

COMPARISON OF S.T.O.N.E. SCORE AND GUY SCORE IN PREDICTING STONE FREE RATES OF PERCUTANEOUS NEPHROLITHOTOMY PROCEDURES IN THE SOETOMO GENERAL HOSPITAL

¹I Dewa Gede Reza Sanjaya, ¹Doddy M. Soebadi, ¹Tarmono Djojodimedjo, ²Bambang Suprijanto.

¹Department of Urology, Faculty of Medicine/Universitas Airlangga, Soetomo General Hospital, Surabaya.

²Department of Radiology, Faculty of Medicine/Universitas Airlangga, Soetomo General Hospital, Surabaya.

ABSTRACT

Objective: To determine the effectiveness of Modified Guy's Stone Score (GSS) and S.T.O.N.E score (SS) as predictors of stone free rates in patients undergoing PCNL. **Material & Methods:** The design of this study was a prospective observational analytic. Samples were patients with kidney stones who came to the Urology Polyclinic of Soetomo General Hospital Surabaya, which was planned to undergo PCNL surgery, patients who met the inclusion criteria will have a CT stonographic examination then counted for the S.T.O.N.E score and Modified Guy's Stone Score before the PCNL procedure. Postoperative stone size evaluation used KUB X-ray (BOF) to assess Stone Free Rate (SFR). **Results:** In the ETA statistical test there was a strong relationship between GSS and SFR with a relationship strength value of 0.609, the direction of the relationship between these two variables was positive. This means that the greater the GSS, the less likely the SFR could be achieved. The relationship between these two variables was significant with $p=0.05$. While between SS and SFR with a relationship strength value of 0.55, the strength of the relationship in these two variables was positive which indicated the higher the SS, the less likely the occurrence of SFR. But both of them were not statistically significant with $p=0.228$. **Conclusion:** Guy Stone Score (GSS) gives a better predictive value than the STONE score (SS) on the stone free rates in patients undergoing PCNL procedures.

Keywords: Modified Guy's Stone Score, S.T.O.N.E score, PCNL, Percutaneous Nephrolithotomy, Stone Free Rate.

ABSTRAK

Tujuan: Mengetahui efektivitas Modified Guy's Stone Score (GSS) dan S.T.O.N.E score (SS) sebagai prediktor angka bebas batu pada pasien yang dilakukan tindakan PCNL. **Bahan & Cara:** Desain penelitian ini adalah analitik observasional yang bersifat prospektif. Sampel adalah penderita batu ginjal yang mendatangi poliklinik Urologi RSUD Dr. Soetomo Surabaya yang direncanakan akan menjalani operasi PCNL, pasien yang memenuhi kriteria inklusi akan dilakukan pemeriksaan CT stonografi kemudian dihitung untuk S.T.O.N.E score dan Modified Guy's Stone Score sebelum prosedur PCNL. Evaluasi ukuran batu pasca operasi menggunakan KUB X-ray (BOF) untuk menilai Stone Free Rate (SFR). **Hasil:** Pada uji statistik ETA terdapat hubungan yang kuat antara skor GSS dan SFR dengan nilai kekuatan hubungan sebesar 0.609, arah hubungan kedua variabel ini bersifat positif. Artinya semakin besar GSS maka semakin kecil kemungkinan SFR dapat tercapai. Hubungan kedua variabel ini bersifat signifikan dengan $p=0.05$. Sedangkan antara SS dan SFR dengan nilai kekuatan hubungan sebesar 0.55, kekuatan hubungan pada kedua variabel ini bersifat positif yang menunjukkan semakin tinggi SS maka semakin kecil kemungkinan terjadinya SFR. Namun keduanya tidak bermakna secara statistik dengan nilai $p=0.228$. **Simpulan:** Guy Stone Score (GSS) memberikan nilai prediktif yang lebih baik jika dibandingkan STONE score (SS) terhadap angka bebas batu pada pasien yang menjalani prosedur PCNL.

Kata Kunci: Modified Guy's Stone Score, S.T.O.N.E score, PCNL, Percutaneous Nephrolithotomy, Stone Free Rate.

Correspondence: Doddy M. Soebadi; c/o: Department of Urology, Faculty of Medicine/Universitas Airlangga, Soetomo General Hospital, Surabaya. Jl. Mayjen. Prof. Dr. Moestopo 6-8 Surabaya 60286. Phone: +62315501318; Fax: +62315024971. Mobile phone: +6281 6500755. Email: dmsobadi@gmail.com.

INTRODUCTION

Kidney stones are still one of the most common diseases in urology cases. The incidence of

kidney stones according to the Ministry of Health Republic of Indonesia data, the prevalence of kidney stones is 0.6% or 6 per 1000 population.¹ The recurrence rate is around 30% to 50% within 5

years.² As many as 37.636 new cases in Indonesia, with several visits of 58.959 people, while the number of patients treated was 19.018 people, with the number of deaths amounting to 378 people or 1.98% of all the number of patients treated.³

As cases increase and diagnostic development increases, the rate of development of kidney stone management has experienced many developments. The gold standard or diagnostic is NCCT (Non-Contrast Computed Tomography). Therapeutic options for kidney stones develop with the presence of RIRS (Retrograde Intra Renal Surgery) and PCNL in the supine position.

PCNL is the latest gold standard method for therapy in large kidney stones, including staghorn stones.⁴ Even though it is minimally invasive, PCNL is a fairly risky surgical method and does not always guarantee patient-free stone success. Several guidelines are available for indication of PCNL and the modified Clavien system to review complications. However, there is no standard method to predict Stone Free Rate (SFR) or clearance after PCNL.

Several scoring systems for PCNL management have been created to minimize side effects of surgery, counseling for patients, and provide reports on the complexity of standardized stones. The scoring system includes the S.T.O.N.E nephrolithotomy score, the Guy's Stone Score (GSS), the Clinical Research Office of the Endourologic Society (CROES) nephrolithotometric normogram, and the Seoul National University Renal Stone Complexity (S-ReSC) score. But until now among all the scoring systems there is still no further study of the scoring system that is best as a predictor of stone-free rates.

This prospective study intends to examine and compare the S.T.O.N.E nephrolithotomy score with the Guy's Stone Score (GSS) to predict the stone-free rates on each score. In addition, the researchers felt that research to compare the predictive stone-free rates in the two scorings was still needed.

OBJECTIVE

To determine the effectiveness of Modified Guy's Stone Score (GSS) and S.T.O.N.E score (SS) as predictors of stone free rates in patients undergoing PCNL.

MATERIAL & METHODS

This type of research was a prospective observational analytic. The subjects used in this

study were patients with kidney stones who would undergo PCNL.

The inclusion criteria of this study were patients with a diagnosis of kidney stones, at least 21 years old, had the results of BOF and NCCT examinations before PCNL action, there were BOF results appear radioopaque shading with suspect kidney stones, PCNL planned to be done, no primary action has been taken anything, and sign a research agreement to follow.

Patients who entered the inclusion criteria and did not include the exclusion criteria had prior informed consent. Samples were patients with kidney stones who came to the Urology Polyclinic Soetomo General Hospital Surabaya, which was planned to undergo PCNL surgery, patients who met the inclusion criteria would have a CT stonographic examination then counted for the S.T.O.N.E score and Modified Guy's Stone Score before the PCNL procedure. Postoperative stone size evaluation used KUB X-ray (BOF) to assess Stone Free Rate (SFR).

RESULTS

The subjects in this study were patients who met the inclusion and exclusion criteria collected at Soetomo General Hospital Surabaya from December 2019 to January 2019. The results were 31 eligible patients and analyzed as subjects in this study.

In this study, patients who underwent percutaneous nephrolithotomy (PCNL) had an average age of 50.06 ± 11.7 years. Gender distribution was dominated by men with 24 patients (80%). In this study, all research subjects had sufficient Hb values before PCNL action with a value of 13.8 ± 1.7 mg/dL. Prior to PCNL, patients in this study had normal white blood cell (WBC) levels with an average of 8.34 ± 2.06 mg/dL. The majority of patients in this study had a Guy's Stone score (GSS) 2 with a total of 12 patients (38.7%) and S.T.O.N.E Score 5 and 6 with a total of 16 patients (51.2%). The stone free rate (SFR) in this study was achieved in 22 patients (70.9%)

Patients who met the inclusion criteria in this study were then collected data in the form of non-contrast CT-scan (NCCT) results before surgery to determine stone criteria and the anatomical condition of the patient before PCNL action. The results of this study found 31 patients with varying GSS values. After the PCNL procedure, the patient was then followed by a plain abdominal radiograph examination. SFR was considered to be achieved if the stone was found to be less than 1.5 cm in size.

Table 1. Overview of Basic Characteristics of Research Subjects.

No	Variable	Value
1	Average age (mean $\pm$ SD)	50.06 $\pm$ 11.7
2	Gender	
	Male (%)	24 (80%)
	Female (%)	7 (20%)
3	Pre-operation Hb (mean $\pm$ SD)	13.8 $\pm$ 1.7
4	Pre-operation WBC (mean $\pm$ SD)	8.34 $\pm$ 2.06
5	Guy Score (%)	
	1	10 (32.2%)
	2	12 (38.7%)
	3	6 (19.3%)
	4	3 (9.6%)
6	S.T.O.N.E Score (%)	
	5	8 (25.6%)
	6	8 (25.6%)
	7	3 (9.6%)
	8	3 (9.6%)
	9	3 (9.6%)
	10	4 (12.1%)
	11	1 (3.1%)
	12	1 (3.1%)
7	Stone free rate (SFR)	
	Bebas	22 (70.9%)
	Sisa	9 (29.1%)

Table 2. Tabulation of GSS scores and SFR.

			SFR		Total
			Free	Residual	
GSS	1.00		8	2	10
	2.00		11	1	12
	3.00		3	3	6
	4.00		0	3	3
Total			22	9	31

Table 3. Tabulation of ETA Test Results on GSS and SFR.

No	Variable	Relationship Strength	P-value
1	GSS and SFR	0.609	0.05

GSS and SFR data were then analyzed using the ETA statistical test. The results found a strong relationship between the GSS and SFR scores with a relationship strength value of 0.609, the direction of the relationship between these two variables was positive. This means that the greater the GSS, the less likely the SFR could be achieved. The relationship between these two variables was significant with $p=0.05$.

In this study, the distribution of patients before surgery was also assessed based on the S.T.O.N.E score system. SS assessment was measured based on the results of the NCCT before

the patient underwent PCNL. In SS, the NCCT results use were stone size, patient's anatomical condition, and stone hardness measurement measured by hounsfield units (HU). SFR on SS was considered to be achieved if the stone size after PCNL was less than 1.5 cm as evidenced by plain abdominal radiograph. In this study there were 31 patients analyzed and presented based on various SS. Data obtained from the SS before the PCNL action and SFR after the PCNL action were further analyzed using the ETA correlation test. The results obtained a moderate relationship between SS and SFR with a value of the strength of the relationship of 0.55. The strength of the relationship between these two variables was positive which indicated the higher the SS, the less likely the occurrence of SFR. In addition, the results of the correlation of SS and SFR in this study were not statistically significant with $p=0.228$ ($p>0.05$).

Table 4. Tabulation of GSS and SFR.

		SFR		Total
		Free	Residual	
STONE	5.00	7	1	8
	6.00	5	3	8
	7.00	3	0	3
	8.00	3	0	3
	9.00	2	1	3
	10.00	2	2	4
	11.00	0	1	1
	12.00	0	1	1
Total		22	9	31

Table 5. Tabulation of ETA Test Results on SS and SFR.

No	Variable	Relationship Strength	P-value
1	SS and SFR	0.55	0.228

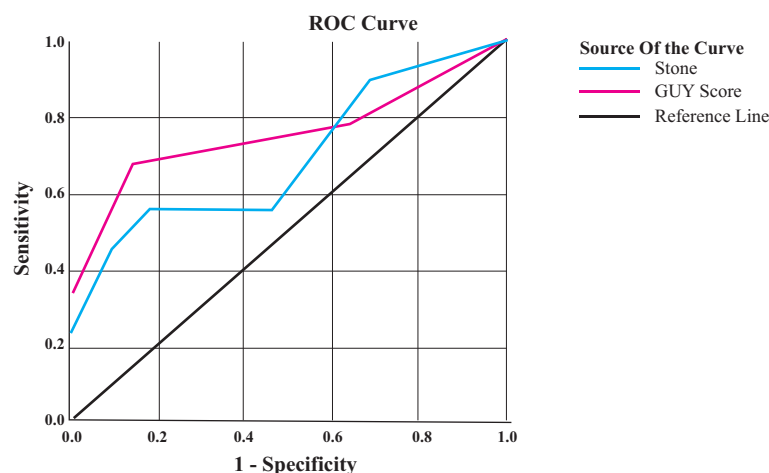
In this study, the scores obtained from the GSS or SS on the SFR were compared to determine a more applicative score to be used as an SFR predictor of PCNL procedure at Soetomo General Hospital Surabaya. The data could be performed logistic regression test to see the probability (odds) on each scoring system with the presence of stones

remaining in the PCNL procedure at Soetomo General Hospital Surabaya. The results obtained each increase in the GSS score found there was a possibility that there were residual stones 3.5 times higher which was statistically significant (OR = 3.496; CI = 1.244-9.896; P = 0.018). While on every increase in SS score there might have been residual stones 1.47 times higher, but the results were not statistically significant (OR = 1.468; CI = 0.981-2.195; P = 0.62).

Furthermore, to assess the quality of the equation, a discrimination test was performed using the receiver operating characteristic curve (ROC) parameter. The results of the comparative graph of this scoring system showed the area under the curve (AUC) with AUC discrimination value on GSS of 0.753 (IK95% 0.525-0.980), where it could be interpreted that there was moderate discrimination on each GSS score. The results showed the GSS, the most effective value for predicting stone free numbers was less than 2 with a sensitivity value of 77.8% and a specificity of 63.6%. In the SS the most effective value in predicting SFR is below a score below 6 with a sensitivity of 88.9% and a specificity of 68.2%. The results of the comparative graphs of the two scoring systems showed that there were differences in the area under the curve (AUC) with the AUC value on the GSS of 0.753 (IK95% 0.525-0.980) and the AUC value on the SS of 0.692 (IK95% 0.468-0.916). The chi-square test was carried out in

Table 6. Tabulation of the logistic regression test result on the GSS and SS scoring to SFR

No	Scoring system	OR	CI	P-value
1	GSS	3.496	1.244-9.896	0.018
2	STONE	1.468	0.981-2.195	0.062

**Figure 1.** Graph of ROC Guys Stone Score (GSS) and STONE Score analysis on Stone Free Rate (SFR).

groups with GSS less than 2 and more or equal to 2. The results showed that there was a possibility of stone remaining 12.6 times higher in groups with GSS 2 or more and were statistically significant (OR= 12.667; CI= 2.003 -80.142; P= 0.003). Thus from the results of this study, it could be concluded that GSS was a better predictor of expected SFR compared.

DISCUSSION

PCNL is the best procedure for achieving stone-free rate in patients with large and complex kidney stones.⁴ Even so, the stone-free rate cannot be ascertained at any time. Some factors could influence the success of PCNL procedure in achieving a stone free rate. Several scoring systems for PCNL procedures have been created to minimize the side effects of operations, predict stone free rate, and provide reports on the complexity of standardized stones.⁵ But until now among all the scoring systems there is still no further study of the scoring system that is best as a predictor of stone-free rate.

In 2008, Tefekli et al. tried to look for a relationship between stone complexity and postoperative complication rates, but the study did not find a significant relationship.⁶ De la Rosette et al. have classified kidney stones according to stone size and found a significant correlation between stone size and duration of surgery.⁷ Thomas et al. found the Guy Stone Score (GSS) grading system using the findings of intravenous pyelography and retrograde urethrography to predict the success rate of PCNL operations and their complications.⁸ In 2013, Okhunov et al developed a STONE Score (SS) grading system that was created to be able to predict the success of PCNL procedures and their complications, but the parameters used were more complex than GSS and had to use CT Scan without contrast.⁹ Smith et al. introduced the CROES nephrolithometric nomogram created using multivariate analysis research from 2806 cases undergoing PCNL in 96 hospitals worldwide. The study concluded that stone size was the best predictor for SFR. Other factors related to stone free level were case volume, previous stone treatment, staghorn stone, stone location, and number of stones.¹⁰

This study compares two grading systems that could predict stone-free rate in patients undergoing PCNL procedures, namely the Guy Stone Score (GSS) and STONE Score (SS) based on the results of a pre-operative CT scan. There were several differences in the two grading. In GSS grading, the parameters used were the number of

stones, location of stones, abnormal anatomy, presence of complete or partial staghorn stones, and spinal cord injury/spina bifida.⁸ Stone size was not included in the GSS parameters, which was one of the main predictors of PCNL success rates. In addition, the definition of partial staghorn stones was still very broad and could add variability in reporting PCNL results. On the other hand, SS grading used stone size parameters (mm²), channel length (mm), hydronephrosis or obstruction, number of calix involved, and stone density (HU).⁹ Although the number of calix is one of the parameters in SS grading, it still does not consider the location of the stone as in the parameters found in GSS grading. This study aims to determine the relationship of stone free rate with GSS grading and STONE scores in patients undergoing PCNL measures and to find out the predictive value of SFR on GSS compared to STONE scores in patients undergoing PCNL procedure at Soetomo General Hospital Surabaya.

The success rate of PCNL procedures measured from SFR in this study was 70.9%. This is in line with the results of research by Yarimoglu et al. with a success rate of 77.9% and higher than the study conducted by Singla et al. with 62.2% success.¹¹⁻¹² The PCNL procedure is the gold standard procedure recommended by EAU for patients with stones larger than 2cm.¹³ Therefore, research is still needed to look for predictors of the success rate of PCNL in Soetomo General Hospital Surabaya.

GSS is a fairly simple but accurate grading system in determining SFR and post-operative PCNL complications in several studies and can be used in places where CT scans are not available. In this study, GSS was measured based on the results of CT scan without contrast before surgery. This is the same as the study conducted by Vicentini et al. and Ingimarsson et al. However, this is different from the study conducted by Sinha et al, in which the study used intravenous urography and retrograde pre-operative pyelography.¹⁴⁻¹⁶ The results of this study indicate that SFR has a strong and statistically significant correlation with GSS grading. This is in line with research conducted by Thomas et al. also found a statistically significant correlation on GSS grading with SFR.⁸ Research conducted by M. Khalil et al. also had a significant correlation with SFR.¹⁷ A meta-analysis with a total of 6 studies comparing stone free rate with stone residual rate in patients undergoing PCNL also supported the results of a significant correlation on GSS with SFR.¹⁸

In this study, it could be concluded that each increase in GSS score was about 3 times as likely to be a higher incidence of residual stones in patients who had undergone PCNL in Soetomo General Hospital. In this case, it could be seen that GSS was a

fairly good predictor in predicting SFR in patients undergoing PCNL. Research conducted by Rathee et al. concluded that each increase in GSS only increased 0.9 times the likelihood of residual stones in patients who had undergone PCNL.¹⁹

Grading STONE scores have more complex parameters compared to GSS. Besides having more parameters, the STONE score also has a stone size parameter but does not have a stone location parameter as in the GSS grading system. In a study conducted by Wayland et al, the STONE score had a statistically significant correlation with SFR in patients undergoing PCNL.⁴ This is supported by other studies comparing STONE grading scores with other grading systems.¹² However, this study did not find a statistically significant correlation and had a weak relationship with SFR. Although not statistically significant, this study shows that for each increase in the STONE grading score, there is a possibility that the remaining stones increase 1.4 times higher in patients who have undergone PCNL procedures. This may still be clinically meaningful and can still be used to help predict SFR in patients who will undergo PCNL at Soetomo General Hospital.

The GSS grading system had a stronger correlation and relationship than the STONE score in this study. GSS could predict SFR in patients who would undergo PCNL of 73.9% and 67% on STONE Score. The results of the study of Sinha et al. showed that GSS could provide SFR prediction of 87.7%.¹⁶ But in a study conducted by Okhunov et al, the STONE score could predict an SFR of 83.1%.⁹ In a study conducted Ujwal Kumar et al., which also compared STONE and GSS showed that the STONE score was superior to GSS, moreover the correlation of the two grading systems to SFR was statistically significant.²⁰ This might be due to the greater number of samples in the study as well as the different cut-off points of stone size which were defined as "Stone-Free" in some studies. This study focuses on SFR after PCNL surgery, for the future a similar study with a larger number of samples was needed and also measures the predictor of complications in patients who will undergo PCNL.

CONCLUSION

1. Guy Stone Score (GSS) is a good scoring system in predicting stone-free rate and the higher the GSS number, the lower the chance of achieving stone-free rate in patients undergoing PCNL procedure.
2. STONE Score (SS) does not give good results in predicting stone-free rate, but the higher the SS

number still shows the lower possibility of achieving stone-free rate in patients undergoing PCNL procedure.

3. Guy Stone Score (GSS) gives a better predictive value than the STONE score (SS) on stone-free rate in patients undergoing PCNL procedures at Soetomo General Hospital Surabaya.

REFERENCES

1. Kemenkes RI, 2013. Riset Kesehatan Dasar.
2. Alelign T, Petros B. Kidney Stone Disease: An Update on Current Concepts. *Adv Urol*. 2018.
3. Akmal. Faktor yang berhubungan dengan batu saluran kemih di RSUD Dr. Wahidin Sudirohusodo makassar. 2013; 3: 56-61.
4. Wu WJ, Okeke Z. Current clinical scoring systems of percutaneous nephrolithotomy outcomes. *Nat Rev Urol*. 2017; 14(8): 459-69.
5. Luca C, Khawashki H Al, Benzakour T, Bozhkova S. The W.A.I.O.T. Definition of High-Grade and Low-Grade Peri-Prosthetic Joint Infection. 2019; 1-20.
6. Tefekli A, Karadag MA, Tepeler K, Sari E, Berberoglu Y, Baykal M, et al. Classification of Percutaneous Nephrolithotomy Complications Using the Modified Clavien Grading System: Looking for a Standard. *Eur Urol*. 2008; 53(1): 184-90.
7. De La Rosette J, Assimos D, Desai M, Gutierrez J, Lingeman J, Scarpa R, et al. The clinical research office of the endourological society percutaneous nephrolithotomy global study: Indications, complications, and outcomes in 5803 patients. *J Endourol*. 2011; 25(1): 11-7.
8. Thomas K, Smith NC, Hegarty N, Glass JM. The guy's stone scoregrading the complexity of percutaneous nephrolithotomy procedures. *Urology [Internet]*. 2011; 78(2): 277-81.
9. Okhunov Z, Friedlander JJ, George AK, Duty BD, Moreira DM, Srinivasan AK, et al. S.T.O.N.E. nephrolithometry: Novel surgical classification system for kidney calculi. *Urology*. 2013; 81(6): 1154-60.
10. Smith A, Averch TD, Shahrour K, Opondo D, Daels FPJ, Labate G, et al. A nephrolithometric nomogram to predict treatment success of percutaneous nephrolithotomy. *J Urol*. 2013; 190(1): 149-56.
11. Yarimoglu S, Bozkurt IH, Aydogdu O, Yonguc T, Gunlusoy B, Degirmenci T. External Validation and Comparisons of the Scoring Systems for Predicting Percutaneous Nephrolithotomy Outcomes: A Single Center Experience with 506 Cases. *J Laparoendosc Adv Surg Tech*. 2017; 27(12): 1284-9.
12. Singla A, Khattar N, Nayyar R, Mehra S, Goel H, Sood R. How practical is the application of percutaneous nephrolithotomy scoring systems? Prospective study comparing Guy's Stone Score, S.T.O.N.E. score and the Clinical Research Office of the Endourological Society (CROES) nomogram. *Arab J Urol*. 2017; 15(1): 7-16.

13. Türk C, Neisius A, Petrik A, Seitz C, Skolarikos A, Thomas K. EAU Guidelines on Urolithiasis. *Eur Assoc Urol.* 2018; 69(3): 475-82.
14. Vicentini FC, Marchini GS, Mazzucchi E, Claro JFA, Srougi M. Utility of the Guy's stone score based on computed tomographic scan findings for predicting percutaneous nephrolithotomy outcomes. *Urology.* 2014; 83(6): 1248-53.
15. Ingimarsson JP, Dagrosa LM, Hyams ES, Pais VM. 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(1): 45-9.
16. Sinha RK, Mukherjee S, Jindal T, Sharma PK, Saha B, Mitra N, et al. Evaluation of stone-free rate using Guy's Stone Score and assessment of complications using modified Clavien grading system for percutaneous nephro-lithotomy. *Urolithiasis.* 2015; 43(4): 349-53.
17. Khalil M, Sherif H, Mohey A, Omar R. Utility of the Guy's Stone Score in predicting different aspects of percutaneous nephrolithotomy. *African J Urol.* 2018; 24(3): 191-6.
18. Jiang K, Sun F, Zhu J, Luo G, Zhang P, Ban Y, et al. Evaluation of three stone-scoring systems for predicting SFR and complications after percutaneous nephrolithotomy: A systematic review and meta-analysis. *BMC Urol.* 2019; 19(1): 1-9.
19. Rathee VS, Vivek HC, Khan SW, Singh AK, Shukla PK, Verma A, et al. Comparison of Guy's vs S.T.O.N.E. nephrolithometry scoring systems in predicting the success rate of PCNL. *J Clin Urol.* 2017; 10(5): 423-9.
20. C.s.manohar. Suspected Torsion score in patients presenting with acute scrotum. *J Endourol.* 2016; 30: A106.