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Guy's Stone Score as a Predictor for Stone-Free Rate and Complications in Percutaneous Nephrolithotomy: A Single-Center Report from a Stone Belt Country

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Keywords
Urolithiasis · Guy's Stone Score · Percutaneous nephrolithotomy · Stone-free rate · Complications

Abstract
Objectives: To evaluate Guy's Stone Score (GSS) as a grading system for the complexity of renal calculi before percutaneous nephrolithotomy (PCNL) and as a predictor for stone-free rate (SFR) and potential complications in the setting of a developing country with many cases of advanced complex stone disease. ***Patients and Methods:*** We performed a prospective study on 115 patients with renal stones who had PCNL between August 2017 and October 2018. Stone complexity was classified according to GSS using preoperative imaging. The rates of perioperative complications were assessed using the Clavien grading system, and the SFR was assessed in the 3rd postoperative week by abdominal X-ray and renal ultrasound. The χ^2 and one-way ANOVA tests were used for statistical analysis. A p value ≤0.05 was considered significant. ***Results:*** The study included 115 patients (77 males) with a mean age of 50.2 (±13.3) years. Cases were classified according to GSS into 4 grades; there were 24 (20.9%) grade I, 48 (41.7%) grade II, 25 (21.7%) grade III, and 18 (15.7%) grade IV cases. There was a significant inverse correlation between GSS grade and SFR ($p < 0.001$). The rate of complications using the Clavien grading system were significantly higher in GSS grades III and IV ($p = 0.002$). So were the rates of blood transfusion, the need for >1 access tract, and the duration of hospitalization. ***Conclusion:*** GSS is a simple and easily reproducible system to classify the complexity of renal stones. In our setting, it also proved an excellent tool to predict SFR, perioperative complications, and associated ancillary procedures. Ultimately, it can help surgeons and, above all, patients to make a more informed decision about their surgery.

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Introduction

Urolithiasis has a prevalence of 5–12% in men and 4–7% in women [1]. The estimated 5-year recurrence rate is up to 50% [2]. Amongst several surgical options, percutaneous nephrolithotomy (PCNL) has stood the test of time and is one of the main procedures performed by stone surgeons [3]. It has become the standard treatment for large and complex kidney stones [4].

However, it is not free of complications. The modified Clavien grading classification of surgical complications has become the most commonly used method to assess these [5]. The most frequent complications accompanying PCNL are postoperative fever in 21–32% and bleeding requiring a blood transfusion in 11.2–17.5% of cases [6, 7].

Different parameters such as stone diameter, stone burden, stone location, or associated hydronephrosis have been used to predict the outcome of PCNL. However, when used separately, these parameters are either not reproducible or not precise enough [8].

This led to the emergence of numerous nephrolithometric scoring systems such as the nephrolithometric nomogram [9] and the Seoul Renal Stone Complexity Score [10] based on preoperative data like stone size, stone site, renal anatomy, and a patients' general condition to predict surgical outcome [11]. All have been found to have similar predictive accuracy for stone-free rate (SFR) [12]. Another recent tool, Guy's Stone Score (GSS), is a simple, rapidly applied classification system to predict SFR and complications, with excellent reproducibility [9]. In this study, we assess whether in our environment, i.e., with highly complex and large stones on the one hand and limited resources on the other, GSS can be used with similar accuracy to predict SFR and complications of PCNL to avoid complications, ancillary procedures, redo-surgery, and wrong clinical decisions, and also to facilitate informed decision-making by surgeons and patients.

Patients and Methods

A prospective study was done between August 2017 and October 2018 involving 115 patients who underwent elective PCNL in the Al-Sulaymaniyah Surgical Teaching Hospital.

Exclusion criteria were pediatric patients, ectopic kidney, obstructed pyelonephritic kidney, and transplanted kidney. Patients had a full medical history taken, and a full physical examination with hematological and biochemical blood investigations. All patients had a definitive preoperative diagnosis of sizeable stones by abdominal CT. Using GSS, stones were classified based on their location and complexity.

Table 1. Patient demographics (n = 115)

Age, years (mean ± SD)	50.27±13.33
Sex	
Male	77 (67%)
Female	38 (33%)
Body mass index, kg/m^2 (mean ± SD)	28.11±4.73
History of extracorporeal shockwave lithotripsy	
Yes	25 (78.3%)
No	90 (21.7%)
Grade of hydronephrosis	
None	25 (21.7%)
Mild	58 (50.4%)
Moderate	29 (25.2%)
Severe	3 (2.6%)
Hypertension	
Yes	41 (35.7%)
No	74 (64.3%)
Diabetes mellitus	
Yes	29 (25.2%)
No	86 (74.8%)
Guy's Stone Score	
Grade I	24 (20.9)
Grade II	48 (41.7%)
Grade III	25 (21.7%)
Grade IV	18 (15.7%)
Previous ipsilateral surgery	
Yes	31 (27%)
No	84 (73%)

All PCNL were performed in a standardized fashion under either general or spinal anesthesia. All patients received prophylactic ceftriaxone (1 g i.v.) at induction. Standard percutaneous access was achieved through a posterior calyx puncture under fluoroscopic and/or ultrasound (US) guidance using an 18-G coaxial needle (Cook Medical Inc., Bloomington, IN, USA). A 20-Fr nephroscope (Karl-Storz, Tuttlingen, Germany) was used through an Amplatz sheath. Stones were fragmented using a pneumatic lithotripter (NidhiLith, Nidhi Medical systems, Delhi, India). Concomitant flexible nephroscopy (Flex X2, Karl Storz) was performed in all cases to check for remaining fragments in all calices. If needed, a second or third puncture was done in the same fashion. A JJ stent was anterogradely inserted in all patients and removed 3 weeks postoperatively.

Apart from stone and patient data as mentioned above, operating time, complications, and SFR at 3-week follow-up were recorded. The last of these was assessed using a combination of abdominal X-ray and renal US. We regarded patients to be stone-free who had so-called clinically insignificant residual fragments (CIRF) ≤4 mm in size which were asymptomatic and noninfectious as well as a sterile urine culture [13, 14].

Data were stratified according to GSS in groups I–IV, and complications were classified according to the Clavien system for all patients and each GSS group separately.

For statistical analysis, SPSS v20 (IBM SPSS Statistics Inc., USA) was used. Descriptive statistics and the χ^2 and one-way ANOVA tests were applied. A p value ≤0.05 was considered as significant.

Table 2. Comparison of patient demographics stratified to GSS groups

	GSS I	GSS II	GSS III	GSS IV	*p* value
Age, years	49.88±13.59	48.98±14.72	51.88±11.98	52±11.35	0.77**, ns
Sex					
Male	18 (75)	31 (64.5)	17 (68)	11 (61)	0.77*, ns
Female	6 (25)	17 (35.4)	8 (32)	7 (38.80	
Body mass index, kg/m^2	26.58±4.13	27.54±3.94	28.04±3.54	31.79±6.91	0.02**, s
Grade of hydronephrosis					
None	7 (29)	10 (20)	3 (12)	5 (27)	
Mild	10 (41)	23 (47)	15 (60)	10 (55)	0.51*, ns
Moderate	7 (29)	14 (29)	5 (20)	3 (16)	
Severe	0 (0)	1 (2)	2 (8)	0 (0)	
A history of ESWL					
Yes	9 (37.5)	11 (23)	4 (16)	1 (5.5)	0.079*, ns
No	15 (62.5)	37 (77)	21 (84)	17 (94.4)	
Previous ipsilateral surgery					
Yes	5 (20.9)	15 (31)	7 (28)	4 (22.2)	0.77*, ns
No	19 (79.1)	33 (69)	18 (72)	14 (77.8)	
Hypertension					
Yes	6 (25)	13 (27)	12 (48)	10 (55.5)	0.058*, ns
No	18 (75)	35 (73)	13 (52)	8 (44.5)	
Diabetes mellitus					
Yes	7 (29.1)	9 (18.8)	8 (32)	5 (27.7)	0.58*, ns
No	17 (70.9)	39 (81.2)	17 (68)	13 (72.3)	

Values express *n* (%) or mean ± SD. * χ^2 test; ** one-way ANOVA. ESWL, extracorporeal shockwave lithotripsy; ns, nonsignificant; s, significant.

Table 3. Complication rates of PCNL stratified by GSS group

Modified Clavien grade	GSS I (*n* = 19)	GSS II (*n* = 35)	GSS III (*n* = 12)	GSS IV (*n* = 6)	*p* value
Grade I	4 (16.6)	11 (22.9)	9 (36)	4 (22.2)	0.002
Grade II	1 (4.3)	2 (4.2)	3 (12)	6 (33.3)	0.002
Grade III	0	0	1 (4)	2 (11.2)	0.002
Grade IV	0	0	0	0	
Grade V	0	0	0	0	

Values express *n* (%). The χ^2 test was used.

Results

Of 115 patients, 77 (67%) were males. Mean age was 50.2 (± 13.3) years.

As to the most frequent comorbidities, 25% had diabetes and 36% suffered from hypertension. Mean body mass index (BMI) was 28.1 (±4.73) for all patients.

Cases were classified according to GSS into 4 grades; there were 24 (20.9%) grade I, 48 (41.7%) grade II, 25 (21.7%) grade III, and 18 (15.7%) grade IV cases. The majority of patients had mild hydronephrosis (50.4%); severe hydronephrosis was found in 2.6% of patients on preoperative US scans. Thirty-one patients (27%) had a history of ipsilateral renal surgery (Table 1).

GSS groups I–IV were comparable according to age, sex, grade of hydronephrosis, a history of previous ipsilateral renal surgery (including extracorporeal shockwave lithotripsy), and medical comorbidities. The BMI of GSS III and IV was significantly higher than in GSS I and II (Table 2).

Table 4. Perioperative variables stratified to GSS groups

	GSS I	GSS II	GSS III	GSS IV	*p* value
Stone-free					
Yes	24 (100)	46 (95.8)	20 (80)	12 (66.6)	0.001*, s
No	0	2 (4.15)	5 (20)	6 (33.3)	
Access tracts					
Single	24 (100)	47 (98)	21 (84)	10 (55.5)	<0.001*, s
Multiple	0	1 (2%)	4 (16)	8 (44.5)	
Blood transfusion					
Yes	1 (4.1)	2 (4.1)	1 (4)	5 (27.7)	0.008*, s
No	23 (95.8)	46 (95.8)	24 (96)	13 (72.2)	
Hemoglobin drop, g/dL	1.14±0.82	1.05±0.97	1.18±0.94	1.16±1.07	0.93**, ns
Operation duration, min	40.42±11.5	45.73±12.37	60.60±21.32	69.72±24.93	<0.001**, s
Hospital stay, days	1.46±0.58	1.5±0.77	1.68±0.94	2.17±1.04	0.023**, s

Values express *n* (%) or mean ± SD. * χ^2 test; ** one-way ANOVA. ns, nonsignificant; s, significant.

Table 5. Residual fragments and management

	GSS I	GSS II	GSS III	GSS IV	Total
Residual fragments	0	2	5	6	13
Management					
Conservative	0	1	0	0	1
SWL	0	1	1	0	2
RIRS	0	0	2	1	3
2nd look PCNL	0	0	2	4	6
Refused treatment	0	0	0	1	1

SWL, shockwave lithotripsy; RIRS, retrograde intrarenal surgery (flexible ureterorenoscopy); PCNL, percutaneous nephrolithotomy.

The overall complication rate according to the Clavien grading system was 37%. GSS groups III (52%) and IV (67%) had significantly more complications than GSS I (21%) and II (27%) ($p < 0.002$) (Table 3). Grade I complications included pain, fever, a transient increase of creatinine, and postoperative nausea and vomiting. Grade II complications included blood transfusion and the need for infection-related additional antibiotics. Grade III included aborting the procedure to stop and control intraoperative bleeding (grade IIIb). There were no grade IV complications in either group.

The overall SFR was 88.7%. When stratified, SFR was significantly higher in GSS I and II (100 and 96%, respectively) than in GSS III and IV (80 and 67%, respectively).

The use of >1 access tract increased significantly with stone complexity. Likewise, operating time increased significantly with complexity.

Postoperative hemoglobin (Hb) drop is regarded as an indication of blood loss. In spite of GSS III and IV having had greater mean postoperative Hb drops, there were no statistically significant differences in the 4 GSS grades. However, there was a significant increase in the blood transfusion rate in GSS III and IV (Table 4).

On follow-up, there were residual fragments (RF) in 13 patients (11.3%). The rate of RF being inversely proportional to SFR, it increased with stone complexity.

Secondary management of RF is listed in Table 5.

Discussion

Although PCNL is a widely performed, minimally invasive procedure, it is still invasive to a degree. This goes in hand with an accepted rate of complications. Not surprisingly, this rate increases with stone complexity, which is associated, in turn, with greater blood loss as well as longer operating time and hospital stay. Stone complexity is dependent on factors such as size, burden, site, and composition (hard or infectious). But it also depends on patient factors such as general health, age, BMI, and comorbidities, i.e., topical (infection or hydronephrosis) and general (hypertension, diabetes mellitus, etc.) [11].

As the ultimate goal of every PCNL should be to render the patient stone-free, the SFR should be the aimed for as an end point.

Table 6. Comparison of stone-free rate and complication rate in different studies

	Mandal et al. [5]	Vincentini et al. [8]	Thomas et al. [16]	Ingimarsson et al. [17]	De Souza Melo et al. [18]	Sinha et al. [19]	Our study
Overall SFR, %	97.73	87.7	62	90	43.8	90.14	87
GSS I SFR, %	100	97.2	81	95	87.9	93.9	100
GSS II SFR, %	96.93	86.5	72.4	97	62.1	85.71	95.8
GSS III SFR, %	100	90.5	35	95	44	90.17	80
GSS IV SFR, %	60	70.5	29	75	24.3	77.77	66.6
Complication rate, %	41.7	18.7	52	37	14.9	40.1	37

SFR, stone-free rate; GSS, Guy's Stone Score.

For proper counselling leading to informed consent of the patient, proper decision-making by the surgeon, proper planning of a procedure and the aftercare, it would be desirable therefore to have a tool at hand to predict the risks of complications for the process of rendering a given patient stone-free. Several stone complexity scoring systems have been developed to attempt this [9, 10]. The criteria of an ideal scoring system should be easily applicable in daily practice and take into consideration the characteristics of the patient besides the preoperative imaging findings (see above) and also the surgeon's experience [15].

Amongst these scoring systems, GSS is the one most widely accepted, applied, and validated [15]. Thomas et al. [16] studied 100 PCNL patients and concluded that GSS is accurate in predicting SFR while factors like stone burden, the surgeon's experience, BMI, age, and comorbidities were not correlated with the SFR in isolation. Several studies have confirmed the inverse relationship between GSS grade and SFR [5, 8, 16–19].

In this study, we applied the GSS successfully to our patient population and confirmed the above relationship. Of our patients, 38% were ≥ GSS III and 80% were ≥ GSS II. Whereas SFR may vary with the proportion and distribution of various GSS grades [18], we can confirm that GSS is accurate in a setting which applies mainly to the developing world with a majority of patients having complex-to-very complex stones. Despite this, our overall SFR was good with 89%. This corresponds with or exceeds SFR from larger-scale studies in the literature [5, 8, 16–19] (Table 6). It has, however, to be borne in mind that we used a cut-off of 4 mm for so-called CIRF. Depending on the respective definitions in other studies, CIRF can be between 2 and 4 mm, asymptomatic, non-infectious, and associated with sterile urine [13, 14]. Conventionally, RF and CIRF are detected on postoperative follow-up by a combination of abdominal X-ray and renal US as in our study. However, an overestimation of SFR of 17–35% may occur with this. Non-contrast enhanced CT is regarded as a more sensitive imaging tool post-PCNL [20].

A similar relationship emerged from our data when looking at complications in the various GSS groups. Our overall complication rate of 37% corresponds to the literature [5, 17, 19]. Complications were more frequent in GSS III and IV (52 and 66%, respectively) than in GSS I and II (22 and 27%, respectively). This is confirmed by some authors [5, 19, 21] but others did not find such a relationship [16, 22].

Whilst our study had a limited number of cases, a short follow-up of only 3 weeks, and SFR assessment by abdominal X-ray and renal US rather than CT, it can still be concluded in view of the comparison with the literature that GSS is accurate in predicting SFR, even in a population with stones of high complexity. On the other hand, there is controversial information out there as to whether the same scores can accurately predict complication rates; to date, this information seems not entirely reliable until proven otherwise by larger studies.

In addition to serving as an aid for patient counselling and surgeon decision-making, GSS may help in planning surgery and, more importantly in developing countries, the allocation of resources to optimise the surgical outcome.

Statement of Ethics

All subjects filled in an informed consent form. The study was approved by the ethics and scientific committee of the Iraqi Board of Urology.

Disclosure Statement

The authors have no conflicts of interest.

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Author Contributions

A.O.R. and H.K. conducted the study. A.O.R. and G.F. collected and analysed the literature. R.Y.H. analysed the data and wrote the first draft. G.F. reviewed several draft versions. N.B. acted as senior advisor and reviewed and edited the final version.

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