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Retrospective Study

Percutaneous Nephrolithotomy 500 Cases in High-Risk and Altered Renal Function Test: Our Experience at Tertiary Care Centre

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ABSTRACT

Introduction

The study aims to evaluate the results of percutaneous nephrolithotomy (PCNL) in high-risk patients and patients with altered renal function tests (RFT) and complications in the management of renal stones in our hospital.

Methods

We retrospectively analyzed the outcomes of 500 patients who underwent PCNL between September 2020 and September 2023. We have analyzed data regarding patient details, investigations, PCNL puncture site, operative duration, number of punctures, stone-free rates (SFRs), duration of hospital stay, and complications.

Results

Out of 500 patients, 384 (76.87%) were males and 116 (23.13%) were females, with a male-to-female ratio of 3.32:1. The average age was 40.8±10.4 (mean±SD) (range: 24 to 74-years). The average operative time was 127±37 min (mean±standard deviation (SD)). The radiation exposure was from 1 min 30 sec to 3 min, with a mean (±SD) of 30 sec. The mean duration of the hospital stay was 2.7±1.6 days. Complete stone clearance was 87%, whereas SFRs defined by no identifiable stone on a plain radiograph or ultrasound or residual fragments <5 mm were 90.93%. The complication rate was 2.2%.

Conclusion

The usual course of treatment for renal stones larger than 2 cm is PCNL. Significant factors influencing the stone-free rate include stone burden, stone type, PCNL puncture, number of punctures, and operative time. With the development of several lithotripsy procedures and the miniaturization of instruments, PCNL continues to be an excellent therapeutic option for patients with large renal stones, comorbidities, and changed RFT, with tolerable rates of complications.

Keywords

Percutaneous nephrolithotomy; Stone-free rates; Flexible nephroscope; Staghorn stone.

INTRODUCTION

Urinary stones and their treatment account for almost 30% of the cost of a urology practice.[1] Fernstrom and Johansson first introduced percutaneous nephrolithotomy (PCNL) in 1976 as a minimally invasive approach for kidney stone treatment.[2] It has now become a standard treatment for kidney stones larger than 2 cm, hard stones, refractory lower pole stones, and those not amenable to extracorporeal shock wave lithotripsy (ESWL).[3] PCNL technology has advanced, now using smaller catheters and transitioning from fluoroscopic to ultrasound-guided punctures. Tract dilatation methods, including balloon dilation and single-step dilatation, have also seen improvement.[4] Significant advances have also been made in technologies such as electrohydraulic, ballistic, ultrasonic, and laser lithotripsy. Advances in technology, such as computed tomography (CT), ultrasound, and simple X-rays, have made it easier to plan surgeries. Guy's Stone Score (GSS) and the STONE Nephrolitometry Score are helpful in initially evaluating PCNL outcomes.[5] Another prognostic tool to predict PCNL outcomes is horn morphometry.[6]

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MATERIALS AND METHODS

Five hundred (500) patients who had PCNL at our hospital between September 2022 and September 2023 had their records retrospectively examined. A full physical examination of the patient was performed, and a medical history was taken. Laboratory tests performed include urinalysis, coagulation profile, blood sugar, kidney function tests, and a complete blood count. All patients with kidney stones detected on kidney, ureter, and bladder X-rays (KUB) or ultrasonography also underwent CT evaluation. The risks of anaesthesia and surgery were evaluated. Patients with urinary tract infections (UTIs) were treated with antibiotics one week before surgery and after confirmation of sterile cultures. The study obtained approval from the institutional review board and adhered to ethical standards.

PCNL Technique

All surgeries are performed under general anaesthesia. A 5-Fr ureteral catheter was positioned in the renal collecting system with fluoroscopic guidance. After the patient was in the prone position, a retrograde pyelogram was performed to identify the bowel and plan the renal access track. The target calyx was punctured with an 18-gauge needle under fluoroscopic guidance using bull's-eye or triangulation techniques. Once the puncture is confirmed, the Terumo guidewire is passed and guided into the ureter. Where more punctures are needed, more entries are made, and guidewires pass through them. The tract was dilated using a fascial dilator from 10 Fr to 24 or 30 Fr using an Alkens telescopic dilator with fluoroscopic guidance. An appropriate-size Amplatz sheath was kept. Nephroscope was inserted, stones were located and fragmented with pneumatic lithotripsy, and they were recovered.

The stone fragments were retrieved using a bi-radiate grasper. All cases were treated with a 5 Fr double-J stent as per the procedure applied in our department. The nephrostomy was kept for 24-48 hours if necessary. On the first day after surgery, X-ray KUB, hemoglobin, and renal function tests (RFT) tests are routinely performed. SFR was defined as no detectable stones on the X-ray or no remaining stones <5 mm. ESWL was planned for patients with residual stones at a later date. Complications were graded according to the Clavien classification and its modifications for percutaneous procedures.

RESULTS

During the study period, 500 patients underwent PCNL. The patient demographics and stone characteristics are as shown in Table 1. The majority of the patients (n=426, 85.2%) presented with flank pain of variable duration. Other symptoms were hematuria (n=52, 10.4%) and fever with urinary tract infection (n=365, 73%). Out of 11 patients with acute kidney injury (AKI), 7 (63.63%) were managed conservatively, 3 (27.27%) patients required double-J stenting, and 1 (9.09%) patient had percutaneous nephrostomy tube placement. Serum creatinine levels came back to normal in 9 patients, and 2 patients had elevated creatinine levels after 2-weeks. Fifty patients (15.62%) had a history of previous stone disease, out of which 5 (10%) underwent open surgery, 26 (52%) underwent ureteroscopy, 9 (18%) underwent extracorporeal shock wave lithotripsy (ESWL), and 10 (20%) had a history of PCNL. Most procedures were done using a single tract in 288 cases (90%), two tracts in 29 cases (9.06%), and three tracts in 3 cases (0.94%).

Table 1 provides an overview of the demographic information and stone characteristics of the 500 patients who underwent PCNL.

Table 1. *Patient Demographics and Stone Characteristics*

Characteristics	Result
Number of patients undergoing PCNL	500
Flank pain (n, %)	426 (85.2%)
Hematuria (n, %)	52 (10.4%)
Fever with urinary tract infection (UTI) (n, %)	365 (73%)
Acute Kidney Injury (AKI) patients (n)	11
AKI management	Conservative: 7 (63.63%)
	Double-J stenting: 3 (27.27%)
	Percutaneous nephrostomy: 1 (9.09%)
Patients with normalized creatinine levels (n)	9
Patients with elevated creatinine after 2 weeks	2
History of previous stone disease (n, %)	50 (15.62%)
Previous stone treatments	Open surgery: 5 (10%)
	Ureteroscopy: 26 (52%)
	ESWL: 9 (18%)
	Previous PCNL: 10 (20%)
Procedure types	Single tract: 288 (90%)
	Two tracts: 29 (9.06%)
	Three tracts: 3 (0.94%)

Additionally, Table 2 outlines the specifics of access punctures during the procedures, including the percentage distribution of single and multiple punctures in different calyces. These tables serve as a comprehensive reference for understanding the patient population and procedural nuances in the study.

Table 2A. *Access Sites and Distribution*

Characteristics	Result
Age (years, mean±SD, range)	40.8±10.4 (24 - 74)
Sex (n, %)	Male: 384 (76.87%)
	Female: 116 (23.13%)
Hemoglobin (g/dL, mean±SD)	11.2±2.2
BMI (kg/m², mean±SD)	28.5±5.2
Stone location (n, %)	Right kidney: 287 (57.4%)
	Left kidney: 213 (42.6%)
Stone size (cm, mean±SD)	2.2±1
Stone type (n, %)	Complete staghorn stone: 88 (17.6%)
	Multiple non-staghorn stones: 90 (18%)
	Single stone: 322 (64.4%)
Hounsfield Unit (mean±SD)	1,223.4±204.6

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Table 2 provides detailed information on access sites and distribution during the PCNL procedures.

Table 2B. *Access Puncture*

Characteristics	Results
Single puncture (n, %)	443 (88.6%)
- Lower Calyx (n, %)	226 (45.2)
- Middle Calyx (n, %)	108 (21.6)
- Upper Calyx (n, %)	109 (21.8)
Multiple Punctures (n, %)	57 (11.4)
- Lower and Middle Calyx (n, %)	29 (5.8)
- Lower and Upper Calyx (n, %)	21 (4.2)
- Upper and Middle Calyx (n, %)	7 (1.4)

Table 3 shows the stone-free rates (SFRs) based on different stone types.

Table 3. *Stone-Free Rates (SFRs) by Stone Type*

Stone Type	Number of Cases	Complete Clearance (%)
Complete staghorn stone	88	68.18
Multiple non-staghorn stones	90	86.66
Single stone	322	92.23
Total	500	87

Complications occurred in 11 cases (2.2%). Fever was observed in nine cases, and hematuria occurred in one case. None of the patients required angioembolization or nephrectomy for bleeding complications. Hematuria was conservatively managed by watchful waiting. Fever was managed by antipyretics and antibiotics. A patient with a colonic injury, identified post-operatively, underwent management with a colostomy.

DISCUSSION

Urolithiasis is very common in India, accounting for almost 30% of urological cases. Various treatments are available, including ESWL, retrograde intrarenal surgery (RIRS), and PCNL. Due to its good performance and good outcome, PCNL has become the standard of care for kidney stones >2 cm.[7] Open surgery for urolithiasis has decreased significantly, but numbers still persist in some developing countries.[8] In our study, the male-female ratio is 3.32:1.

One hundred percent (100%) of the patients in our study underwent CT for a preliminary evaluation. CT is the first choice for PCNL for measurement of stone size, location, hounsfield units (HU) (harder stone has more HU), estimated stone removal, planning access, and prediction problems.[9]

The complete clearance of stones in the present study was 87%. SFR is defined as the absence of stones or the presence of insignificant stones (CIRF) detectable on ultrasound and X-ray.[10] All the patients with residual fragments >5 mm were rendered stone-free after combination therapy with ESWL.

In a multicenter study, a higher body mass index (BMI) was associated with an increased risk of bleeding, a lower SFR, and longer surgery time.[11] However, this study did not show that high BMI causes decreased SFR. Kuntz et al[12] and Tomaszewski et al[13] also reported similar findings.

In a study to evaluate stone-free rates (SFR) using stone surface area and stone type, Turna et al.[14] This is similar to the current study; SFR decreases as surface area increases and is not good, from the highest SFR for a single stone (92%) to the lowest SFR for Staghorn stone (68%). When Anastasiadis et al[15] investigated the effect of stone density on PCNL results, they found that the highest success rates were found when stone HU was 1250 and that the success rates were reduced when the density of the stone decreased or increased beyond 1,250 HU. However, in the current study, no significant difference was found between stone density and SFR.[16]

PCNL was performed with a single tract puncture in 88.6% (n=443) of the cases, while two beams were used in 11.4% (n=57). Shalaby et al[17] also reported improved stone removal by treating large, difficult stones through single punctures. However, in a study conducted by Desai et al[18] they found that creatinine values were high when multiple tracts were used. However, recent studies have shown that the estimated GFR confirms the absence of severe kidney damage in many fascicles.[19] However, multiple tracts were associated with an increased risk of intraoperative bleeding and the need for blood transfusion.

In this study, percutaneous access was achieved with fluoroscopy using cow eye or triangulation techniques in 100% of the patients.[20] However, the use of ultrasonography in percutaneous imaging to reduce radiation exposure has become popular because it is cheap and easily accessible.[21] In addition, the advantages of ultrasound examination during pregnancy for the ectopic kidney and horseshoe kidney make it a valuable tool for the urologist. The average surgery time in this study was 127±37 minutes, and it is in the long operative time group according to the Endourology Research Office (Clinical Research Office of the. Endourological Society (CROES)) study.[22] Longer operating time is associated with increased risk of anaesthesia and respiratory distress,[23] increased blood loss, and transfusion.[24] Factors affecting surgery time include stone burden and stone type, complexity of procedures, obesity, and surgeon experience.[25]

One study showed that placement of a nephrostomy tube reduced complications but had no effect on length of hospital stay or anaesthesia considerations.[26] A total of 491 (98.2%) nephrostomy patients were included in this study, and there was no significant difference between nephrostomy placement and complications. In this study, stone load, stone type, stone density, working time, and number of puncture points affect the SFR. This is supported by the work of Abdelhafez and colleagues.[27] A complication rate of 20.5% was reported by the CROES PCNL global study group.[3] Another study reported the prevalence to be 48.2%.[28] Our study shows a prevalence of 2.2%. With advances in technology, the use of miniaturized instruments, scoring machines, flexible nephroscopes,

and laser lithotripsy equipment can improve stone treatment and reduce complications. None of the above were used in our study and are not without their limitations.

CONCLUSION

PCNL is the standard of care for kidney stones >2 cm in terms of complications and morbidity. As technology advances, SFR can be improved and further reduced.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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