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Utility of the Guy's Stone Score in predicting different aspects of percutaneous nephrolithotomy

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Abstract
Objective: To evaluate Guy's scoring system (GSS) as a grading system for complexity of kidney stone before percutaneous nephrolithotomy (PCNL) as a predictor for different items of outcome.
Patients and methods: Between July 2014 till July 2015, 100 patients with renal stone (s) and candidates for prone PCNL were evaluated and graded by GSS preoperatively. All intraoperative and postoperative data and complications using modified Clavien system were recorded, collected and statistically analyzed in relation to different grades of GSS to evaluate its predictive ability to different items of outcome.
Results: Mean age of the patients was 47.38 ± 14.6 years. The patients were distributed in different grades of GSS with no statistically significant difference as mean age, sex, and mean BMI of the patients, stone side and previous renal surgery. There was high statistically significant difference in mean operative time, rate of blood transfusion, and mean number of renal punctures between different Guy's scores, with all of them showed the highest values at GS IV. There was significant correlation between increase in the grade of GS and the need for re-PCNL and auxiliary procedures. The final stone free rate (SFR) was 93% and complication rate was 27% with significant increase in the immediate success rate, SFR, and complication rate with advancement of the grade of GSS.
Conclusion: GSS has a positive correlation with SFR, re-treatment rate, need for auxiliary procedure, and rate of complication.

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Abbreviations: BMI, body mass index; CIRF, clinically insignificant residual fragments; ESWL, extra corporeal shock wave lithotripsy; GS, Guy score; GSS, Guy's scoring system; IVU, intravenous urography; NCCT, non-contrast enhanced spiral computed tomography; PCNL, percutaneous nephrolithotomy; PUT, plain X ray urinary tract; SFR, stone free rate.

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Introduction

Percutaneous nephrolithotomy (PCNL) is considered nowadays as a standard endoscopic treatment for large and complex kidney calculi and replacing to a large degree open surgical management of these stones [1]. Despite being a minimally invasive procedure with high stone free rate, PCNL is not devoid of complications and stone free rate is not 100% [2]. Many parameters were used to predict the outcome of the procedure like stone diameter or burden, stone location, association of hydronephrosis, however, when these parameters are used separately, they are not reproducible and do not give precise idea about the outcome [3]. For that reason, nephrolithometric scoring systems were developed based on preoperative data like stone size and site, renal anatomy and patients' conditions to predict the outcome (stone free rate and complications) [4,5]. Defining stone complexity by grading or scoring systems has other benefits beside prediction of the outcome, like patients counseling, adjustment of training program, and monitoring the technical refinement of the procedure [6,7].

Many scoring systems and nomograms are used to predict stone free rate and complication of PCNL like Guy's scoring system [7], the CROES (Clinical Research Office of Endourological Society) nomogram [8], the STONE nephrolithometric scoring system [9], and the S-ReSC Scoring System of the Seoul National University [2]. Guy's scoring system is simple, rapid, and easy to perform scoring system, with good reproducibility with stone free rate (SFR) and complications [7–10]. The current study evaluates the Guy's scoring system not only in predicting the stone free rate and complication like that in most published studies, but also in evaluation of the intraoperative events and the re-treatment rate of the failed cases after PCNL.

Patients and methods

Between July 2014 till July 2015, 100 patients with renal stone(s) and candidates for PCNL were enrolled in the study, all patients were presented to the outpatient clinic managed by PCNL in the same hospital. All patients were evaluated by careful general and local examination with estimation of the body mass index (BMI), full laboratory examination including complete blood picture, serum biochemistry, coagulation profile and urine culture and sensitivity. In case of positive urine culture, the patients were treated first with proper antibiotic before the procedure. Radiological examination in the form of ultrasound abdomen and pelvis, plain X ray on urinary tract (PUT), and non-contrast enhanced spiral computed tomography (NCCT) were done for all patients. The inclusion criteria of the patients were, renal stone(s) more than 2 cm, and less than 2 cm in case of pelvicalyceal anatomy or body habitus that unfavorable for extra corporeal shock wave lithotripsy (ESWL), or failed ESWL as a primary management for the stone. Patients with uncorrected bleeding disorders, concomitant ureteral calculi in the same side, active urinary tract infection (UTI) and renal impairment were excluded from the study. All patients were informed by the study, details of the surgical procedure, and signed an informed written consent. The study protocol was approved by our university research ethical committee.

Preoperative

Two urology residents revised the NCCT preoperatively and classified each case using the GSS as Guy's I, II, III and IV. When there was a difference between them in classifying any case, an opinion of a urology consultant was taken (Fig. 1).

Intra-operative

The procedure was performed by the standard prone PCNL technique under general anesthesia by three urology consultants. The data of operative time, number of access (puncture), and need for blood transfusion were recorded.

Post-operative

All patients underwent NCCT in the first post-operative day. The outcome of the treatment was considered stone free if there were no stone at all or clinically insignificant residual fragments (CIRF) less than 4 mm without obstruction, infection or symptoms that would not need any further intervention.

Patients with significant residual stone were subjected to re-treatment by re-PCNL through the same tract or by another puncture within one week. Auxiliary procedures in the form of ESWL were performed for cases with residual stones not amenable for re-PCNL or failed re-PCNL.

The modified Clavien grading system was used to evaluate postoperative complications of PCNL [11].

Statistical analysis

All data were collected and tabulated using SPSS (statistical program for social science version 20) with description of quantitative variables as mean ± SD and range, and qualitative variables as number and percent. Chi-square test, Fisher exact test, Unpaired t-test and Mann Whitney Wilcoxon U test were used.

Results

There was an agreement on classification in a specific GS between the two-urology residents in 84 patients (84%) and the remaining 16 patients were revised by a urology consultant before classification. This disagreement was between GS II and III in 11 cases and in the other 5 cases between GS III and IV.

The mean age of the patients was 47.38 ± 14.6 years, 47 (47%) of them were female, and 53 (53%) were males. According to Guy's scoring system (GSS), patients were stratified into 4 groups as shown in Table 1. Patients and stone characters' stratifications according to GSS are presented in Table 2 and, we found no statistically significant difference as regard mean age, sex, and mean BMI of the patients, stone side, and previous renal surgery in between different scores, however the stone size showed high statistically significant difference with the highest mean stone diameter was in GS IV (47.2 ± 13.4 mm).

There was high statistically significant difference in mean operative time, rate of blood transfusion, and mean number of renal punctures between different Guy's scores, with all of them showed the highest values at GS IV.

Immediate stone free rate was 77%, there was statistically significant difference regarding immediate stone free rate, between different

Guy's scoring system

Grade I: solitary stone in mid/lower pole or solitary stone in the pelvis with simple anatomy.

Grade II: solitary stone in the upper pole or multiple stones in a patient with simple anatomy, or a 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 stag horn calculus.

Grade IV: stag horn calculus or any stone in a patient with spina bifida or spinal.

Thomas, et all 2011(7)

Figure 1 Guy's Stone Score.

Table 1 Classification of 100 patients according to the GSS.

GSS	The patients stratified according to the Guy's Stone Score	N	%
GS I	-A solitary stone in the mid pole with normal anatomy.	8	8%
N = 37	-A solitary stone in lower pole with normal anatomy.	10	10%
	-A solitary stone in the renal pelvis with normal anatomy.	19	19%
GS II	-Multiple stones in a patient with simple anatomy.	21	21%
N = 28	-A solitary stone in a patient with abnormal anatomy.	4	4%
	-A solitary stone in the upper pole.	3	3%
GS III	-Partial stag horn calculus.	20	20%
N = 22	-Multiple stones in a patient with abnormal anatomy.	2	2%
GS IV	-A complete stag horn calculus	10	10%
N = 13	-Any stone in a patient with spinal injury.	3	3%

GSS: Guy's scoring system.
GS: Guy score.

Table 2 Patients and stone characters according to Guy's score.

		GS I N = 37	GS II N = 28	GS III N = 22	GS IV N = 13	P-value
Mean age (years)		48.3 ± 14.4	47.2 ± 14.6	45.7 ± 13.9	47.9 ± 17.9	0.93
Sex	F	20(54.1%)	14(50%)	11(50%)	8(61.5%)	0.89
	M	17(45.9%)	14(50%)	11(50%)	5(38.5%)	
BMI		27.6 ± 5.3	27.3 ± 5.1	28.1 ± 6.1	27.5 ± 5.6	0.96
Stone size (mm)		25.9 ± 7.1	29.4 ± 4.6	36.7 ± 4.2	47.2 ± 13.4	<0.001*
Stone	Lt	16 (43.2%)	12(42.9%)	9(40.9%)	7(53.8%)	0.91
side	Rt	21(56.8%)	16(57.1%)	13(59.1%)	6(46.2%)	
Previous renal surgery		8 (21.6%)	10 (35.7%)	7(31.8%)	4(30.8%)	0.66

GSS: Guy's scoring system, GS: Guy score, BMI: body mass index, Lt: left, Rt: right, F: female, M: male.

GSS with the highest incidence of immediate stone free rate was at GS I (86.5%).

There were significant residual stone in 23 patients, 7 patients of them were subjected to re-PCNL and 12 patients were managed by ESWL as an auxiliary maneuver, and 4 patients underwent both procedures all of them were in GS IV, with statistically significant difference between different Guy's scores. There was statistically significant difference in the final stone free rate with the highest stone free rate was in GS I (100%) and the lowest in GS IV (76.9%). Overall the final significance difference in different item in Table 3 means that there was a correlation between different items and the grade of GSS.

The operative and postoperative data were presented in Table 4. After classification of the complications according to modified Clavien grading system in relation to GSS (Table 4), it was found that there was statistically significant difference with highest total rate of complication in GS IV (61.5%) and the lowest in GS I (21.6%).

Discussion

Great efforts were made by researchers to create and develop a standard system to anticipate patients who are more vulnerable to residual stone burden after PCNL, in possible need for staged procedure or alternative procedures, and more liable for complications, to help in both counseling of patients and in making good clinical decision [12].

Tefekli et al. in 2008 [11] tried to find a relationship between stone complexity and rate of complication, but they did not report a significant correlation. De la Rosette et al. also did not find a relation

Table 3 Intraoperative and postoperative data.

	GS I N = 37	GS II N = 28	GS III N = 22	GS IV N = 13	P-value
Mean surgical time in min	69.5 ± 13.4	111.4 ± 14.5	128.2 ± 22.2	153.9 ± 43.5	0.001
Blood transfusion	1(2.7%)	3(10.7%)	5(22.7%)	6(46.2%)	0.001
No of puncture	1.16 ± 0.37	1.39 ± 0.49	1.41 ± 0.5	1.46 ± 0.52	0.075
Immediate stone free rate (N = 77)	32(86.5%)	22(78.6%)	17(77.3%)	6(46.2%)	0.03
Residual (N = 23)	5(13.5%)	6 (21.4%)	5 (22.7%)	7(53.8%)	
Re PCNL (N = 7)	1(20%)	2(33.3%)	2(40%)	2(28.6%)	0.047
(ESWL) (N = 12)	4(80%)	4(66.7%)	3 (60%)	1(14.3%)	
Both Re PCNL & ESWL (N = 4)	0(0%)	0(0%)	0(0%)	4(57.1%)	
Final stone free rate (N = 93)	37(100%)	27(96.4%)	19(89.3%)	10(76.9%)	0.019

GSS: Guy's scoring system, GS: Guy score, ESWL: extra corporeal shock wave lithotripsy, PCNL: percutaneous nephrolithotomy.

Table 4 Grading of complications according to modified Clavien grading system.

Complications rate	GS I N = 7	GS II N = 6	GS III N = 6	GS IV N = 8	P-value
Clavien1 N = 9	3(42.9%)	3(50.0%)	1(16.7%)	2(25%)	0.023
Clavien 2 N = 8	3(42.9%)	2(33.3%)	1(16.7%)	2(25%)	
Clavien 3a N = 5	1(14.2%)	1(16.7%)	2(33.3%)	1(12.5%)	
Clavien 3b N = 3	0(0%)	0(0%)	2(33.3%)	1(12.5%)	
Clavien 4a N = 1	0(0%)	0(0%)	0(0%)	1(12.5%)	
Clavien 4b N = 0	0(0%)	0(0%)	0(0%)	0(0%)	
Clavien 5 N = 1	0(0%)	0(0%)	0(0%)	1(12.5%)	
Total N = 27	7(18.9%)	6(21.4%)	6(27.3%)	8(61.5%)	

GS: Guy score, GSS: Guy's scoring system, N:number.

between stone burden and complication, the significance in their study was found between operative time and stone burden [13]. Michel et al. found a significant relation between stone size and complications [14]. Despite of the previous researches and other ones on preoperative variables to predict the stone free rate and outcome after PCNL, all of them were lacking standardization of the preoperative data [15].

The current study is a prospective one that was conducted on 100 patients, like that of the original study of Thomas et al. who invented the score in 2011 [7], however the score was evaluated by other studies in a retrospective manner with different number of patients [16–18]. We used NCCT to evaluate patients preoperatively, and that was the same in the study of Vicentini et al. [3] and Ingimarsson et al. [17] and in contrast to Sinha et al. [16] who classified their patients by intravenous urography and preoperative retrograde pyelography, while Mandal et al. [10] used plain X ray urinary tract (PUT), intravenous urography (IVU) and ultrasonography of KUB and NCCT if needed.

In our study, the inter-observer agreement was good (84%) in comparison to 78% in the study of Ingimarsson et al. [17] and 86% in Thomas et al. [7]. The main disagreement in our study was between GS II and III in 11 cases due to the difference in opinion about the abnormal and normal calyceal anatomy, and in the remaining 5 cases between GS III and GS IV about the definition of partial and complete staghorn stone. This was similar to the study of Thomas et al. [7] in which the main difference was in between GS I and II and in contrast to the study of Ingimarsson et al. [17] as the main disagreement was between GS I and II, and they also applied Cohen's kappa coefficient to calculate the inter-observer agreement (k = 0.72 and 95% confidence interval was 0.61–0.80), but in our study, we did not apply a statistical analysis for this disagreement.

All patients underwent standard PCNL in prone position with nephrostomy tube was inserted at the end of the procedure, and this was not a constant in all studies, however most of them were in the prone position [10,16–18].

In the current study, there was statistically significant difference in terms of mean operative time and need for blood transfusion between different grades of GS, with significant tendency to increase in the previous items with advancement in the grade of GSS, but this significant difference was not the same in mean number of puncture. In the study of Sfoungaristos et al. [18] they found a significant difference in number of punctures and tracts (≤ 1 versus >1) between the four grades of GSS, In the study of Vicentini et al. [3] there was high statistically significant difference in rate of blood transfusion, mean operative time, and mean number of accesses between the grades of the GSS, the significant difference of higher mean number

of stone access in GS IV in Vicentini et al. [3] study may be attributed to the larger number of cases with complete staghorn stone in their study (27 patients) while in our study there was 10 patients with complete staghorn stone.

In our study, we evaluated the presence of residual stone by NCCT, that agreed with others that used also NCCT in evaluation of residual stone [3–18]. Ingimarsson et al. [17] used NCCT in evaluation of SFR in staghorn and radiolucent stones, and (PUT) in other cases. Mandal et al. [10] used PUT to assess residual stone; however, the main concern in their study was on the evaluation of postoperative complication. Although (PUT) is not expensive, available, of lower dose of radiation than NCCT, and used in clinical rapid follow up of patient in routine practice, it has lower sensitivity in comparison to NCCT, and it is not the ideal modality in rigorous assessment of residual stone to evaluate the predictive pattern in such studies [12].

In our study, the treatment outcome was considered successful if there is no residual stone or clinically insignificant residual fragments (CIRF) less than 4 mm, without infection, obstruction, or symptoms. These defining criteria of success were used in many studies [3,7,10,18] Others had more strict criteria; Sinha et al. [16] considered outcome is successful if there was no residual stone, while Ingimarsson et al. [17] evaluated different three outcomes in their study; no residual stone, residual less than 2 mm, and less than 4 mm.

The immediate stone free rate in our study was 77% with statistically significant difference in between different grades of GS, with the highest in GS I (86.5%), and the lowest was in GS IV (46.2%). The 23 patients with significant residual stone were managed by re-PCNL, ESWL or both with statistically significant difference between different GS. After that, the final SFR was 93% with statistically significant difference in between grades of GS. In GS I, the SFR was 100%, and GS IV it was 76.9%.

Almost all studies found a positive correlation between GSS and SFR, the inventors of GSS 7 stated clearly that the score accurately predict the SFR, Sinha et al. [16] found that the difference in immediate and final SFR was significant in between grades of GS, with insignificant difference between them as regard to re-PCNL. Vicentini et al. [3] found a highly statistically significant difference between different grades of GSS as regard to immediate SFR, rate, re-PCNL, and auxiliary procedure, however the final SFR showed no significant differences. In the study of Ingimarsson et al. [17] used three different criteria of stone free (no stones, <4 mm, and <2 mm) showed interesting findings, when NCCT was used to evaluate residual stone, the difference between different grades of GS was statistically significant regardless of stone free criteria used, however when PUT was used, the significance was limited only to the criterion of no residual stone at all. Finally, Sfoungaristos et al. [18] in their multivariate analytic study reported that GSS has statistically significant predictive ability as regard SFR.

The reported rate of complication in our study was 27%, after application of modified Clavien grading system and stratification of patients with GSS, we found a statistically significant difference between grades of GS, with the lowest incidence of complication in GS I (18.9%) and the highest in GS IV (61.5%). The significant positive correlation of complication with increasing the grade of GSS is still a matter of debate. Thomas et al. [7] who described the GSS failed to find any positive correlation between either overall rate or severity of complications and GSS, Ingimarsson et al. [17] and Noureldin et al. [19] also in their studies did not find any significant correlation with complications. In contrast Mandal et al. [10] in their big study on 221 renal units that mainly evaluated this issue, found a significant relation between GSS and rate of complication, this positive correlation has also been proved in the studies of Sinha et al. [16] and Vicentini et al. [3]. In our study complications of Clavien 2 were the most frequently reported complication and bleeding necessitating blood transfusion was the most common complication (15%), followed by fever >38 °C (6%) that managed by antibiotics. These results were in agree with others [3–10] who reported that complications in Clavien 2 were the most frequent, moreover Manadal et al. [10] showed that blood transfusion due to bleeding and postoperative fever were the 1st and 2nd most common complications in their series. In our opinion, the ability of GSS to predict the rate and severity of complications needs more studies with prospective nature and larger number of patients to be evaluated.

The strength in the current study was the prospective design, the two observers rating with a relative high rate of agreement (84%), and the performance of the procedure by consultants. The limitations were the small number of patients, more than one surgeon operated, and that the study was mainly stressed on the comparative analysis between different grades of GSS with lacking the logistic regression analysis.

The main limitations of the study, is the relatively small number of patients (100 patients) to evaluate such scoring systems, and the lack of some statistical date like kappa coefficient to calculate the inter-observer agreement, and univariate and multivariate analysis to study the effect of each factor on stone free rate and complication rate.

Conclusion

Guy's scoring system is simple, easy to perform, and reliable system to grade stone complexity before PCNL. It has a great value in patients counseling with good predicative ability for the need of re-treatment and auxiliary procedure. It has also good positive correlation with both stone free rate and rate of postoperative complications.

Conflict of interest

No conflict of interest.

Source of funding

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Authors' contributions

Mostafa Khalil: First and corresponding author, research idea, protocol/project development, statistical analysis, and writing the manuscript.

Hammouda Sherif: Research idea, protocol/project development, collecting data, statistical analysis, and revision of manuscript.

Ahmed Mohey: Protocol/project development, collecting and managing data, data analysis, and revision of manuscript.

Rabea Omar: Protocol/project development, collecting and managing data, data analysis, and revision of manuscript.

Ethical committee approval

The Research Ethics Committee at Faculty of Medicine, Benha University (REC-FOMBU) has approved the study.

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