



COMPARATIVE STUDY OF MINI VS STANDARD PERCUTANEOUS NEPHROLITHOTOMY [PCNL] FOR RENAL STONES

General Surgery

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ABSTRACT

Introduction: Percutaneous nephrolithotomy (PCNL) is the preferred treatment for large renal calculi, with Standard PCNL (S-PCNL) offering high stone-free rates (SFR) but being associated with increased bleeding, longer hospital stays, and postoperative pain. Mini PCNL (M-PCNL) was developed as a minimally invasive alternative, reducing renal trauma while maintaining efficacy. This study aimed to compare the safety, efficacy, and outcomes of M-PCNL versus S-PCNL in the treatment of renal stones. **Materials And Methods:** This randomized controlled trial was conducted at KD Medical College and Research Centre, Mathura, over two years, including 66 patients with renal stones. Patients were randomly assigned to either the S-PCNL or M-PCNL group. Standard PCNL was performed using a 22–26 Fr tract, while Mini PCNL used a 15.5–16.5 Fr tract. Postoperative outcomes, including stone clearance, operative time, complications, hospital stay, and pain scores, were analyzed. **Results:** Both techniques achieved comparable SFRs (96.97%). However, M-PCNL demonstrated advantages, including shorter hospital stays, reduced pain, lower analgesic requirements, and fewer complications. M-PCNL had a longer operative time but resulted in less blood loss and a higher rate of tubeless procedures. **Conclusion:** Mini PCNL is a safe and effective alternative to Standard PCNL, offering similar efficacy with reduced morbidity. Despite a longer operative time, its benefits in terms of recovery and complications make it a preferable choice for selected patients. Further studies are needed to assess long-term outcomes.

KEYWORDS

Mini- Percutaneous nephrolithotomy (PCNL) , Renal Stone, Morbidity, Standard-PCNL

INTRODUCTION

Renal stones, or urolithiasis, represent one of the most prevalent urological disorders globally, affecting approximately 10% of the population. [1] Urolithiasis arises from the crystallization or precipitation of urinary minerals and constituents, stemming from an imbalance between solubility and precipitation within the urinary system. It is the third most common urinary tract condition, following urinary tract infections and prostate disorders [2]. Surgical interventions, including shock wave lithotripsy (SWL), retrograde intrarenal surgery (RIRS), and percutaneous nephrolithotomy (PCNL), have become the primary approaches for managing renal calculi. Since its introduction in the 1980s, PCNL has been widely used for large renal stones. [3] Advancements in its technique have continually improved outcomes. Over time, advancements in instrumentation, energy sources for stone fragmentation, patient positioning, tract dilation methods, and the adoption of smaller nephrostomy tubes or tubeless approaches have refined the PCNL procedure [4].

Standard percutaneous nephrolithotomy (standard-PCNL) remains the preferred treatment for renal stones larger than 2 cm, offering a high stone-free rate (SFR). However, this superior efficacy often comes with notable complications, including significant bleeding and the need for blood transfusions [5]. To address these concerns, mini-percutaneous nephrolithotomy (Mini-PCNL) was developed. M-PCNL, with its smaller tract size (≤ 18 Fr), has shown promising results in adults, providing high stone-free rates (SFR), minimal bleeding risk, shorter hospital stays, and reduced postoperative analgesia requirements [6]. While M-PCNL and RIRS are increasingly preferred for treating lower pole stones measuring 1.5–2.5 cm, S-PCNL remains the gold standard for managing large and complex stones, particularly those exceeding 2 cm in diameter [7]. Therefore, this comparative study aims to evaluate the safety, efficacy, and clinical outcomes of mini-PCNL versus standard PCNL in the management of renal stones. This study seeks to provide evidence to inform clinical practice and optimize patient outcomes.

MATERIALS AND METHODS

A randomized controlled trial was conducted at KD Medical College and Research Centre, Mathura, Uttar Pradesh. Ethical approval was obtained from the Institutional Ethics Committee of KD Medical College, Mathura. Written informed consent was collected from all recruited patients before participation in the study. The study was conducted over a period of two years. A total of 66 patients were included in the study, divided equally into two groups. The sample size was determined based on a pilot study.

Inclusion Criteria

- Age between 10 to 80 years

- All renal positions and stone complexities
- Stone size ≥ 10 mm
- Patients who provided written informed consent

Exclusion Criteria

- Presence of congenital renal anomalies, solitary kidney, or pyonephrosis
- Impaired renal function or coagulopathies
- Presence of staghorn calculus

Methodology

All patients who showed clinical and radiological evidence of renal stones were enrolled in the study. Renal stones were diagnosed using abdominal ultrasonography (USG).

After confirmation, patients scheduled for percutaneous nephrolithotomy (PCNL) underwent pre-anesthetic evaluation. Data collection included demographic details, stone size, surgical outcomes, and postoperative recovery parameters.

Those who were fit for surgery were randomly assigned to one of two groups using random number tables:

- Group A – Standard PCNL was performed.
- Group B – Mini PCNL was performed

Statistical Analysis

Statistical comparisons for quantitative variables were performed using Student's t-test or Mann-Whitney U test. Categorical variables were compared using the Chi-square test or Fisher's exact test, depending on data distribution.

All statistical analyses were performed using SPSS software (Version 25, SPSS Inc., Chicago, IL, USA). A p-value of less than 0.05 was considered statistically significant.

RESULTS

The study was conducted to compare the outcomes of Mini Percutaneous Nephrolithotomy (Mini PCNL) and Standard Percutaneous Nephrolithotomy (Standard PCNL) in patients undergoing treatment for renal stones. A total of 66 patients were included in the study, with 33 patients in Group A (Standard PCNL) and 33 patients in Group B (Mini PCNL). Various perioperative and postoperative parameters were assessed.

Stone-free rate (SFR) in Group A and Group B was 32(96.9%) respectively. The absence of a p-value suggests that statistical comparison was not performed. By using Chi square test, results showed that there is no apparent difference in stone-free outcomes between Group A and Group B, suggesting that both approaches (if different) yielded similar success rates in clearing stones. (Figure 1)

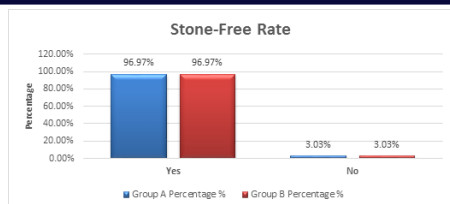


Figure1: Stone-Free Rate (SFR) in study population

Postoperative pain, measured using the Visual Analogue Pain Scale (VAS), was higher in Group A (4.27 ± 1.17) compared to Group B (1.87 ± 0.81), with a p-value of 0.01, indicating a statistically significant difference. Similarly, the postoperative need for analgesia in terms of the number of days was longer in Group A (4.06 ± 0.74) compared to Group B (2.63 ± 0.60), also showing a significant difference ($p = 0.01$). The hospital stay was also longer in Group A (4.21 ± 0.92 days) compared to Group B (2.66 ± 0.54 days), with a statistically significant difference ($p = 0.01$). This indicates that patients in Group A required a more extended recovery period before discharge. Interestingly, the operative time was significantly shorter in Group A (88.90 ± 11.13 minutes) compared to Group B (113.66 ± 8.77 minutes), with a p-value of 0.01. This suggests that the surgical procedure or intervention in Group A was performed more quickly than in Group B. Mann whitney test was used. (Figure 2)

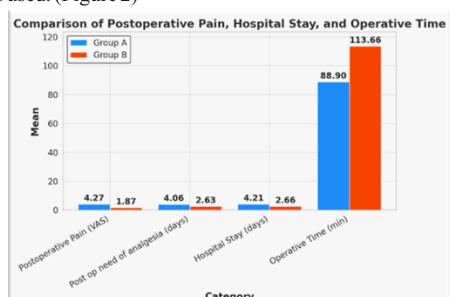


Figure 2 : Comparison of Postoperative Pain, Hospital Stay, and Operative Time Between Groups

DISCUSSION

Percutaneous nephrolithotomy (PCNL) is a well-established surgical technique for the management of renal calculi, with various modifications such as Mini-PCNL and Standard-PCNL aimed at optimizing patient outcomes. This study compared the efficacy, safety, and postoperative recovery parameters between Mini-PCNL and Standard-PCNL.

In this study both groups had an identical stone-free rate (SFR) of 96.97%, indicating that Mini-PCNL was as effective as Standard PCNL in achieving complete stone clearance. This is consistent with studies by Zeng et al. (2021) [8], which reported a non-inferior SFR for Mini-PCNL (67.1%) compared to Standard PCNL (67.9%) for 20–40 mm stones. Similarly, Ioannis et al. (2022) [9] found no significant difference in SFR (OR: 0.92, 95% CI: 0.74–1.16, $p = 0.30$).

Postoperative pain (VAS score) was significantly higher in Group A (4.27 ± 1.17) than in Group B (1.87 ± 0.81) ($p = 0.01$). The duration of analgesia use was longer in Group A (4.06 ± 0.74 days) vs. Group B (2.63 ± 0.60 days) ($p = 0.01$). Hospital stay was longer in Group A (4.21 ± 0.92 days) vs. Group B (2.66 ± 0.54 days) ($p = 0.01$). Operative time was shorter in Group A (88.90 ± 11.13 min) vs. Group B (113.66 ± 8.77 min) ($p = 0.01$). These findings align with ElSheemy et al. (2019) [10], Datta et al. (2022) [11], and Ioannis et al. (2022) [9], which reported lower post-op pain, shorter hospital stays, and faster recovery with Mini-PCNL. Our study demonstrates that Mini-PCNL (Group B) provides comparable stone-free rates to Standard PCNL (Group A), while also reducing post-operative pain, hospital stay, and analgesia requirements. Despite a longer operative time, Mini-PCNL was associated with fewer complications and an overall improved patient recovery profile. These findings are in agreement with multiple previous studies, reinforcing the clinical advantages of Mini-PCNL as a viable alternative for renal stone management.

CONCLUSION

The findings confirm that both techniques (Mini PCNL & Standard PCNL) achieved comparable stone-free rates (96.97%),

reinforcing the effectiveness of Mini PCNL as a viable alternative to Standard PCNL for renal stone management.

Mini PCNL was associated with reduced post-operative pain, lower analgesia requirements, and shorter hospital stays compared to Standard PCNL. Additionally, Mini PCNL had a longer operative time (113.66 ± 8.77 min vs. 88.90 ± 11.13 min, $p = 0.01$), suggesting a trade-off between procedural duration and post-operative benefits.

Our findings align with multiple previous studies and highlight the clinical benefits of Mini PCNL in reducing morbidity and enhancing patient recovery. Given its lower complication rates and faster post-operative recovery, Mini PCNL may be the preferred approach for appropriately selected patients, particularly those for whom a shorter hospital stay and reduced post-operative discomfort are priorities.

Further research with larger sample sizes and long-term follow-up is warranted to evaluate the recurrence rates, long-term functional outcomes, and patient satisfaction associated with these two techniques. Our study underscores the growing preference for Mini PCNL as an effective alternative to Standard PCNL, particularly in cases where a minimally invasive approach with faster recovery is desirable.

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