International Journal of Research in Medical Sciences
Mishra N et al. Int J Res Med Sci. 2025 Oct;13(10):4268-4272
www.msjonline.org
pISSN 2320-6071 | eISSN 2320-6012
DOI: https://dx.doi.org/10.18203/2320-6012.ijrms20253176

Original Research Article

Evaluating upper versus lower calyceal access in percutaneous nephrolithotomy: a prospective comparative study in complex renal calculi

Navneet Mishra*, Ashish Kumar Singh, M. Chandra Vamsi Krishna, Umesh Gautam, Manoj Kumar Mishra

Hind Institute of Medical Sciences, Barabanki, Uttar Pradesh, India

Received: 05 August 2025
Accepted: 16 September 2025

***Correspondence:**
Dr. Navneet Mishra,
E-mail: navneetmishrakgmu@gmail.com

ABSTRACT

Background: Percutaneous nephrolithotomy (PCNL) is the preferred modality for managing complex renal calculi, yet the optimal calyceal access upper or lower remains debated due to varied outcomes and complication profiles.
Methods: The research included 100 patients undergoing PCNL for treatment of complex renal stones. A division of patients occurred into two distinct groups: those accessing the upper calyces with n=46 and those accessing the lower calyces with n=54. Medical staff evaluated stone size together with operative time and haemoglobin drop and stone clearance and hospital stay duration.
Results: Finding shows operative durations (84.35 min vs. 84.66 min, p>0.05), baseline stone sizes (39.07 mm vs. 39.41 mm, p>0.05), haemoglobin decline (1.58 vs. 1.57 gm%, p>0.05) and hospital stay (3.80 vs. 3.67 days, p>0.05) were similar for both groups. Though the variation was not statistically noteworthy (p>0.05), the upper calyceal group (86.96%) had a greater total stone clearance rate than the lower (75.93%).
Conclusions: Regarding operative time, safety and recuperation, upper and lower calyceal access in PCNL produced similar clinical results. Upper calyceal access, on the other hand, indicated a tendency toward improved stone clearance, implying possible clinical preference in certain complicated situations.

Keywords: Endourology, Lower calyceal access, Percutaneous nephrolithotomy, Renal calculi, Stone clearance, Upper calyceal access

INTRODUCTION

Percutaneous nephrolithotomy (PCNL) has become the standardized approach for treating complex renal stones because it provides effective stone elimination and reduces surgical invasion.[1] Hospital practitioners debate the choice between upper and lower calyceal access because it affects patient surgery outcomes and postoperative complication frequencies.[2] Urolithiasis functions as a frequent urological condition affecting 5-15% of the worldwide population whose recurrence rate reaches half throughout their lives.[3,4] The global health burden of renal stone disease includes our regional area because the disorder leads to decreased patient quality of life and creates continuous clinical problems.[5] Modern urological surgery now selects minimally invasive procedures which minimize patient risk while achieving successful stone removal. Particularly when less invasive techniques like extracorporeal shock wave lithotripsy (ESWL) are judged ineffectual, PCNL has surfaced as the preferred way to manage large, complicated or staghorn renal stones among these.[6]

The safety, accuracy and effectiveness of PCNL have been greatly improved by developments in nephroscopic technology, tract dilatation instruments and lithotripsy techniques, therefore enabling success rates over 90% in some investigations.[7] A key factor in the result of PCNL is

the method used upper, middle or lower calyx. Although the lower calyceal puncture is usually safer and less likely to cause thoracic problems, particularly in complicated or staghorn stone situations it may provide limited access to the whole collecting system. On the other hand, upper calyceal access offers a more direct and advantageous path to the renal pelvis and calyceal system, hence enabling total stone elimination with less tracts and less disturbance.[8]

This method, however, is technically challenging and linked with a greater risk of thoracic injury, particularly when done via the supra costal route. Given the therapeutic relevance of access route choice in PCNL, this prospective observational investigation was done to gauge the safety, effectiveness, along with complication profile of upper against lower calyceal methods in the therapy of complicated renal calculi. By means of patient demographic data analysis including variables such prior open surgery and stone size this study aims to do a comparative assessment of the upper versus lower calyceal approach in PCNL for complicated renal calculi. The study also intends to evaluate and contrast surgical parameters such as length of surgery and intraoperative findings between the two groups. Finally, the study aims to assess surgical results especially stone-free rates to find the relative effectiveness of each method.

METHODS

Study place

The study was conducted at the Department of Urology, Sri Venkateswara Institute of Medical Sciences, Tirupati.

Study duration

This prospective observational study was conducted from June 2020 to September 2021.

Participants

A total of 100 patients from age 18 and above participated in the study after they met both age requirements and had complex renal calculi that needed percutaneous nephrolithotomy (PCNL) treatment.

Data collection and outcome evaluation

The data gathered operative information about puncture locations as well as surgical duration and postoperative complications and stone clearance status and second procedure requirements. The X-ray examination of the chest became necessary after surgical operations with supracostally puncture to identify any damage occurring in the thoracic area. The Institutional Ethics Committee endorsed this study following which researchers obtained written consent from their participants. The patients involved in this study were subject to no new dangers or operational requirements or monetary costs.

Inclusion criteria

Patients aged 18 years and above. Radiopaque renal calculi visible on X-ray KUB. Normal upper urinary tract anatomy. Requiring PCNL with a single calyceal tract puncture (either upper or lower pole). Provided informed written consent.

Exclusion criteria

Refusal to participate. Radiolucent stones. Pyonephrosis. Significant comorbidities (e.g., diabetes mellitus, hypertension, patients on anticoagulants). Congenital anomalies (e.g., PUJ obstruction, bifid pelvis, megaureter, horseshoe kidney). Requirement for multiple puncture access tracts.

Procedure:

History, physical examination and full blood count, along with renal function tests, coagulation profile, urine culture, X-ray KUB, ultrasonography and CT abdomen comprised preoperative assessment. While some got preventive antibiotics, those with positive urine cultures got focused antibiotics.

The same surgical team carried out all PCNL operations. Patients were catheterized in the lithotomy position under fluoroscopic direction, then a 6Fr ureteric catheter was inserted. Based on intraoperative results, C-arm fluoroscopy guided calyceal punctures (upper or lower) in the prone posture. Using a stiff nephroscope and Swiss Lithoclast, the stones were broken and removed; Alkens metal dilator (20Fr) was used to expand the tracts. Operative time, complications (e.g., hydrothorax, hemorrhage, infection) and requirement for blood transfusion or additional treatments were included of postoperative assessment.

Data analysis

Following data collection, Microsoft Excel facilitated initial entry. Subsequent statistical analysis employed dedicated software. The Chi-square test served to compare categorical variables, while continuous variables underwent analysis using the independent samples t-test. A p value <0.05 was deemed statistically noteworthy.

RESULTS

In this study, total number of 100 patients having complex renal stones underwent PNCL. The patients were distributed among two groups based on the preferential calyceal puncture. The selection of puncture for each patient was based on the principle as described in materials and methods. 100 patients who received PCNL treatment for complex renal stones formed the basis of this study according to Table 1. The patients were divided between those managed through upper calyceal puncture (46 patients) and those managed through lower calyceal

puncture (54 patients). The authors maintained a proportionate distribution of subjects to enable standardized evaluation of both methods. The puncture methods used for the upper calyceal patients split equally into supracostally and intracoastal approaches.

Table 2 side-wise distribution indicated that most procedures in both groups were done on the right kidney: 29 right-sided punctures inside upper calyceal group and 35 inside lower. There were 17 and 19 occurrences on the left side, respectively. Statistical analysis revealed no notable variation in side preference (Chi-square=0.0338, p>0.05), suggesting that side selection had no effect on the choice of calyceal puncture.

The stone size averaged at 39.07 mm inside upper calyceal puncture group and 39.41 mm in the lower calyceal group as per table 3. The outcomes designated no noteworthy variance (P>0.05) between groups which showed the renal stones had no impact on puncture site selection and both groups had comparable stone size.

The mean operative time came out similar among the study groups at 84.35 minutes for upper calyceal puncture and 84.66 minutes for lower calyceal puncture as shown in Table 4. PCNL procedural duration remained unaffected by the selected calyceal puncture entry point since their duration comparison indicated no statistical difference (p>0.05).

Haemoglobin levels experienced an average decrease of 1.58 gm% inside upper calyceal group and 1.57 gm% inside lower calyceal group according to Table 5 without any noticeable statistical variation (p>0.05). The amount of blood loss during surgery remained equal between the two puncture techniques.

The complete clearance rate achieved by patients in the upper calyceal puncture group reached 86.96% and exceeded the rate of 75.93% achieved by the lower calyceal group as shown in Table 6. Upper calyceal patients experienced residual stones in 13.04% of their cases while lower calyceal patients had residual stones in 24.07% of their cases. The stone clearance outcome of upper calyceal puncture tests demonstrated an in noteworthy yet promising trend compared to lower calyceal puncture measures (p>0.05).

As shown in Table 7 upper calyceal group patients required 3.80 days for hospitalization but lower calyceal group patients needed 3.67 days for their hospital stay. Both treatment groups showed comparable postoperative recovery periods because the statistical test outcomes discovered no noteworthy variance (p>0.05).

Table 1: Distribution of cases in study group.

Calyceal puncture	No. of cases	%
Upper	46	46
Lower	54	54
Total	100	100

Table 2: Side wise distribution of cases in upper and lower calyceal puncture group.

Side	Calyceal puncture		Total
	Upper (n=46)	Lower (n=54)	
Right	29	35	64
Left	17	19	36
Total	46	54	100

Table 3: Comparison of stone size in upper and lower calyceal puncture group.

Parameter	Calyceal puncture				t value	P value
	Upper (n=46)		Lower (n=54)			
	Mean	SD	Mean	SD		
Stone size (mm)	39.07	6.14	39.41	7.03	0.26	>0.05

Table 4: Comparison of operative time in upper and lower calyceal puncture group.

Operative	Calyceal puncture				t value	P value
	Upper (n=46)		Lower (n=54)			
	Mean	SD	Mean	SD		
Time (min)	84.35	8.17	84.66	7.47	0.198	>0.05

Table 5: Comparison of Hb% drop in upper and lower calyceal puncture group.

Parameter	Calyceal puncture				t Value	P value
	Upper (n=46)		Lower (n=54)			
	Mean	SD	Mean	SD		
Hb drop (gm%)	1.58	0.5	1.57	0.52	0.098	>0.05

Table 6: Clearance rate in upper and lower Calyceal puncture group.

Complication	Upper calyceal puncture		Total
	Upper	Lower	
Complete clearance (CC)	40 (86.96)	41 (75.93)	81 (81)
Residual stones (RS)	6 (13.04)	13 (24.07)	19 (19)
Total	46 (100)	54 (100)	100 (100)

Table 7: Comparison of hospital stay in upper and lower calyceal puncture group.

Operative	Calyceal puncture				t value	P value
	Upper (n=46)		Lower (n=54)			
	Mean	SD	Mean	SD		
Hospital Stay (in Days)	3.8	1.2	3.67	1.12	0.559	>.05

DISCUSSION

This prospective research of 100 patients compared upper and lower calyceal techniques in PCNL to treat complicated renal calculi. The near-equal distribution allowed a balanced comparison with 46% under upper and 54% lower calyceal access. Side-wise distribution revealed no notable variation, suggesting that kidney laterality had no effect on access site choice. With respect to stone load, both groups had a comparable average stone size (upper: 39.07 mm, lower: 39.41 mm) and the absence of statistically noteworthy difference (P>0.05) verifies that stone size was uniformly distributed, hence excluding size as a confounding factor in outcome comparison. Mean surgery time (upper: 84.35 min, lower: 84.66 min) and mean haemoglobin decline (upper: 1.58 gm%; lower: 1.57 gm%) were similarly statistically comparable between the two groups.

These results draw attention to the fact that both methods are similar in intraoperative performance and blood loss, hence implying that either path can be safely used in skilled hands. Though the difference did not attain statistical significance (p>0.05), the upper calyceal puncture group (86.96%) had a greater stone clearance rate than the lower calyceal group (75.93%). This trend supports the anatomical benefit of upper pole access, which provides a more direct, linear path to the renal pelvis and calyceal system, therefore minimizing the need for several punctures or complicated nephroscopy manoeuvring.

A study by Baltar et al results, they found that upper pole access gave patients with complicated renal stones, especially staghorn calculi, much better stone clearance because to the broader visibility and accessibility of all calyces through a single tract.[9] Another multicentric study by Yucheng et al, found that while upper pole access has a little greater peril of thoracic problems when done supracostally, it always provides better stone-free rates with less residual pieces in complicated situations.[8]

Without lengthening problems or hospital stay, prospective research by Amaresh et al, revealed upper calyceal access exhibited greater stone-free rates, quicker operating time and fewer secondary tracts.[10] Taber et al, conducted another study showing that upper calyceal puncture gave more effective access to several calyces and renal pelvis, hence improving stone clearance in complicated stones.[11] Similar work by Nottingham et al, showed comparable complication rates between upper and lower calyceal access with marginally superior stone clearance results in upper calyceal group.[12] Liu et al also discovered no notable change in blood loss or surgical duration, so supporting that upper access is as safe as lower access with more effective clearing.[13]

Moreover, the groups' hospital stay length was similar (upper: 3.80 days, lower: 3.67 days), suggesting that the selection of access site did not notably affect postoperative recovery or morbidity in the near run. Though both upper and lower calyceal accesses are efficient and safe methods in PCNL, the upper calyceal route indicated a tendency toward improved stone clearance without extra problems or extended recovery.

Given the treatment is done with suitable skill and imaging assistance, this supports the idea that upper calyceal access may yield better results in suitably chosen patients particularly those with staghorn or complicated stones.

CONCLUSION

In conclusion both upper and lower calyceal access routes in PCNL offer similar safety profiles, operative times and recovery outcomes for managing complex renal stones. While statistical significance was not achieved, the upper calyceal approach demonstrated a higher trend in complete stone clearance. This suggests it may be preferable in select cases, particularly when targeting multiple or staghorn calculi. Further large-scale studies are warranted to validate these findings.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Huang T, Jiao BB, Luo ZK, Zhao H, Geng L, Zhang G. Evidence of the outcome and safety of upper pole vs. other pole access single puncture PCNL for kidney stones: which is better. Eur Rev Med Pharmacol Sci. 2023;27(10):4406-4420.
2. Mazumder MK, Haque MM, Nandy SP, Ghose A, Rahman MT, Khondoker S. Quasi-Experimental Comparison between Upper and Lower Calyceal Approach in Percutaneous Nephrolithotomy for Complex Renal Calculi in Bangladesh. IAHS Med J. 2023;6(1):62-7.
3. Memon WA, El Khalid S, Haider A, Saulat S, Khan SA, Quddus MB, et al. Comparative evaluation of upper versus lower calyceal approach in percutaneous nephrolithotomy (PCNL) for managing renal calculi. J Pak Med Assoc. 2021;71(2):602-7.
4. Ricapito A, Gupta K, Savin Z, Gupta KR, Connors C, Khargi R, et al. Comparative analysis of safety and efficacy between anterior and posterior calyceal entry in supine percutaneous nephrolithotomy. J Endourol. 2025;1;39(1):19-25.
5. Balaji S, Ganpule A, Herrmann T. Contemporary role of multi-tract percutaneous nephrolithotomy in the treatment of complex renal calculi. Asian J Urol. 2020;7(2):102-9.
6. Ma Y, Lin L, Luo Z, Jin T. Superior calyceal access vs. other calyceal access in percutaneous nephrolithotomy: A systematic review and meta-analysis. Front Surg. 2022;9:930159.
7. Leslie SW, Sajjad H, Murphy PB. Renal Calculi, Nephrolithiasis. In: StatPearls. Treasure Island (FL): StatPearls Publishing 2024.
8. Sanchez-Ruiz MJ, Khalaf T, Tadros N. Personality research in Lebanon: Personal reflections on challenges and opportunities. Personality Sci. 2025;6:27000710241264456.
9. Fernández Baltar C, Martínez Corral ME, Pérez Fentes D. Predicting and avoiding complications in percutaneous nephrolithotomy in the era of personalized medicine: a scoping review. J Pers Med. 2024;14:962.
10. Amaresh M, Hegde P, Chawla A. Safety and efficacy of superior calyceal access versus inferior calyceal access for pelvic and/or lower calyceal renal calculi-a prospective observational comparative study. World J Urol. 2021;39:2155-61.
11. Tabei T, Ito H, Inoue T, Watanabe T, Fukuda T, Yamamichi F, et al. Influence of tract location on the outcomes of endoscopic combined intrarenal surgery: a retrospective analysis of 1000 cases. Int J Urol. 2023;31(4):349–54.
12. Nottingham CU, Large T, Lingeman JE, Krambeck AE. A comparison of perioperative stone-free rates and complications following unilateral, single-access percutaneous nephrolithotomy by access location in 767 patients. Urology. 2020;142:70-5.
13. Yung-Hao L, Heng C. Contemporary management of large and complex renal calculi: have we found the perfect solution yet. Urol Sci. 34(4):164-9.

Cite this article as: Mishra N, Singh AK, Krishna MCV, Gautam U, Mishra MK. Evaluating upper versus lower calyceal access in percutaneous nephrolithotomy: a prospective comparative study in complex renal calculi. Int J Res Med Sci 2025;13:4268-72.