Original Research Article

Preoperative assessment of stone free rate following percutaneous nephrolithotomy

Dheeraj SS[1], G.V. Charan Kumar[2*], Rahul Devraj[3], Vidyasagar[4], Ramachandraiah[5], Ramreddy Ch.[6]

[1]Senior Resident, Department of Urology, Nizams Institute of Medical Sciences, Hyderabad, Telangana, India
[2]Associate Professor, Department of Urology, Nizams Institute of Medical Sciences, Hyderabad, Telangana, India
[3]Professor, Department of Urology, Nizams Institute of Medical Sciences, Hyderabad, Telangana, India
[4]Addl. Professor, Department of Urology, Nizams Institute of Medical Sciences, Hyderabad, Telangana, India
[5]Associate Professor, Department of Urology, Nizams Institute of Medical Sciences, Hyderabad, Telangana, India
[6]Professor and HOD, Department of Urology, Nizams Institute of Medical Sciences, Hyderabad, Telangana, India

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Abstract

Introduction: Renal stones are one of the most common reason for patient's visit to Urologic outpatient department. PCNL is novel minimally invasive modality for renal stone management and approved by the European Association of Urology (EAU) as 1st line approach. Inspite of high success rates, PCNL can be associated with wide range of complications, ranging from 20-83%.A scoring system which can pre-operatively grade the extent of stone disease, its possible impact on treatment outcomes and occurrence of complications are not only essential but should become an integral part of the care plan.Guy's score has been externally validated in many studies. In this study we use this Guy's score in predicting Post op stone free rate following PCNL and also assess the complications of PCNL. **Materials and methods**: This is retrospective observational Study conducted in Department of urology, Nizam Institute of Medical Sciences, Hyderabad between November 2018 and October2020. Information was obtained from previous records of total 100 patients and analysed retrospectively. All patients with renal calculi > 18 years of age , posted electively for Percutaneous Nephrolithotomy were included in the study. Patients with severe comorbid illness and who underwent Percutaneous Nephrolithotomy in pastwere excluded. **Results**: Total number of patient included in the study were 100 , (n=100). Majority of the patients were in the 5th decade (27%) Among them males were 64 (64%) and females were 36 (36%). Patient with comorbid conditions were 28 (28%) . Among the comorbidities, Diabetes mellitus was present in 16% of patients.Patients were classified using Guy's Stone Scoring system to assess the preoperative complexity of the calculus and predict the stone free rate and the complications. Most of the patients were included in the category of Guy's stone score –1.All patients were evaluated for residual fragments by post PCNL ultrasound on post-operative day 1. Clinically Insignificant Residual Fragments (CIRF)were defined as <4mm, non- obstructive and asymptomatic residual fragments. All perioperative complications were stratified by clavin –Dindo classification system. Peri-operative complications includes intraoperative and post operative complications including CSRF. Total number of patients who had complications include 25 (25%) . Of them 9 patients had grade 1 complication., 6 had grade-2, 7 had grade -3 and 3 had grade -4 complications. Statistical analysis showed significant association between Clinically Significant Residual Fragements, number of punctures required and post operative stay with Guys Stone Score. There is no significant association between Guys stone score and complications graded as per modified ClavienDindoclassification , but there is non significant increased incidence of complication grade with increase in stone score. **Conclusion:** Guys stone score significantly predict, number of punctures required for PCNL, Stone free rate, Post operative hospital stay.

Keywords: Percutaneous Nephrolithotomy,clavin –Dindo classification system,Clinically Significant Residual Fragements, postoperative complications.

Introduction

Renal stones are one of the most common reason for patient's visit to Urologic outpatient department. It affects about 12 % of world population in their lifetime[1]. Because of renal stones, among affected population 50 % may end up in losing renal function[2]. There is increase in number of people being affected with renal stones, probable because of dietary and environmental changes[3,4]. PCNL is novel minimally invasive modality for renal stone management and approved by the European Association of Urology (EAU) as 1st line approach[5,6]. PCNL has replaced open stone surgery because of its cost effectiveness, lower morbidity, shorter operative time and lower post operative complications[7,8]. With the availability of newer instruments (flexible pyeloscopes and ureteroscopes) and refinement of PCNL indications, there is increasing trend in utilisation of PCNL[9].

Inspite of high success rates, PCNL can be associated with wide range of complications, ranging from 20-83%[9,10,11]. True complication rates are difficult to determine as most of the reviews report only specific complications of PCNL. The complications are intraoperative complications like bleeding, injury to adjacent organs (colon, liver,

*Correspondence
Dr. G.V. Charan Kumar
Associate Professor, Department of Urology, Nizams Institute of Medical Sciences, Hyderabad, Telangana, India.
E-mail: charan.gv@gmail.com

spleen , pleura). Post operative complications include haemorrhage, sepsis, stent / nephrostomy related complications, MODS, death.

A scoring system which can pre-operatively grade the extent of stone disease, its possible impact on treatment outcomes and occurrence of complications are not only essential but should become an integral part of the care plan. Many such scoring systems are described: Guy's stone score (G.S.S), the CROES (Clinical Research Office of the Endourological Society) nomogram, STONE (size, tract length, obstruction, number of involved calyces, essence/stone density) nephrolithometric score, S-ReSC (seoul National University Renal stone complexity) score. An ideal scoring system should include variables that both influence surgical planning and predictive of post-operative complications. Guy's stone score, 1st described by Thomas et al[12]., is novel assessment tool to predict Stone Free Rate (SFR) in patient who require PCNL .Guy's score has been externally validated in many studies[13,14]. In this study we use this Guy's score in predicting Post op stone free rate following PCNL and also assess the complications of PCNL

While preoperative stone assessment predicts treatment outcomes. There is a need to reliably evaluate the complications that may arise following surgery. Many different ways are being proposed to stratify post-surgical complications. Standardization of the complications are essential, which ensures relevant data comparison between different studies. Modified Clavien Dindo classification[15,16] is one of the methods for classifying the post operative complications depending on the grade of complication. In this study we used the same to classify the complications following PCNL.

Aims and Objectives

1. To assess the complexity of renal stone preoperatively by Guy's stone scoring system
2. To analyse complications of PCNL and to stratify with modified claviendindo grading system
3. To correlate preoperative Guy's stone score with stone free rates after surgery and complications

Methodology

This is retrospective observational Study conducted in Department of urology, Nizam Institute of Medical Sciences, Hyderabad between November 2018 andOctober 2020. Information was obtained from previous records of total 100 patients and analysed retrospectively. All patients with renal calculi > 18 years of age , posted electively for Percutaneous Nephrolithotomy were included in the study. Patients with severe comorbid illness and who underwent Percutaneous Nephrolithotomy in pastwere excluded.

All patients who are included in the study underwent preoperative investigations including X-ray Kidney, Ureter and Bladder (KUB) , Intravenous pyelography, Ultrasonography of abdomen , Non Contrast computerized tomography (NCCT) or Contrast enhanced CT urogram (CECT Urogram) as necessary. CT scan was performed in cases with radiolucent calculus and in patients with abnormal anatomy.

Parameters such as renal stone size , location , and associated abnormal renal anatomy were noted based on radiographic evaluation. Stones were classified using Guy's Stone Score as GSS-I/II/III/IV.

Percutaneous Nephrolithotomy was performed as per standard protocol after obtaining informed and written consent. Antibiotic prophylaxis was given to all patients. Routine placement of foley catheter and percutaneous Nephrostomy was practiced.

Stone free rate assessment was done by detecting the CSRF(Clinically Significant Residual Fragements). CSRF is defined as size of the residual fragment after PCNL more than 4 mm, symptomatic and obstructive. Absence of CSRF were considered as stone free.

CSRF was determined by ultrasonography on postoperative day -1. In the absence of CSRF and absence of haematuria, nephrostomy tube and foleys catheter were removed. Patient was advised to review after 3 to 4 weeks following PCNL for DJ stent removal.

Perioperative complications were stratified based on Modified ClavienDindo classification system[15,16].

Statistical methods

Data was analyzed in SPSS (Statistical Package for Social Sciences) version 17.0. Categorical variables were analyzed using chi-square test. **Fischer's exact** p value < 0.05 was considered significant. Frequencies and percentage distribution were expressed after performing descriptive analysis

Data analysis and results

Total number of patient included in the study were 100 , (n=100). Majority of the patients were in the 5th decade (27%) Among them males were 64 (64%) and females were 36 (36%). Patient with comorbid conditions were 28 (28%) . Among the comorbidities, Diabetes mellitus was present in 16% of patients.Mean creatinine is 0.96mg/dl.

Table1 : Age distribution

Age of the patients (range)	Frequency	Percent
30 and below	21	21%
31 – 40	23	23%
41 – 50	27	27%
51 – 60	16	16%
Above 60	13	13%
Total	100	100.0

Patients were classified using Guy's Stone Scoring system to assess the preoperative complexity of the calculus and predict the stone free rate and the complications. Most of the patients were included in the category of Guy's stone score –1

Table2 : Classification based on Guy's stone scoring system

Guy score	Frequency	Percent
1	37	37%
2	28	28%
3	8	8%
4	27	27%

Table 3:Frequency distribution of abnormal renal anatomy

Abnormal renal anatomy	Frequency	Total Percentage (%)	Percentage with in the category (%)
Gross hydronephrosis	4	4	
Compact pelvicalyceal system	2	4	
Horse shoe kidney	2	2	
Total	8	8%	100%

Stone density was estimated by comparing the density of the calculus with 12th or 11th rib(in the absence of 12th rib) in the X-ray KUB . Based on this , calculi were categorized into denser than rib, less dense and radiolucent. Most of the patients had denser calculi (93%)

Table 4:Density of the calculus

Density of the calculus	Frequency	Percent
Denser(HU>1000)	92	92.0
Less denser (HU: 500-1000)	2	2.0
Very less density /radiolucent(HU<500)	6	6.0
Total	100	100.0

During surgery,16 patients needed multiple punctures to complete PCNL. Rest of the patients required single puncture.
All patients were evaluated for residual fragments by post PCNL ultrasound on post-operative day 1. Clinically Insignificant Residual Fragments (CIRF)were defined as <4mm, non- obstructive and asymptomatic residual fragments. Others are considered as Clinically Significant Residual Fragments (CSRF). 13% of the patients had clinically significant residual fragments which were followed up subsequently. Among them three patient underwent Redo-PCNL in the immediate post-operative period.

Table 5: CSRF (Clinically Significant Residual fragments)

CSRF	Frequency	Percent
Nil	89	89.0
Present	11	11.0
Total	100	100.0

Post operative complications

All perioperative complications were stratified by clavin –Dindo classification system. Peri-operative complications includes intraoperative and post operative complications including CSRF. Total number of patients who had complications include 25 (25%) . Of them 9 patients had grade 1 complication., 6 had grade-2, 7 had grade -3 and 3 had grade -4 complications.Among complications, fever is present in 9 patients who didn't require any deviation from normal treatment- grade 1 clavin –Dindo classification.7 patient required blood transfusion.5 patients required Redo surgery and one patient required clot evacuation procedure for bladder clot evacuation.One patient had colonic perforation which was noticed on day 2, as patient developed persistent tachycardia and signs of peritonism. Laparotomy and exploration was done, where perforation was noted in the colon for which colostomy was made and patient recovered well. Among the patients who had grade 4 complications, 2 patients had septic shock and were recovered after intensive care. One patient had Acute Kidney Injury for which 2 sessions of dialysis was given and patient slowly recovered from renal injury.

Table 6 : Post-operative complications (over-all)

Post-operative complications	Frequency	Percentage
Nil	75	75%
Present	25	25%
Total	100	100.0

Table7 : Stratification of peri-operative complications: (Clavien's grading system)

Clavien grading	Frequency	Percentage with in complication group (n=25)	Percentage of complications in the study population (n=100)
Grade 1	9	36%	9%
Grade 2	6	24%	6%
Grade 3	7	28%	7%
Grade 4	3	12%	3%
Total	31	100.0	31%

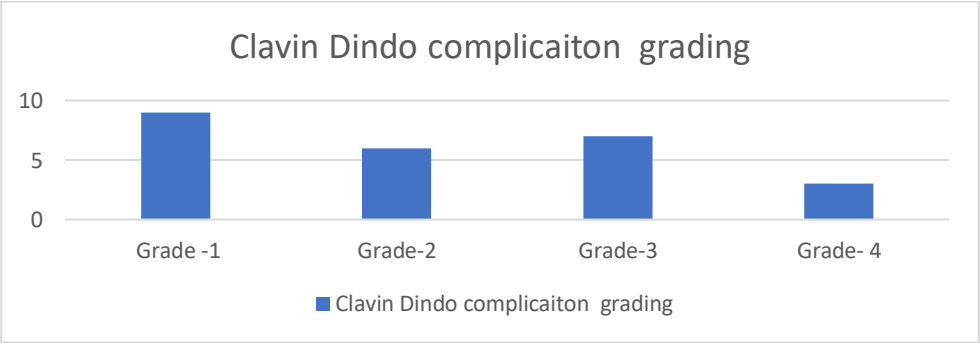

Fig 1:Clavin Dindo complication grading

The average length of hospital stay for majority of the patients 73% of patients was 4 days. Patients who had complications had prolonged post operative stay

Analysis

Table8 :CSRF versus Guys_score Crosstabulation							
			Guys_score				Total
			1.00	2.00	3.00	4.00	
CSRF	NIl	Count	36	26	7	20	89
		% within CSRF	40.4%	29.2%	7.9%	22.5 %	100.0 %
		% within Guys_score	97.3%	92.9%	87.5 %	74.1 %	89.0%
	present	Count	1	2	1	7	11
		% within CSRF	9.1%	18.2%	9.1%	63.6 %	100.0 %
		% within Guys_score	2.7%	7.1%	12.5 %	25.9 %	11.0%
Total		Count	37	28	8	27	100
		% within CSRF	37.0%	28.0%	8.0%	27.0 %	100.0 %
		% within Guys_score	100.0 %	100.0 %	100. 0%	100. 0%	100.0 %

P value as per Pearson Chi-square test= 0.027

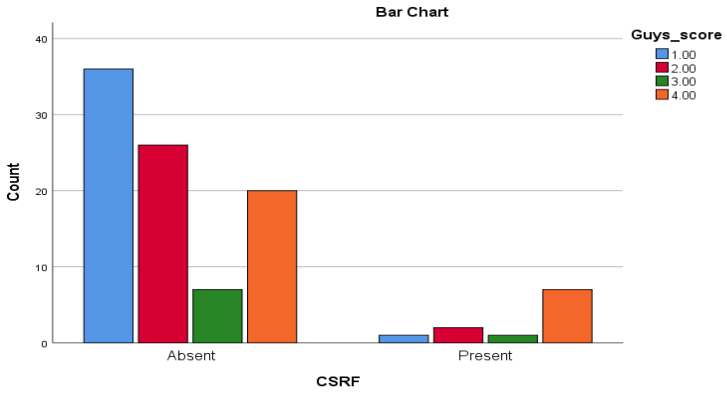

Fig 2: GUYS score vs CSRF

Table 9 : Stone free status (absence of CSRF)

Guy score	Frequency	CSRF	Stone free status
1	37	1	97%
2	28	2	92%
3	8	1	87%
4	27	7	74%

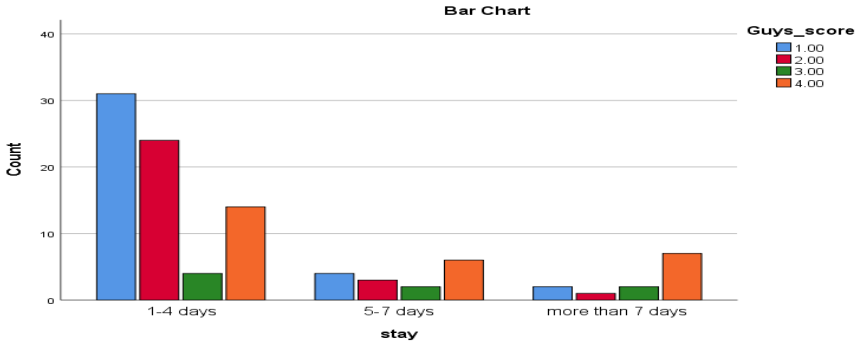

Fig 3: Post-operative stay Vs Guys Stone Score

Table 10 :Number of punctures versus Guy's score cross tabulation:							
			Guys_score				Total
			1	2	3	4	
puncture	0	Count	37	23	6	18	84
		% within puncture	44.0%	27.4%	7.1%	21.4 %	100.0 %
		% within Guys_score	100.0 %	82.1%	75.0 %	66.7 %	84.0%
	4	Count	0	5	2	9	16
		% within puncture	0.0%	31.3%	12.5 %	56.3 %	100.0 %
		% within Guys_score	0.0%	17.9%	25.0 %	33.3 %	16.0%
Total		Count	37	28	8	27	100
		% within puncture	37.0%	28.0%	8.0%	27.0 %	100.0 %
		% within Guys_score	100.0 %	100.0 %	100. 0%	100. 0%	100.0 %

P value =0.003

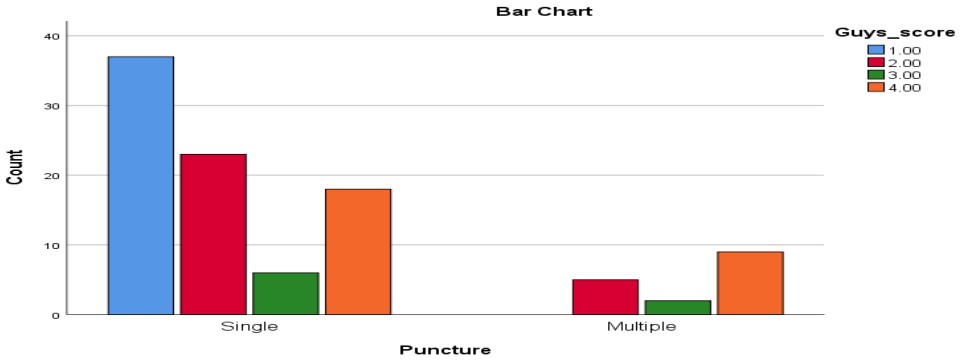

Fig 4: Guys score vs number of punctures

Table 11: P value of analyzed parameters

Parameter	Fishers exact test P value
Number of punctures vs Guy's score	0.003 (S)
CSRF vs Guy's score	0.027(S)
Clavien grade of peri-op complications vs Guy's score	0.168(NS)
Post-op stay vs Guy's score	0.028(S)

S- Significant, NS- Not Significant, CSRF- Clinically Significant Residual Fragments

Statistical analysis showed significant association between Clinically Significant Residual Fragements, Number of punctures required and post operative stay with Guys Stone Score. There is no significant association between Guys stone score and Complications graded as per modified ClavienDindoclassification , but there is non significant increased incidence of complication grade with increase in stone score.

Discussion

With the advances in endourology instrument and optics, PCNL has established itself as first line therapeutic intervention for renal stones. European Association of Urology guidelines recommend PCNL as primary treatment option for large, multiple and inferior calyceal stones[6]. Eventhough PCNL is generally safe, it is not without complications. These complications after PCNL are poorly stratified. Several workers have assessed stone complexity preoperative by various parameters[12,30,32]. These tools have not found to have universal application because of heterogenesity. However Guy's Stone scoring system is one of the very few systems that has been externally validated in several series[12,13,14].

Guys scoring system is a preoperative assessment tool, which can best predict the probability of complications following surgery. Post surgical complications need to be stratified accurately not only for reporting purpose but also for evaluation of management purpose.

The combination of preoperative stone complexity score assessment and accurate stratification of complications are important as they both can give an insight into interventional care provided in a given situation and helps in refining treatment strategies.

This study was designed to assess the preoperative stone complexity with the help of Guys stone score and to predict the stone free status after surgery by using GSS. Post operative complications were analysed and stratified based on modified clavienDindo classification system and are correlated with Guys stone score.

Total number of patients included in our study were 100 (n=100). Majority of the patients were in 5th decade, comprising about 27% of the entire study population with the mean age of 43.69 years. Study population is male predominant comprising around 64%.

Patients were classified by using Guy's Stone Score to assess the preoperative complexity of the calculus , based on preoperative imaging findings. Most of the patients were in the category 1, similar to in study by Sinha et al**[50].**

Table 12:Comparison of stone complexity based on Guy's stone score with other studies

Guy stone Grading	Our study	Sinha et al[50]
1	37	82

2	28	21
3	8	21
4	27	18

Guys stone score was initially proposed by Thomas et al and was validated in 100 patients in a tertiary care centre[12]. Their study revealed Guys score has predicted the stone free status with high accuracy and concluded that it was easy to use and reproducible. Mandal et al[49] and Labate et al[9], also observed similar correlation between the preoperative stone complexity by Guys score and stone complexity rates after PCNL. Similarly in our study stone free rate was accurately predicted by Guys Score. It suggests that increasing stone complexity leads to decreased clearance of stones.

Table 13:Comparison of correlation between Guys Stone score and stone free rate with previous studies

GUY's score	Our study	Kay Thomas et al[12]	Labate G et al[9]	Mandal et al[49]
1	97.3%	81%	70.2%	100%
2	92.9%	72.4%	65.4%	74%
3	87.5%	35%	48.1%	56%
4	74.1%	29%	35.9%	0%
Overall	89%	62%	56%	76%

The overall complication rate of PCNL reported in previous studies ranging from 20% to as high as 83% [9,10,49]. IN our study the overall complication rate was 31% .Most of them are minor i.e., Modified ClavienDindo grade 1 and 2. Major complications were encountered in 10% of patients, grade 3 in 7 and grade 4 in 3.

Table14 : Comparison of co-relation between GUY's score and PCNL complications with previous studies

Study	PCNL complications
Our study	**31%**
Labate G et al: 2011[9]	20.5%
Mandal s et al: 2012[49]	41.7%
Michel MS et al: 2007[10]	83%

In our study there is a higher incidence of higher grade complications in patients who had higher Guys stone score, but the association is not significant. This is in accordance with Thomas et al[12], Kumar U et al[51] and Noureldin et al[47], who didn't find any correlation between Guys stone score and complication rates. In other studies by Vicentini[13] et al and mandal et al[49], they found a positive correlation between the Guys stone score and complication rates.

In the study by Mandal et al,[49] they prospectively documented the perioperative complications of PCNL using modified Clavien Dindo grading and the stone complexity was graded by validated Guy's Stone score. In their series, complications were common with higher Guys stone score like in our study but was found to have significant association between them.As mentioned in other studies like, wezel et al[55], minor grade complications were more common in our study,i.e., grade 1 and 2 complications were more common than higher grade complications.

Table 15: Classification of PCNL complications using the Modified Clavien grading system- Comparison with the other studies

Study	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5
Our study	**9%**	**6%**	**7%**	**3%**	**0%**
de la Rosette et al.[11]	11.1%	5.3%	3.6%	0.5%	0.03%
Wang et al.[52]	13.1%	5.1%	0%	0%	0%
Tefekli et al.[53]	4%	16.3%	9.4%	1.4%	0.1%
Chang et al.[54]	7.6%	7.6%	3.1%	0%	0%
Wezel et al.[55]	37%	12%	3%	0.5%	0%

With regards to complications, most common post-operative complications that were encountered after PCNL was fever. Several studies reported on post PCNL fever, all with different results ranged incidence between 10-32%[56,39]. In our study, the incidence is 11 %, which correlates with previous studies. And 2% of patients had severe sepsis which required critical care management. This sepsis occurred in patients with higher stone burden, i.e., grade 3 and 4. This impact of stone burden as a risk factor for post PCNL fever is clear and confirmed by several studies[56,57].

According to Lee et al[58]. the predictive factors associated with hemorrhage during percutaneous surgery includes patient characteristics, multiple access sites, supracostal access, increased tract size, tract dilation with methods other than balloon dilation, prolonged operative time, and renal pelvic perforation. In our study 6 patients required blood transfusion. A widely accepted way to prevent bleeding related complications is to puncture the kidney through a calyx with a minimal angulation of the dilators and nephroscopy shaft. If significant bleeding in terms of decreased visibility or low hemoglobin occurs, a nephrostomy tube should be placed and re-intervention should be planned 48 hours later. The nephrostomy may tamponade further bleeding[58].

Inour study one patient had colonic injury during PCNL. This patient had left lower calyceal calculus for which PCNL was performed electively. Colonic injury was suspected in the post operative period in view new onset signs of peritonism and persistent tachycardia. CT scan was performed which showed pericolonic collection. In this patient in view of signs of peritonism , exploratory laparotomy was performed and colostomy was made. Thorough literature review suggests colonic injury happens in about 1% percutaneous renal procedures in prone position. It is thought to be due to retro-renal position of the colon. It is more common on the left side when a lower calyx access is attempted. Thin patients, elderly age group, dilated colon, prior colon surgery or disease, and the presence of a horseshoe kidney are additional risk factors. It can also happen in patients who undergo significant weight loss in a short time like patients after bariatric surgery, ileal diseases and resections[59,60]. A recent hypothesis by MaheshwariPN et al. proposed retro-renal colon to be an acquired anomaly[61]. Five patients in 2nd stage of PCNL developed colonic injury. All these patients had a long-standing large hydronephrosis that was initially drained by either nephrostomy or a DJ stent. They proposed that the colonic mesocolon lengthens over the gradually dilating obstructed kidney. Once the kidney is de-obstructed, it shrinks but the long mesocolon persists. The colon with the long mesocolon drops posterior to kidney forming a retro-renal colon. Prevention of colonic injury is very difficult. In patients who are predisposed to colonic injury, a preoperative CT scan in prone position could help to identify the position of colon in relation to the proposed tract. Awareness of the colonic gas bubble on fluoroscopy at

the time of making access and monitoring any changes in the bubble could help in preventing this injury[59,60]. The initial management includes withdrawal of the nephrostomy tube outside of the kidney and colon to the retroperitoneal space, insertion of a double-J ureteral stent, anal dilatation, total parenteral nutrition, bowel rest, and intravenous antibiotics for 7 days[60]. We had to perform exploratory laparotomy for our patient in view of delayed diagnosis of colonic injury with large retroperitoneal collection. The risk factors seen in our patient were left side surgery, thin built with infected hydronephrosis and status post DJ stenting.

One of the patient (1%) in the study developed transient renal insuffiency with raised serum creatinine levels following surgery. This is also in accordance with previous studies, Shin et al[56] observed that transient increase in creatinine occurs in 1% of cases.

Table 16:Important complications of PCNL: Comparison with other studies

Study	Shin et al.[56]	MausaviBahar et al.[62]	El Nahas et al.[60]	de La Rosette et. Al[11]	Lee et al[58]	Rana et al.[63]	Osman et al.[48]	Our study
Number of patients	88	671	241	5803	582	667	315	100
Hemorrhage requiring transfusion	6.9	0.6	16	5.7	11.2	1.49	0	6
Hemorrhage requiring intervention	1.4	0.15	2	NA	NA	0.14	0.3	0
Colonic injury	0.7	0.3	NA	NA	0.2	0	0	1
Pleural injury/ effusion	1.1	0.7	2.4	1.8	3.1	0.14	0	0
Mortality	0.4	0.3	0.4	0.3	0.3	0	0.3	0

Mortality following PCNL is rare and rate ranges from 0.1-0.7%. Death associated with PCNL is typically secondary to complications such as pulmonary embolus, myocardial infarction or severe sepsis. In our study no such event occurred.

Conclusion

PCNL is well established and minimally invasive treatment option for renal calculi. It is associated with lesser grade complications.(grade 1&2)

Guys stone score significantly predict:

1. Number of punctures required for PCNL
2. Stone free rare
3. Post operative hospital stay

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Ethical clearance obtained from the institutional ethics committee.

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