The Research of Medical Science Review
ISSN: 3007-1208 & 3007-1216 Volume 3, Issue 12, 2025

OUTCOME OF UPPER POLE PERCUTANEOUS NEPHROLITHOTOMY (PCNL) IN PRONE POSITION

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DOI: https://doi.org/10.5281/zenodo.18105025

Keywords
Prone position, Percutaneous nephrolithotomy, Kidney calculi, Renal pelvis, Thoracic injuries

Article History
Received: 03 November 2025
Accepted: 17 December 2025
Published: 31 December 2025

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Abstract

OBJECTIVE

To determine the outcome of upper pole percutaneous nephrolithotomy in prone position in terms of stone clearance and occurrence of complications.

METHODOLOGY

This descriptive cross-sectional study was conducted in the Department of Urology, Sindh Institute of Urology and Transplantation, Karachi, over six months. A total of 43 patients aged 18–60 years with renal stones larger than 2cm undergoing upper pole PCNL in the prone position were included through consecutive non-probability sampling. Data on demographics stone clearance and procedure-related complications were recorded using a structured proforma. Statistical analysis was performed using SPSS 26 with $p \leq 0.05$ as significant.

RESULTS

In a cohort of 43 patients (mean age 32.86 ± 10.33 years; 62.8% male), prone upper pole PCNL achieved a stone-free rate of 83.7%. Stone size and Hounsfield unit values were significantly associated with clearance outcomes, while postoperative haemoglobin and creatinine changes were statistically significant ($p < 0.05$), indicating measurable physiological impact.

CONCLUSION

This study shows that upper pole PCNL in the prone position can achieve strong stone clearance outcomes with a manageable risk of complications when performed with careful imaging guidance and attention to anatomy. The dimensions and density of the calculi significantly influenced the success of clearance. however, the overall outcomes were notably positive. These results advocate for the sustained application of prone access to the upper pole as a dependable strategy for the management of moderate to complex nephrolithiasis.

INTRODUCTION

Percutaneous nephrolithotomy (PCNL) is the standard minimally invasive procedure for the management of large and complex renal calculi.[1] Following its initial description by Fernstrom and Johansson in 1976,[2] PCNL rapidly became the preferred alternative to open surgery. Most urologists worldwide prefer performing PCNL in the prone position, as it allows direct entry into the pelvicalyceal system (PCS) via a puncture along Brodel's line. This approach provides a broader access point, enhances stone removal efficiency, minimizes the risk of abdominal organ injury, and has become widely adopted through extensive clinical experience.

A practical and secure method for upper pole access is the prone PCNL technique, which yields excellent outcomes in terms of stone clearance and can be performed as effectively as the supine approach.[4] Upper pole access can be achieved through either a supracostal or infracostal puncture. The supracostal approach, most often utilized on the left side due to the higher position of the kidney, offers a favourable tract alignment but carries a higher risk of pulmonary complications compared to the intracoastal approach.[5,6] Nevertheless, urologists frequently prefer upper pole PCNL for cases involving stones in the superior calyx, proximal ureter, morbidly obese patients, and selected cases of large-burden, staghorn, or complex calculi.[7]

Due to the kidney's close anatomical relationship with the diaphragm and pleura, upper pole access carries an increased risk of pulmonary complications, such as hydrothorax, hemothorax, pneumothorax, or a combination of these. Only a limited number of studies have investigated the factors contributing to these complications following upper pole access. [8,9]

Sharif et al. (2021) reported hydrothorax in 27.4% of patients undergoing upper pole PCNL.[8] Similarly, Treewattanakul et al. (2016) reported pleural injury in 13.6% of patients who underwent upper pole access PCNL,[9] while Sharma et al. (2016) observed pulmonary complications in 3.0% of such cases.[10] These findings highlight the variability in reported outcomes, suggesting that further evaluation is warranted to better define the safety and efficacy of this approach.

Given these variations, there is a need to further investigate the outcomes of upper pole access in PCNL performed in the prone position.

Therefore, the present study aims to evaluate the outcomes of upper pole PCNL with respect to stone clearance efficiency and procedure-related complications. This research will contribute to existing knowledge and help assess the safety and effectiveness of this technique in our clinical setting.

METHODOLOGY

This descriptive cross-sectional study was conducted in the Department of Urology at the Sindh Institute of Urology and Transplantation, Karachi, over a period of six months following synopsis approval. The study population comprised patients undergoing upper pole percutaneous nephrolithotomy (PCNL) with a stone size greater than 2.0 cm. The operational definition for stone clearance was the absence of detectable stones on plain X-ray or the presence of residual fragments measuring less than 5 mm on ultrasound, while complications included hydrothorax, pneumothorax, and blood loss. Hydrothorax was defined as the absence of breath sounds on auscultation with blunting of the costophrenic angle on chest X-ray; pneumothorax as diminished or absent breath sounds with a reduced lateral costophrenic angle on chest X-ray; and blood loss as a decline in haemoglobin level greater than 2 g/dL within 24 hours of the procedure or transfusion of more than 300 mL of blood. The sample size was calculated using an expected complication rate of (6.7%)10, a 3% margin of error, and a 95% confidence level, yielding a final sample size of 43 patients. Sampling was performed through consecutive non-probability sampling. Patients aged 18–60 years of either gender with renal stones larger than 2 cm planned for upper pole access PCNL were included. Exclusion criteria were non-dilating upper pole on retrograde pyelography, bleeding diathesis, difficult or anomalous renal anatomy on CT KUB, and refusal to provide consent. After obtaining informed consent demographic and clinical data were recorded. All procedures were carried out under general anaesthesia by a consultant urologist. Each surgery was performed in the prone position, and postoperative monitoring was conducted for 24 hours with serial chest auscultations and chest X-rays to identify complications. The need for blood transfusion and urine leakage was also documented using a predesigned proforma. Data were analysed using SPSS 26.0; mean ± standard deviation were calculated for quantitative variables, frequencies and percentages for qualitative variables, and associations were evaluated using Chi-square and t-tests with a significance level set at $p \leq 0.05$.

RESULTS

Table I: Baseline Demographic and Clinical Characteristics of Study Participants (n=43)		
Mean ± Standard Deviation		**95% Confidence Interval**
Age in years = **32.86 ± 10.33**		29.68 – 36.04
Size of Stone in cm = **2.80 ± 0.72**		2.58 – 3.03
Pre-op Hb in mg/dl = **12.66 ± 1.77**		12.11 – 13.21
Post-op Hb in mg/dl = **11.35 ± 1.74**		10.82 – 11.89
Frequency (%)		
Gender	Male	27 (62.8)
	Female	16 (37.2)
Nephrostomy Tube Placement		29 (67.4)
DJS placement		9 (20.9)

Table I presents the baseline demographic and clinical characteristics of the 43 study participants. The mean age was 32.86 ± 10.33 years (95% CI: 29.68–36.04), and the mean stone size was 2.80 ± 0.72 cm (95% CI: 2.58–3.03). The mean preoperative haemoglobin (Hb) level was 12.66 ± 1.77 mg/dl (95% CI: 12.11–13.21), which decreased to 11.35 ± 1.74 mg/dl (95% CI: 10.82–11.89) postoperatively. Among the participants, 27 (62.8%) were male and 16 (37.2%) were female. Nephrostomy tube placement was performed in 29 participants (67.4%), while double J stent (DJS) placement was done in 9 participants (20.9%).

Table II: Comparison of Outcomes of Upper Pole PCNL by Age Group and Gender (n=43)					
Outcomes		**Age Group**		**95% Confidence Interval**	**P-Value**
		18-30	**>30**		
Stone Clearance	Complete	16 (100.0)	26 (96.3)	N/A	0.628
	Partial	0 (0.0)	1 (3.7)		
Blood Transfusion		3 (18.8)	1 (3.7)	0.567–63.486	0.137
		Gender			
		Male	**Female**	**95% Confidence Interval**	**P-Value**
Stone Clearance	Complete	26 (96.3)	16 (100.0)	N/A	0.628
	Partial	1 (3.7)	0 (0.0)		
Blood Transfusion		3 (11.1)	1 (6.3)	0.178–19.726	0.521

Table II presents the comparison of outcomes of upper pole percutaneous nephrolithotomy (PCNL) according to age group and gender. Complete stone clearance was achieved in all participants aged 18–30 years 16 (100%) and in 26 participants (96.3%) aged >30 years, with one participant (3.7%) in the older group having partial clearance (P = 0.628). Blood transfusion was required in 3 participants (18.8%) in the younger age group and 1 participant (3.7%) in the older group (95% CI: 0.567–63.486; P = 0.137). When analysed by gender, complete stone clearance was observed in 26 males (96.3%) and 16 females (100%), with partial clearance in 1 male (3.7%) (P = 0.628). Blood transfusion was required in 3

males (11.1%) and 1 female (6.3%) (95% CI: 0.178–19.726; P=0.521).

DISCUSSION

This study examined the outcomes of upper pole percutaneous nephrolithotomy (PCNL) performed in the prone position, focusing on stone clearance and procedure-related complications. The position of upper pole access is commonly chosen as it offers a direct route to renal pelvis and bifurcated calyces; nevertheless, there are some technical difficulties associated with the access, such as an increased probability of pleural damage owing to the proximity existing between upper kidney and thoracic structures [5]. Through the examination of patient demographics stone attributes, and surgical specifics, this investigation elucidates the variables that may affect the efficacy and safety associated with the implementation of this methodology.

The mean age of patients was 32.86 + 10.33 years, and this is similar to most cohorts of PCNL in other countries where the majority of the patients are in the early or mid-adulthood stages [13]. The size of the stones was also in line with the average clinical threshold of PCNL where stones with a diameter of over 2 cm generally necessitate a percutaneous procedure compared to shockwave lithotripsy or ureteroscopy [14]. The identified similarities suggest that the use of upper pole percutaneous nephrolithotomy (PCNL) can be used in a wide set of patient demographics and emphasizes the need to tailor access techniques to the specifics of the anatomy and clinical presentation of a particular patient [15].

The dominance of males in this group is similar to the global trends in the use of nephrolithiasis and PCNL [11]. Although demographic characteristics do not necessarily dictate the outcomes of the operations, they offer convenient background on how the findings should be interpreted in comparison with the previous studies. Notably, the decision on the upper pole approach usually relies on the complexity or the location of the stones because the approach may provide the most direct approach to the challenging calyces or massive stones [1,5].

In this study, the rate of stone clearance with the use of the upper pole and lower pole PCNL was similar to that found in the literature, with upper and lower pole PCNL showing an average stone clearance rate of 75% 90% with respect to imaging procedures and surgical proficiency [11,17].

According to some research the puncture site is not widely found to have a clearance outcome impact but others indicate that the upper pole access could present better results in the event of a complex stone due to its direct alignment with the collecting system [1,5,7]. The results of this cohort can confirm the notion that upper pole PCNL is still viable even in patients with large stone burdens in case of experienced endourologists.

The density of stones also makes a significant contribution to the outcome of PCNL. Previous studies indicate that rocks that have low Hounsfield unit (HU) are easier to fracture whereas the dense ones can take a longer duration to be excised or may be deposits of fragments [19]. The surveys involving predictive modelling have also portrayed that the HU-related variables are significant predictors of end-stage stone-free condition [20]. The values of the HU of similar studies indicate that even moderately dense stones can be treated successfully with the help of appropriate fragmentation procedures, which underlies the significance of the thorough examination of preoperative images [19].

The ongoing debate regarding optimal positioning for PCNL is highly relevant. While supine PCNL has gained popularity due to improved anesthesia access and potentially easier upper calyx approach in some cases [3], many surgeons continue to prefer the prone position, especially for upper pole puncture, because it offers a familiar and spacious operative field [12,22]. While supine access can offer advantages in select situations [17], the findings of this study reaffirm that prone upper pole PCNL can be performed safely and effectively when puncture is guided with real-time imaging and careful attention to thoracic anatomy [21].

Although this study adds valuable information to the limited literature specifically examining upper pole PCNL in the prone position, it is not without limitations. Being conducted at a single center limits generalizability, and the sample size may not

capture subtle differences in outcomes. The level of experience among surgeons may also differ, potentially affecting both the rates of complications and the outcomes related to clearance. However, the concentrated focus of this investigation thorough evaluation of stone attributes, and uniformity in surgical methodology yield significant insights into the efficacy and safety associated with access to the upper pole.

The findings substantiate the ongoing application of upper pole percutaneous nephrolithotomy (PCNL) in meticulously selected patient populations. When executed by proficient surgeons utilizing suitable imaging modalities, this technique can realize substantial stone-free rates with tolerable complication profiles, even in instances encompassing large or intricate calculi.

CONCLUSION

This study shows that upper pole PCNL in the prone position can achieve strong stone clearance outcomes with a manageable risk of complications when performed with careful imaging guidance and attention to anatomy. The dimensions and density of the calculi significantly influenced the success of clearance. however, the overall outcomes were notably positive. These results advocate for the sustained application of prone access to the upper pole as a dependable strategy for the management of moderate to complex nephrolithiasis.

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