

Is supine percutaneous nephrolithotomy an alternative to prone percutaneous nephrolithotomy? Our experience at a tertiary care center



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ABSTRACT

Background: Majority of urologists prefer the usual prone position for percutaneous nephrolithotomy (PCNL) but due to various disadvantages of prone PCNL, several alternative positions are being used. **Aims and Objectives:** The aim of the study was to compare the surgical outcomes of PCNL performed using supine position with those performed in the prone position. **Materials and Methods:** This was a prospective and observational study. After applying inclusion criteria, 60 renal calculi patients were randomly assigned to two groups, each with 30 patients, all demographic, operative, and post-operative characteristics were recorded. **Results:** Out of 60 patients, 38 (63%) patients were male and 22 (37%) were female. The mean age (in years) in prone PCNL was 45.03 ± 17 while in supine, it was 51.7 ± 15 . Forty patients had mild, 12 had moderate, and eight had gross hydronephrosis. Stone size (mm) ranged from 20 to 55 with a mean stone size of 22.5 ± 8.8 in prone PCNL and 23.9 ± 13.5 in supine PCNL. The mean operative time (minutes) was 65.1 ± 27.2 in prone PCNL and 68.7 ± 16 in supine PCNL ($P=0.068$). Complete stone clearance was seen in 26 (86%) patients in prone PCNL versus 25 (83%) patients in supine PCNL. Five patients in supine PCNL had Grade 1–2 complications. There were no serious complications in either group. The mean post-operative hospital stay (days) was 3.53 in prone PCNL versus 3.63 in supine PCNL, ($P=0.715$). **Conclusion:** Supine PCNL is an effective and safe procedure with similar operative time, stone-free rate, and complications to prone PCNL.

Key words: Percutaneous nephrolithotomy; Prone; Supine

INTRODUCTION

For renal calculi larger than 2 cm, percutaneous nephrolithotomy (PCNL) is the preferred treatment. In 1954, radiologists managed to puncture the pelvis of hydronephrotic kidneys to perform an anterograde pyelography, which is the 1st-time percutaneous access to the kidney was performed.¹ PCNL was performed with the patient prone since its first description by Fernstrom and Johansson in 1976, with a very low morbidity and high success rate.² Majority of urologists prefer the usual prone position for PCNL due to

familiarity with the surgery, a bigger surface area for puncture site selection, and potentially more direct access to the kidney.^{3,4}

The prone position has a number of anesthetic, surgical, and logistical drawbacks. As a result, several alternative positions, such as complete supine, modified supine, or flank positioning, are being used because they provide benefits such as reduced ventilation and circulation difficulties, reduced radiation exposure to the surgeon, more direct renal puncture, and avoidance of repositioning patient during the procedure.⁵⁻¹⁰

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Case reports of patients who had PCNL in the supine position have been described since 1980. Valdivia et al., reported safe percutaneous kidney access in a supine patient in 1987–1988, 10 years later, they reported their experience with 557 patients.^{7,11} Nevertheless, until 2007, when the Galdakao modified supine Valdivia posture was developed, supine position was not commonly employed.⁹ The advantages of PCNL conducted in this posture, according to supporters of the supine position, include both anesthesiologic and urological.¹²

Aims and objectives

The aim of the study was to compare the surgical outcomes of PCNL performed using supine position with those performed in the standard prone position.

MATERIALS AND METHODS

This was a single, institutional, prospective, and observational study conducted in the Department of Urology at a tertiary care center from November 2019 to October 2021. The study was pre-approved by the Institutional Ethics Committee for the final permission. All the patients with renal calculi of size >2 cm in age groups more than 12 years presenting to the department of urology were included in our study. Patients with age <12 years, bilateral stone disease, pregnancy, previously operated patients, and patients with uncontrolled coagulopathies and renal abnormalities (such as whole horseshoe kidney and ectopic kidney) were excluded from the study. After meeting the inclusion and exclusion criteria and getting informed written consent, 60 renal calculi patients were randomly assigned to two groups, each with 30 patients. The institutional ethics and scientific committee approved the study. The patient's demographic data, clinical data, and pre- and post-treatment data were noted in a study proforma. Patients were evaluated by preoperative (ultrasonography) (kidney, ureter, and bladder) intravenous pyelography, and computed tomography (CT) urography. The patients were divided into two groups (supine and prone). The variables compared between two groups were sex, age, grade of hydronephrosis, comorbidities, baseline hemoglobin, and serum creatinine. The stone characteristics including number, location, stone-free rate (SFR), operative time, postoperative hemoglobin, length of stay in hospital, and post-operative complications were also compared. Post-operative complications were classified according to the modified Clavien-Dindo grading system.

Statistical analysis

The data were collected and compiled into Microsoft Excel. Continuous data such as age, stone location, operative time,

SFR, hospital stay, and complications rate were expressed in mean±standard deviation and compared within the groups using paired t-test and between the groups using unpaired t-test. Statistical analysis was done using IBM SPSS version 24.0 software (SPSS Inc, Chicago, IL). P<0.05 was considered statistically significant for all the results.

PCNL procedure-supine

Patient is placed in modified galdavako position (patient is placed in a supine lateral position with a 3 L bag placed to raise the flank. The ipsilateral leg is extended and the contralateral leg is abducted and flexed, achieving a modified lithotomy position), and ureteric catheterization is done, kidney is punctured using 18G PCN needle. Serial dilatation is done over the guidewire accordingly for mini PCNL and standard PCNL taking into consideration the age, stone burden, and PCS dilatation. 12 Fr Wolf nephroscope is used in mini PCNL and 18.5 Fr Wolf nephroscope is used in standard PCNL procedures. A pneumatic lithotripter is used in all cases for stone fragmentation. After stone fragments retrieval, thorough inspection is done for residual stones with direct visualization and fluoroguidance.

PCNL procedure-prone

All the patients are placed in lithotomy position initially and ureteric catheterization is done. Later, they are put on prone position and with the help of fluoroscopy, kidney is punctured using 18G PCN needle. Serial dilatation is done over the guidewire accordingly for mini PCNL and standard PCNL taking into consideration the age, stone burden, and PCS dilatation. 12Fr Wolf nephroscope is used in mini PCNL and 18.5Fr Wolf nephroscope is used in standard PCNL procedures. A pneumatic lithotripter is used in all cases for stone fragmentation. After stone fragments retrieval, thorough inspection is done for residual stones with direct visualization and fluoroguidance.

RESULTS

A total of 60 patients were included in this study. In our study, out of 60 patients, 38 (63%) patients were male and 22 (37%) were female. The mean age in prone PCNL was 45.03±17 years while in supine, it was 51.7±15 years (Table 1).

Forty patients (67%) had mild, 12 (20%) had moderate, and 8 (13%) had gross hydronephrosis (Figure 1).

Stone size ranged from 20 mm to 55 mm with a mean stone size of 22.5±8.8 mm in prone PCNL and 23.9±13.5 mm in supine PCNL. There were no significant differences in stone size between the two

groups. While 28 of stones were located in renal pelvis, 10 were located in lower calyx, four were located in middle calyx, two in upper calyx, and five in multiple calyces. Six were partial staghorn and five were complete staghorn calculi. The mean operative time was 65.1±27.2 min in prone PCNL and 68.7±16 min in supine PCNL. There was no significant difference between the two groups (P=0.068). In prone PCNL, 26 (86%) patients had complete stone clearance and 4 (13%) had residual stone. In supine PCNL, 25 (83%) patients had complete clearance with 5 (16%) patients having residual stone. The difference between the two groups was statistically insignificant (Table 2). Post-operative complications were classified according to Clavien Dindo classification. In prone PCNL, five patients had complications (Grade I in three patients and Grade II in two patients). Five patients in supine PCNL had complications (Grade I in four patients and Grade II in one patient). Post-operative blood transfusion was required in one patient in prone PCNL and two patients in supine PCNL. There were no serious complications (Grade 3 and 4) in either group (Table 3).

The mean post-operative hospital stay was 3.53 days in prone PCNL versus 3.63 days in supine PCNL, (P=0.715). One patient required relook PCNL in prone group. ESWL was done for four patients in prone PCNL and five patients in supine PCNL (Table 2).

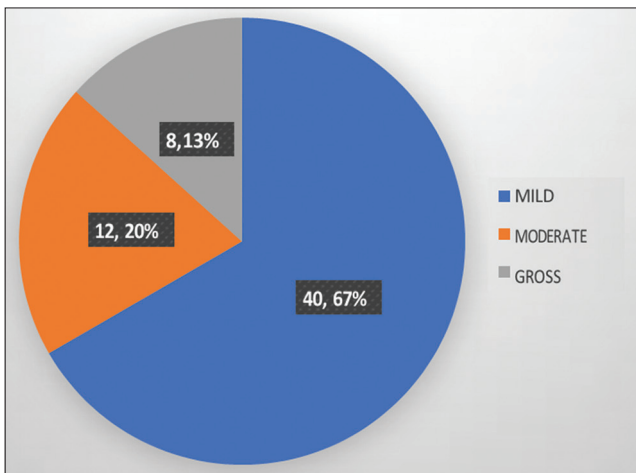


Figure 1: Grades of hydronephrosis

	Prone (n=30)	Supine (n=30)	Total	P-value
Mean age (years)	45.03±17	51.7±15		0.124
Sex				
Male	20	18	38 (63%)	0.59
Female	10	12	22 (37)	

DISCUSSION

PCNL has been established the gold standard for the treatment of kidney stones >20 mm in diameter or those with a complicated nature.^{13,14} Initially, the prone posture was used in PCNL, but over time, supine or modified supine approaches are gaining prominence.^{7,9,15-17}

For a safe access to the kidney, PCNL is generally done in prone position. The prone posture provides a number of advantages. For example, a large surgical field for puncture site selection, appropriate nephroscopic manipulation, and effective distention of the collecting system; yet, prone position is generally linked with restricted breathing movements and the risk of anesthesia.^{18,19}

One of the key worries since the supine PCNL was proposed was if PCNL in supine position may increase

Table 2: Perioperative characteristics

Parameters	Prone	Supine	P-value
Stone Size (mm)	22.5±8.8	23.9±13.5	0.636
Stone Location			
Lower pole	7	3	
Upper pole	1	1	
Middle pole	1	3	
Renal pelvis	13	15	
Multiple Calyceal	2	3	
Partial Staghorn	3	3	
Complete staghorn	3	2	
Puncture site			
Lower pole	21	20	
Upper pole	3	3	
Middle pole	4	3	
LP+UP	1	3	
LP+MP	1	1	
Number of tracts			
Single	28	26	
Multiple	2	4	
Mean intraoperative period (in min)	65.1±27.2	68.7±16	0.068
Mean haemoglobin drop (g/dl)	0.5	0.54	
Mean duration of hospital stay (post-operative in days)	3.53±1	3.63±1.09	0.715
Requirement of relook PCNL	1		
Requirement of blood transfusion	1	2	
Stone free rate	26/30	25/30	
ESWL	4	5	

Table 3: Complications

Position	Complications (Clavien Dindo Grade)		Total	P-value
	Grade 1	Grade 2		
Supine	3	2	5 (16%)	0.494
Prone	4	1	5 (16%)	

the chance of colon damage, which was assumed to be the main cause for the supine position's lack of popularity. Tuttle et al., employed CT to show that in prone position, the colon is closer to the kidney than in supine position.²⁰ Desoky et al., also found that in the supine position, the mean perpendicular distance between the colon and the renal access appeared to be greater than in prone position.²¹ Furthermore, according to another research by Hopper, the retrorenal colon was discovered by CT in 1.9% of supine patients and 10% of prone patients. According to these research, supine PCNL seems to have a decreased risk of colon damage.²²

In this aspect, the modified supine posture has a number of benefits. To begin with, because the patient is laying supine for the length of the surgery, less pressure is imposed on their lungs than if they were lying prone. This alleviates the challenges of maintaining steady breathing in prone patients, especially obese individuals whose abdominal pressure might result in lower venous outflow.²³ In the event that reintubation is required, the supine posture offers better and faster access to the airway.

Second, performing PCNL in the traditional prone position necessitated the patient being moved from a supine to a prone position partway through the procedure, necessitating repositioning and redraping, staff also rescrubbing and regowning, which poses additional challenges in obese patients, which are avoided in supine position.²⁴ In addition, the prone posture has been linked to an increased risk of post-operative vision loss, direct pressure injuries, and peripheral nerve injury, especially in obese individuals.^{23,25} A study conducted in obese patients by Mazzucchi et al., discovered that the total supine posture gives considerably lower operative durations and post-operative duration of stay in hospital.²⁶ These considerations greatly favor doing PCNL in the supine position, particularly in obese patients and those who have cardiopulmonary comorbidities. Variations of the supine posture have demonstrated improved outcomes in obese patients, patients with a solitary kidney, and patients with spinal abnormalities, some of whom are unable to lie in the prone position totally.²⁷⁻³⁰

The risk of fever is much lower in supine position, according to findings from a large multicentric investigation.³ Fever is thought to be linked to bacterial translocation through the lymphatic and circulatory systems.³¹ Because supine posture is linked with much poorer fluid absorption, this pathophysiological mechanism may explain disparities in fever rate.³² Fluid absorption and fever have also been linked to intrarenal pressure.³¹ Based on the finding of pyelocaliceal cavity collapse during supine PNCL, some

authors believe that intrarenal pressure is lower in the supine position.

The supine posture also allows for easier access to the upper pole following a puncture of the lower pole. When treating difficult stones, the upper pole access has been advocated, although it comes with a higher risk. In supine position, however, reaching the upper calyx through the lower calyx is possible, validating the lower pole access choice.³³

However, while the supine position has several advantages in terms of complication rate, the low compressed abdomen in this position allows the kidney to move more freely, making instrument navigation toward the kidney more difficult, and the risk of unsuccessful access is higher.^{3,34,35}

In our study, we have seen mean operative time of 68.7 ± 16 min in supine PCNL compared to 65.1 ± 27.2 min in prone PCNL, with $P=0.068$ which is not statistically significant. Because we are new to this technique, we attribute the increased intraoperative time to difficulties with initial punctures.

However, a comparison of positions by Valdivia et al.,³ which comprised of 5803 patients from the Clinical Research Office of the Endourological Society's (CROES) prospective PCNL database found that SFRs (77% vs. 70.2%) and operative time (82.7 min vs. 90.1 min) were significantly higher for the prone PCNL group as compared with supine PCNL group, though the vast majority of these cases would have been in the complete supine position. In addition to the CROES study, there were other studies favoring the prone position.

Meta-analysis by Falahatkar et al.,³⁶ showed that both positions had similar success rates, operation times, complication rates, urinary leaking, and hospital stays. Melo et al.,³⁷ showed, mean overall operative time was 111.44 min. The mean operative time in supine=120.85 min and prone=123.48 min ($P<0.001$). Our findings showed a similar SFR of (supine PCNL: 83% vs. prone PCNL: 86%, $P=0.563$), on 1st post-operative day. In meta-analysis by Li et al., the authors showed a similar SFR between both positions, that is 78.1% in supine PCNL group versus 80.0% in prone PCNL group with no significant difference (RR-0.97, 95% CI 0.93–1.02, $P=0.31$).³⁸

Our study shows that neither prone nor supine position has a significant advantage in terms of SFR. However, our results are in contrast to that of the CROES study, in which they concluded that prone PCNL leads to a better SFR. One major criticism of the CROES study

is that cases were not randomized, and evaluation of success was not standardized, thus reducing its evidence level.⁸ Another meta-analysis by Birowo et al., which included 11 studies reported SFR was lower in supine PCNL group (OR:0.74; 95% CI:0.66–0.83; P<0.00001), which was statistically significant and with a low heterogeneity.³⁹

Our study had an overall complication rate of 16.6%, for both supine and prone which was similar to the literature. Most of the complications were Grades 1 and 2 (fever, blood transfusion, and change of antibiotics). There were no serious complications (Grades 3 and 4).

The latest meta-analysis by Tendi showed that there is a statistically significant lower complication rate in the supine PCNL group (OR: 0.70; 95% CI: 0.51–0.96; P=0.03). The subgroup analysis of complication parameters such as visceral injuries including pleural effusion and organ perforation, the need of blood transfusion, and infection which lead to sepsis revealed that there is no significant difference between groups when analyzed separately (P=0.16; P=0.10; and P=0.35, respectively). However, the combined analysis of these specific complications leads to a significant difference in which the risk is lower in the supine PCNL group (OR: 0.81; 95% CI: 0.68 – 0.97; P=0.02).³⁹

In our study, mean hospital stay was 3.53 days in prone and 3.63 days in supine PCNL, with P=0.715 which is not statistically significant, our study findings are similar to meta-analysis by Tendi³⁹ where there is no difference in the length of hospital stay between groups. A study by Giustiand and De Lisa,⁴⁰ the mean hospital stay in the supine position was 3.244 days±0.484, while it was 3.133±0.344 (P=0.2127) in prone position.

Limitations of the study

The main limitations of the study were that it was a non-randomized controlled study with less number of patients. All the procedures were not done by the same surgeon, so possibility of bias was there.

CONCLUSION

Supine PCNL is an effective and safe procedure with similar operative time, SFR, and complications. It also has advantages for high-risk patients (cardiac, respiratory, and obese patients) and allows for simultaneous antegrade and retrograde access for treating renal calculi. We believe that a surgeon should have familiarity with both prone and supine positions, which can be chosen according to patient's characteristics.

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