ORIGINAL RESEARCH

Retrospective assessment of the efficacy and safety of tubeless mini-percutaneous nephrolithotomy for the management of large (>20 mm) renal stones in patients attending tertiary care centre, South India

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ABSTRACT

Objective: To evaluate the efficacy and safety of tubeless mini-percutaneous nephrolithotomy (mini-PCNL) for the management of large (>20 mm) renal stones.

Materials and Methods: Hospital based retrospective study which analysed 110 consecutive adult patients who underwent tubeless mini-PCNL for large renal stones between January 2023 to January 2024 in the department of Urology. Data on demographics, stone characteristics, operative parameters, and outcomes were collected. Stone-free status was assessed within 2 weeks postoperatively using X-ray or noncontrast computed tomography (NCCT). Complications were recorded using the Clavien-Dindo classification, and statistical analysis identified predictors of residual fragments.

Results: The mean stone size was 28.3 ± 5.6 mm, and single-tract access was achieved in 92% of cases. The mean operative time was 82.5 ± 15.4 minutes, and the overall stone-free rate was 88%. Residual fragments (<4 mm) were observed in 12% of patients. The complication rate was 13.6%, with most classified as minor (Clavien-Dindo Grades I and II). The mean hospital stay was 2.8 ± 1.2 days, with no major complications (Grade IV or V) reported. Higher Guy's stone scores and larger stone sizes were significant predictors of residual fragments (p<0.05).

Conclusion: Tubeless mini-PCNL is an effective and safe treatment option for large renal stones, achieving high stone-free rates with minimal morbidity and reduced hospital stays. Its minimally invasive nature and favorable outcomes make it a promising alternative to standard PCNL, particularly for appropriately selected patients.

Key words: Mini-PCNL, tubeless PCNL, large renal stones, percutaneous nephrolithotomy, stone-free rate, complications

INTRODUCTION

Renal stones larger than 20 mm pose significant clinical challenges due to their potential to cause complications such as obstruction, infection, and renal impairment. These stones often necessitate active surgical management, as conservative methods like extracorporeal shock wave lithotripsy (ESWL) are insufficient for complete stone clearance. Percutaneous nephrolithotomy (PCNL) is the established gold standard for large renal stones, offering high efficacy and stone-free rates (SFR). However, traditional PCNL, which involves larger access tracts and routine nephrostomy tube placement, is associated with postoperative pain, bleeding, and prolonged recovery [1, 2].

The advent of mini-PCNL, employing smaller access tracts (14-20 Fr), has significantly reduced renal trauma without compromising SFR. Further advancements led to tubeless mini-PCNL, where the nephrostomy tube is omitted postoperatively. Instead, drainage is achieved using a ureteral stent or catheter. This modification reduces postoperative pain, hospital stays, and complications, aligning with minimally invasive surgical principles [3, 4].

The benefits of tubeless mini-PCNL are particularly relevant for patients with large renal stones. By

reducing postoperative pain, hospital stay, and complications associated with the nephrostomy tube, this approach aligns with the broader shift towards minimally invasive and patient-centered care in urology. Furthermore, studies have demonstrated that tubeless mini-PCNL offers comparable stone-free rates and safety profiles to traditional PCNL, with some reports indicating lower rates of postoperative morbidity and faster return to normal activities [5, 6].

However, the application of tubeless mini-PCNL requires careful patient selection, as well as technical expertise to mitigate potential complications, such as ureteral obstruction or incomplete drainage. This study aims to evaluate the efficacy, safety, and clinical outcomes of tubeless mini-PCNL in managing renal stones larger than 20 mm, contributing to the growing body of evidence supporting its role in contemporary urolithiasis management.

METHODOLOGY

This study analyzed data from consecutive adult patients who underwent mini-PCNL for large (>20 mm) renal stones between January 2023 to January 2024 at urology department of Great Eastern Medical School and Hospital Srikakulam,South India.Preoperative, operative, postoperative, and follow-up data were prospectively recorded in a computerized database and analyzed retrospectively. Patients with concomitant ipsilateral obstructing ureteric calculi were excluded.

Stone size was defined as the largest dimension of a single stone or the sum of the largest dimensions of multiple stones. Key variables included age, sex, stone location, Guy's stone score [7], stone size, history of urolithiasis, percutaneous tract location and number, perioperative hemoglobin change, hospital stay, stone-free status, and 30-day complications. All patients underwent preoperative noncontrast computed tomography (NCCT) as the diagnostic modality. The study adhered to the ethical guidelines of the Declaration of Helsinki, and informed consent was obtained from all participants.

SURGICAL TECHNIQUE

All procedures were performed by a single surgeon under spinal anesthesia. After retrograde pyelography in the lithotomy position, the patient was repositioned to prone. Fluoroscopic-guided renal puncture, preferably via a supra 12th rib approach, was used to access the desired calyx, allowing comprehensive access to the pelvicalyceal system. Tract dilation was performed using either single-step or serial dilation techniques, or a 16-20 Fr peel-away renal sheath was inserted.

Stone fragmentation was achieved using a pneumatic ballistic lithotripter, with fragment evacuation facilitated by saline flushing and the vacuum cleaner effect. No nephrostomy tube was placed, even for patients requiring multiple tracts. A double-J stent was placed antegrade at the end of the procedure.

Operative time was measured from ureteric catheter insertion to double-J stent placement. Complications were classified using the modified Clavien-Dindo classification. Stone-free status was determined within 2 weeks postoperatively using X-ray for radiopaque stones and NCCT for radiolucent stones. Residual fragments <4 mm were considered clinically insignificant. Double-J stents were removed 2-4 weeks postoperatively under topical anesthesia.

Data was spread over excel sheet and analyzed using SPSS software (version 20, IBM, USA). Univariate analyses (Chi-square or t-test) compared variables between stone-free patients and those with residual fragments. Multivariate logistic regression identified independent risk factors, with statistical significance set at $p<0.05$.

RESULTS

A total of 110 adult patients underwent mini-PCNL for renal stones larger than 20 mm. The mean age of the patients was 45.6±12.3 years, with a male-to-female ratio of 1.4:1. The majority of stones were located in the renal pelvis (45%), followed by the lower pole (35%) and other calyces (20%). The mean stone size was 28.3 ± 5.6 mm.

Table 1: Demographic Variables among the study participants

Characteristics	Values
Total patients	110
Mean age (years)	45.6 ± 12.3
Male:Female ratio	1.4:1
Mean stone size (mm)	28.3 ± 5.6

Table 2: Gender variability, Stone size and location among study participants

Variables		
Gender	Male	64 (58.2%)
	Female	46 (41.8%)
Stone location	Pelvis	49 (44.5%)
	Lower pole	38 (34.5%)
	Others	23 (20.9%)
Guy's stone size (mm)	Grade 1	22 (20%)
	Grade 2	44 (40%)

	Grade 3	32 (29.1%)
	Grade 4	12 (10.9%)

The procedure was completed successfully in all patients, with a mean operative time of 82.5 ± 15.4 minutes. Single-tract access was used in 92% of cases, while multiple tracts were required in 8%.

Table 3: Operative parameters among the study participants

Operative Parameters	Values
Mean operative time (minutes)	82.5 ± 15.4
Single-tract access	92%
Multiple-tract access	8%
Perioperative hemoglobin drop (g/dL)	1.8 ± 0.6

The overall stone-free rate (SFR) was 88%, with 12% of patients having insignificant residual fragments (<4 mm). The mean hospital stay was 2.8 ± 1.2 days, and no major complications (Grade IV or V) were reported. Complications were observed in 15 patients (13.6%), classified according to the Clavien-Dindo system:

Grade I: 5 patients (mild pain, fever).

Grade II: 7 patients (requiring blood transfusion).

Grade III: 3 patients (stent migration requiring repositioning).

Table 4: Postoperative outcome among the study participants

Postoperative Outcomes		Values
Stone-free rate (SFR)		88%
Residual fragments (<4 mm)		12%
Complications	Grade I	5 (4.5%)
	Grade II	7 (6.4%)
	Grade III	3 (2.7%)
Mean hospital stay (days)		2.8 ± 1.2
Stent removal (weeks)		2–4

Univariate analysis identified Guy's stone score and stone size as significant predictors of stone-free status (p<0.05). Multivariate logistic regression showed that a higher Guy's stone score (Grade 3 or 4) was an independent risk factor for residual fragments (OR: 3.4, P = 0.01). These results indicate that mini-PCNL with a tubeless approach is highly effective and safe for managing large renal stones, offering a high stone-free rate with minimal morbidity.

DISCUSSION

The results of this study demonstrate that tubeless mini-PCNL is an effective and safe technique for managing large (>20 mm) renal stones, with a high stone-free rate (88%) and minimal complications. These findings align with previously reported outcomes of mini-PCNL, reinforcing its role as a minimally invasive alternative to standard PCNL for large renal stones [1, 3].

The stone-free rate in this study (88%) is consistent with other reports in the literature, where SFRs for mini-PCNL typically range between 85% and 90% [4, 7]. This success can be attributed to the precise access provided by fluoroscopic guidance and the efficient stone disintegration and evacuation techniques employed. However, higher Guy's stone scores and larger stone sizes were identified as predictors of incomplete clearance, highlighting the need for careful preoperative assessment and counseling in such cases.

The use of tubeless mini-PCNL, with an antegrade double-J stent for drainage, has been shown to significantly reduce postoperative pain and hospital stay compared to conventional PCNL with nephrostomy tube placement [8]. In this study, the mean hospital stay was 2.8 ± 1.2 days, which is shorter than the average stay reported for standard PCNL. Additionally, the elimination of the nephrostomy tube reduced postoperative discomfort and facilitated earlier recovery, consistent with findings from other studies [5].

The overall complication rate of 13.6% in this study is comparable to previously reported rates for mini-PCNL, which range from 10% to 20% [6]. Most complications were minor (Clavien-Dindo Grades I and II), with only 3 patients requiring intervention for stent migration. Importantly, no major complications (Grades IV or V) were observed, underscoring the safety of the procedure when performed by experienced surgeons.

While the results affirm the advantages of tubeless mini-PCNL, certain limitations warrant consideration. The study excluded patients with complex staghorn calculi, which may have affected the generalizability of the findings to more complex cases. Additionally, the retrospective nature of the analysis, despite prospective data collection, may introduce selection

bias. Future randomized controlled trials comparing tubeless mini-PCNL to conventional PCNL for large renal stones would provide more robust evidence.

CONCLUSION

In conclusion, tubeless mini-PCNL is a highly effective and safe treatment option for large renal stones, offering excellent stone clearance rates, reduced morbidity, and shorter hospital stays. Its minimally invasive nature makes it an appealing alternative to standard PCNL, particularly in cases where a single-tract approach is feasible.

CONFLICT OF INTEREST: None to be declared.

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