no relevant financial or non-financial interests to disclose.

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Consent for publication

Consent for publication has been given by all the authors mentioned in the study.

Availability of data and material:

The data and material required for the conduct of the study was collected by filing out case proforma sheets and use of hospital information system to collect patient related reports and other related data required for the study after obtaining consent from the patient and the hospital administration.

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