Which Is Better? Guy's Versus S.T.O.N.E. Nephrolithometry Scoring Systems in Predicting the Outcomes of Ultrasonic Guided Percutaneous Nephrolithotomy (PCNL)

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ABSTRACT:

BACKGROUND:

Stone disease of the renal system is a challenging problem in urologic practice particularly in our area because of the large stone burden and recurrence. Scoring systems are beneficial to counsel the patients about the success and complication rates before surgery.

OBJECTIVE:

To compare two widely used scoring systems, namely Guy's and S.T.O.N.E. nephrolithometry scores in predicting the outcomes of ultrasound-guided PCNL.

MATERIALS AND METHODS:

In this prospective study, a total of 50 patients underwent PCNL in Al-Imamein Kadhimein Medical City from 1st of October 2018 to 1st of August 2019 and were enrolled. Guy's and S.T.O.N.E. scores were based on non-enhanced CT scan of abdomen and pelvis. Complications were graded using the Clavien-Dindo classification system. Ultrasound was used to guide PCNL in all cases.

RESULTS:

In our study the median age, body mass index (BMI) and stone size were 34.5 years, 31.4 kg/m^2 and 765 mm^2, respectively. The overall stone-free status was 82%. All complications were grades I-II (60%). The average operative time was 150 minutes. The stone-free status and complications rate were significantly associated with Guy's score ($P < 0.001$, $P < 0.001$) and S.T.O.N.E. score ($P < 0.001$, $P < 0.001$), respectively. Moreover, there was a significant positive correlation between Guy's and S.T.O.N.E scores with length of hospital stay (r = 0.277, $p < 0.001$; r = 0.544, $p < 0.001$), operative time(r = 0.449, p = 0.001; r = 0.573, $p < 0.001$) and need for blood transfusion (r = 0.573, $p < 0.001$; r = 0.568, $p < 0.001$) respectively. In addition, both Guy's and S.T.O.N.E systems were significantly predictive of stone-free status, need for blood transfusion, operative time and length of hospital stay. The receiver operating characteristic (ROC) showed no significant difference in area under the Guy's and STONE curve (AUC = 0.877 vs. 0.821; $p = 0.51$).

CONCLUSION:

Both Guy's and S.T.O.N.E. scoring systems showed a comparable efficacy in predicting the outcomes of PCNL such as stone-free status, necessity for blood transfusion, operative time and length of hospital stay.

KEYWORDS: Nephrolithotometry scoring systems, Guy's score, S.T.O.N.E.Score.

INTRODUCTION:

Since its introduction in 1976, percutaneous nephrolithotomy (PCNL) has become the standard reference for the treatment of patients with stones larger than 2 cm, those who have failed extracorporeal shock wave lithotripsy (ESWL) and those with abnormal renal anatomy [1, 2]. The successful adoption of (PCNL) to treat large renal calculi means open surgery is now rarely necessary[3]

Although minimally invasive, PCNL is a major operation, with the risk of significant complications, and does not always render the patient stone free. The widespread use of a standardized stone scoring system is very precious for counseling patient, clinical decision, and assessment of outcomes, in addition to improving academic reporting [4]. However, no universally accepted stone scoring system for predicting stone free rate (SFR) and complications after PCNL exists.

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For PCNL, four different scoring systems have been developed: Guy's stone score (GSS) [13], S.T.O.N.E. nephrolithometry[12, 17], Clinical Research Office of the Endourology Society (CROES) nomogram [18], and Seoul National University Renal Stone Complexity (S-ReSC) [11]. Though it has been established that scoring systems are vital in contributing to surgical planning, patient counseling, and outcome assessment, the gold standard for PCNL has yet to be established [5].

An accurate estimate of treatment success is crucial for optimal decision making and informed patient counseling [6]. Clear benefits exist for having a standardized method of predicting the SFR after PCNL [12, 14]. Patients could be more accurately counseled preoperatively about the chance of becoming stone free after their procedure [12, 15]. In addition, it would facilitate the objective assessment of technical modifications (e.g., supine vs prone) [7].Moreover, surgeons could use it to compare their own SFR against the predicted SFR (benchmarking). This could aid in service rationalization of complex cases into specialist centers [8, 9, and 15]. Preoperative nomograms, such as image-based scoring systems, are methods to assess patients, predict outcomes, and improve treatment.

The Guy's Stone Score (GSS) was developed by Thomas et al in 2011[13]. This score categorizes patients according to the complexity of the stone and the pelvicaliceal anatomy based on plain radiography, ultrasonography, computed tomography (CT) and intravenous urography findings, Guy`s scoring system had been validated by Smith et al (2013) [9]. In March 2013 the S.T.O.N.E nephrolithometric score was reported [9], based on five characteristics detected on preoperative non contrast-enhanced CT scan. These five features were abbreviated using the acronym "S.T.O.N.E." in relation to the Stone size, Tract length, Obstruction, Number of involved calices, and Essence or stone density [16].

We aimed to compare two widely used scoring systems, namely Guy's and S.T.O.N.E. nephrolithometry scores in predicting the outcomes of ultrasound-guided PCNL.

MATERIALS AND METHODS:

2.1. Design, settings & sampling: This study is a prospective non-randomized comparative study conducted at Al-Imamein Kadhimein Medical City, in Baghdad. Patient collection was from 1st of October 2018 to 1st of August 2019. Ethical clearance to do the research was acquired from the hospital`s and Iraqi`s board institute. Informed consent was obtained from all participants.

Inclusion criteria were adults more than 18 years of age, normal renal function, and renal stones of more than 2 cm in size; patients with congenital renal anomalies were included. The exclusion criteria were uncorrected coagulopathy, untreated urinary tract infection and uncontrolled blood pressure.

A sample of 50 patients with renal stone (s) who underwent PCNL by single urologist was selected after eligibility to inclusion and exclusion criteria were met. Both Guy's and S.T.O.N.E. nephrolithometry scores were calculated and correlated with stone-free status (stone-free vs. non-stone-free), operative time (minutes), length of hospital stays (LOS) (days), need for blood transfusion and postoperative complications using the Clavien-dindo classification system.

The following data were collected: a thorough preoperative checkup, comprising a complete medical history and examination, complete blood count (CBC), serum creatinine, urine culture, coagulation profile, CT scan of abdomen and pelvis was carried out At Al-Imamein Kadhimein Medical City.

Stone free status defined as no residual or presence clinically insignificant residual fragments (CIRFs) as stone <4 mm non obstructing, noninfectious and asymptomatic residual fragments on X-ray KUB on first post-operative day and ultrasonography done at the 4th week of follow up [19].

2.2. Statistical analysis: The Statistical Package of Social Sciences for Windows (SPSS) version 22 was used for statistical analysis.

RESULTS:

The total number of the patients who were eligible for final analysis in our study was 50. The demographic data of the patients are summarized in table (1). The median age of the patients was 34.5 years. Male to female ratio was 1.17: 1 with (54%) males and (46%) females.

The stone on the left accounted for 62% of all cases. The median body mass index of the patients was 31.4 kg/m^2. The median stone size was 765 mm^2. The median Guy's scoring system (GSS) was 2 and the median for S.T.O.N.E. score was 10.

The overall stone-free rate was 82% (in 41 patients), of which 31 of 50 of the cases found to be stone free (62%) at immediate postoperative period. Auxiliary procedures were used in 10 (20%) patients, to improve the stone clearance, including 8 patients underwent ESWL, 2 patients treated by 2nd PCNL. Residual stones were ultimately remained in only 7/50 (14%). Conversion to open surgery was only needed in two (4%) patients. As seen in table (2), showed the association of Guy's and S.T.O.N.E. scoring systems with increasing the grades and scores for both Guy's and S.T.O.N.E. scoring systems, the stone free status for having residuals increased ($p < 0.001$ and $p = 0.008$), as well as for having development grade II complications increased ($p = 0.001$ and $p < 0.001$) respectively.

There was significant positive correlation between both Guy's and S.T.O.N.E. scoring systems with length of hospital stay, operative time and need for blood transfusion all with p value < 0.05, table (3). Logistic regression analysis revealed a significant association of both Guy's and S.T.O.N.E. scoring systems with stone free rate, need for blood transfusion, length of hospital stay and operative time all p value < 0.05, as showed in table (4).

Receiver operating characteristic curve, there was no significant difference in the area under the curve (AUC) for the Guy's and STONE scoring systems (0.877 [95% confidence interval (CI) 0.777-0.977] vs. 0.82 [95% CI 0.692–0.950]; $P > 0.05$) and both the scoring systems have good predictive rate for stone free status [Figure 1].

Table 1. Demographic and perioperative features of the studied sample, n =50.

Variables	
Age (years), median *(IQR)	34.5 (12.3)
Gender, n (%) Male Female	 27 (54%) 23 (46%)
BMI (kg/m^2), median (IQR)	31.4 (7.6)
Previous open renal surgery rate (%)	46%
Guy's score, median (IQR):	2 (2)
Grade I n (%)	22 (44%)
Grade II n (%)	15 (30%)
Grade III n (%)	12 (24%)
Grade IV n (%)	1 (2%)
S.T.O.N.E .nephrolithometry score, median (IQR):	10 (3)
Score 5 n (%)	1 (2%)
Score 6 n (%)	7 (14%)
Score 7 n (%)	12(24%)
Score 8 n (%)	5 (10%)
Score 9 n (%)	8 (16%)
Score 10 n (%)	7 (14%)
Score 11 n (%)	10 (20%)
Postoperative nephrostomy tube, n (%)	36 (72%)
Operative time (minutes), median (IQR)	150 (102)
Length of hospital stay, median (IQR)	1 (2)
Modified Clavien graded complications, n (%):	30 (60%)
Grade I	18 (36%)
Grade II	12 (24%)
Need for blood transfusion, n (%)	6 (12%)

*IQR Interquartile range.

Table 2. Patients' distribution by stone free status and complications according to Guy's and S.T.O.N.E. scoring systems.

Scoring systems	N (%)	Stone-free status N (%)	*p value	Complications, grade II N (%)	*P value
Guy`s grades					
Grade I	22 (44)	21 (95.5)	< 0.001	2 (9)	0.001
Grade II	15 (30)	8 (53.3)		3 (20)	
Grade III	12 (24)	2 (16.7)		6 (50)	
Grade IV	1 (2)	0		1 (100)	
S.T.O.N.E scores					
Score 5	1 (2)	1 (100)	0.008	0	< 0.001
Score 6	7 (14)	6 (85.7)		0	
Score 7	12 (24)	10 (83.3)		0	
Score 8	5 (10)	4 (80)		1 (20)	
Score 9	8 (16)	6 (75)		2 (25)	
Score 10	7 (14)	3 (42.9)		3 (42.9)	
Score 11	10 (20)	1 (10)		6 (60.2)	

* Fisher`s exact test

Table 3: Correlation of scoring systems with age, BMI, operative time and length of hospital stay.

Scoring systems	Spearman's correlation (r)	P value
Age (years)		
Guy's	r = 0.277	0.052
S.T.O.N.E	r = 0.058	0.688
BMI (kg/m^2)		
Guy's	r = - 0.022	0.878
S.T.O.N. E	r = - 0.018	0.899
Length of hospital stay (days)		
Guy's	r = 0.594	< 0.001
S.T.O.N.E	r = 0.544	< 0.001
Operative time (minutes)		
Guy's score	r = 0.449	0.001
S.T.O.N.E. score	r = 0.573	< 0.001
Need for blood transfusion		
Guy's score	r = 0.573	< 0.001
S.T.O.N.E. score	r = 0.568	< 0.001

Table 4: Logistic regression analysis of the dependent variables with both scoring systems.

Variables	GUY'S system				STONE system			
	B	*OR	95% CI	*P*	B	OR	95% CI	*P*
Stone-free status	2.291	9.882	3.02-32.30	< 0.001	0.786	2.195	1.40-3.42	0.001
Need for blood transfusion	1.718	5.574	2.15-14.43	< 0.001	0.843	2.324	1.45-3.72	< 0.001
Length of hospital stay (days)	0.525	*N/A	0.48-1.34	< 0.001	0.437	N/A	0.14-0.57	0.002
Operation time (minutes)	0.440	N/A	11.39-44.4	0.001	0.590	N/A	10.6-24.7	< 0.001

*N/A: Not applicable *OR: Odd Ratio

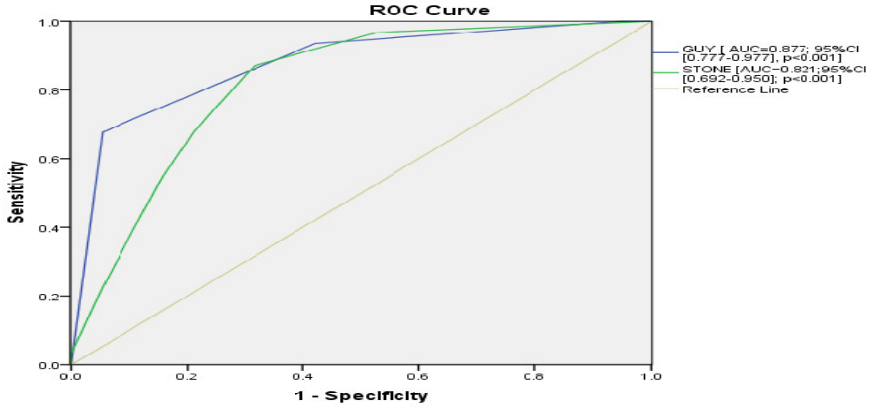

Figure 1. Receiver operating characteristic (ROC) curves for both scoring systems in predicting stone-free status

DISCUSSION:

Preoperative prediction of success rate and complications for PCNL has drawn the attention of the urologists in the recent years. Prognostic nomograms have been proposed and validated for this purpose [10]. There is still no universally accepted scoring system [5]. Comparison of the scoring systems will contribute to the literature about which scoring system is better. Here we prospectively compare two widely used scoring systems, namely Guy's and S.T.O.N.E. nephrolithometry scores in ultrasound-guided PCNL. There are some differences in these two scoring systems. In Guy's scoring system, the parameters include stone factors, such as number, location and whether the stone is staghorn or not; renal factor, namely normal or abnormal anatomy; and patient factor, by assessing the integrity of the spinal cord [11]. However, Guy's scoring system does not assess stone size, which in itself is a major predictor of the success rate of PCNL [19]. In addition, the definition of partial staghorn stone varies in literature and this may impose some difficulty in grading the stone. On the other hand, the S.T.O.N.E. scoring system does include stone size, together with factors such as tract length, the presence of hydronephrosis, the number of involved calyces, and stone density. However, renal anatomy and patient factors such as spinal cord integrity are not included. Our study intended to find whether these differences affect the predictive value of both systems in assessing clinically-important outcomes such as stone-free rate, the need for blood transfusion, operative time and length of hospital stay. Regarding Guy's scoring system, our results are consistent with previous reports, the original study by Thomas et al[13] and subsequent three validation studies by Ingimarsson et al[15], Mandal et al[10] and Kumar et

al[19], all demonstrated that Guy's scoring system was significantly associated with stone-free status. In addition, Labadie et al [18] reported that Guy's scoring system was significantly associated with complications and hospitalization time. Moreover, Vicentini et al [14] studied 155 PCNLs and determined that Guy's scoring system was significantly associated with operative time and necessity for blood transfusion. Our results in term of S.T.O.N.E. scoring system approves with other studies such as Okhunov et al[12] , Noureldin et al[17] , Labadie et al[18] and Kumar et al[19] which stated that S.T.O.N.E. scoring system is significantly associated with stone-free status ($p < 0.001$, $p < 0.001$, $p < 0.004$ and $p = 0.001$ respectively). Similar to the present study, these studies found that S.T.O.N.E. score was significantly association with the necessity for blood transfusion, hospitalization time and operation time. On the other hand, Akhavein et al [16] assessed 117 patients who performed PCNL and found that S.T.O.N.E. scoring system was associated with stone-free status ($p < 0.001$); however, both the need for blood transfusion and length of hospital stay were not significantly associated with S.T.O.N.E. scoring system. In term of accuracy of both Guy's and S.T.O.N.E. scoring systems in predicting the stone-free status post-PCNL, our study displayed relatively high accuracy for both scoring systems since the AUC for the Guy's and S.T.O.N.E. scoring systems were 0.877 vs. 0.821; $P = 0.51$). Other studies reported a similar finding [17, 18, 19].The overall stone free rate in our study of 50 patients who underwent ultrasound-guided PCNL was 62% and increased to 82% by using auxiliary procedures postoperatively[21],This rate is lower than that reported by Rahman's study (86.2% - 90.8%)[22] and higher than that reported by El-Nahas et al study (56.6% - 72.7%)[20] , keeping in mind that both studies used fluoroscopic guidance instead of ultrasound. Preoperative nomograms can verify to be extremely useful tools meant for preoperative guess of success rate and complication rate of any procedure. For a nomogram to be perfect it should be easy to apply, should have good quality inter-observer reproducibility and should associate with the success and complication rate of the procedure [19]. The best scoring system would be one which would help in unifying reporting for research, training purposes and also for proper patient counseling. GSS can be evenly being applied based on a simple X-ray and RGU or an IVU beside CT scan whereas STONE score is based only on CT scan. The strength of our study was it is a prospective study but the limitations include the relatively small number of patients, loss of follow up of some patients and the fact that it was done in a single center by the same surgeon.

CONCLUSION:

Both Guy's and S.T.O.N.E. scoring systems displayed a similar efficacy in predicting the outcomes of PCNL such as stone-free status, necessity for blood transfusion, operative time and extent of hospitalization. Although both Guy's and S.T.O.N.E. scoring system accuracy in prediction PCNL outcomes in our study, the large number of patients in multiple tertiary centers by multiple surgeons who had experience in percutaneous nephrolithotomy. Whether there is a need to develop new nomogram combining these scores for better stone characterizations.

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