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Original Research Article

Retrospective evaluation of outcome of percutaneous nephrolithotomy at a tertiary care center in eastern Nepal

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ABSTRACT

Background: Percutaneous nephrolithotomy (PCNL) is considered as the standard treatment for renal tract stones. It is a successful procedure with low complication rate. Objective was to evaluate the outcome measures in large renal stone including stone free rates and complications in patients underwent PCNL.
Methods: A retrospective study was conducted in 120 patients who underwent PCNL for renal stone size 2 to 2.5 cm, between 2019 and 2021. Ethical clearance was obtained from the institutional review committee (IRC/2430/022). The data were collected from the records available in the medical record section. The data were analyzed for patient demographics, investigations, site of puncture, stone-free rates (SFRs), type of nephroscope, use of nephrostomy tube, blood transfusion, hospital stay and complications.
Results: Out of 120 cases, 64 (53.3%) were males and 67 (55.8%) presented with renal stone on the right kidney. Renal stone was in pelvis in 47 (39.2%) patients. In 47 (39.2%) cases puncture was made in the lower pole. Stone free clearance rate was 92.5% and 4.2% patients required blood transfusion. There was no statistical difference in intraoperative complication like bleeding in supracostal puncture group and subcostal puncture group [25% vs 13.2%; p=0.13] and in tube group and tubeless group (43.9% vs 3.8%; p<0.001). There was significant difference in length of hospital stay and duration of Foley's catheter removal between supracostal group vs subcostal group and tube group vs tubeless group (p<0.05). Postoperative complications like fever were seen in 14 (23.0%) and four (6.8%) patients with standard nephroscope group and mini nephroscope group respectively and it was statistically significant (p<0.05).
Conclusions: Mini and tubeless PCNL had a good success rate with minimal complication. The total stone clearance rate in our study was 92.5%.

INTRODUCTION

Urolithiasis is a common urinary system disease globally.[1] It can be formed by the precipitation or crystallization of minerals and urinary constituents. It is the third most common urinary tract problem after urinary tract infections and prostate disorders.[2] The incidence of this preventable disease ranges from 7-13% in North America, 5-9% in Europe, and 1-5% in Asia.[3] In 2019, more than 115 million incident cases of urolithiasis occurred worldwide.[4] Lageju et al reported that the highest prevalence of urolithiasis is in the age group 20-30 years with male predominance and the common site being ureter.[5] The most common current treatments for renal stones include extracorporeal shock wave

lithotripsy (ESWL), PCNL, and retrograde intrarenal surgery.[6]

PCNL is considered as the standard treatment for large upper renal tract stones.[7] It is highly effective but carries a risk of significant morbidity than less invasive treatment options such as ureteroscopy or ESWL. The use of PCNL is now considered as the standard treatment for large and complex renal stones.[8] Since its introduction in 1976, the operative technique and the endoscopic equipment have had constant evolution, increased the success rates and decreasing complications and morbidity.[9] The usual indications for PCNL are stones larger than 20 mm, staghorn, partial staghorn calculi. The contraindications for PCNL include pregnancy, bleeding disorders, uncontrolled urinary tract infections. PCNL attains stone free rates of up to 95%.[10]

Efficacy of PCNL is unbeaten by other minimally invasive modalities. PCNL is one of the most frequently done endourological procedures done in B. P. Koirala institute of health sciences (BPKIHS) for renal stone and upper ureteric stones of variable sizes. Despite the advantages of PCNL over open surgery, the rates of complication for this procedure remain high.[11] Potential complications, such as bleeding, occur. There is a paucity of literature on outcomes of PCNL in our set-up. This audit would help us to understand success and complication rate of PCNL in our setting. The objective was to evaluate the outcome measures including stone free rates and complications in the patients underwent PCNL.

METHODS

Type of study

Retrospective study

Study duration and site

The study was conducted at urology division, department of surgery, BPKIHS, Dharan, Nepal in December 2022.

Study population

Patients with clinical and radiological diagnosis of renal stone and who underwent for PCNL from December 2019 to December 2021 were the study population.

Sampling methods

Purposive sampling technique was used.

Sample size calculation

Sample size calculation for the study was estimated using the following formula:

$n=(Z\alpha/_2)^2\ p\times q\ /d^2$

Where, n=required sample size, $z=Z\alpha/_2$ value of 95% confidence interval (1.96), p=94 (Complete clearance of stone was 94% in a study by Raya et al), q=6, d=allowable error (5%). Using formula, N= 98 and adding 10% as non-responder, the sample size was 108.[12]

Inclusion criteria

All patients with renal stone who underwent PCNL procedure as per standard protocols in urology division, department of surgery, patients with clinical and radiological diagnosis of renal stone, 1-80 years of age and patients with high stone burden, single pelvic calculus, calyceal stones of size 2-2.5 cm were included in the study.

Exclusion criteria

Patients not giving consent to participate and patients with features of untreated coagulopathy, active urinary tract infection or pyonephrosis excluded from the study.

Ethical approval

It was obtained from institutional review committee, BPKIHS (IRC/2430/022).

Data collection tools and techniques

A self-designed proforma was used to collect the relevant data. The case record file of the eligible patients were reviewed and sociodemographic data, relevant imaging studies, nephroscope used (mini or standard nephroscope), stone size, laterality of stone, puncture site (supra/sub coastal), intrarenal calyceal access, stone clearance intraoperatively visualization in nephroscope and fluoroscope, tube versus tubeless PCNL, complications (Fever, Haematuria), need of transfusion, days of PCN and Foley's catheter removal and duration of hospital stay were recorded. Stone free rate (SFR) was defined as no identifiable stone on plain abdominal X-ray of kidney, ureter and kidney (KUB).

Statistical analysis

The data were entered into Microsoft excel 2016. Descriptive statistics mean, frequency and percentage were calculated. Independent t test was used to analyze continuous data and Chi-square test for categorical data at $p<0.05$ using SPSS version 22.0. The findings were presented as tables and graphs.

RESULTS

A total of 120 cases of PCNL were reviewed out of which 64 (53.3%) were males, 37 (30.8%) patients belonged to the age group of 20-29 years (Table 1). CT urography, USG and X-ray KUB were done in all patients.

Table 1: Demographic profile of the study participants, (n=120).

Variables		Frequency (%)
Age group (Years)	1-9	3 (2.5)
	10-19	7 (5.8)
	20-29	37 (30.8)
	30-39	24 (20.0)
	40-49	18 (15.0)
	50-59	16 (13.3)
	≥ 60	15 (12.5)
Gender	Male	64 (53.3)
	Female	56 (46.7)
Occupation	Not employed	57 (47.4)
	Student	23 (19.2)
	Housewife	38 (31.7)
	Service	2 (1.7)
Religion	Hindu	97 (80.8)
	Buddhist	3 (2.5)
	Kirati	15 (12.5)
	Others	5 (4.2)
Marital status	Married	86 (71.7)
	Unmarried	34 (28.3)
Address of the participants	Dharan	46 (38.3)
	Others	74 (61.7)
Education	Illiterate	15 (12.5)
	Primary level completed	52 (43.3)
	Secondary level completed	35 (29.2)
	Bachelor level completed	17 (14.2)
	Master and above completed	1 (0.8)

Among the total cases, 67 (55.8%) presented with renal stone on the right kidney. Renal stone was in pelvis in 47 (39.2%) patients. Subcostal puncture site was used in 76 (63.3%) cases. Lower calyceal access was used in 47 (39.2%) patients. Nephrostomy tube was placed in 41 (35.1%) patients. Standard nephroscope was used in 61 (50.8%) patients. SFR was 92.5% (Table 2).

There was no statistical difference in intraoperative complication like bleeding in supracostal puncture group and subcostal puncture group [25% vs 13.2%; p=0.13]. Similarly, postoperative complications like fever and hematuria were more in supracostal puncture group as compared to subcostal puncture group [fever 18.2% vs 13.2% and hematuria 29.5% vs 17.1%]; however, it was statistically not significant (p=0.59). Stone free rates were statistically similar in both supracostal and subcostal puncture group (p>0.05). Length of hospital stay 3.8±1.2 days in supracostal group as compared to subcostal group (3.0±0.8 days) and it was statistically significant (p=0.001) (Table 3).

Table 2: Description of renal stone, PCNL procedure and its outcome, (n=120).

Variables		Frequency (%)
Intrarenal stone location	Pelvis	47 (39.2)
	Upper calyx	23 (19.2)
	Mid calyx	17 (14.2)
	Lower calyx	33 (27.5)
Stone location side	Left	53 (44.2)
	Right	67 (55.8)
Renal puncture site	Supracostal	44 (36.7)
	Subcostal	76 (63.3)
Calyceal access	Upper	28 (23.3)
	Mid	45 (37.5)
	Lower	47 (39.2)
Tube placement	Yes	41 (34.1)
	No	79 (65.9)
Type of nephroscope used	Standard	61 (50.8)
	Mini	59 (49.2)
Stone free rate		111 (92.5)
Blood transfusion		5 (4.2)

There was no statistical difference in intraoperative complication like bleeding in standard nephroscope group and mini nephroscope group [23.0% vs 11.9%; p=0.15]. Similarly, postoperative complications like fever was seen in 14 (23.0%) and four (6.8%) patients with standard nephroscope group and mini nephroscope group respectively and it was statistically significant (p<0.05). Hematuria was seen in 15 (24.6%) and 18 (11.6%) patients with standard nephroscope group and mini nephroscope group respectively; however, it was statistically not significant (p>0.05). Stone clearance rate were statistically similar in both standard nephroscope group as well as the mini nephroscope group (p>0.05) (Table 4). There was statistical difference in intraoperative complication like bleeding in tube group and tubeless group (43.9% versus 3.8%; p<0.001). Similarly, there was statistical difference in postoperative complications like fever and hematuria in the both groups [fever 37.5% versus 3.8% and hematuria 57.5% versus 3.8%; p<0.001]. Blood transfusion was needed in five (12.2%) patients in tube group and none of the patients needed blood transfusion in the tubeless group and it was statistically significant (p=0.004).

Stone was seen in X-ray KUB in nine (22.0%) and zero patients in the tube group and the tubeless group respectively as well as it was statistically significant (p<0.001). Length of the hospital stay was 4.2±1.1 days in the patients with tube placement as compared to the patients without the tube (2.8±0.6 days) as well as it was statistically significant (p<0.001) (Table 5).

Table 3: Outcomes of PCNL based on puncture site, (n=120).

Outcomes variables		Supra-costal, (n=44) (%)	Sub-costal, (n=76) (%)	P value
Intraoperative complication: Bleeding		11 (25.0)	10 (13.2)	0.13
Stone clearance	Not-visualized in nephroscope and fluoroscope	40 (90.9)	74 (97.4)	0.15
	Visualized in nephroscope and fluoroscope	2 (4.5)	1 (1.3)	0.23
	Visualized in fluoroscope only	2 (4.5)	0 (0.0)	0.91
	Not-visualized in nephroscope and visualized in fluoroscope	0 (0.0)	1 (1.3)	0.81
Post-operative complications	Fever	8 (18.2)	10 (13.2)	0.59
	Hematuria	13 (29.5)	13 (17.1)	0.16
Blood transfusion		4 (9.0)	1 (1.3)	0.06
Stone seen in X-ray KUB		6 (13.6)	3 (3.9)	0.07
Length of hospital stay (days) (mean ± SD)*		3.8±1.2	3.0±0.8	0.001
Foley's catheter removal (days) (mean ± SD)*		3.6±1.1	2.9±0.8	0.001

*Statistically significant at p<0.05 (Independent t test).

Table 4: Outcomes of PCNL based on type of nephroscope used, (n=120).

Outcomes variables		Standard, (n=61) (%)	Mini nephroscope, (n=59) (%)	P value
Intraoperative complication: Bleeding		14 (23.0)	7 (11.9)	0.15
Stone clearance	Not-visualized in nephroscope and fluoroscope	58 (95.1)	56 (94.9)	0.72
	Visualized in nephroscope and fluoroscope	2 (3.3)	1 (1.7)	0.23
	Visualized in fluoroscope only	1 (1.6)	1 (1.7)	0.12
	Not-visualized in nephroscope and visualized in fluoroscope	0 (0.0)	1 (1.7)	0.32
Post-operative complications	Fever	14 (23.0)	4 (6.8)	0.02*
	Hematuria	15 (24.6)	18 (11.6)	0.42
Blood transfusion		4 (6.5)	1 (1.6)	0.36
Stone seen in X-Ray KUB		5 (8.2)	4 (6.8)	0.76
Length of hospital stay (days) (mean ± SD)		3.4±1.2	3.2±0.9	0.21
Foley's catheter removal (days) (mean ±SD)		3.2±1.1	3.1±0.8	0.35

*Statistically significant at p<0.05 (Chi square test).

Table 5: Outcomes of PCNL based on placement of tubes, (n=120).

Outcomes variables		Tube, (n=41) (%)	Tubeless, (n=79) (%)	P value
Intraoperative complication: Bleeding		18 (43.9)	3 (3.8)	<0.001*
Stone clearance	Not-visualized in nephroscope and fluoroscope	35 (85.4)	79 (100.0)	0.18
	Visualized in nephroscope and fluoroscope	3 (7.3)	0 (0.0)	NA
	Visualized in fluoroscope only	1 (2.4)	0 (0.0)	NA
	Not-visualized in nephroscope and visualized in fluoroscope	2 (4.9)	0 (0.0)	NA
Post-operative complications	Fever	15 (37.5)	3 (3.8)	<0.001*
	Hematuria	23 (57.5)	3 (3.8)	<0.001*
Blood transfusion		5 (12.2)	0 (0.0)	0.004*
Stone seen in X-ray KUB		9 (22.0)	0 (0.0)	<0.001*
Length of hospital stay (days) (mean±SD)*		4.2±1.1	2.8±0.6	<0.001$
Foley's catheter removal (days) (mean ± SD)*		4.0±0.9	2.7±0.6	<0.001$

*-Statistically significant at p<0.05 (*Chi square test, $Independent "t" test); NA: Not applicable.

DISCUSSION

When managing stones in patients, we need to focus on achieving a complete stone clearance rate with minimal morbidity. As stone recurrence is observed frequently, endoscopic treatment is preferred over open surgery. PCNL has gained popularity in all group of and is now a procedure of choice for renal stones of size more than 2 cm. Most of the patients with renal stone were in the age group of 20-39 years. It might be due to the presence of metabolic abnormality like hypercalciuria.[13] Majority of the patients were males in our study and similar finding was also reported in other reports.[14,15] This gender gap might be due to protective effects of estrogen females and this this gender gap declines in post-menopausal ages.[16] As majority of the patients had studied up to primary level, proper education on risk factors of renal stone should be emphasized to adopt a healthy life style. CT scan for pre-operative evaluation was done in all of the patients in our study. CT is the imaging modality of choice before percutaneous nephrolithotomy as it helps in measuring stone size, localizing the stone, for various scoring systems, predicting stone clearance and planning access to the collecting system, and predicting complications.

Among the total cases, majority (55.8%) of the patients presented with renal stone on the right kidney and this was in line with Karki et al (51.1%).[14] In contrast to this, majority (52%) cases presented with renal stone on the left kidney in another study.[17] Renal stone was in pelvis in about two-thirds (39.2%) patients and was consistent with Karki et al (32.44%).[14] In contrast to this, Raya et al reported that 54% patients in their study presented with stone in the PUJ.[17] Most of urinary stones are formed initially as plaques and these plaques gradually grow until they break through into the renal pelvis.[18]

Subcostal puncture site was used in majority (63.3%) of the cases and this finding was in consistent with findings of Karki et al (69.7%).[14] Subcostal approach should be used when possible because complication rates of supracostal approach are higher.[19] Identification of appropriate puncture site is the one of the crucial step for a successful PCNL. Majority of patients (39.2%) were approached via lower pole of calyces and this finding was lower than that of Ali et al (51.43%).[20] Nephrostomy tube was placed in around one third (35.1%) patients. In contrast to this, nephrostomy tube was kept in 93.75% in a study by Deole et al.[21] Around two-thirds of the patients (65.9%) underwent tubeless percutaneous nephrolithotomy in our study which was higher than Rizvi et al (2.03%).[15]

Stone free rate (SFR) is a common indicator used to access the clinical success of PCNL and is evaluated either using abdominal ultrasonography or X-ray of kidney, ureter and bladder (KUB).[22] In this study, SFR was assessed by a plain abdominal X-ray KUB and was 92.5% which was higher than Ali et al (80.57%), Armitage et al (80%), and Rijvi et al (83.2%).[15,20,23] However, it was 94% in a study by Raya et al.[17] Blood transfusion was needed in 4.2% patients as well as the similar finding was also mentioned by the Raya et al (6.3%).[17]

Subcoastal puncture approach for PCNL had statistically significant association with fewer days of hospital stay and Foley's catheter removal as compared to the supracostal approach. However, intraoperative bleeding, postoperative complications, need of blood transfusion and stone clearance rate were statistically similar in both supracostal and subcostal approach. Supracostal punctures are safe and effective options in PCNL and the overall results are almost on par with that of the infra costal punctures.[24] PCNL with standard nephroscopre had significantly fewer cases of postoperative complication like fever as compared to PCNL with mini nephroscope. PCNL using mini nephroscopre was associated with less blood loss, lower transfusion rate, and shorter hospitalization and this was in line with other report.[25] Tubeless PCNL is a safe and economical procedure with reduced postoperative pain and morbidity and shorter hospital stay and our study findings support this. In our study, patients with tubeless PCNL had significantly fewer cases of intraoperative and postoperative complications, less need of blood transfusion, fewer days of hospital stay and Foley's catheter removal and fewer cases of stone presence in X-ray KUB as compared to patients with tube placed after PCNL and these findings are similar to other reports.[26] Stone clearance was statistically similar in supra and sub-costal approach and in standard and mini-nephroscope percutaneous nephrolithotomy.

The present study had some limitations. Number of the sample size was small. Stone analysis could not be done. Intraoperative surgery time, fluoroscopy time was not included, post-operative pain, use of analgesic was not included in the analysis.

Our data came from a single high-volume center, and hence it might not be applicable to all. Future research should use a prospective design in a larger sample with longitudinal follow-up at multiple centers.

CONCLUSION

PCNL is effective and safe in patients with stone size 2-2.5cm. Tubeless and mini- PCNL had few intraoperative and postoperative complications with shorter hospital stay and hence it would be accepted as an economic and effective option in the management of urolithiasis with acceptable stone clearance rates in a resource-constrained healthcare system like Nepal.

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