

Risk Factors for Postoperative Complications after Percutaneous Nephrolithotomy

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ABSTRACT

Background: To identify the perioperative factors associated with complications after percutaneous nephrolithotomy by classification of complications according to the modified Clavien scoring system and evaluation of the minor and major complications related to the procedure.

Methods: A prospective study of all the percutaneous nephrolithotomy performed by standard technique within 1.5 years at Bir Hospital was made. Possible demographic, preoperative and intraoperative variables were included in the study and patients were followed up postoperatively for any complications. All complications were classified according to modified Clavien scoring system and analyzed to identify the prognostic variables.

Results: Two hundred and forty six percutaneous nephrolithotomy done within the study period were analyzed. Although 41.06 % of the study population developed complications, only 9.35 % had major complications. Age, body mass index, gender, clinical presentation, history of previous surgery and ASA score did not correlate with complications. Diabetes was the only comorbidity associated ($p = 0.0482$). Preoperatively estimated stone burden ($p = 0.0023$), number of calyces involved by the stones ($p = 0.0002$), and presence of staghorn calculi were significantly associated with development of postoperative complications. Multiple tracts were required ($p = 0.0151$) and operative time was longer ($p < 0001$) in the patients who developed complications.

Conclusions: Percutaneous nephrolithotomy has lesser complications. Diabetic patients are more prone to develop complications. Larger stone burden, involvement of multiple calyces by stones and staghorn calculi are associated with need of multiple tracts and longer operative time, thus predisposing to higher incidence of complications.

Keywords: Clavien score; complications; percutaneous; nephrolithotomy.

INTRODUCTION

Since its first description in 1976, percutaneous nephrolithotomy (PCNL) has become the surgery of choice for renal stones 2 cm or larger.¹ With stone-free rates ranging from 75% to 95%, PCNL has proven to be an efficacious treatment for large calculi, staghorn, stones in kidneys with abnormal anatomy, and stones in more complicated patient groups.²⁻⁶ Despite the advantages, incidence of complications is reported from 16% to 83%, with major complications representing 4.7% in tertiary referral centers.^{3,4,7-10}

The Clavien classification is widely used in grading surgical complications. This system was modified in 2004¹¹ to increase its accuracy and applicability. Recent studies have extended the use of the modified Clavien classification system to the assessment of outcomes of PCNL; and has been formally validated with

categorization of PCNL specific complications.¹²⁻¹⁴

We present the results of PCNL with the aim to determine the preoperative and perioperative prognostic factors of complications associated with PCNL.

METHODS

After ethical clearance for the study from the subject committee of department of urology and institutional review board, a prospective observational study of all patients who underwent PCNL at Bir hospital of Kathmandu, Nepal, was undertaken from August 2015 to January 2017. Informed consents for the study were taken from all patients.

All patients were assessed preoperatively and records of demographic parameters, medical history including those of recurrent urinary tract infections, hematuria,

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pain, medical comorbidities were made. In addition to routine investigations; CT urography, along with stone density measured in unenhanced film, were done for all the patients. Staghorn stone was defined in the study as stone in the pelvis with branches extending to all three poles and partial staghorn as pelvic stone with branches extending to calyces in one or two polar calyces.

PCNL were performed under General or Spinal Anaesthesia. Six French ureteral catheter were placed in ipsilateral pelvicalyceal system by cystoscopy or ureteroscopy in lithotomy position under fluoroscopic guidance in the beginning. All PCNL done in prone position, transpapillary puncture made with help of fluoroscopic guidance using 18 gauge two-part needle after retrograde opacification of the pelvicalyceal system via the ureteral catheter were only included in the study. The tract dilatation and number were either by single shot technique or serial telescopic dilatation and single or multiple tracts respectively. Nephroscopy were done with a 21 French rigid nephroscope. Large stones were fragmented with pneumatic lithotripter. Small stones and fragments were removed either by continuous normal saline irrigation using a pump or removed with forceps. The exit strategies were total tubeless, tubeless or standard. Intraoperative variables studied included operative time and number and location of the tracts.

Postoperatively, patients were managed with intravenous fluids, antibiotics and analgesics. They were discharged when clinically stable. The patients were routinely followed up at 2 weeks with an X-ray and ultrasound of KUB and those who were not stone free were followed up again at 4 weeks of operation.

Any complications during this period were classified by the modified Clavien Score for PCNL. Complications classified as Clavien 3a, 3b, 4a, 4b and 5 were categorized as major complications.⁹ In cases where patients had more than one complication, only the highest Clavien score were included. Final analysis was done for patients fulfilling all the inclusion criteria.

RESULTS

During the study period, a total of 289 PCNL were performed by two consultant urologists. Two hundred and forty six patients fulfilled the inclusion criteria and 43 patients had to be excluded due to various reasons as shown in table 1.

The demographic variables studied and the outcomes have been summarized in table 2. The mean age of the cohort was 37.56 years and the mean BMI was 25.08 Kg/m². Male population made up 60.17% of the cohort. The

most common presentation was pain in the abdomen or flank, in 59.76%. Fifty six patients had undergone surgery on the ipsilateral side in the past; 13% with history of open surgery and 4.88% with history of PCNL.

Table 1. PCNL Performed during the study period.

Total	289
Fulfilling the inclusion criteria	246
Excluded	43
Age below 14 years	4
No preoperative CT scan available	5
Bilateral Procedures	1
Supine Position	3
Conversion to Open Procedure	1
Ureteric Calculus	4
Not reporting with X-ray KUB at 2 and 4 weeks	5
Non pneumatic stone fragmentation (Laser, ultrasonic)	20

Full staghorn calculus were present in 7.32% and partial staghorn were present in 19.92%. The average number of calyces involved was 1.3. The mean stone burden, calculated from non enhanced CT scan as size of an ellipsoid, was 411.26 mm², and mean stone density of 1051.58 HU. Renal anomalies such as horse shoe kidney and ectopic kidney and collecting system anomalies such as bifid pelvis was present in 6.5% of the cohort.

Single upper pole access, either supracostal or infracostal, to the kidney was chosen in 15.45% and 30.08 % of PCNL were done with multiple tracts. The mean operative time, i.e. time from the first puncture to exit, was 45.54 minutes, ranging from 15 minutes to 125 minutes. The mean post operative hospital stay was 3.38 days.

As summarized in table 4, a total of 101, i.e. 41.06 % had some postoperative complications, with 9.35% developing major complications. The most common complication was postoperative fever.

The relation of different variables to outcome is briefly summarized in table 2. Age, BMI, gender, clinical presentation, history of previous surgery and ASA score did not significantly correlate with complications. Diabetes was significantly related with development of complications, with 75% of diabetic cohorts developing some form of complication, most common being postoperative fever. Among the stone characteristics, the preoperatively estimated stone burden ($p = 0.0023$), number of calyces involved by the stones ($p = 0.0002$), and presence of staghorn calculi were significantly associated with development of postoperative

complications. Similarly, multiple tracts ($p = 0.0151$) and longer operative time ($p < 0.001$) was needed in the patients bound to develop complications.

Bleeding was the most common major complication. Out of 7 patients (2.84%) who required blood transfusion, only one had solitary stone and PCNL was done through a single tract. Three patients (1.22%) in the entire

cohort underwent angioembolisation for development of pseudoaneurysm. Seven (2.84%) patients required placement of intercostal drains for chest complications. One patient had colonic perforation and managed with controlled colcutaneous fistula. We had no patients requiring ICU care, nor were there any mortality.

Table 2. Demographic Variables and outcome.

Variables	Cohort	No Complications 145 (58.94 %)	Complications 101 (41.06 %)	Significance p
Age (Mean \pm SD)	37.56 \pm 14.02	38.71 \pm 12.60	41.10 \pm 13.92	0.1623
BMI (Mean \pm SD)	25.08 \pm 12.51	23.83 \pm 14.29	26.32 \pm 11.54	0.1478
Gender				
Male (%)	148 (60.16%)	91 (62.76%)	57 (56.44%)	0.3202
Female (%)	98 (39.84%)	54 (37.24%)	44 (43.56%)	0.3202
Clinical (preoperative)				
Pain (%)	147 (59.75%)	89 (61.38%)	58 (57.43%)	0.5351
Hematuria (%)	21(8.5%)	10 (6.90%)	11 (10.89%)	0.2716
UTI (%)	45 (18.29%)	24 (16.55%)	21 (20.79%)	0.3984
Comorbidities				
Hypertension (%)	41 (5.69%)	25 (17.24%)	16 (15.84%)	0.7724
Diabetes (%)	32 (13.01%)	24 (16.55%)	8 (7.92%)	0.0482
Other/more than one (%)	8 (3.25%)	4 (2.76%)	4(3.96%)	0.6025
History of previous surgery				
Open	32 (13.01%)	18 (12.41%)	14(13.86%)	0.7399
PCNL	12 (4.88%)	6 (4.14%)	6 (5.94%)	0.5200
SWL	6 (2.44%)	4 (2.76%)	2 (1.98%)	0.6971
URSL	6 (2.44%)	5 (3.45%)	1 (0.99%)	0.7744
ASA Score				
1	142 (57.72%)	89 (61.38%)	53 (52.47%)	0.1649
2	92 (37.40%)	54 (37.24%)	38 (37.62%)	0.9518
3	12 (4.88%)	6 (4.14%)	6 (3.96%)	0.9441

Table 3. Stone Characteristics, Intraoperative variables and outcome.

Variables	Cohort	No Complications 145 (58.94 %)	Complications 101 (41.06 %)	Significance p
Laterality				
Left	131 (53.25%)	74 (51.03%)	57 (56.44%)	0.4038
Right	115 (46.75%)	63 (43.44%)	52 (51.48%)	0.2147
Stone Burden in mm ² (Mean \pm SD)	411.26 \pm 128.32	302.25 \pm 221.02	402.97 \pm 291.23	0.0023
Number of Calyces Involved (Mean)	1.3 \pm 0.73	1.4 \pm 0.8	1.8 \pm 0.86	0.0002
Stone Density (HU) (Mean \pm SD)	1051.58 \pm 233.832	1066.38 \pm 216.99	1018.61 \pm 274.56	0.1294

Location of the stone				
Pelvic	64 (26.02%)	39 (26.90%)	25 (24.75%)	0.7059
Upper pole	15 (6.10%)	8 (5.51%)	7 (6.93%)	0.6476
Mid pole	7 (2.85%)	4 (2.76%)	3 (2.97%)	0.9225
Lower pole	56 (22.76%)	29 (20.00%)	27 (26.73%)	0.2165
Multiple	104 (42.28%)	58 (40.00%)	46 (45.54%)	0.3878
Full Staghorn	18 (7.32%)	6 (4.14%)	12(11.88%)	0.0221
Partial staghorn	49 (19.92%)	17 (11.72%)	32 (31.68%)	0.0001
Multiple tracts	74 (30.08%)	35 (24.14%)	39 (38.61%)	0.0151
Upper pole tract	38 (15.45%)	18 (12.41%)	20 (19.80%)	0.1153
Urinary tract anomaly	16 (6.5%)	12 (8.27%)	4 (3.96%)	0.1783
Operative time	45.54±20.42	38.75±17.64	70.77±14.26	<0.001
Hospital Stay	3.38±1.28	3.28±0.91	3.48±1.83	0.2591

Table 4. Complications classified according to modified Clavien score.

Clavien Score	Number	Percentage
1	56	55.44 %
2	22	21.78 %
3a	20	19.80%
3b	3	2.97 %
4a	0	0 %
4b	0	0%
5	0	0%

The patients with complications were taken as a new cohort and the significant variables in table 2 and 3 were further analyzed to establish the factors responsible for major complications, and have been summarized in table 5. Among them, presence of full staghorn calculi ($p = 0.0264$), partial staghorn ($p = 0.0092$) multiple tracts made for stone removal ($p < 0.0001$) and longer operation time ($p = 0.0067$) were significantly correlated with development of major complications .

Table 5. Assessment of risk factors for major complications.

Variables	Any Complications 101 (41.06%)	Major Complications 23 (9.35 %)	Significance p
Diabetes (%)	8 (7.9%)	2 (8.7%)	0.8991
Stone Size in mm ² (Mean ± SD)	402.97±291.23	415.07±351.41	0.8630
Number of Calyces Involved (Mean)	1.8 ± 0.86	1.48±0.65	0.0962
Full Staghorn	12(11.88%)	7(30.43 %)	0.0264
Partial staghorn	32 (31.68%)	14 (60.86%)	0.0092
Multiple tracts	39 (38.61%)	21 (91.30 %)	<0.0001
Operative time	70.77±14.26	60.87±20.39	0.0067

DISCUSSION

PCNL is a safe and reliable technique for the treatment of renal stones, which has replaced open surgery as the treatment of choice for large or multiple renal calculi. PCNL is an invasive procedure with reported complication rate of up to 83%¹⁰ and major complication rates of about 4.7% in tertiary referral centers.^{3,4,7-10} Although our study population had a complication rate of 41.06 % and major complication of 9.35%, all of them could be managed with minimal further medical or surgical intervention. No patients required intensive care service and there were no mortalities.

The presence of comorbidity has been reported to increase the risk of complications during or after PCNL. Major complications after PCNL have been reported to

be more common in patients with diabetes mellitus.¹⁵ Among the patients with comorbidities, only diabetes had a higher chance of complications in our study. PCNL is considered safe in patients with history of renal surgery on ipsilateral side.^{16,17} This was also reflected in our study.

Higher stone burden and presence of staghorn calculi have been identified as risk factors for need of multiple tracts, increase in operative time and incomplete stone clearance and complications in many series.¹⁸⁻²⁰ This was also seen in our study, with more number of febrile episodes, bleeding and chest complications occurring in these population. Laterality, stone density and calyceal location of stones were not significantly associated with complications.

The study was conducted in a single center in a short period of time. Further studies taking into account both high and low volume centers; and also general and specialist centers with multiple observers are recommended for better validation of the results.

CONCLUSIONS

PCNL has lesser complications. Diabetic patients are more prone to develop complications. Larger stone burden, involvement of multiple calyces by stones and staghorn calculi are associated with need of multiple tracts and longer operative time, thus predisposing to higher incidence of complications.

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