International Journal of Endorsing
HEALTH SCIENCE RESEARCH

IJEHSR

Short Communication

Outcomes associated with Percutaneous Nephrolithotomy performed in the supine position.

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Doi: 10.29052/IJEHSR.v12.i3.2024.125-130

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Received 02/01/2024
Accepted 23/04/2024
First Published 18/07/2024

OPEN ACCESS

Abstract

Background: Valdivia first reported safe percutaneous kidney access with a supine patient in 1987-1988. The supine position gained further popularity following the 2007 publication of an international study revealing the Galdakao modification. This study aimed to determine the outcomes associated with percutaneous nephrolithotomy (PCNL) performed in the supine position.

Methodology: This descriptive case series study was conducted at the Department of Urology, Sindh Institute of Urology & Transplantation (SIUT), Karachi, Pakistan, from November 7, 2019, to May 6, 2020. Patients were monitored for up to four weeks post-procedure to evaluate complications resulting from PCNL, including fever, hematuria, gross hematuria, ureteral stones, and urine extravasation.

Results: Among the 221 patients included in the study, the frequency of complications following PCNL in the supine position was as follows, fever in 27 patients (12.2%), hematuria in 30 patients (13.6%), gross hematuria in 10 patients (4.5%), ureteral stones in 2 patients (0.9%), and urine extravasation in 3 patients (1.3%). Notably, 149 patients (67.5%) experienced no complications.

Conclusion: The most frequently reported complication among patients undergoing supine PCNL was fever, followed by hematuria and gross hematuria. These findings underscore the importance of monitoring for these specific complications in clinical practice.

Keywords

Complications, Nephrolithotomy, Percutaneous, Supine Position, Kidney Calculi, Treatment Outcome.

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Introduction

Pakistan, located in the Afro-Asian stone belt, exhibits a high prevalence of urinary stone disease, ranging from 12 to 15%. This condition contributes significantly to the urological workload, accounting for 50% in adults and 60% in children[1]. In comparison to regions like Europe and the United States, where the prevalence is lower, the western zone of Pakistan reports a higher prevalence of kidney stones, ranging from 5% to 9% and 13% to 15%, respectively[2].

PCNL has emerged as a preferred treatment modality for large volume renal and staghorn calculi. Initially developed by Fernström and Johansson in 1976, PCNL involves dilating the tract following percutaneous renal puncture for the removal of urinary calculi. Traditionally, PCNL has been performed with the patient in the prone position, offering advantages such as ease of access to the kidneys and various urinary system components. However, this position poses challenges, including patient discomfort and breathing difficulties during anesthesia, particularly in obese individuals[3].

To address these challenges, supine PNL has gained attention. The supine position presents several advantages, including decreased risk of intra-abdominal organ injury and improved accessibility to the kidneys. This makes it especially advantageous for obese individuals and those with cardiovascular complications. However, data regarding the outcomes and complications of supine PCNL in the local context are lacking[4,5].

Complications associated with PCNL vary in severity, ranging from minor deviations in the postoperative course to life-threatening situations requiring intensive care. Common complications include fever, ureteral blockage, hemo-peritoneum, and bleeding necessitating blood transfusions[6-11]. Despite advancements in surgical techniques and equipment, the prevalence of complications, such as fever, hematuria, and urine extravasation, remains noteworthy.

While international studies have evaluated the outcomes of supine PCNL, local data from Pakistan are scarce, particularly in high-impact publications. Given the high prevalence of renal calculi in the region and the increasing number of PCNL procedures, it is imperative to assess the rate of complications associated with supine PCNL in our community. This study aims to fill this gap by providing insights into the outcomes and complications of supine PCNL, ultimately contributing to enhancing the current standard of treatment and minimizing complications in our population.

Methodology

Study Design

This study was designed as a descriptive case series, conducted to observe and document the outcomes of patients undergoing PCNL in a supine position.

Setting

The study was carried out in the Department of Urology at the Sindh Institute of Urology & Transplantation (SIUT) in Karachi. The research period spanned six months, from November 7, 2019, to May 6, 2020.

Participants

The study included patients aged 18 to 70 years of either gender who were admitted to SIUT for PCNL and met the inclusion criteria. Written informed consent was obtained from all participants before their inclusion in the study.

Inclusion Criteria

The inclusion criteria encompassed patients aged 18 to 70 years, of either gender, who presented with particular types and sizes of kidney stones. Specifically, patients with upper caliceal, middle caliceal, and renal pelvic stones with a stone burden greater than 2 cm were included. Additionally, those with lower caliceal stones larger than 1.5 cm, upper ureteral stones exceeding 1 cm, and stones resistant to extracorporeal shock wave lithotripsy that were greater than 1 cm were considered eligible. The study also included patients with multiple location stones with a

cumulative stone burden over 2 cm, as well as those with complete or partial staghorn stones. Furthermore, individuals with cysteine stones, stones located in calyceal diverticuli, and stones in patients with renal anatomical anomalies were included in the study.

Exclusion Criteria

Patients with a body mass index (BMI) greater than 32 kg/m² were excluded due to potential complications and the impact of obesity on surgical outcomes. Those with chronic liver disease or uncontrolled bleeding diathesis were also excluded to prevent perioperative complications. Participants with untreated preoperative urinary tract infections (UTIs). Additionally, patients with renal failure, defined as an estimated glomerular filtration rate (eGFR) less than 60 ml/min, were excluded to avoid complications related to impaired kidney function. Immunosuppressed individuals, patients classified as ASA PS IV-V according to the American Society of Anesthesiologists Physical Status Classification System, and pregnant women were also excluded from the study to ensure a homogeneous study population and reduce risk factors.

Variables

The primary variables assessed in this study included both demographic and clinical characteristics. Demographic variables comprised age, gender, height, weight, and BMI. Clinically, the stone size and serum creatinine levels were evaluated to provide a comprehensive understanding of the patients' renal function and the extent of the stone burden.

All the patients were followed for up to 4 weeks to assess the complications of PCNL with the PCNL procedure. These complications included fever, hematuria, gross hematuria, ureteral stones, and extravasation of urine.

Data Sources/Measurement

Preoperative assessments included recording hemoglobin, hematocrit, serum creatinine, and stone size. Data were collected using a proforma specifically designed for the study.

Bias

Bias and effect modifiers were minimized by strictly adhering to the inclusion criteria. Consistent surgical techniques and postoperative care protocols were employed to ensure uniformity.

Study Size

The sample size was calculated using the WHO sample size calculator, based on a fever frequency of 7.6% post-PCNL in the supine position, a margin of error (d) of 3.5%, and a confidence level (CI) of 95%. The estimated sample size was 221 patients.

Quantitative Variables

The quantitative variables included age, height, weight, BMI, stone size, and serum creatinine.

Statistical Methods

Data were entered and analyzed using SPSS version 22.0. Descriptive statistics were used to summarize the data, Mean ± SD for continuous variables (age, height, weight, BMI, stone size, serum creatinine). Frequency and percentage for categorical variables (gender and complications).

To assess the impact of effect modifiers (age, gender, BMI, stone size) on complications, stratification was performed, followed by the Chi-square test. A two-sided P-value ≤ 0.05 was considered statistically significant.

Results

Participants

A total of 221 patients participated in this study to assess the frequency of complications associated with PCNL performed in the supine position. These participants were selected based on specific inclusion and exclusion criteria, ensuring a homogenous study population. Informed consent was obtained from all patients before their inclusion in the study.

Descriptive Data

The demographic and clinical characteristics of the participants showed a mean age of 40.1 years with a standard deviation (SD) of 7.7 years. The mean height of the patients was 163.4 cm (SD = 14.2 cm), and the mean weight was 67.8 kg (SD = 11.3 kg).

The mean BMI was recorded at 27.5 kg/m² (SD = 5.4 kg/m²). Clinically, the mean stone size was 3.1 cm (SD = 1.9 cm), and the mean serum creatinine level was 1.3 mg/dl (SD = 0.8 mg/dl). Gender distribution indicated that 123 patients (55.7%) were male, while 98 patients (44.3%) were female.

Outcome Data

The study monitored several complications arising from the PCNL procedure. Fever was observed in 27 patients (12.2%), hematuria in 30 patients (13.6%), and gross hematuria in 10 patients (4.5%). Additionally, ureteral stones were noted in 2 patients (0.9%), and extravasation of urine was documented in 3 patients (1.3%). Notably, 149 patients (67.5%) experienced no complications post-procedure.

Main Results

Stratification of complications based on age group, BMI, stone size, and gender revealed significant insights. The stratification by age showed a significant difference ($p<0.01$). While no significant difference was found in the stratification by BMI, stone size, and gender.

Table 1: Stratification of complications following percutaneous nephrolithotomy by patient characteristics (n=221).

Variables		Fever	Hematuria	Gross Hematuria	Ureteral Stones	Extravasation of Urine	No Complication	p-value
Age (years)	18-40	22(10.0)	22(10.0)	8(3.6)	2(0.9)	2(0.9)	60(27.1)	<0.01*
	> 40	5(2.3)	8(3.6)	2(0.9)	-	1(0.5)	89(40.3)	
BMI (kg/m²)	18-24	12(5.4)	10(4.5)	4(1.8)	-	1(0.5)	42(19.0)	0.525
	> 24	15(6.8)	20(9.0)	6(2.7)	2(0.9)	2(0.9)	107(48.4)	
Stone Size (cm)	2-3	14(6.3)	16(7.2)	6(2.7)	1(0.5)	3(1.4)	110(49.8)	0.062
	> 3	13(5.9)	14(6.3)	4(1.8)	1(0.5)	-	39(17.6)	
Gender	Male	18(8.1)	20(9.0)	5(2.3)	1(0.5)	2(0.9)	77(34.8)	0.541
	Female	9(4.1)	10(4.5)	5(2.3)	1(0.5)	1(0.5)	72(32.6)	

*p-value<0.05 is considered statistically significant

Discussion

Percutaneous nephrolithotomy (PCNL) has emerged as the preferred treatment modality for large renal stones, including staghorn stones, owing to its minimally invasive nature, high success rates, and lower complication rates compared to open surgical approaches. Traditionally, PCNL has been performed with the patient in the prone position. However, the supine position has gained attention as an alternative approach, offering several potential advantages for both patients and surgeons[12].

The supine position during PCNL offers several benefits, including reduced risk of intra-abdominal organ injury, improved access to the kidneys, and enhanced comfort for the surgeon, who can perform the procedure while seated. Studies by Valdivia et al. and others have demonstrated the safety and effectiveness of supine PCNL, with outcomes comparable to those of prone PCNL[7,13-17].

The supine position offers several advantages during percutaneous nephrolithotomy (PCNL). By eliminating the need for patient repositioning, it reduces the risks associated with general anesthesia and enhances surgeon comfort, enabling them to perform procedures while seated. Additionally, the surgeon's hands are no longer within the fluoroscopic field, leading to reduced radiation exposure. In our study involving 221 patients undergoing supine PCNL, we observed a mean BMI of 27.5±5.4 kg/m², indicating a predominantly overweight participant cohort. The median operating time was 130 (range 90–210)

minutes, consistent with findings reported in previous studies. Valdivia et al.[7] and Falahatkar et al.[17] reported mean operational times of 85 and 98 minutes, respectively.

Comparisons with existing literature revealed similar trends in patient demographics and outcomes. Our study showed an average age of 40.1±7.7 years, slightly lower than previous reports by Valdivia et al.[7] and Reddy et al.[20] Additionally, the average weight and height observed in the present study were 67.8±11.3 kg and 163.4±14.2 cm, respectively, with a stone size of 3.1±1.9 cm and serum creatinine level of 1.3±0.8 mg/dL.

Despite concerns regarding potential colon injuries associated with the supine technique, our study suggests that the anterior displacement of the colon in the supine position may mitigate these risks. Furthermore, stratification of confounders and effect modifiers revealed a significant difference in age groups ($P < 0.01$) but not in body mass index ($P < 0.525$), stone size ($P < 0.062$), or gender ($P < 0.541$) concerning PCNL complications.

Overall, our findings support the feasibility and safety of supine PCNL as an alternative to the prone approach, with comparable outcomes and lower radiation exposure for surgeons. Further investigations are warranted to explore long-term outcomes and refine patient selection criteria for optimal treatment efficacy. Supine PCNL presents certain technical challenges, such as difficulty in nephroscopy due to continuous collapse of the collecting system. However, these challenges can be managed, and supine PCNL remains a viable option, particularly for high-risk patients and those with larger renal stones.

Conclusion

In conclusion, our study highlights fever as the most prevalent complication among patients undergoing supine PCNL, followed by hematuria and gross hematuria. However, further research is warranted to validate these findings. Future studies conducted across multiple centers in Pakistan with larger sample sizes and additional parameters would provide more robust evidence. This could enhance our understanding of the outcomes associated with supine PCNL and contribute to improving clinical management strategies for patients with renal stones.

Conflicts of Interest

The authors declare no conflicts of interest.

Acknowledgement

The authors would like to sincerely recognize the work of Mr. Iqbal, the statistician, without his efforts, the data analysis would have been challenging.

Funding

All funds required in the investigation, treatment and follow up investigation is borne by the hospital.

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