



PROSPECTIVE COMPARATIVE STUDY OF MINI PCNL AND STANDARD PCNL FOR THE TREATMENT OF 1 TO 2 CM LOWER CALYCEAL RENAL STONE

Dr Lakshay Goyal	Senior Resident, Department Of Urology, NIMS University Jaipur Rajasthan
Dr Vinay Tomar	Senior Professor And Head, Department Of Urology, NIMS University Jaipur Rajasthan
Dr Nisar Ahmed	Professor, Department Of Urology, NIMS University Jaipur Rajasthan
Dr Mahakshit Bhat	Associate Professor, Department Of Urology, NIMS University Jaipur Rajasthan

ABSTRACT

Background: Urolithiasis remains one of the most common urological conditions, and several treatment options are available, ranging from non-invasive to minimally invasive techniques. Standard percutaneous nephrolithotomy (PCNL) and its miniaturized version (Mini-PCNL) are frequently employed. This study evaluates the safety, effectiveness, and practicality of Mini-PCNL in managing 1–2 cm lower calyceal renal stones. **Methods:** A prospective comparative study was carried out on 60 patients diagnosed with lower calyceal calculi. Participants were divided into two groups: Standard-PCNL (control group) and Mini-PCNL (study group). Key parameters assessed included operative time, peri- and postoperative complications, stone clearance rates, need for analgesics, hemoglobin drop, requirement of blood transfusion, and duration of hospitalization. Data were recorded in Microsoft Excel and analyzed using SPSS and Statistica software. **Results:** The Mini-PCNL group demonstrated a significantly longer mean operative time (55.06 ± 5.02 min) compared with Standard-PCNL (39.06 ± 4.54 min; $p < 0.0001$). However, Mini-PCNL required less postoperative analgesia (35.0 ± 16.86 vs. 55.83 ± 27.60 ; $p = 0.001$) and showed a lower mean hemoglobin drop (0.55 ± 0.17 g/dL vs. 1.0 ± 0.32 g/dL; $p = 0.0001$). The stone-free rates were comparable between both groups (96.66% vs. 100%; $p = 0.313$). Complications were generally fewer in the Mini-PCNL group, though differences were not statistically significant. **Conclusion:** Mini-PCNL achieves stone clearance rates comparable to Standard-PCNL for stones measuring 1–2 cm. Although it requires a longer operative time, Mini-PCNL is associated with reduced blood loss, lower analgesic requirement, and a trend toward shorter hospital stay, making it an effective and safe alternative for managing lower calyceal renal stones.

KEYWORDS : Mini-percutaneous nephrolithotomy, Standard-percutaneous nephrolithotomy, renal calculi, complications

BACKGROUND

Urolithiasis is a prevalent condition worldwide, with its incidence steadily increasing and carrying substantial social and economic consequences [1,2]. Over the past four decades, the management of renal calculi has evolved significantly, with several treatment options available. For smaller renal stones, the main modalities include percutaneous nephrolithotomy (PCNL), retrograde intrarenal surgery (RIRS), and extracorporeal shockwave lithotripsy (SWL) [3].

The management of lower calyceal stones measuring 1–2 cm continues to be debated. Multiple factors—such as patient body habitus, renal anatomy, cost implications, and patient preference—must be considered when choosing the optimal intervention [4–7]. Approximately 60% of patients present with unfavorable calyceal anatomy (e.g., narrow infundibulum, acute infundibulopelvic angle, or elongated infundibular length), which hampers effective stone clearance across all modalities.

Shockwave lithotripsy often results in residual fragments, particularly within the dependent lower calyx, and is less effective in patients with challenging anatomy. Similarly, RIRS can be limited by the difficulty of maneuvering the flexible ureteroscope through acute angles and the challenges of stone retrieval or laser targeting. Furthermore, the need for advanced and costly endoscopic equipment may restrict its wider use [8].

In contrast, PCNL provides direct percutaneous access to the renal collecting system, followed by tract dilation, stone fragmentation, and removal through a nephroscope. This approach has consistently demonstrated high stone-free rates and shorter treatment courses [9–11]. However, PCNL is also associated with potentially serious complications, most of which are linked to the tract size and formation [12,13].

To mitigate morbidity—such as blood loss, postoperative pain, and renal parenchymal trauma—efforts have been directed toward reducing tract size. This led to the development of miniaturized techniques, where PCNL is performed using smaller endoscopes (11–20 Fr access sheaths), referred to as Mini-PCNL. The term is typically applied to tracts less than 20 Fr.

From a technical standpoint, Mini-PCNL is considered less invasive, as smaller tracts are associated with reduced transfusion requirements and less renal trauma. Although studies suggest no major differences in postoperative renal scarring or loss of function compared to standard PCNL, the smaller working channel can sometimes limit the efficiency of stone fragmentation and extraction [14].

Given these considerations, this study was designed to prospectively compare Mini-PCNL with Standard PCNL in the management of 1–2 cm lower calyceal stones, evaluating their relative safety, efficacy, and feasibility.

MATERIALS AND METHODS

This was a prospective comparative study conducted at NIMS Hospital between July 2023 to December 2024. A total of 60 patients with lower calyceal renal stones measuring 1–2 cm were enrolled. Approval was obtained from the Institutional Ethics Committee prior to the start of the study. Patients were informed about the investigational nature of the procedures, and written consent was obtained before inclusion.

Participants Were Assigned To Two Groups:

- Standard-PCNL group ($n = 30$)
- Mini-PCNL group ($n = 30$)

Inclusion Criteria: Patients aged 18–60 years with a solitary lower calyceal stone measuring 1–2 cm.

Exclusion Criteria: Patients with untreated coagulopathies, active urinary tract infection or pyonephrosis, abnormal renal anatomy or function on imaging, multiple stones, or age outside the defined range.

Stone size was defined as the maximum dimension observed on preoperative plain abdominal radiographs.

The following outcomes were evaluated: operative time, intraoperative and postoperative complications, blood loss (hemoglobin drop and transfusion requirement), stone clearance at 1 month (X-ray KUB; fragments <4 mm considered insignificant), analgesic requirement (mg tramadol), and hospital stay (days).

All procedures were performed by a single surgeon. Mini-PCNL was carried out with tract dilation up to 16–18 Fr and use of an 16 Fr miniature nephroscope. Stones were fragmented using Holmium:YAG laser. A 16 Fr nephrostomy tube was placed at the end. Standard-PCNL involved tract dilation up to 24–26 Fr, stone fragmentation with pneumatic lithotripsy, and placement of a 20 Fr nephrostomy tube. In both groups, a 5 Fr double-J stent was inserted. Nephrostomy tubes were removed on first postoperative day, catheter were removed 24 hours after that and patients were discharged accordingly.

Data were analyzed using Microsoft Excel, SPSS (version 27.0). Continuous variables were expressed as mean $\pm$ SD, and a p-value <0.05 was considered statistically significant.

RESULTS

Sixty patients were studied, with 30 in each treatment group. Out of the 30 patients in each group, the mini PC group comprised 18 males and 12 females while the standard PCNL group included 16 males and 14 females. The mean age was 38.2 ± 19.8 years in the Mini-PCNL group and 45.2 ± 14.8 years in the Standard-PCNL group.

The mean operative time was significantly longer in Mini-PCNL (55.06 ± 5.02 minutes) compared with Standard-PCNL (39.06 ± 4.54 minutes; $p < 0.0001$). The mean hospital stay was slightly shorter in Mini-PCNL (2.8 ± 0.40 days) compared to Standard-PCNL (3.0 ± 0.64 days), but this difference was not statistically significant ($p = 0.156$). Analgesic requirement was significantly lower in Mini-PCNL (35.0 ± 16.86 mg) versus Standard-PCNL (55.83 ± 27.60 mg; $p = 0.001$). Hemoglobin drop was also less in Mini-PCNL (0.55 ± 0.17 g/dL) compared with Standard-PCNL (1.0 ± 0.32 g/dL; $p = 0.0001$). Stone clearance rates were similar, with 96.66% in Mini-PCNL and 100% in Standard-PCNL ($p = 0.313$).

Complications were fewer in Mini-PCNL but without significant differences. Pelviccalyceal perforation occurred in 1 Mini-PCNL patient and 2 Standard-PCNL patients ($p = 0.700$). Significant bleeding was reported in 3 Standard-PCNL cases but none in Mini-PCNL ($p = 0.248$), with 1 patient requiring transfusion. Postoperative fever occurred in 2 Mini-PCNL and 4 Standard-PCNL patients ($p = 0.505$).

DISCUSSION

PCNL remains a cornerstone in the management of renal calculi, offering direct access to the collecting system and high clearance rates in a single procedure. In our study, male predominance (56.7%) was observed, consistent with earlier studies by De la Rosette et al. [15] and Bayles et al. [16]. The mean age was slightly lower compared to those studies, likely reflecting sample size limitations.

The most notable limitation of Mini-PCNL was its longer operative time, in agreement with findings from Mishra et al. [19] and Zhu et al. [20]. Prolonged surgery may be due to smaller instrument size, limited visibility, and the need for extensive laser fragmentation.

Analgesic use was significantly lower in Mini-PCNL patients, supporting the view that smaller tract sizes reduce postoperative pain [21]. Hospital stay was marginally shorter with Mini-PCNL but not statistically significant, possibly due to the routine placement of nephrostomy tubes in all patients. Zhu et al. [20] reported shorter hospitalization in Mini-PCNL when tubeless techniques were used.

Complications such as fever, bleeding, and perforation were slightly more common in Standard-PCNL, with bleeding being the most clinically relevant. Tract size has consistently been identified as a major factor influencing blood loss [19,22,23]. In our series, no Mini-PCNL patient required transfusion, further supporting the safety of this approach.

Stone-free rates were excellent in both groups, with no significant difference, echoing findings from previous meta-analyses [22]. Overall, Mini-PCNL demonstrates comparable efficacy and safety to Standard-PCNL while reducing blood loss and analgesic requirement. Its main drawback remains longer operative time.

CONCLUSION

Mini-PCNL provides stone clearance outcomes comparable to Standard-PCNL for lower calyceal stones measuring 1–2 cm. Despite requiring a longer operative time, Mini-PCNL offers advantages such as reduced bleeding, smaller hemoglobin drop, and lower analgesic requirement. Hospital stay was marginally shorter, though not statistically significant. Both procedures demonstrated a similar safety profile. Mini-PCNL can therefore be considered a safe and effective alternative to Standard-PCNL.

REFERENCES

- Romero V, Akpinar H, Assimos DG. Kidney stones: a global overview of prevalence, incidence, and associated risk factors. *Rev Urol.* 2010;12:e86–96.
- Clark JY, Thompson IM, Optenberg SA. The economic impact of urolithiasis in the United States. *J Urol.* 1995;154:2020–2024.
- Türk C, Knoll T, Petrik A, Sarica K, Skolarikos A, Straub M, et al. EAU Guidelines on Urolithiasis. *Eur Urol.* 2013.
- Skolarikos A, Gross AJ, Krebs A, Unal D, Bercowsky E, Eltahawy E, et al. Outcomes of flexible ureteroscopy for solitary renal stones: results from the CROES URS Global study. *J Urol.* 2015.
- Schoenthaler M, Wilhelm K, Hein S, Adams F, Schlager D, Wetterauer U, et al. Ultra-mini PCNL versus flexible ureteroscopy: a matched cost analysis for renal stones 10–20 mm. *World J Urol.* 2015;33:1601–1605.
- Knoll T, Jessen JP, Honeck P, Wendt-Nordahl G. Flexible ureterorenoscopy versus miniaturized PCNL for solitary renal calculi 10–30 mm. *World J Urol.* 2011;29(6):755–759.
- Jessen JP, Honeck P, Knoll T, Wendt-Nordahl G. Influence of collecting system anatomy on flexible ureterorenoscopy for lower pole stones. *J Endourol.* 2014;28(2):146–151.
- Karalides T, Bach C, Kachrilas S, Goyal A, Masood J, Buchholz N. Improving durability of digital flexible ureteroscopes. *Urology.* 2013;81(4):717–722.
- Albala DM, Assimos DG, Clayman RV, et al. A randomized trial of ESWL and PCNL for lower pole nephrolithiasis: initial results. *J Urol.* 2001;166(6):2076–2080.
- Srisubut A, Potisat S, Lojanapiwat B, Sethawong V, Laopaiboon M. ESWL versus PCNL or RIRS for kidney stones. *Cochrane Database Syst Rev.* 2009;(4):CD007044.
- Sabnis RB, Jagtap J, Mishra S, Desai M. Management of 1–2 cm renal calculi with Mini-PCNL or RIRS: a prospective comparative study. *BJU Int.* 2012;110(8b):E346–E349.
- Michel MS, Trojan L, Rassweiler JJ. Complications in PCNL. *Eur Urol.* 2007;51(4):899–906.
- Tefekli A, Karadag MA, Tepeler K, et al. Classification of PCNL complications using the modified Clavien system. *Eur Urol.* 2008;53(1):184–190.
- Traxer O, et al. Renal parenchymal injury after Standard and Mini-PCNL. *J Urol.* 2001;165:1693–1695.
- De la Rosette J, Assimos D, Desai M, et al. CROES PCNL global study: indications, complications, and outcomes in 5803 patients. *J Endourol.* 2011;25:11–17.
- Bayles A, Chitale S, Irving SO, Burgess NA. Audit of PCNL practice in the United Kingdom. *Br J Med Surg Urol.* 2007;4:119–125.
- Giusti G, Piccinelli A, Taverna G, Benetti A, Pasini L, Corinti M, et al. 'Miniperç? No, thank you!' *Eur Urol.* 2007;51:810–814.
- Bilen CY, Koçak B, Kitirci G, Ozkaya O, Sarikaya S. PCNL in children: lessons from 5 years at a single center. *J Urol.* 2007;177:1867–1871.
- Mishra S, Sharma R, Garg C, Kurien A, Sabnis R, Desai M. Prospective comparison of Mini-PCNL and Standard-PCNL for 1–2 cm renal stones. *BJU Int.* 2011;108:896–899.
- Zhu W, Liu Y, Liu L, et al. Minimally invasive versus Standard-PCNL: a meta-analysis. *Urolithiasis.* 2015;43:563–570.
- Maheshwari PN, Andankar MG, Bansal M. Nephrostomy tube after PCNL: large-bore versus pigtail catheter. *J Endourol.* 2000;14:735–737.

22. De la Rosette J, Assimos D, Desai M, et al. CROES PCNL global study: outcomes in 5803 patients. *J Endourol.* 2011;25:11–17.
23. Yamaguchi A, Skolarikos A, Buchholz NP, Chomón GB, Grasso M, Saba P et al. Operating times and bleeding complications in PCNL: comparison of dilation methods in 5537 patients from the CROES study. *J Endourol.* 2011;25:933–939.