10.5005/jp-journals-10036-1128

ORIGINAL ARTICLE

Prospective Study of Percutaneous Nephrolithotomy in the Management of Renal Calculi

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ABSTRACT

Introduction: Kidney stones are a common problem affecting all population groups across the globe. Percutaneous extraction of renal stone – properly termed percutaneous nephrolithotomy (PCNL) which was invented over three decades ago – has become a standard, well-established procedure for the management of renal stones. This study will evaluate the role of PCNL in the management of renal calculi.

Materials and methods: A total of 107 cases of renal calculi who underwent PCNL from May 1, 2014 to April 30, 2016 were studied. Intraoperative findings and immediate postoperative complications were noted. They were followed up for 1 month after the surgical procedure.

Results: Mean age of cases was 43.64 years. Multiple calculi were seen in 43.9%, while a staghorn calculus was seen in 16.8%. Stone clearance was done through a single tract in 78.5%. Additional tracts were made in 21.5%. Tubeless PCNL was done in 45%; 12.1% of the cases had urinary tract infection. Pulmonary complications were noted in 4.67% in the form of hydrothorax. Urinary leak was noted in 4.6%; 70% of the cases were left stone free, with an overall success rate of 85.98%.

Conclusion: This study reveals that PCNL is a safe procedure with less complications and higher stone-free rates without compromising patient safety in a short period.

Keywords: Minimally invasive, Nephroscopy, Percutaneous nephrolithotomy, Renal calculi.

How to cite this article: Raut N, Singhania P, Joshi N, Shringarpure S, Sathe S, Tiwari N. Prospective Study of Percutaneous Nephrolithotomy in the Management of Renal Calculi. MGM J Med Sci 2017;4(1):1-5.

Source of support: MGMIHS

Conflict of interest: None

INTRODUCTION

Minimally invasive treatment options for treatment of kidney stones have evolved over the last several decades. Once the patient has history of urolithiasis, the risk of recurrence is 50% in next 5 years. The objective of stone clearance is to relieve obstruction, prevent further stone growth and any associated infection, and preserve kidney function.[1,2] Previously, the surgical options to the urologist for treatment of larger renal calculi were limited to open surgical techniques, with their inherent disadvantages of prolonged morbidity.

Percutaneous extraction of renal stone – properly termed percutaneous nephrolithotomy (PCNL) – has become a standard, well-established procedure for the treatment of renal stones.[3-6] Indications and limitations of PCNL have been well established. The most important indication for treating renal stone disease is the large stone burden.[7,8] This technique has high rates of success and acceptable morbidity.[9] The placement of a nephrostomy tube after completion of PCNL was initially considered a standard procedure. Recent reports from various authors have challenged routine need for nephrostomy tube. Tube-free PCNL has several purported advantages, including reduced hospital stay, decreased patient discomfort, earlier return to normal activities, and decreased hospital costs.[10,11]

If properly carried out, PCNL provides stone-free rates between 76 and 84%.[12] If not performed well, it can be associated with significant complications.[13-15] This study evaluates the role of PCNL in the management of renal calculi in our setup with respect to efficacy and attending complications.

MATERIALS AND METHODS

Prospective study of 107 patients of renal calculi, who underwent PCNL in our institution from May 1, 2014 to April 30, 2016, was carried out. Each patient's medical chart was reviewed to ascertain the history, examination findings, X-ray and ultrasonography of kidney, ureter, bladder (KUB), intravenous urography (IVU), and computed tomography (CT) KUB (plain or contrast). All patients were subjected to PCNL under strict aseptic measures. The procedure was performed in prone position under general anesthesia in a purpose-built operating room with state-of-the-art facilities of uroradiological imaging. The operative procedure comprised the following integral steps:

- Cystoscopy and retrograde ureteric catheterization in lithotomy position

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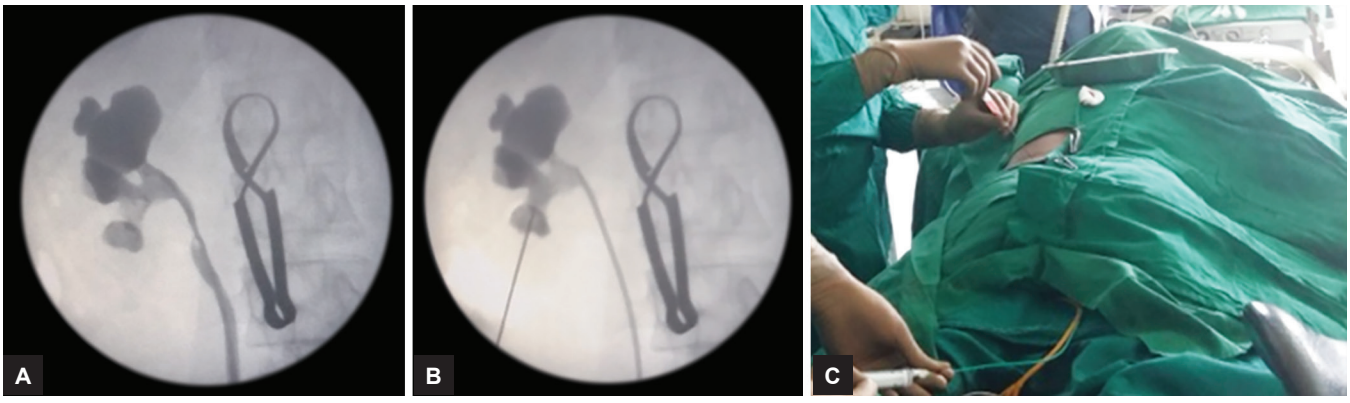
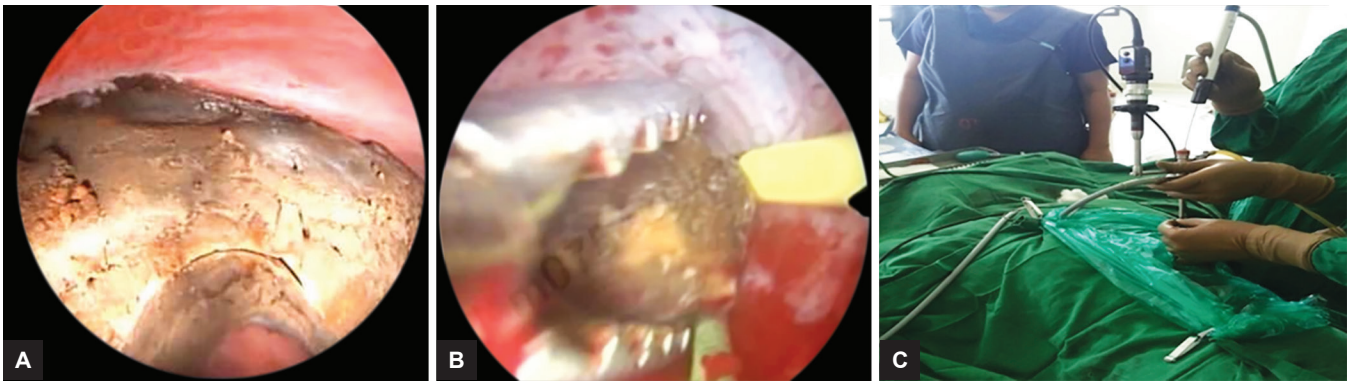


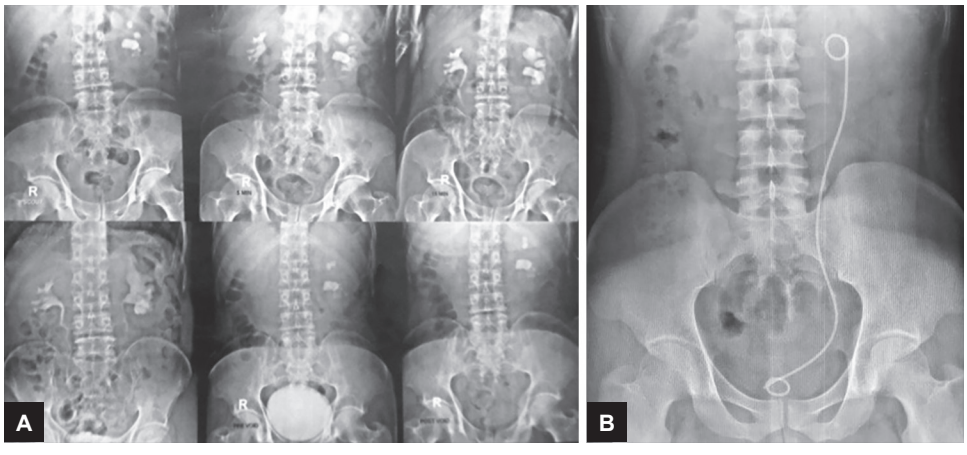
Figs 1A to C: Retrograde pyelography with puncture of the calyceal system under fluoroscopic guidance in prone position



Figs 2A to C: Nephroscopy with pneumatic lithotripsy (stone fragmentation with lithoclast) and removal of fragments

- Retrograde pyelography with puncture of the calyceal system under fluoroscopic guidance in prone position (Figs 1A to C)
- Dilation of the tract with Amplatz sequential fascial dilators and Alken metallic telescopic dilators till 24 F routinely or 28 F if large stone burden or single-step dilation
- Nephroscopy with pneumatic lithotripsy (stone fragmentation with lithoclast) and removal of fragments (Figs 2A to C)
- Confirmation of stone-free status visually and under fluoroscopy
- Antegrade DJ stenting/ureteric catheterization
- Placement of nephrostomy tube at the end of the procedure, if required.

Intraoperative findings and immediate postoperative complications were noted. Success rate was defined as patients who were stone-free or who were having clinically insignificant residual fragments (CIRF). The cut-off point of 4 mm was used to define the size of CIRF. Patients were reviewed 1 month following the surgical procedure with X-ray and ultrasonography of KUB, and requirement of any additional procedure was noted. The DJ stent was removed after 30 days if no stone was visible (Figs 3A and B).



Figs 3A and B: Preoperative IVU representing left renal calculi and postoperative X-ray KUB showing complete clearance with DJ stent *in situ*

The data were analyzed statistically using Statistical Package for the Social Sciences statistical software (version 22.0.0) and primer. All the outcome variables, i.e., quantitative data, were summarized in the form of mean ± standard deviation. Study results were statistically analyzed by using appropriate statistical methods, such as Cochrane test and Pearson test. The differences between proportions were analyzed using chi-square test. The levels of significance and αerror were kept at 95 and 5% respectively, for all statistical analyses. The p-values <0.05 were considered as statistically significant (S).

RESULTS

Mean age of cases considered for the study purposes was 43.64 years, with males comprising 60.7% and females 39.3%. Right side involvement was seen in 56 (52.3%) and left 51 (47.7%) cases. One patient had horseshoe kidney. Multiple calculi were seen in 43.9%. Another 11.2% had pelvic calculi. A staghorn calculus was seen in 16.8%. Stone clearance was done through a single tract in 78.5%. Additional tracts were made in 21.5%. Average operative time required for PCNL was 34 to 102 minutes with a mean of 57.67 minutes. Tubeless PCNL was done in 45%, 71% had postoperative fever, and 12.1% developed urinary tract infection (UTI). Hemorrhage occurred in 4%. One patient had sepsis, while 4.67% had pulmonary complications in the form of hydrothorax. Urinary leak was noted in 4.6% (Table 1); 70% of the cases were stone free with overall success rate of 85.98%. Residual stones were seen in 14.01% (Table 2). These patients were managed with additional procedures in the form of extracorporeal shock-wave lithotripsy (ESWL) (n = 13), PCNL (n = 1), and ureteroscopic lithotripsy (URSL) (n = 1).

Table 1: Postoperative complications

Complications	*Frequency*	*Percent*
Nausea	19	17.8
Vomiting	8	7.5
Fever	76	71
TUR syndrome	0	0
Urinary tract infection	13	12.1
Hemorrhage	4	3.7
Sepsis	1	1
Pulmonary complications	5	4.6
Urinary leak	5	4.6

Table 2: Results of surgery

Procedures	*Frequency*	*Percent*
Stone free (SF)	75	70.1%
Retained stone	15	14.01%
CIRF	17	15.89%
Total	107	100%
Success rate (SF + CIRF)	92	85.98%

DISCUSSION

Over the last three decades, PCNL has evolved into a safe and effective treatment of patients with large (>2 or >1.5 cm for lower calyx) or otherwise complex calculous disease.

Mean age of cases was 43.64 years. Sohail et al[16] did a study in September 2015 and found that most of the cases were around 40 years age group. More number of cases were males (60.7%) than females (39.3%). Khawaja et al[17] did a similar study in 2014 and found that males predominated, with male/female ratio 2.6:1 (86:33). Khan et al[18] did a study in 2005 and found that, out of 200 patients, 110 (55%) had right-sided stone and 90 (45%) had left-sided stone. Multiple calculi were seen in 43.9%, while another 11.2% had pelvic calculi. A staghorn calculus was seen in 16.8% cases.

In most of the cases kidney is approached through a subcostal access. However, in the presence of staghorn calculi or complex stones, supracostal access is preferable. Supracostal access offers optimal control and manipulation of stones in the mid and lower calyx.[19] Subcostal access was chosen in 46.7%, while supracostal access was preferred in 53.3% for the complete stone clearance. Stone clearance was done in maximum number of cases through a single tract (78.5%). Additional tracts were made in an attempt to clear the stones in 21.5%. Hegarty and Desai[20] in their study concluded that monotherapy with PCNL utilizing multiple percutaneous tracts is highly effective in the treatment of staghorn calculus and other large-volume renal calculi. It was found that average operative time required for PCNL was 34 to 102 minutes with a mean of 57.67 minutes, while the nephroscopy time on an average was 27 minutes. It seems that staghorn and multiple calculi required significantly more time than other calculi with p-value <0.05. Hayder[21] also noted the average procedure time of 57.40 ± 21.05 minutes.

Nephrostomy tube was inserted in 55% of the cases, while tubeless PCNL was done in 45%. Tubeless PCNL was associated with less postoperative pain and a shorter hospital stay than conventional PCNL with nephrostomy tube. Also, tubeless PCNL can be safely done in patients with a history of open nephrolithotomy and in those having a supracostal puncture without increased morbidity. Other published reports also recommend tubeless PCNL in selected uncomplicated case.[22-24]

The main complications of PCNL are residual calculi, bleeding, and renal perforation. Infectious complications related to PCNL are reported in up to 32.7%. In most of the cases, it is limited to postoperative fever, despite antimicrobial prophylaxis, and it usually resolves with continuing antibiotics for 48 hours. Although rare, postoperative septicemia or severe sepsis can induce

life-threatening situations,[12] and 71% of the cases had postoperative fever, while 12.1% had UTI. One patient had sepsis that was managed in the intensive care unit with higher antibiotics and supportive care.

Bleeding can occur at any step of the procedure: during the creation of the track, due to vascular injury after puncture, or after excessive dilation. In general, most of the bleeding is venous and is controlled by the Amplatz sheath. If the bleeding is excessive, the procedure should be stopped and a tamponading nephrostomy tube inserted. Requirement of blood transfusion is unusual. Hemorrhage was seen in 4% of our cases which was managed conservatively. Entry through the pleural cavity may lead to an accumulation of fluid, causing hydrothorax, which occurred in 4.6% of patients. Gupta et al[25] reported similar incidence (5%). Others have reported the incidence of hydrothorax to be 0 to 12%.[26,27] Pleural injury can be avoided by staying above the lateral half of the 12th rib.[28,29] Urinary leak was noted in 4.6%. It improved in majority of the cases without any intervention. In two patients nephrostomy tube slipped, which was managed by delaying removal of ureteric catheter by 24 hours. One patient developed persistent urinary leak for 3 days, which was managed conservatively with solifinacin 10 mg at bedtime without the need for DJ stenting. Ali et al[30] reported the incidence of urinary leakage in 8.57% of the patients.

In horseshoe kidneys, PCNL is a safe and effective method of stone removal in patients with calculi.[31] In the patient with horseshoe kidney, stone was removed through posteriorly placed upper pole puncture, and successful stone removal was achieved. Traditionally, post-PCNL radiographic imaging studies have been used to detect residual fragments (RF). The method for detecting RF in our study was a combination of ultrasonography KUB and plain radiography KUB. Most of the authors use sonography or KUB (sensitivity for RF: 47%), and only a few use CT as the most sensitive tool.[32] Both success rate and complication rate are important for determination of the surgical outcome of PCNL. Success rate is defined as sum of CIRF and stone-free rates,[33] where 70% of the cases were stone free, while only 16% had CIRF. The overall success rate was 85.98%. We attribute our high success rate to a well-organized team, where the anesthetist is prepared to deal with possible lengthy surgery and bleeding complications if any and the working staff are well trained with the equipment. Residual stone was seen in 14.01%. It was also noted that maximum residual stones were seen in cases having staghorn calculus and multiple calculi with a significant p-value (<0.005). Findings of the study were comparable to the study of Gupta et al[25] where the stone clearance was 75%. Aron et al[34] in 2004 found that stone clearance was seen in 72% patients. It was observed that as the size of the stone increases, and as the complexity of the situation increases, the stone-free rate decreases.[35,36]

Residual stone of varying size was seen in 15 (14.1%) cases. Re-PCNL was required in 1 patient, while 1 patient required URSL in whom the stone had descended into the ureter, and ESWL was given to 13 (12.1%) patients. In this study, most patients who required additional postoperative procedures had staghorn or multiple calculi. Farhan et al[37] in their study found that among patients with residual stones, six (29%) had additional treatments, with shock-wave lithotripsy in four and semi-rigid ureteroscopy and JJ stenting in one each. Average hospital stay was 5.5 days. Wickham et al[38] did a study on elective PCNL in 50 patients and found that the stone-free rate was 71% with the average hospital stay of 8.3 days.

With the development of new devices for renal access, lithotripsy, and renal drainage systems, PCNL has become the first choice of treatment modality for renal stones larger than 2 cm by urologists worldwide. As experience is gained in percutaneous stone surgery, there is going to be continuous improvement in the success rate and a decrease in operating time, complication rate, and hospital stay after treatment.

CONCLUSION

The findings of the study reveal that PCNL as first-line treatment modality for the management of the renal calculi offers the advantage of minimally invasive therapy with lower morbidity, shorter hospital stay, and higher stone-free rates without compromising patient safety. Data also suggest that the tubeless PCNL has better outcome. Advancements in technology, training, learning, experience of the urologist and availability of good, well-maintained instruments are critical in improving the success rate of PCNL.

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