

## COMPLICATIONS OF PERCUTANEOUS NEPHROLITHOTOMY IN PRIVATE PRACTICE

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### ABSTRACT

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#### BACKGROUND

The increasing global prevalence of nephrolithiasis continues to burden the health care delivery systems of developing nations. Percutaneous Nephrolithotomy (PCNL) is considered the standard treatment for many types of calculi. This study focuses on the complications of PCNL in private practice setting at a peripheral center using the modified Clavien system and role of Guy's stone score as a predictor of stone free rate and complications.

#### METHODS

This is a prospective cohort study of 480 patients who underwent PCNL during August 2011 to July 2015. The complications were classified according to modified Clavien system and correlated with the stone complexity as per the Guy's stone score.

#### RESULTS

It was found that overall 120 complications were reported in 480 patients with the incidence of complications of Grade I, II, IIIa, IIIb, IVb being 48 (10%), 38 (7.9%), 15 (3.5%), 12 (2.5%) and 4 (0.8%) respectively. As per the Guy's stone score there were 336, 104 and 40 cases belonging to GSS I, II and III respectively. All grades of complications were more common in GSS II and III. The stone clearance was found to be complete in 95%, 82% and 75% of GSS I, II, III respectively.

#### CONCLUSION

The stone complexity is related to complication rate and GSS helps to predict stone free rate and complications.

#### KEYWORDS

Nephrolithiasis, Percutaneous Nephrolithotomy, Guy Stone Score, Clavien System, Renal Calculi.

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#### INTRODUCTION

The increasing global prevalence of nephrolithiasis continues to burden the health care delivery systems of developing nations and extracts a disproportionate toll on populations of the developing world. In India alone, the prevalence of nephrolithiasis is nearly twice the rate reported in 1990. Percutaneous entry into the collecting system was first described in 1950s, but it was not until the mid 1970s and 1980s that percutaneous access to the renal collecting system was utilized routinely for the removal of nephrolithiasis. Although Percutaneous Nephrolithotomy (PCNL) initially proved to be an effective technique, the concurrent introduction of Shock Wave Lithotripsy (SWL) resulted in a rapid and marked decrease in the utilization of PCNL. There has been however a recent increase in the utilization of PCNL, largely attributable to the limitations of newer SWL equipment.

Greater surgeon experience and improvements in instruments (Mini PCNL, Ultramini PCNL and Micro PCNL) and

lithotripsy technology (Holmium YAG laser) have increased the efficiency of PCNL.<sup>1</sup>

PCNL is considered the standard treatment for staghorn calculi and large volume renal calculi as well as upper tract calculi refractory to other modalities, difficult lower pole stones, cysteine stones and calculi in anatomically abnormal kidneys. PCNL is well tolerated procedure, but as with any surgical intervention is associated with a specific set of complications.

An international multinational study of 5,803 patients undergoing PCNL reported an overall complication rate of 21.5%. The study conducted by the clinical research of the Endourological Society (CROES).<sup>(1)</sup> utilized the modified Clavien system for reporting complications.<sup>(1)</sup> The modified Clavien system was validated in general surgery and is being adopted by urologists for grading of complications in urology.<sup>2,3</sup>

The rate of complications varies according to the complexity of stone disease. The stones are generally classified into single/multiple, pelvic/calyceal and simple/staghorn which may be a partial /complete staghorn. Guy's stone score (GSS) was conceived and validated for better prediction of the complications and stone free rates after PCNL.<sup>4</sup>

The private practice has its own constraints, especially in a peripheral centre. We report our perioperative complications of PCNL according to modified Clavien system, in which the stone complexity has been classified using Guy's stone score.

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## MATERIALS AND METHODS

This is a prospective observational study on 480 patients undergoing percutaneous nephrolithotomy. All patients who were operated between June 2011 and August 2015 with percutaneous nephrolithotomy were included in the study. That means those cases with certain comorbidities like diabetes mellitus, hypertension and chronic obstructive pulmonary obstructive disease were also included in the study. Permission was obtained from the Institutional Ethical Committee of Sri Venkateswara Medical College, Tirupati. The exclusion criteria included those cases with complete staghorn calculi and those with proven recurrence of calculi. A written consent was obtained from all patients who were recruited for the research study. The patients were explained clearly the purpose of the study in local language by the investigators. Pre-operative surgical workup included route investigations like complete blood picture, sugar levels, urine routine, urine culture, serum creatinine, HIV, HBV and HCV testing. Radiographic evaluation included X-ray of Kidney Ureter Bladder (KUB), Ultrasound, IVU or NCCT. Complexity of stone analysis was done based on Guy's stone score and was given in Table 1.

Patients underwent PCNL under spinal anaesthesia in almost all cases except children <6 years of age and cases with upper calyceal puncture in high lying kidney when general anaesthesia was used. Antibiotic prophylaxis was given to all patients.

Patients underwent cystoscopy and ureteric catheterization in lithotomy position. Unimpacted stones in upper ureter were pushed into the kidney with urethroscope and impacted stones were partially fragmented and pushed into the kidney and were removed by PCNL.

The lower calyceal puncture was preferred for lower calyceal and pelvic calculi. Middle calyceal puncture was done for middle calyceal stone or pelvic stone where the lower calyceal axis was not convenient to reach the pelvis. Upper calyceal puncture was done for upper calyceal stone. A Terumo guidewire was positioned in the ureter whenever possible. The track dilatation was done with coaxial metal Alken dilators up to 22F. When the guidewire did not go to the pelvis because of stone impaction in the calyx, dilatation was done upto 20F only and 15.5F nephroscope was used to enter the pelvi-calyceal system under vision. Stones measuring 1 cm were removed intact and larger ones are fragmented with pneumatic lithotripter. The stone clearance was confirmed by intraoperative fluoroscopy.

A Double J stent was passed antegradely when there was injury to the pelvis/PUJ/ureter. Nephrostomy tube was clamped for 6-12 hours if there was significant bleeding intraoperative or the return was bloody at the end of procedure.

The patient was evaluated after 48 hours by plain X-ray KUB and Ultrasonography. If the stone clearance was complete, nephrostomy tube is removed. If there were residual fragments which needed a relook nephrostomy, the nephrostomy tube was retained and relook was done after 4-5 days.

The PCNL procedure was considered successful if the patient was stone free or the stone fragments were less than 4 mm (Clinically insignificant residual stone fragments). The data included age, sex, GSS stone score, number of punctures, punctured calyx, site of puncture in relation to the last rib,

number of operative punctures and mean duration of surgery. The modified Clavien grading system (Table 2) was used for evaluating peri- and post-operative complications.<sup>5</sup>

## RESULTS

The data from all the 480 patients who underwent PCNL during the study period from 2011 to 2015 were analysed using Epi Info 7.1.4 version available freely from CDC (Center for Disease Control) of Atlanta, USA. The categorical variables were expressed as proportions, while continuous measures were expressed as mean with standard deviation. The differences between proportions were analysed using Chi-square test. The GSS (GUYS stone score) was used to classify the stones. The descriptive details of the cohort were summarized in Table 3. Majority of the calculi belonged to GSS I (70.0%) followed by GSS II (21.7%) and GSS III (8.3%). The following are the sub-types within each category.

GSS1 (336): Primary pelvic (156), PUJ (90), upper ureteric stones pushed into renal pelvis (50), lower calyceal (40) and middle calyceal stones (10).

GSS2: Multiple calculi (70), upper calyceal calculi (20) and calculi in abnormal anatomy (14).

GSS3: Partial staghorn calculi (40).

The stone clearance was complete in one session in 90% of the patients and 2nd session was required in 2% of patients. The stone clearance was incomplete in 8% of the patients.

One hundred and twenty complications were seen in 480 patients as shown in Table 4. The occurrence of complications was correlated with Guy's stone score. The commonest complication, fever was seen in 10% of total patients and as per the GSS score it was seen in 6.8%, 14.4% and 25% of GSS I, II and III respectively.

Blood transfusion was required in 7.9% of total cases and as per the GSS score it was 3.3%, 11.5% and 37.5% in GSS I, II and III respectively. Preoperative cross matching was done for all GSS III cases and for the other groups cross match was done only when blood transfusion was required.

Intraoperative bleeding resulting in poor vision and incomplete clearance of the fragments requiring relook and clearance after 1 week occurred in 10 patients, out of which 6 belonged to GSS III and IV to GSS II. Four patients required clot evacuation in the postoperative period. Two of them belonged to GSS I and the other 2 belonged to GSS II. The 2 patients in GSS I who required clot evacuation also needed angio-embolization because of recurrent haematuria.

Mucosal pelvicalyceal injury occurred in 15 patients in PUJ and pelvicalyceal system. They were managed by DJ stenting in 6, 5 and 4 patients who belonged to GSS I, II and III categories respectively. Urosepsis requiring ICU care occurred in 1, 1 and 2 patients belonging to GSS I, II and III categories respectively.

Stone clearance was achieved in 97% of GSS I, 82% of GSS II and 75% of GSS III patients. A second session was required to clear the residual stones, which was due to the poor vision on account of bleeding. It occurred in GSS II and III categories.

## DISCUSSION

PCNL is recommended as the standard treatment for renal calculi >2.5 cm, partial and complete staghorn calculi. ESWL is preferred for small size calculi. RIRS is emerging as the treatment of choice for smaller calculi.<sup>6</sup>

In private practice the situation is not ideal, especially for patients with low socio-economic status and in government sponsored health insurance where the package is non-negotiable and complete stone clearance is mandatory to get that package. RIRS is not economically viable for these patients and ESWL with unpredictable success rate for lower pole stone, cystic stone and the need for ancillary procedure like ureteroscopy is not an ideal option. This makes the PCNL as the preferred choice for upper ureteric stone >1 cm, pelvic stone >1.5cm and lower calyceal stone >1 cm to achieve complete clearance without the need for ancillary procedures.

The complication rate of PCNL may vary widely from 20% to 83% and hence the true complication rate of PCNL is difficult to compare.<sup>7</sup> The means by which the data are obtained and reported probably have an impact on the complications rate as the procedure. Modified Clavien grading system has been shown to be a reliable tool for more objective comparison of outcome in urology.<sup>8,9,10,11,12</sup> Complications graded as Clavien Grade 1 and 2 are considered as minor, while Grades 3, 4 and 5 are considered as major. Our overall complication rate among 480 consecutive patients of PCNL is 25%. Among them 70% belonged to Clavien Grade 1, 2 (Minor) and 30% belonged to Clavien Grade 3, 4 (Major).

Fever in the postoperative period was the most common complication (14%). The reported incidence of fever after PCNL varied from as low as 2.8% (5) to 27-30%. It may be because of the different patient population and the policy regarding the use of antibiotics. It is our policy to give the patients culture specific antibiotics when urine culture was positive preoperatively and to give Inj. Cefoperazone (1000 mg + Sulbactam 500 mg) for others which was continued for 48 hours postoperatively. The patients who developed intraoperative/postoperative rigors are given additional coverage with Inj. Amikacin (500 mg) Factors predisposing to fever after PCNL include pre-existing UTI, infected stone, diabetes mellitus, renal insufficiency, the amount pressure of the irrigation fluid and the duration of surgery.<sup>13,14</sup>

Bleeding requiring blood transfusion was the second most common complication observed in 7.9% patients. This is comparable to the 5.7% reported in the CROES (Clinical Research Office of the Endourology Society) group. However, an overall transfusion rate of 24% has been reported by Mandal et al.<sup>15</sup> The procedure was abandoned due to intraoperative bleeding and repeats PCNL was done in 10 patients. Two patients required (0.04%) super selective angio-embolization due to recurrent, severe haematuria with clot retention in the postoperative period. The rate of intervention for renal haemorrhage has been reported to be 0.6-1.4% in the review by Skolarikos and Rosette.<sup>13</sup>

Bleeding is the most feared complication of PCNL. Puncture is always attempted through the posterior calyx aiming the cup of the calyx avoiding the hypervascular region adjacent to the infundibulum. The nephrostomy tube is kept clamped at the end of the procedure in case of significant bleeding to provide intrarenal tamponade. The increased stone complexity is directly associated with the need for transfusion.<sup>15</sup> Multiple attempts at initial puncture increase

the risk of bleeding. Additional risk factor includes torque of the instrument, infection, renal insufficiency and prolonged operation time.<sup>16</sup>

Renal collective system injury occurred in 3% patients, in our series majority of them were mucosal injuries without any clinical significance. Injury to the collecting system can occur during dilatation of the tract, during fragmentation of hard stone and due to inadvertent injury to the mucosa with forceps during extraction of stone fragments.

Urosepsis requiring ICU management with Oxygen inhalation, vasopressors and broad-spectrum antibiotics was seen in (0.8%) patients. Female gender, multiple punctures, struvite calculi and positive pelvic urine and stone cultures are risk factors for the development of Systemic Inflammatory Response Syndrome.<sup>14</sup>

Plural injury is seen in 3-7% of supracostal punctures.<sup>17</sup> Though we have done intercostal puncture in nearly 30% patients, we have not encountered any pleural injury. Because the pleura and diaphragm are related to the upper pole of the kidney, upper pole punctures are commonly associated with plural injury. Though we have done upper pole puncture in 20 patients, plural injury was not encountered, probably because we punctured through 11<sup>th</sup> intercostal space in all the intercostal punctures and not through 10<sup>th</sup> intercostal space.

The colonic injury was reported as 0.2-0.8% of patients in the review by Skolaris and Rosette.<sup>13</sup> We have not encountered any colonic injury in our patients. The risk factors for colon injury are retrorenal colon, thin patient and previous open renal surgery. We have not encountered any colonic injury, though some of our patients had the above risk factors.

The GSS accurately predicted the stone free rate after PCNL in our study, as it was by Mandal et al.<sup>15</sup> It was easy to use, reproducible, objective and reliable method for describing the complexity of the stone and predicts SFR after PCNL. The stone clearance was 97% in GSS1 and 82% in GSS2 and 75% in GSS3.

## CONCLUSION

This is a prospective study of complications of PCNL in a private practice setting at a district centre, where there are several constraints like complete stone clearance in one sitting is necessary, especially for patients with government sponsored health schemes where there is no scope for upward revision of the package, inadequate availability of blood and lack of angio-embolization facility. The proper selection of patient is very important in private practice in a peripheral centre unlike Institutional setting. The GSS helps in the selection of patients, to counsel them about stone clearance, need for blood transfusion and to avoid difficult and complicated cases. Needless to say that the expertise and the experience of the surgeon are also important to avoid major mishaps in PCNL in a private practice sitting. The social implications from patients' perspective is that those patients with pre-existing morbidities and large and recurrent calculi need to undergo at a bigger centre with better infrastructure and facilities including angio-embolization.

Sl. No.	Parameter	Value (%)
1.	Mean age	40.2 years (Range 2-65)
2.	Male/Female ratio	5:1
3.	Classification of calculi	
(a)	GSS I	336 (70.0)
(b)	GSS II	104 (21.7)
(c)	GSS III	40 (8.3)
(d)	GSS IV	0 (0.0)
4.	Clearance after sessions	
(a)	Clearance after 1 session	432 (90.0)
(b)	Clearance after 2 sessions	10 (2.1)
(c)	Incomplete clearance	38 (7.9)
5.	Site of puncture	
(a)	Sub-costal	336 (70.0)
(b)	Supra-costal	144 (30.0)
6.	Mean duration of operation (min)	40 min (30-180)

**Table 1: Descriptive data of patients (N=480)**

Grade	Complication	No. of Patients	Percentage
Grade I	Fever	48	14.3
Grade II	Blood transfusion	37	36.5
*Grade III a	Double J stent placement for ureteropelvic junction and pelvic injury	15	3.0
	Retention and colic due to blood clots	4	0.8
*Grade III b	Arteriovenous fistula	2	0.4
	Intraoperative bleeding requiring termination of operation	10	4.8
*Grade IV a	Neighbouring organ injury	0	0.0
	Myocardial infarction	0	0.0
*Grade IV b	Urosepsis	4	0.8

**Table 2: Complications of PCNL Classified according to Modified Clavien System (N=480)**

Grade	Total (480)	GSS I (336)	GSS II (104)	GSS III (40)	P Value
Grade 1	48 (10.0%)	23 (6.8)	15 (14.4%)	10 (25.0)	<0.001; S
Grade 2	37 (7.9)	10 (3.3)	12 (11.5)	15 (37.5)	<0.001; S
Grade 3 a	19 (4.0)	10 (3.0)	4 (1.2)	5 (12.5)	0.01; S
Grade 3 b	12 (2.7)	2 (1.8)	4 (2.9)	6 (10.0)	0.01; S
Grade 4 a	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	---
Grade 4 b	4 (0.8)	1 (0.3)	1 (1.0)	2 (5.0)	0.008; S
Grade 5	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	---

**Table 3: Comparison of Complications Classified according to the Modified Clavien System between and Calculi Classified according to GSS**

	Total Cases	Complete Clearance (%)	Incomplete Clearance (%)
GSS I	336	326 (97.0)	10 (3.0)
GSS II	104	86 (82.7)	18 (17.3)
GSS III	40	30 (75.0)	10 (25.0)

**Table 4: Stone Clearance Rate in Relation to GSS Rate**

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