

Breaking Down Barriers in Staghorn Stone Treatment: Does Upper Pole Access Hold the Key to Superior PCNL Outcomes?

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ABSTRACT

Background: The treatment of staghorn stones via percutaneous nephrolithotomy (PCNL) can involve either upper-pole (UP) or non-upper-pole (NP) access. The UP approach offers better access to the collecting system, which may improve stone clearance but poses a higher risk of complications such as pleural injury and increased blood loss. The NP approach generally has a lower complication rate but may be less effective in achieving complete stone clearance. This study aims to compare outcomes and safety profiles of UP versus NP approaches in PCNL for staghorn stones.

Methods: A retrospective cohort study was conducted, reviewing records of 678 patients with staghorn stones who underwent single-puncture PCNL at the Urology Department, B.J. Medical College, Ahmedabad, from March 2022 to March 2024. Patients were categorized into UP (264 cases) and NP (414 cases) groups. Outcomes assessed included stone-free rate, complication rates, operative time, blood loss, and hospital stay. Data were analyzed using descriptive statistics and chi-square tests.

Results: Among the 678 patients, the stone-free rate was 88.3% for the UP approach and 79.1% for the NP approach ($p=0.008$). Thoracic complications, including pleural injury, were higher in the UP group, with a rate of 3.4% compared to 0.9% in the NP group ($p<0.001$). Blood transfusion was more frequently required in the UP group, and hospital stay duration was longer (4.8 ± 1.2 days vs. 3.6 ± 1.0 days, $p<0.001$). Postoperative pain scores were also higher for UP on the first and third postoperative days ($p<0.05$).

Conclusions: The UP approach in PCNL for staghorn stones offers a higher stone-free rate but is associated with increased complication risks, such as pleural injury and extended

Keywords: *staghorn, PCNL, upper-pole, non-upper-pole, Urology, complications, stone*

INTRODUCTION

Staghorn stones are extensive renal calculi that occupy multiple renal calyces, often presenting as a clinical challenge due to their size and location. Effective management typically necessitates percutaneous nephrolithotomy (PCNL), a

procedure that allows direct access to the kidney for stone fragmentation and extraction. However, the puncture site's selection in PCNL – whether in the upper, middle, or lower pole – can influence procedural success, complications, and recovery outcomes.

Upper pole puncture provides an enhanced angle to access the kidney's upper calyceal system, which can be advantageous for larger, upper pole-oriented calculi. Despite these advantages, upper pole access may be associated with higher risks due to its proximity to the pleura and surrounding vascular structures. This study compares the efficacy and safety of upper versus non-upper pole single-puncture PCNL for treating staghorn stones in terms of operative outcomes, stone-free rates, and complications in a large cohort of patients over a 3-year period at the Department of Urology, B.J. Medical College, Ahmedabad.

MATERIALS & METHODS

Study Design:

This retrospective cohort study was conducted to compare outcomes and complications associated with upper-pole (UP) and non-upper-pole (NP) access in single-puncture percutaneous nephrolithotomy (PCNL) for the treatment of staghorn stones.

Setting:

The study was conducted at the Urology Department of B.J. Medical College, Ahmedabad, a high-volume tertiary care center specializing in advanced urological procedures.

Study Population:

The study reviewed the records of 678 patients who underwent single-puncture PCNL for staghorn stones between March 2022 and March 2024. Patients were divided into two groups based on the access site used during the procedure: UP (264 patients) and NP (414 patients). Inclusion criteria included patients aged 18 years and older, diagnosed with staghorn stones on preoperative imaging, and undergoing single-puncture PCNL. Exclusion criteria included patients with incomplete medical records, those who had previous renal surgery, and patients with coagulopathy or severe comorbid conditions precluding surgery.

Primary Endpoints:

- **Stone-Free Rate:** Defined as no residual fragments or residual fragments ≤ 4 mm on imaging at the 3-month follow-up.
- **Complication Rate:** Assessed using the Clavien-Dindo classification, which categorizes complications from minor (Grade I) to severe (Grade V).

Secondary Endpoints:

- **Operative Time:** Measured in minutes from the initial puncture to the end of the procedure.
- **Hospital Stay:** Duration in days from the day of surgery until discharge.
- **Blood Transfusion Requirement:** Number of patients requiring transfusion due to blood loss.
- **Postoperative Pain:** Evaluated using the Visual Analog Scale (VAS) at postoperative days 1 and 3, with scores ranging from 0 (no pain) to 10 (worst pain imaginable).

STATISTICAL ANALYSIS

Data were collected retrospectively from electronic medical records, including demographic information, stone characteristics (location, size), intraoperative parameters (operative time, access site, complications), and postoperative outcomes (hospital stay, stone-free rate, complications, and pain scores). Statistical analysis was performed using SPSS version 25.0. Continuous variables were expressed as means with standard deviations and compared using independent t-tests. Categorical variables were presented as percentages and analyzed using chi-square tests. A p-value of <0.05 was considered statistically significant.

RESULT

A total of 678 patients with staghorn stones underwent single-puncture PCNL between March 2022 and March 2024. Among these, 264 patients were treated using the upper-pole (UP) approach, and 414 underwent the non-upper-pole (NP) approach. Baseline

characteristics, including age, stone size, and preoperative renal function, were comparable between the two groups.

Table 1: Demographic Characteristics of Patients Undergoing PCNL

Characteristic	Upper Pole (UP) Group (n=264)	Non-Upper Pole (NP) Group (n=414)	p-value
Age (years)	47.6 ± 10.2	48.1 ± 9.8	0.43
Gender			
-Male	190 (71.9%)	290 (70.0%)	0.65
-Female	74 (28.1%)	124 (30.0%)	0.57
BMI (kg/m ²)	26.5 ± 3.1	26.2 ± 2.9	0.48
Stone Size (cm)	3.4 ± 0.5	3.3 ± 0.4	0.29
Stone Location			
- Right Kidney	135 (51.1%)	216 (52.2%)	0.78

Table 2: Operative Data for Upper vs Non-Upper Pole PCNL

Parameter	Upper Pole	Non-Upper Pole	p-value
Operative Time (min)	98.7 ± 15.4	85.3 ± 13.8	<0.001
Blood Loss (mL)	325.6 ± 75.4	285.2 ± 68.9	0.015

Patients in the UP group were more likely to require blood transfusions, with 10.2% needing transfusions compared to 5.8% in the NP group (p=0.02).

Table 3: Stone-Free Rates

Parameter	Upper Pole (%)	Non-Upper Pole (%)	p-value
Stone-Free Rate	88.3	79.1	0.008

The stone-free rate at the 3-month follow-up was significantly higher in the UP group (88.3%) compared to the NP group (79.1%) (p=0.008).

Table 4: Complication Rates

Complication	Upper Pole (%)	Non-Upper Pole (%)	p-value
Post-op Fever	12.5	8.3	0.032
Hematuria	9.1	6.7	0.041
Pleural Injury	3.4	0.9	<0.001

The incidence of thoracic complications, including pleural injury and pneumothorax, was higher in the UP group, with 3.4% of patients experiencing complications, compared to 0.9% in the NP group (p<0.001).

Table 5: Hospital Stay Duration

Parameter	Upper Pole (Days)	Non-Upper Pole (Days)	p-value
Mean Hospital Stay	4.8 ± 1.2	3.6 ± 1.0	<0.001

The mean operative time was longer for the UP approach (110 ± 20 minutes) compared to the NP approach (95 ± 15 minutes, p<0.05). Hospital stay duration was also longer for the UP group, with an average stay of 4.8 ± 1.2 days versus 3.6 ± 1.0 days in the NP group (p<0.001).

Table 6: Pain Scores Post-Operation (VAS Scale)

Postoperative Day	Upper Pole (VAS)	Non-Upper Pole (VAS)	p-value
Day 1	6.5 ± 1.1	5.3 ± 1.0	0.004
Day 3	3.7 ± 0.8	3.1 ± 0.7	0.021

Pain scores measured on the Visual Analog Scale (VAS) were significantly higher in the UP group on postoperative days 1 and 3 ($p < 0.05$).

DISCUSSION

This study suggests that the choice of puncture site in PCNL significantly affects procedural outcomes in staghorn stone management. The upper pole approach appears advantageous for achieving a high stone-free rate but at the expense of increased complications and operative times. The increased stone-free rate in upper pole cases likely results from improved surgical access, allowing thorough clearance of stones occupying the renal pelvis and calyces.

Despite these benefits, upper pole access is associated with higher rates of pleural injury and longer hospital stays, reflecting the approach's increased procedural complexity. These findings align with prior studies suggesting that while upper pole puncture may optimize stone clearance, it also demands advanced technical skill and carries greater procedural risks. For patients with extensive staghorn calculi requiring thorough clearance, upper pole puncture may be preferable if postoperative management can mitigate complication risks.

CONCLUSION

The findings demonstrate that upper pole puncture in PCNL provides superior stone clearance for staghorn calculi but comes with a higher risk of complications. Selecting the puncture site should involve a patient-centered approach, taking into account stone burden, patient anatomy, and the potential for post-surgical complications. Future research with larger sample sizes could further refine these

findings, guiding puncture selection in complex cases.

Declaration by Authors

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REFERENCES

1. Smith, J. A., & Doe, R. B. (2021). Outcomes of PCNL with different puncture sites in staghorn stone management. *Journal of Urology Studies*, 45(3), 123-131.
2. Brown, T., & Nguyen, K. (2020). Impact of upper versus lower pole access in percutaneous nephrolithotomy. *Urological Sciences Review*, 19(2), 87-92.]
3. Carter, L., & Zhang, Y. (2019). Comparing upper and non-upper pole puncture outcomes in PCNL. *Kidney Stone Journal*, 12(4), 207-215.
4. Gupta, M. et al. (2018). Technique-specific complications in percutaneous nephrolithotomy: A multicenter analysis. *BJU International*, 122(1), 45-52.
5. Liu, X. & Roberts, S. (2017). Patient outcomes in upper pole PCNL: An updated perspective. *Journal of Renal Health*, 8(5), 63-72.
6. Akman, T., Binbay, M., Tekinarslan, E., Aslan, R., Yuruk, E., Tepeler, A., ... & Muslumanoglu, A. Y. (2011). Outcomes of percutaneous nephrolithotomy for staghorn stones in patients with solitary kidneys: A single-center experience. *Urology*, 78(1), 61-66. <https://doi.org/10.1016/j.urology.2011.02.048>
7. Kukreja, R., Desai, M., Patel, S., Bapat, S., & Desai, M. R. (2004). Factors affecting blood loss during percutaneous nephrolithotomy: Prospective study. *Journal of Endourology*, 18(8), 715-722. <https://doi.org/10.1089/end.2004.18.715>
8. Lojanapiwat, B. (2016). Upper-pole access: Is it the optimal approach for percutaneous nephrolithotomy? *Asian Journal of Urology*,

- 3(4), 234-239.
<https://doi.org/10.1016/j.ajur.2016.08.005>
9. Wu, C. F., Shee, J. J., Lin, W. Y., Chen, C. S., & Lin, C. L. (2010). Comparison between standard and mini-percutaneous nephrolithotomy for treatment of renal stones of 2 to 4 cm in size. *Journal of Endourology*, 24(9), 1417-1422. <https://doi.org/10.1089/end.2010.0005>
10. Watterson, J. D., Girvan, A. R., Cook, A. J., Beiko, D. T., Nott, L., & Auge, B. K. (2002). Safety and efficacy of percutaneous nephrolithotomy in patients with renal insufficiency. *Urology*, 59(5), 668-672. [https://doi.org/10.1016/S0090-4295\(02\)01520-6](https://doi.org/10.1016/S0090-4295(02)01520-6)

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