A Prospective Study on Percutaneous Nephrolithotomy (PCNL) Outcomes and Grading of Complexity of PCNL Procedures Using "Guy's Stone Score"

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ABSTRACT

Introduction: In modern society, kidney stone disease is one of the most common afflictions and there is global rise in its prevalence. Further, westernization of culture leads to migration of stone disease from lower to the upper urinary tract and the disease once limited to men is increasingly gender blind. The main objective was to evaluate outcomes of percutaneous nephrolithotomy (PCNL) and to study the grading & complexity of PCNL procedures using "Guy's Stone Score".

Material and Methods: It was a prospective observational study in which 100 patients were subjected for PCNL. Guy's stone score (GSS) was ascertained on CT urography. During the study of demographic data, preoperative and intraoperative findings as well as postoperative outcomes were recorded and finally data of all parameters were compiled and compared with different grades of Guy's Stone Score.

Result: The GSS was found to be significantly correlating with various outcome parameters like Stone burden ($p<0.0001$); No. of puncture ($p<0.0001$); Operating time ($p<0.0001$); Complications ($p<0.0002$); Residual stone ($p<0.05$). Urinary stone disease affects individuals in the prime of their life, affecting males more than females. PCNL is safe and successful method for renal stones treatment. It is minimally invasive and easily reproducible.

Conclusion: In our study complete clearance of stone was achieved in 85% patients without need of ancillary procedure. Guy's Stone score is a reliable method to preoperatively assess the outcome of PCNL and therefore valuable for preoperative counselling of patients & the family.

Keywords: Clavien-Dindo classification, Guy's Stone Score, Percutaneous Nephrolithotomy

INTRODUCTION

In 1976 Fernstrom and Johansson, reported the technique of creating a percutaneous tract specifically to remove a renal stone. Subsequent reports have established PCNL as a routinely used technique to treat patients with large or otherwise complex calculi. Advances in surgical techniques and technology have enabled the continuous evolution of PCNL, allowing the urologist to remove calculi percutaneously with increasing efficiency. Because the percutaneous approach to renal stone removal is better than the open approach in terms of morbidity, convalescence, and cost. PCNL has replaced the open surgical removal of large or complex stone at most institutions.[1,2]

Stone characteristics have a significant impact on surgical outcomes and features such as size, the extent of calyceal involvement and stone density all of them play an important role in the decision making process.[3] Various efforts have been made by different groups to characterize stones in the kidney. Preoperative patient counselling necessitates the development of an integrated scoring system to assess and quantify renal stone complexity for optimal decision making. It also allows a way to account for the methodological differences among studies reporting outcomes of PCNL in renal stone disease.[3] Different scoring systems developed for preoperative prediction of stone free status (SFS) and complications through assessment of the complexity of renal stones before performing a percutaneous nephrolithotomy. Guy's stone score [(GSS) (Table 1)], S.T.O.N.E. nephrolithometry score, Clinical Research Office of the Endourology Society (CROES) nomogram, and Seoul National University Renal Stone Complexity (S ReSC) score are the four most common nephrolithometry scoring system used today.[3] Guy's stone score (Figure 1) was developed to be quick, simple, and reproducible with good correlation with stone free status and complication rates so that it could be used in day to day practice.[3]

It consists of four grades based on renal stone burden and patient anatomy. The score was prospectively validated in 100 patients who underwent PCNL procedure in a tertiary care centre. Various researchers had used intravenous and CT / abdominal radiography to determine stone free pyelography / CT urography preoperatively status which was defined as no stones visible or presence of clinically insignificant residual fragments <4 mm, 6 weeks post percutaneous nephrolithotomy.[3]

MATERIAL AND METHODS

This prospective observational study was carried out in Department of Urology at Maharishi Markandeshwar Institute of Medical Sciences and Research (MMIMSR),

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How to cite this article: Jain J, Sharma K, Aggarwal D. A prospective study on percutaneous nephrolithotomy (PCNL) outcomes and grading of complexity of PCNL procedures using "guy's stone score". International Journal of Contemporary Medical Research 2020;7(9):I1-I6.

DOI: http://dx.doi.org/10.21276/ijcmr.2020.7.9.31

Mullana-Ambala from July 2018 to June 2019 after scientific committee approval. Patients with renal stone undergoing PCNL were included in the study. Patients of renal stone with indwelling nephrostomy / ureteric stent, active UTI, bleeding diathesis, bilateral renal stones and azotemia were excluded from the study. 100 (n = cohort) patients were included in the study who underwent PCNL and were followed up for the presence of significant residual calculi or any other complications. Patients were enrolled after taking informed written consent. They were worked up as per proforma and guy's stone score was ascertained on CT urography. The patients were taken up for PCNL after confirming sterile urine culture and anaesthetic fitness.

All PCNL, were performed under general anaesthesia by a single surgeon. Under lithotomy position, 5 Fr ureteric catheter was inserted and PCNL was done in prone position. After satisfactory clearance of stone, a DJ stent and 20 French nephrostomy tube was placed. On post-operative day 1, nephrostomy tube was removed, once the X-Ray KUB documented no residual stone, ureteral stent insitu, patient is afebrile and urine is clear. The urethral catheter was removed after a few hours once leakage from nephrostomy site was minimised / stopped. Presence of significant residual calculus i.e. more than 4mm was assessed with a help of X-ray KUB / USG KUB / NCCT abdomen and pelvis on 14th postoperative day before removal of DJ stent. During the study demographic data, preoperative and intraoperative findings as well as postoperative outcomes were recorded. Bleeding was considered a complication when it was severe enough to lead to procedural termination or requiring blood transfusion. All post-operative complications like Fever, Transient Renal Dysfunction, Sepsis, Other organ injury, death due to procedure were noted and graded using Clavien-Dindo Classification (Table 2). If any patient required any ancillary procedures like ESWL, Ureteroscopy, Redo PCNL was also recorded and finally data of all parameters were compiled and compared with different grades of Guy's Stone Score.

Categorical variables were presented in number and percentage (%) and continuous variables were presented as mean ± SD and median. Normality of data was tested by Kolmogorov-Smirnov test. If the normality was rejected then non parametric test was used. Quantitative variables were associated using Kruskal Wallis Test (as the data sets were not normally distributed) with Guy's Grade. Qualitative variables were associated using Chi-Square test. A p value of <0.05 was considered statistically significant. The data was entered in MS EXCEL spread sheet and analysis was done using Statistical Package for Social Sciences (SPSS) version 21.0.

RESULTS

In our study, there were 66 men and 34 women with the age range of 20 to 65 years. Maximum numbers of patients (54%) were in age range of 30 to 50 years. Mean age of patient is 43 years. Male: female ratio was 2:1. Out of hundred patients, 51 were operated on left side i.e. slightly more than right. The size of stone ranges from 1.5 cm to 5 cm with a mean of 2.81 cm. Stone burden was calculated by summing of largest dimension of all stones in multiple stones or considering the largest dimension as stone size in solitary stone. Maximum numbers of patients were in grade 1 (38%), followed by grade three (28%), than grade two (21%) and last is grade 4 (13%) (Table 3).

Maximum number of patients were operated with single calyx puncture i.e. 64 per cent. But some patient requires more than one puncture because of pelvi-calyceal anatomy and stone in different calyx. Operating time was calculated from completion of anaesthesia till nephrostomy tube fixation. The range was from 30 minutes till maximum 180 minutes. One patient with pickup stone in pelvis was operated in 30 minutes (Table 3).

The procedure was uneventful in 62% cases; complication in some form was encountered in 38% of the patients. Most common complication was pain occurred in 20% of patients which was managed with analgesia. Fifteen percent of patients had fever out of 100 patients which was managed by antipyretics +/- up gradation of antibiotics (according to urine culture and sensitivity report). Seven percent of patients needed readmission after discharge in view of uncontrolled sepsis. Five percent of patients had elevation of serum creatinine in post-operative period which was managed conservatively. None required renal replacement therapy. No patient had Septic shock / MODS / Death. All complications were graded according to Clavien-Dindo, majority of patients had grade 1 and 2 complications, only four had grade 3 complications. No one suffered grade 4 and grade 5 complications. Patient stayed in hospital from 4 to 7 days with average of 4 days i.e. 77 per cent. Only one patient stayed for 7 days because of postoperative complication (see Table 4). Complete clearance of stone was accomplished in 85% of patients. Patients with residual stone were treated by ancillary procedures. Out of 15 patients with residual stones, five patients passed stone spontaneously. Other 10 patients underwent ancillary procedure (REDO / RIRS / ESWL).

Comparision of Guy's stone score with various outcomes

In relation with Guy's stone score, as the grade of renal stone increases number of punctures also increase (p<0.0001). Mean and range of operating time seems to increase as Guy's stone score is increasing (p <0.0001). Mean operating time

Grade 1	Solitary calculi in the mid / lower pole with simple anatomy, Solitary calculi in the pelvis with simple anatomy
Grade 2	Solitary calculi in the upper pole with simple anatomy, Multiple calculi in a patient with simple anatomy, Solitary calculi in a patient with abnormal anatomy
Grade 3	Multiple calculi in a patient with abnormal anatomy, Calculi in a calyceal diverticulum; partial staghorn stone
Grade 4	Staghorn stone, Calculi in a patient with spina bifida or spinal injury

Table-1: Guy's stone score

Grades	Definition
Grade 1	Any deviation from the normal postoperative course without the need for pharmacological treatment, or surgical, endoscopic, and radiological interventions.
Grade 2	Allowed therapeutic regimens are: drugs as antiemetics, antipyretics, analgetics, diuretics and electrolytes, and physiotherapy. This grade also includes wound infections opened at the bedside
Grade3	Requiring pharmacological treatment with drugs other than such allowed for grade I complications.
Grade 3a	Blood transfusions and total parenteral nutrition are also included
Grade 3b	Requiring surgical, endoscopic, or radiological intervention
Grade 4	Intervention not under general anesthesia
Grade 4a	Intervention under general anesthesia
Grade 4b	Life-threatening complication (including central nervous system complications) requiring IC/ICU management
Grade 5	Death of a patient

Table 2: Clavien-Dindo classification[4]

Preoperative and intraoperative parameters	Category	No. of patients (%)
Age (in years)	<=30	19%
	31-50	54%
	51-70	27%
Gender (M/F)	Male	66%
	Female	34%
Laterality of stone (Left/Right)	Left	51%
	Right	49%
Comorbidity (Diabetes / Hypertension)	Diabetes	17%
	Hypertension	18%
	Both	7%
	No comorbidity	72%
Stone burden (mean)	2.81 ± 0.8 (1.5 - 5 cm)	
Guy's stone score	Grade 1	38%
	Grade 2	21%
	Grade 3	28%
	Grade 4	13%
Renal function status	Normal	95%
	Elevated	5%
Number of calyx punctured	1	64%
	2	23%
	3	13%
Operating time (minutes)	98.05 ± 33.51	30-180

Table 3: Preoperative and intraoperative parameters

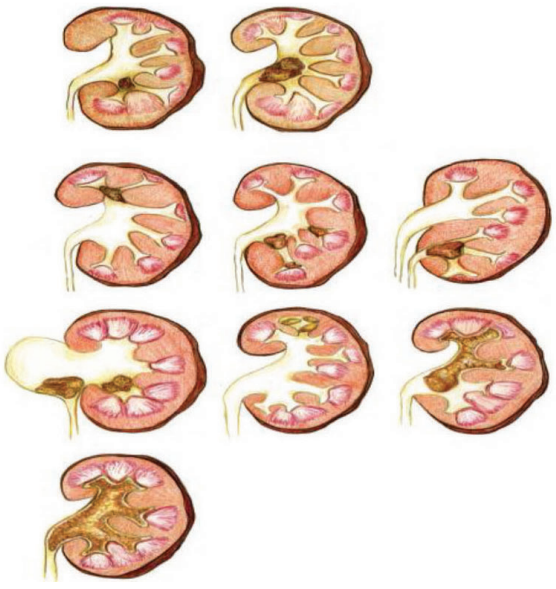

Figure-1: Guy's stone score

in grade 1 is 72.97 min as compared to grade 4 (127.31 min). This may be because of increased stone burden and more the no. of punctures.

Overall number of patients who had complications increased as GSS increases came out to be statistically significant $p < 0.0002$. When comparing pain with different grades of patients, number of patients who had pain were more in grade 4 as compared to grade 1($p<0.007$). Same way creatinine rise in number of patients increases as Guy's stone score increases with a p value <0.0001. It's clearly appreciable from above mentioned table that there is no association between Clavien-Dindo grade and Guy's stone score as p value is >0.05. Most of the patients stayed in hospital from 4 to 6 days and this is seen in all grades of Guy's stone score. One important point is that as Guy's stone score are increasing, mean of hospital stay also tend to increase. This could be because of increase in complication rate as Guy's stone score is increasing. In grade 1 five per cent of patients had residual stone as compared to grade 4 who had fifteen

Postoperative parameters	Category	Percentage (%)
Complications	Pain	20%
	Fever	15%
	Sepsis	7%
	Creatinine rise	5%
	Blood transfusion	2%
	Nausea and vomiting	2%
	Ureteral stent insertion	2%
	Nephrostomy site leak	2%
	Urinary retention	1%
	Other organ injury	1%
Hospital stay (days)	4	77%
	5	13%
	6	9%
	7	1%
Residual stones	Complete clearance	85%
	Residual stone	15%
Requirement of ancillary procedures	ESWL	1%
	Redo PCNL	8%
	RIRS	1%

Table-4: Postoperative parameters

Author	Year / Place	Clavien dindo classification of complications (Grades)						
		1	2	3A	3B	4A	4B	5
Khalil M et al[5]	2018 / Egypt	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Jaipuria J et al[6]	2016 / India	20.5%	12.39%	4.95%	0.16%	0.33%	0.16%	0%
Sfoungaristos S et al[7]	2015 / Israel	20.3%	9.20%	8.43%	0%	0%	0%	0%
Ingimarsson JP et al[8]	2013 / US	18%	10%	5%		4%		0%
Mandal S et al[9]	2012 / India	18.7%	43.8%	15.1%	6.4%	2.1%	1.4%	0.3%
Thomas K et al[10]	2011 / UK	30%	12%	4%	6%	0%		0%
Our study	2020 / India	24%	10%	3%	1%	0%		0%

Table-5: Comparision of complications (Clavien dindo classification)

Author	Year / Place	P value			
		GSS v/s Operating time	GSS v/s Complications	GSS v/s Residual stone	GSS v/s Ancillary procedure
Khalil M et al[5]	2018 / Egypt	0.001	0.023	N/A	0.047
Jaipuria J et al[6]	2016 / India	N/A	N/A	N/A	N/A
Sfoungaristos S et al[7]	2015 / Israel	N/A	0.025	<0.001	N/A
Ingimarsson JP et al[8]	2013 / US	N/A	N/A	N/A	N/A
Mandal S et al[9]	2012 / India	N/A	N/A	<0.05	N/A
Thomas K et al[10]	2011 / UK	N/A	N/A	N/A	N/A
Our study	2020 / India	<.0001	0.0002	0.045	0.225

Table-6: Comparision of GSS with various outcomes

per cent and p value is statistically significant <0.045. There were total 15 patients who had residual stones. Out of 15 patients, 10 opted for ancillary procedures. In Guy's stone score 1, 97 per cent of patients didn't require any ancillary procedure as compared to grade 4 (76.9%), but p value is not statistically significant. Same way patients who underwent Redo-PCNL were 23 per cent in grade 4 of GSS as compared to grade 1 (0%).

DISCUSSION

In our study, mean age of the patients was 43.52, which is similar to other studies [Jaipuria J (44.5) and Mandal S (38.29)] performed in India. Male to female ratio in most of the studies were 2:1 like [Current, Sfoungaristos S, Mandal S].[7] In our study mean of stone burden is 2.81 ± 0.8, less as compared to Thomas K (3.16 ± 1.9). In present study 38% were grade 1, 21% were grade 2, 28% were grade 3 and 13% were grade 4. Similarly in other studies (Khalil M, Sfoungaristos S)[5,7] grade 1 (37% and 35.6 respectively) were more common and least were grade 4 (13% and 10% respectively). But other studies like Jaipuria J (Grade 1 - 28.2%, Grade 2 - 29.2%, Grade 3 - 29.7 and Grade 3 - 12.9%), Ingimarsson JP (Grade 1 - 22%, Grade 2 - 37%, Grade 3 - 16% and Grade 4 - 24%) and Mandal S (Grade - 30.7%, Grade 2 - 44.34%, Grade 3 - 22.62% and Grade 4 -

2.26%) had most common patients in grade 2.

In all of the studies (Current, Sfoungaristos S, Ingimarsson and Thomas K)[7,8,10] maximum number of patients were operated with single puncture. Maximum number of punctures were 3 as described in most of the studies. Three punctures were maximum in current study (13%) and least in Thomas K[10] (1%). In our study we had calculated mean of operating time (98.05 ± 33.51) which was comparable to Thomas K (94 ± 35). But as compared to above mentioned studies Ingimarsson had much higher mean time of operation (186 ± 72).

Our study, Sfoungaristos S[7] and Thomas K[10] had comparable findings in relation to complications. All three studies do not have any grade 4 and grade 5 complications. Jaipuria J[6] had grade 4A (0.33%), grade 4B (0.16%) complications but no grade 5 complication. Ingimarsson JP had 4 per cent grade 4 complications but no grade 5 complications. Mandal S had grade 4A (2.1%), grade 4B (1.4%) and grade 5 (0.3%). Most of studies had maximum grade 1 complication as we had except Mandal S who had grade 2 complications. In our study fever (15%) is most common complication similar to other studies like Mandal S (15%), Thomas K (13%).[9,10] Jaipuria J[6] had least number of patients with fever i.e. 2.64%. In Thomas K study 5 per cent of patients had pain as compared to our study that had 2 per cent. In Thomas K study two percent of patients had urinary retention as compared to our study who had one percent. Nephrostomy site leakage was maximum in Mandal S study (10.1%) and current study had least (2%). Thomas K had five percent and Jaipuria J[6] had 7.6%. In current study one percent of patient had gall bladder injury and in Jaipuria J 1.6% had colon injury. Mandal S had 0.3% of mortality rate and Jaipuria J[6] had 0.16% of MODS. In current study no patient had MODS / death (Table 5).

Our mean days of hospital stay was 4.34 days, little less as compared to Sfoungaristos S (5.90 ± 2.11). The range of residual stones was 10% to 38% when comparing different studies. Thomas K had maximum (38%), Ingimarsson had least (10%) and in current study it was 15%. Current study (10%) had least requirement of ancillary procedures as compared to other studies. Thomas K[9] had maximum requirement of ancillary procedures i.e. 24 percent. Others are as follows Khalil M (21%) and Jaipuria J (16.3%).

Mean operating time was statistically significant different in Guy's stone score in current study with p value <0.0001, similar findings were seen in Khalil M with a P value <0.001. So it signifies that as grade of Guy's stone score increases operative time increases. But Sfoungaristos S showed there was not much difference in operating time in different grades. Current study showed number of complications were more as grade of Guy's stone score increases with a statistically significant p value < 0.0002. Similar findings were seen in other studies i.e. Khalil M (0.023),Sfoungaristos S (0.025), Jaipuria J and Mandal S.[7-10] Chances of residual stone occurrence in different grades of Guy's stone score was assessed and compared with different studies. Current study showed that as guy's grade increased there were more chances of residual stone with a p value <0.045. Similar findings were seen in Sfoungaristos S (<0.001), Mandal S (0.005), Khalil M, Jaipuria J, Thomas K except Ingimarsson JP.[7-10] Current study showed there were more chances of ancillary procedure in higher grades of Guy's stone score as compared to lower grades but the p value (0.025) was not statistically significant. Khalil M had significant p value (0.047) and Jaipuria J also showed similar finding but didn't mentioned p value (Table 6).[8-10]

CONCLUSION

Urinary stone disease affects individuals in the prime of their life. Men are more commonly affected than women. Flank pain is the most common presenting symptom. Symptomatic renal stone of size 1.5 cm or larger is the commonest indication of PCNL. PCNL is safe and successful method of treatment for renal stones. It is minimally invasive and easily reproducible. In the present study complete clearance of stone was achieved in 85% patients without need of any ancillary procedure. Guy's Stone score is a reliable method to preoperatively assess the outcome of PCNL and therefore valuable for preoperative counselling of patients & the family.

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Source of Support: Nil; **Conflict of Interest:** None

Submitted: 11-07-2020; **Accepted:** 16-08-2020; **Published:** 19-09-2020