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***Original research article***

# STANDARD PERCUTANEOUS NEPHROLITHOTOMY VERSUS MINI-PERCUTANEOUS NEPHROLITHOTOMY IN PATIENTS WITH RENAL STONES: A RANDOMIZED CONTROLLED TRIAL

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**Abstract:** *Percutaneous nephrolithotomy (PCNL) is a widely used procedure for removing renal stones. Recent advancements have led to the development of mini-PCNL, which is believed to offer better outcomes regarding stone clearance and reduce complications. Comparing these techniques is critical to optimising treatment approaches for patients with renal stones.* ***Objective:*** *To compare the effectiveness of conventional PCNL and mini-PCNL in stone clearance rates in patients with renal stones.* ***Methods:*** *This randomised trial was conducted from July 2023 to July 2024, involving 120 patients aged 18 to 60 with renal stones. Patients were randomly assigned to two groups: Group A (n=60) underwent conventional PCNL, and Group B (n=60) underwent mini-PCNL. Stone-free rates were evaluated one month postoperatively using X-ray KUB and ultrasound. Descriptive statistics were used to summarise patient demographics, and comparative analysis between the two groups was performed using a chi-square test, with statistical significance set at $P < 0.05$.* ***Results:*** *The mean age of patients in Group A (conventional PCNL) was 38.70 ± 10.98 years, while in Group B (mini-PCNL), it was 41.87 ± 11.45 years. The stone-free rate was significantly higher in Group B, with 54 patients (90.0%) achieving stone clearance compared to 45 patients (75.0%) in Group A ($P = 0.03$). Additionally, mini-PCNL was associated with fewer postoperative complications.* ***Conclusion:*** *The study demonstrates that mini-PCNL offers a higher stone-free rate than conventional PCNL, with a significant outcome difference ($P = 0.03$). Mini-PCNL also exhibited a better safety profile, suggesting it is preferable for managing renal stones.*

**Keywords:** Percutaneous Nephrolithotomy, Stone-free rate, Renal stones, Comparison.

## Introduction

Renal calculi, or kidney stones, are solid mineral and salt deposits that develop within the kidneys and constitute a widespread health concern impacting millions worldwide (1, 2). These stones can vary considerably in size, ranging from minute crystals to more extensive forms that may clog the urinary tract, resulting in significant discomfort and serious consequences. (3) Kidney stones arise due to an imbalance in the constituents of urine; typical urine comprises waste materials and compounds such as calcium, oxalate, and uric acid, which, when concentrated, may crystallise and ultimately evolve into stones (4, 5).

Standard percutaneous nephrolithotomy (PCNL) and mini-percutaneous nephrolithotomy (mini-PCNL) are two significant surgical methods for treating renal calculi, each offering unique benefits and drawbacks that require thorough analysis. PCNL has traditionally been considered the standard for managing substantial and complex renal calculi, providing direct access to the renal collecting system via a little flank incision (6, 7). This approach allows urologists to break and remove stones efficiently, resulting in elevated stone-free rates. Nonetheless, it is linked to specific problems, such as bleeding, infection, and extended recovery durations, primarily due to the enormous access sheath and the possibility of increased tissue stress (8, 9).

Conversely, mini-PCNL, developed to address the demand for minimally invasive techniques, utilises a smaller access sheath, generally between 16F and 20F, thereby decreasing tissue trauma, reducing postoperative discomfort, and improving recovery duration. The reduced incision size in mini-PCNL results in fewer problems, rendering it a favourable choice, especially for patients with comorbidities or those desiring expedited recovery. Furthermore, the technique's ability to provide excellent stone clearance rates has positioned it as a viable alternative to standard PCNL, especially for smaller stones or in pediatric populations (10, 11).

The increasing prevalence of renal stones has led to a need for effective and minimally invasive surgical interventions, prompting a comparison between standard PCNL and mini-PCNL. This study aims to standard PCNL versus mini-PCNL in patients with renal stones. Analysing parameters such as stone clearance and complication rates will provide valuable insights into the optimal approach for managing renal stones, ultimately guiding clinical decision-making and enhancing patient care.

## Methodology

This controlled trial was initiated in the Department of Urology and conducted from July 2023 to July 2024 at the Nephrology Department of Rehman Medical Institute Peshawar. One hundred twenty patients were enrolled and divided equally into two groups: Group A, which underwent standard percutaneous nephrolithotomy (S-PCNL), and

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Group B, which underwent mini-percutaneous nephrolithotomy (M-PCNL).

The study included patients aged 18-60 years, of both genders, with either single or multiple renal stones larger than 2 cm that had been present for more than two weeks. Patients were excluded from the study if they had conditions that could confound the results or introduce bias. These conditions included active urinary tract infections (as confirmed by positive urine cultures), elevated serum creatinine levels (based on lab results), pregnancy (confirmed by history and ultrasound), morbid obesity (defined as BMI > 40 kg/m²), and unfavourable renal anatomy such as calyceal diverticula with infundibular stenosis, horseshoe kidney, malrotation kidney, ectopic kidney, suspected pelvic-ureteric junction obstruction, kidney with the duplex system, or vesicoureteral reflux/stenosis (assessed via CT-KUB). Additionally, patients with coagulopathies were excluded based on history and lab results. Ethical approval was obtained from the hospital, and all participants provided written informed consent before the study.

All patients underwent comprehensive investigations, including ultrasound of the bladder, kidney, and ureters, computed tomography, and X-ray, to confirm the presence, size, and location of the renal stones and the anatomy of the pelvicalyceal system. The hospital's senior-most sonologist performed these imaging procedures. A complete blood picture and coagulation profile were also obtained, including PT, APTT, INR, bleeding time, and clotting time. Patients were randomly allocated into two groups using blocked randomisation. Group A underwent conventional S-PCNL, while Group B underwent M-PCNL. All procedures were performed by an expert urologist (FCPS) with a minimum of five years of experience in performing PCNL. Patients were discharged on the second day of the procedures and followed up for one month. A follow-up X-ray KUB was performed to determine the stone-free rates, which were assessed based on the absence of residual stones on imaging one month after the procedure.

Demographic data such as age, gender, duration of disease, number of stones, and stone size were recorded in a predesigned proforma and analysed using SPSS 24. We used Chi-Square to compare both groups, keeping the value of P significant at < 0.05.

**Results**

The average age of Group A participants who underwent standard PCNL was 38.70±10.977 years, while the average age of participants in Group B, who underwent mini-PCNL, was 41.87±11.451 years. In terms of the number of stones, Group A had an average of 3.13±1.241 stones per patient, and Group B had an average of 2.92±1.183 stones. The average size of stones in Group A was 3.4953±0.81389 cm, while in Group B, the average stone size was slightly larger, at 3.6443±0.87505 cm.

In Group A, 41 participants (68.3%) were male, and 19 (31.7%) were female. In Group B, 46 participants (76.7%) were male, and 14 (23.3%) were female. Regarding the presence of diabetes, 9 participants (15.0%) in Group A had diabetes, compared to 8 participants (13.3%) in Group B. Hypertension was present in 12 participants (20.0%) in Group A and 15 participants (25.0%) in Group B. As for obesity, it was more common in Group A, with 26 participants (43.3%) classified as obese, while in Group B, 18 participants (30.0%) were obese. (Table 1)

When comparing the stone-free rates and complications between both groups, it was observed that 75% of participants in Group A (45 out of 60) were stone-free after the procedure, whereas 90% of participants in Group B (54 out of 60) achieved a stone-free status, with a statistically significant difference (p=0.03). In terms of complications, leakage occurred in 23.3% of participants in Group A (14 out of 60), while only 5% of participants in Group B (3 out of 60) experienced leakage, showing a highly significant difference (p=0.0001). Bleeding complications were reported in 5% of Group A participants (3 out of 60) and 1.7% in Group B (1 out of 60). Fever was observed in 18.3% of Group A participants (11 out of 60) and only 3.3% of Group B participants (2 out of 60). Notably, 53.3% of participants in Group A experienced no complications, compared to 90% in Group B, further highlighting the differences in safety profiles between the two procedures. (Table 2)

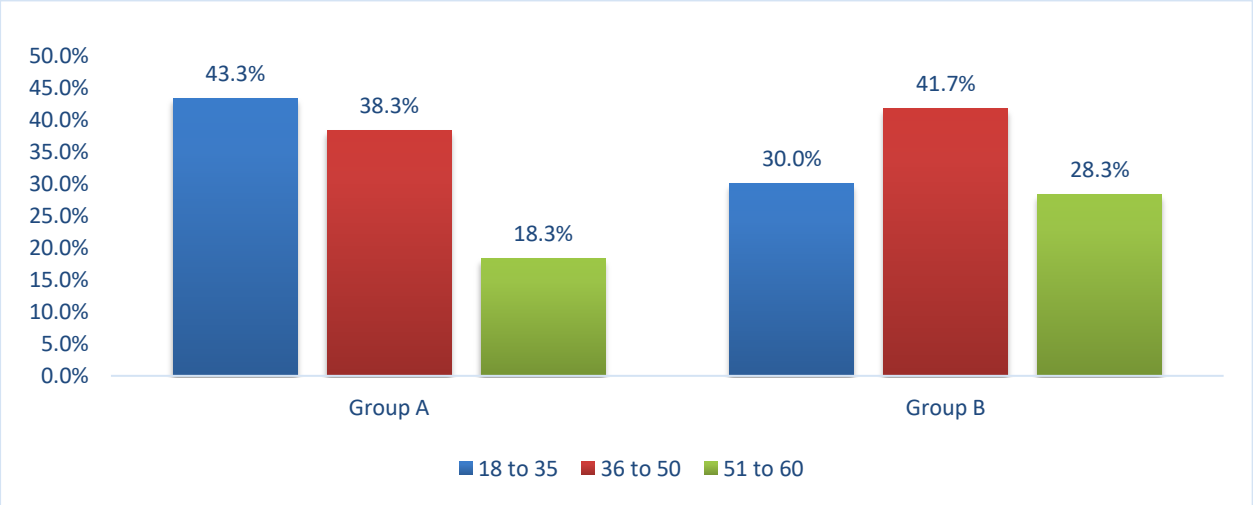


**Figure 1 Age distribution**

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**Table 1 Demographic and clinical characteristics**

| Demographic and clinical characteristics | | Groups | | | |
|---|---|---|---|---|---|
| | | Group A (Standard PCNL) | | Group B (Mini PCNL) | |
| | | N | % | N | % |
| Gender | Male | 41 | 68.3% | 46 | 76.7% |
| | Female | 19 | 31.7% | 14 | 23.3% |
| Diabetes | Yes | 9 | 15.0% | 8 | 13.3% |
| | No | 51 | 85.0% | 52 | 86.7% |
| Hypertension | Yes | 12 | 20.0% | 15 | 25.0% |
| | No | 48 | 80.0% | 45 | 75.0% |
| Obesity | Yes | 26 | 43.3% | 18 | 30.0% |
| | No | 34 | 56.7% | 42 | 70.0% |

**Table 2 Comparison of stone-free rate and complications between both groups**

| | | Groups | | | | P value |
|---|---|---|---|---|---|---|
| | | Group A (Standard PCNL) | | Group B (Mini PCNL) | | |
| | | N | % | N | % | |
| Stone free rate | Yes | 45 | 75.0% | 54 | 90.0% | 0.03 |
| | No | 15 | 25.0% | 6 | 10.0% | |
| Complications | Leakage | 14 | 23.3% | 3 | 5.0% | 0.0001 |
| | Bleeding | 3 | 5.0% | 1 | 1.7% | |
| | Fever | 11 | 18.3% | 2 | 3.3% | |
| | No complication | 32 | 53.3% | 54 | 90.0% | |

## Discussion

Regarding demographic and clinical characteristics, both groups were comparable. The average age of participants in the S-PCNL group was 38.7 years, while the average age in the M-PCNL group was slightly higher at 41.87 years. Both groups had a similar distribution of comorbidities, such as diabetes and hypertension, which did not appear to affect the outcomes significantly. However, obesity was more prevalent in the S-PCNL group (43.3%) compared to the M-PCNL group (30%). These differences in patient characteristics are unlikely to have significantly influenced the primary clinical outcomes, as both procedures are effective across a range of patient demographics.

The stone-free rate (SFR) was notably higher in the M-PCNL group, with 90% of participants achieving complete stone clearance, compared to 75% in the S-PCNL group ($p = 0.03$). This significant difference is consistent with several studies' findings, which suggest that while both procedures are effective, M-PCNL can achieve higher success rates, particularly for smaller and less complex stones. A meta-analysis by Deng J et al. reported similar outcomes, noting that M-PCNL resulted in comparable SFR to S-PCNL, with fewer postoperative complications (12). Furthermore, Refaat HM et al. concluded that M-PCNL was more effective than S-PCNL in treating renal calculi smaller than 3 cm, with a higher stone-free rate. (13)

Regarding complications, our study revealed a significantly lower rate of postoperative issues in the M-PCNL group. Only 5% of patients in the M-PCNL group experienced leakage, compared to 23.3% in the S-PCNL group ($p = 0.0001$). Additionally, bleeding was reported in 5% of S-PCNL cases, compared to 1.7% in M-PCNL cases. Fever, another common complication, occurred in 18.3% of S-PCNL patients but only in 3.3% of M-PCNL patients. These findings align with Refaat et al. They reported that the mini-PCNL group had notably fewer leakage and fever cases than the S-PCNL group. (13)

Notably, 90% of participants in the M-PCNL group experienced no complications, compared to only 53.3% in the S-PCNL group. This stark difference highlights the superior safety profile of M-PCNL. Sharma G. et al. also emphasised the reduced complication rates in M-PCNL compared to S-PCNL, particularly regarding bleeding and the need for blood transfusions. The smaller surgical tract in M-PCNL minimises damage to surrounding tissues, thus lowering the likelihood of postoperative issues such as leakage and infection. (14)

## Conclusion

In conclusion, our study demonstrates that M-PCNL offers a higher stone-free rate and a significantly lower risk of complications than S-PCNL, making it a safer and more practical option for patients with renal stones smaller than 3 cm. These findings are consistent with the broader literature, which consistently shows that while S-PCNL may be necessary for larger or more complex stones, M-PCNL provides a more favourable balance between efficacy and safety for most patients.

## Declarations

**Data Availability statement**

All data generated or analysed during the study are included in the manuscript.

**Ethics approval and consent to participate.**

Approved by the department concerned. (IRBEC-SZDA-232/23)

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