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Original Research Article

SUPINE VERSUS PRONE POSITION IN PERCUTANEOUS NEPHROLITHOTOMY SURGERIES – A COMPARATIVE STUDY IN A TERTIARY CARE HOSPITAL

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ABSTRACT

Background: Percutaneous nephrolithotomy (PCNL) is an established treatment for large and complex renal calculi. Although prone PCNL is the conventional approach, the supine position may offer advantages in operative efficiency and perioperative safety. **Objective**: To compare the efficacy and safety of supine and prone PCNL.

Materials and Methods: This prospective observational comparative study was conducted at the Department of Urology, Sigma Hospital, Mysore, from December 2022 to June 2024. A total of 100 patients with renal stones ≥14 mm were included and randomly allocated into supine (n=50) and prone (n=50) groups. Operative time, calyceal access, number of punctures, radiation exposure, stone-free rate, postoperative pain, hospital stay, and complications were compared.

Results: Baseline demographic and stone characteristics were comparable between the groups. Lower-pole access was more frequent in the supine group, whereas upper-pole access predominated in the prone group (P<0.001). Mean operative time was significantly shorter in the supine group than in the prone group (86.5±27.8 vs. 115.4±23.7 minutes; P<0.001). Stone-free rates were 92% and 86%, respectively. Pain scores, hospital stay, number of punctures, and radiation exposure were comparable. Overall complications were significantly lower in the supine group (4% vs. 20%; P=0.028).

Conclusion: Both supine and prone PCNL achieved satisfactory stone clearance. Supine PCNL was associated with significantly shorter operative time and fewer overall complications, suggesting advantages in operative efficiency and perioperative safety.

Keywords: Percutaneous nephrolithotomy; PCNL; Supine position; Prone position; Renal calculi; Nephrolithiasis; Stone-free rate.

INTRODUCTION

Renal stone disease, also known as nephrolithiasis or urolithiasis, is characterized by the formation of solid mineral deposits within the urinary tract, including the kidneys, ureters, bladder, and urethra.[1] It is a common condition worldwide and may result in severe pain, urinary tract obstruction, infection, and progressive renal damage. Stone formation is multifactorial and is influenced by inadequate fluid intake, dietary habits, metabolic abnormalities such as hypercalciuria, hyperoxaluria, and hyperuricosuria, and genetic predisposition.[2] Structural abnormalities of the urinary tract that impair urine drainage may further increase the risk of stone formation. In addition, obesity, gout, inflammatory bowel disease, and recurrent urinary tract infections have been identified as important predisposing factors.[2]

Renal stone disease affects approximately 1%–15% of individuals during their lifetime, with considerable variation according to age, sex, ethnicity, dietary habits, and geographical location.[3] Its increasing prevalence worldwide has

resulted in a substantial clinical and economic burden. The available treatment options for urinary calculi include extracorporeal shock wave lithotripsy (ESWL), ureteroscopic lithotripsy (URSL), retrograde intrarenal surgery (RIRS), percutaneous nephrolithotomy (PCNL), and, in selected cases, open surgery. Among these modalities, PCNL has become the preferred treatment for large and complex renal calculi since its introduction in 1976.[4] Despite being associated with greater morbidity than some other minimally invasive procedures, PCNL provides excellent stone clearance and has largely replaced open surgery. Potential complications include bleeding, infection, and injury to adjacent organs; however, improvements in surgical techniques and instrumentation have contributed to improved safety and outcomes.[5]

The supine approach was initially described by Valdivia-Urìa in 1987 and was subsequently modified by other investigators.[5,6] Supine PCNL offers several potential advantages, including easier anesthetic access, avoidance of patient repositioning, shorter operating room time, and the possibility of simultaneous antegrade and retrograde access to the upper urinary tract. This facilitates combined endoscopic intrarenal surgery in patients with complex stone disease.[7] Despite these advantages, supine PCNL may present technical challenges, including anterior displacement and increased mobility of the kidney during puncture and tract dilatation, potentially resulting in a deeper and more challenging access tract. Consequently, uncertainty remains regarding whether prone or supine positioning provides superior outcomes. Therefore, the present study aimed to compare the efficacy and safety of PCNL performed in the traditional prone position and the supine position by evaluating key operative outcomes, stone clearance, and procedure-related complications.

MATERIALS AND METHODS

This prospective observational comparative study was conducted in the Department of Urology, Sigma Hospital, Mysore, from December 2022 to June 2024. The study compared the perioperative outcomes and complications of percutaneous nephrolithotomy (PCNL) performed in the supine and prone positions.

Study Participants and Sample Size

Adult patients aged 18 years or older of either sex with renal stones measuring ≥14 mm and willing to provide written informed consent were included in the study. Patients receiving anticoagulant therapy and those undergoing PCNL in combination with other surgical procedures or techniques were excluded.

The sample size was calculated using the standard formula for comparison of proportions, considering a 95% confidence interval and 80% study power. Based on the assumed proportions of the primary outcome, the minimum calculated sample size was 84 participants. After accounting for an anticipated non-response rate of approximately 20%, the final sample size was increased to 100 participants. The participants were randomly allocated in a 1:1 ratio into two groups: Group I, comprising 50 patients undergoing PCNL in the modified supine position, and Group II, comprising 50 patients undergoing PCNL in the conventional prone position.

Study Procedure

The purpose and procedure of the study were explained to all eligible participants, and written informed consent was obtained before enrolment. Baseline demographic and clinical information, including age, sex, medical history, and physical examination findings, was recorded. Anthropometric parameters, including height, weight, body mass index, and waist circumference, were documented. Routine preoperative investigations included complete blood count, serum electrolytes, liver function tests, and renal function tests.

Participants were allocated to either study group using randomly generated numbers. In the prone group, patients initially underwent retrograde ureteric catheterization in the lithotomy position, following which they were repositioned for PCNL in the conventional prone position. In the modified supine group, patients were positioned in an intermediate supine-lateral position with approximately 15° lateral tilt, achieved by elevation of the flank and stabilization with bolsters. The ipsilateral leg was extended, while the contralateral leg was abducted and flexed to obtain a modified lithotomy position. The ipsilateral arm was positioned across the chest with the elbow flexed, while the contralateral arm was placed alongside the torso.

PCNL was subsequently performed according to standard surgical principles in both groups, including renal puncture, tract dilatation, and stone fragmentation and removal. The size of the percutaneous tract was selected according to the calyceal anatomy and stone characteristics as per the institutional protocol.

The recorded outcome measures included operative time, number of renal punctures, stone-free rate, duration of hospital stay, and postoperative complications. Complications assessed included pain, fever, and the need for further management of residual stones. Postoperative pain was assessed using the Smiley pain scale. Stone clearance rate, procedural success, and complication rates were calculated and compared between the two groups.

Statistical Analysis

Data were collected using a predesigned proforma, entered into Microsoft Excel, and subsequently analyzed using MedCalc version 20.0. Categorical variables were expressed as frequencies and percentages, while continuous variables were expressed as mean and standard deviation.

Categorical variables were compared using the Chi-square test. Continuous variables were compared using Student's t-test or one-way analysis of variance (ANOVA), as appropriate. A P-value of ≤0.05 was considered statistically significant.

Ethical Considerations and Confidentiality

Written informed consent was obtained from all participants before enrolment. The consent process ensured that participants received adequate information regarding the study and their role in participation in a language they could understand. Ethical clearance was obtained from the appropriate institutional ethics committee before commencement of the study. All patient-related information was kept strictly confidential, and no personally identifiable information was disclosed in any publication or public forum.

RESULTS

A total of 100 patients were included in the study, with 50 patients each undergoing supine and prone percutaneous nephrolithotomy (PCNL).

Table 1: Baseline demographic and clinical characteristics of the study participants

Parameter	Supine PCNL (n=50)	Prone PCNL (n=50)	P value
Male sex, n (%)	36 (72)	32 (64)	0.391
Female sex, n (%)	14 (28)	18 (36)	
Age group, n (%)			0.852
18–39 years	12 (24)	14 (28)	
40–59 years	25 (50)	25 (50)	
≥60 years	13 (26)	11 (22)	
Diabetes mellitus, n (%)	10 (20)	11 (22)	
Hypertension, n (%)	14 (28)	12 (24)	
COPD, n (%)	4 (8)	3 (6)	
Other comorbidities, n (%)	3 (6)	3 (6)	0.964
Stone burden (mm), mean ± SD	23.6 ± 9.2	24.5 ± 8.8	0.507
Right-sided stone, n (%)	29 (58)	26 (52)	0.562

The two groups were comparable with respect to gender distribution, age distribution, comorbidities, stone burden, and side of renal involvement (P>0.05). The majority of patients in both groups belonged to the 40–59-year age group. Hypertension and diabetes mellitus were the most common comorbidities.

Table 2: Operative characteristics and procedural outcomes

Parameter	Supine PCNL (n=50)	Prone PCNL (n=50)	P value
Calyx puncture, n (%)			<0.001
Upper pole	4 (8)	31 (62)	
Middle pole	9 (18)	12 (24)	
Lower pole	37 (74)	7 (14)	
Single puncture, n (%)	45 (90)	43 (86)	0.538
Multiple punctures, n (%)	5 (10)	7 (14)	
Operating time (minutes), mean ± SD	86.5 ± 27.8	115.4 ± 23.7	<0.001
Radiation dose (mSv), mean ± SD	93.7 ± 19.1	101.6 ± 24.8	0.077

The distribution of calyceal access differed significantly between the groups. Lower pole access was predominantly used in the supine group (74%), whereas upper pole access was more common in the prone group (62%) (P<0.001). The number of punctures and radiation exposure were comparable between the groups. However, the mean operating time was significantly shorter in the supine group compared with the prone group (86.5 ± 27.8 vs. 115.4 ± 23.7 minutes; P<0.001).

Table 3: Postoperative outcomes and complications

Parameter	Supine PCNL (n=50)	Prone PCNL (n=50)	P value
Stone-free rate, n (%)	46 (92)	43 (86)	Not reported
VAS score, mean ± SD	3.61 ± 1.3	4.04 ± 1.7	0.159
Hospital stay (days), mean ± SD	3.9 ± 1.3	4.2 ± 2.1	0.393
Blood transfusion, n (%)	0 (0)	3 (6)	
Sepsis, n (%)	0 (0)	5 (10)	
Transient fever, n (%)	2 (4)	1 (2)	
Urine leak, n (%)	0 (0)	0 (0)	
Pleural injury, n (%)	0 (0)	1 (2)	
Overall complications, n (%)	2 (4)	10 (20)	0.028*

P value reported for the overall comparison of complications in the original dataset.

The stone-free rate was high in both groups, with a slightly higher rate in the supine group (92%) compared with the prone group (86%). Postoperative pain scores and duration of hospital

stay were comparable between the groups. Complications were less frequent in the supine group, occurring in 4% of patients compared with 20% in the prone group. Blood transfusion, sepsis, and pleural injury were observed only in the prone group, whereas transient fever occurred in both groups.

DISCUSSION

Percutaneous nephrolithotomy (PCNL) remains an important treatment modality for large and complex renal calculi. Although the prone position has traditionally been the standard approach, the supine position has gained increasing acceptance because it avoids patient repositioning and may facilitate anesthesia management and simultaneous retrograde access. However, the optimal patient position remains debatable. The present prospective comparative study evaluated perioperative outcomes and complications in 100 patients undergoing PCNL, with 50 patients each in the supine and prone groups.

The baseline characteristics of the two groups were comparable. There was no significant difference in gender distribution, age distribution, comorbidities, side of stone involvement, or mean stone burden between the groups. Most patients were aged between 40 and 59 years, and hypertension and diabetes mellitus were the most common comorbidities. The mean stone burden was 23.6 ± 9.2 mm in the supine group and 24.5 ± 8.8 mm in the prone group (P=0.5067). This baseline comparability strengthens the comparison of surgical outcomes between the two positions and is consistent with previous comparative studies reporting similar demographic and stone characteristics between supine and prone PCNL groups.[7,8]

A significant difference was observed in the site of calyceal puncture. Lower-pole access was predominantly used in the supine group (74%), whereas upper-pole access was more common in the prone group (62%) (P<0.001). This difference may reflect the altered anatomical orientation and accessibility of the kidney in the two positions. Despite this variation in access site, the requirement for multiple punctures was comparable between the groups, with a single puncture being sufficient in 90% of supine and 86% of prone procedures (P=0.5382). Thus, patient position appeared to influence the preferred calyceal access but not the overall number of access tracts required. Similar differences in the pattern of renal access have been reported in previous studies, with lower-pole access being frequently used in supine PCNL and upper-pole access being more common in prone procedures.[9,10]

Stone clearance was high in both groups, with stone-free rates of 92% in the supine group and 86% in the prone group. Although the stone-free rate was numerically higher in the supine group, statistical significance for this comparison was not available in the reported results. Therefore, the present findings suggest comparable efficacy of both positions for achieving satisfactory stone clearance rather than superiority of either technique. This observation is broadly consistent with previous studies that have reported similar stone-free rates between supine and prone PCNL.[9,10,11]

Postoperative recovery outcomes were also comparable. The mean postoperative pain score was lower in the supine group (3.61 ± 1.3) than in the prone group (4.04 ± 1.7), but the difference was not statistically significant (P=0.1586). Similarly, the mean duration of hospital stay was slightly shorter in the supine group (3.9 ± 1.3 days) compared with the prone group (4.2 ± 2.1 days), without statistical significance (P=0.3925). These findings indicate that both surgical positions provide comparable postoperative recovery.

The most notable finding of the present study was the significantly shorter operative time in the supine PCNL group. The mean operating time was 86.5 ± 27.8 minutes in the supine group compared with 115.4 ± 23.7 minutes in the prone group (P<0.001). Avoidance of patient repositioning after retrograde ureteric catheterization and easier intraoperative access may contribute to this reduction in operative duration. A shorter procedure may also reduce the duration of anesthesia and improve operating room efficiency. Similar reductions in operative time with supine PCNL have been reported in several previous comparative studies, although some studies have found no significant difference.[11,12]

Complications were significantly less frequent in the supine group. Only two patients (4%) in the supine group developed transient fever, whereas complications occurred in 10 patients (20%) in the prone group. Blood transfusion was required in 6% of prone procedures, sepsis occurred in 10%, and pleural injury occurred in 2%, while these complications were not observed in the supine group. No urine leak occurred in either group. The overall difference in complication rates was statistically significant (P=0.0284), favouring the supine position. These findings suggest that supine PCNL may offer a favourable safety profile, although the relatively small sample size and low number of individual complications should be considered when interpreting these results. Previous studies have reported variable findings regarding complication rates, with some demonstrating lower complication rates with supine PCNL and others reporting comparable safety between the two approaches.[12,13,14]

Limitations

The findings should be interpreted in light of certain limitations. The study included 100 participants from a single centre, which may limit the generalizability of the results. In addition, long-term

outcomes such as stone recurrence, renal functional outcomes, patient-reported satisfaction, and cost-effectiveness were not assessed. Larger multicentre studies with longer follow-up are required to further define the relative advantages of supine and prone PCNL.

CONCLUSION

The comparison between supine and prone PCNL positions reveals important insights into their respective advantages and complications. Supine PCNL demonstrates significant benefits in terms of reduced operating time and potentially lower complication rates, particularly concerning blood transfusion and sepsis. In the present study, stone-free rates were 92% and 86% for the supine and prone PCNL groups, respectively. Although this difference was not statistically significant, the slightly higher stone-free rate in the supine group further supports its effectiveness. The mean operating time in supine PCNL was significantly shorter (86.5 ± 27.8 minutes) compared to the prone group (115.4 ± 23.7 minutes), indicating a more efficient procedure. Additionally, the supine group showed a trend towards a lower radiation dose, although this difference was not statistically significant. Further studies with larger sample sizes and diverse patient populations could provide more definitive guidance on optimizing PCNL techniques for improved patient outcomes, reinforcing the preference for the supine position in many clinical scenarios.

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