Section: General Surgery

Original Research Article

AN OBSERVATIONAL STUDY TO COMPARE THE OUTCOME OF MINI-PCNL VERSUS STANDARD PCNL IN MANAGING LARGE RENAL CALCULI IN OBESE PATIENTS AT TERTIARY CARE CENTRE

Received : 03/08/2025
Received in revised form : 22/08/2025
Accepted : 10/09/2025

Keywords:
Percutaneous nephrolithotomy (PCNL), M-PCNL, S-PCNL, Obese patients.

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DOI: 10.47009/jamp.2025.7.6.80

Source of Support: Nil,
Conflict of Interest: None declared

Int J Acad Med Pharm
2025; 7 (6); 422-426

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ABSTRACT

Background: Percutaneous nephrolithotomy (PCNL) is the recommended treatment for large or complex renal stones. Renal stones are a prevalent urological disorder with various treatment options, including minimally invasive techniques such as Standard-PCNL (S-PCNL) and Mini-percutaneous nephrolithotomy (M-PCNL). This study aims to compare the efficacy and safety outcomes of M-PCNL and S-PCNL for managing renal calculi. **Materials and Methods:** This observational study enrolled 50 patients with renal stones, comparing the efficacy and safety of M-PCNL (Group A) and S-PCNL (Group B) procedures. Preoperative assessments, surgical procedures, and postoperative care were conducted, and outcomes such as operating time, stone clearance, analgesic requirement, and hospital stay were evaluated. Data analysis was performed using SPSS software, with comparisons between groups conducted using the Chi-square test and Student t test. **Results:** The operation time was longer for M-PCNL (130.64±27.23 min) than for S-PCNL (50.7±16.85 min), as stone fragmentation took longer ($p<0.05$*). The mean drop in hemoglobin levels was significantly ($P<0.05$*) lower in the M-PCNL group (0.22±0.01 g/dL) compared to the S-PCNL group (0.92±0.03g/dL). Success rates (SFR %) differed significantly ($p<0.05$*) between the two groups, with 100% in the M-PCNL group and 88% in the S-PCNL group. A few complications occurred and were classified according to the Modified Clavien Score. These included intraoperative bleeding (Grade I) in 2 cases from Group B, which was controlled with a nephrostomy tube and JJ insertion; postoperative fever (Grade II) in 2 cases from Group A and 7 cases from Group B; intraoperative pelvic injury (Grade III) in 2 cases from Group B; and mild collection in 3 cases from Group A and 22 cases from Group B. **Conclusion:** Obese patients can safely undergo either mini or standard PCNL; in this series, mini performed better than standard PCNL in terms of SFR and blood transfusion rates.

INTRODUCTION

Renal stones represent the most prevalent disorder in urology, with 10 percent of humans reporting complaint.[1] They exhibit a high recurrence rate of approximately 70%. As the stone moves, renal colic emerges, and kidney function may be compromised due to stone obstruction.[2,3]

Obesity, defined as a body mass index (BMI) of ≥30 kg/m^2, has become a worldwide health concern for both developed and developing countries.[4] The association between obesity and kidney stone formation has a prevalence of 10-35%.[5,6]

Advancements in the management of renal stones have been significant, with the introduction of minimally invasive approaches such as laparoscopy, percutaneous nephrolithotomy (PCNL), and retrograde intrarenal surgery (RIRS), as well as noninvasive procedures like extracorporeal shock wave lithotripsy (ESWL).[7] The European Association of Urology (EAU) recommends PCNL as the treatment of choice for renal stones larger than 20 mm and for stones between 10 and 20 mm in the lower pole of a kidney when ESWL has failed due to unsuitable conditions.[8]

The recommended treatment for large or complex renal or proximal ureteral stones is percutaneous nephrolithotomy (PCNL), but several factors may limit its use in obese patients. A high BMI may create difficulties with patient positioning and anesthesia, particularly in the prone position. The supine position can at least partly overcome these drawbacks. However, the prone position leads to greater kidney mobility and a further increase in stone-to-skin distance, thus requiring longer access sheaths and greater skill in creating the tract.

The standard option to renal stones larger than 2 cm is Standard-PCNL (S-PCNL) to achieve a high stone-free rate (SFR).[9] However, S-PCNL is sometimes associated with complications, such as major bleeding, prompting the need for less invasive techniques to reduce the likelihood of morbidity.[10] Mini-PCNL (M- PCNL) which is a modification of standard PCNL (S-PCNL) has been developed using a miniature endoscope through a small percutaneous tract (11–20 F) to reduce morbidity associated with larger instruments like significant blood loss, postoperative pain and possible renal parenchymal damage.[8] M-PCNL was first described by Jackman et al. and Helal et al. in children using 11–15-F sheath.[11] The aim of the study was to conduct a detailed evaluation and comparison of M-PCNL and S-PCNL for treating renal stones in obese patients.

MATERIALS AND METHODS

A hospital based prospective observational study was conducted in Department of General Surgery, SSMCH, Jabalpur, M.P., India for a period of 12 months. Patients presenting with renal calculus who were admitted in Department of General Surgery, were considered for the study.

Inclusion Criteria

1. Both men and women of the age group 20- 80 years
2. Old and newly diagnosed patients presented with renal calculus less than 3 cm in size.
3. Patients who wanted to get operated on and gave consent for the study.

Exclusion Criteria

1. Age of men and women below 20 years and above 80 years
2. Abnormal coagulation profile, complicated urinary tract infection, congenital renal anatomy (horseshoe, pelvic, and mal-rotated kidneys), renal stones larger than 3 cm, staghorn stones, multiple renal stones, patients who had undergone transplant or urinary diversion, solitary kidney patients and pregnancy.
3. Patient who didn't give consent for the study

Methods: A total of 50 Patients admitted to the outpatient clinic meeting the inclusion and exclusion criteria were systematically randomized into one of two groups: M-PCNL (Group A) and S-PCNL (Group B) in a 1:1 ratio. The allocation was performed blindly to minimize bias.

Preoperative assessment: Prior to the procedure, each patient underwent a detailed personal, medical, and surgical history, physical examination (general and local), and laboratory investigations (CBC, liver function, kidney function, coagulation profile, urinalysis, and urine culture). Imaging studies included kidney–urinary bladder X-ray (KUB), pelvic and abdominal ultrasonography, and either computed tomography urinary tract (CTUT) or intravenous pyelography (IVP). Patients with positive urine cultures received appropriate prophylactic antibiotics 48 h preoperatively and continued postoperatively.

Surgical procedure

The procedure was performed under general anesthesia. Retrograde ureteric catheterization with a 5–6-Fr open-ended ureteric catheter was done, and the patient was positioned prone under a C-arm image intensifier. An 18-gauge needle was placed under fluoroscopic guidance through the flank into the target calyx (lower calyx) of the kidney through the desired access. A guide wire of 0.035 or 0.038 sizes was passed through the needle, followed by a small incision in the skin and fascia. The tract was dilated using a Teflon or metal dilator over the guide wire. Single-tract dilation was performed for all cases under fluoroscopic control. An 11–13-Fr AmPlatz sheath for Group A and a 30-Fr AmPlatz sheath for Group B were passed over the dilator. A semi-rigid ureteroscope and nephroscope were passed through the sheath for Group A and Group B, respectively. In Group A, a ureteroscope sized 9.8–13 Fr and 38 cm long was used due to the unavailability of a miniperc scope at our hospital. A single-step dilatation was employed, and the calculus was fragmented using a pneumatic lithotripter with a 1.6-mm probe. Stone fragments were extracted with forceps. Stone clearance was assessed using nephroscope visualization and C-arm imaging during the operation. At the end of the procedure, a 10-Fr nephrostomy tube was placed in M-PCNL (Group A) patients, and a 22-Fr nephrostomy tube was placed in S-PCNL (Group B) patients, or a double J stent was inserted if necessary. Postoperatively, non-steroidal anti-inflammatory drugs (diclofenac) were administered for analgesia.

Postoperative care and follow-up

Patients were routinely discharged from the hospital the day after the procedure. If a double J (JJ) ureteral stent was inserted, it was removed two weeks after the procedure at the follow-up visit. In cases where postoperative leakage persisted for more than 72 h (three days), catheterization was prolonged. We evaluated operating time, stone clearance, postoperative analgesic requirement, and both postoperative hospital stay and leakage. Hemoglobin levels were measured, and a kidney, ureter, and bladder (KUB) X-ray and pelvic-abdominal ultrasound were performed on a postoperative day one before discharge from the hospital to determine stone clearance. Clinically insignificant residual stone fragments in the kidney were defined as $\leqq 4$ mm. Patients were followed one week after the operation.

Statistical Data Analysis: The Mean ± SD was be calculated for quantitative data. Percentage and proportion were calculated for qualitative data. Chi-square was used to find out the association between categorical variables. Using SPSS (Version 20) Software, a p-value < 0.05 was considered statistically significant.

RESULTS

In total, 50 patients were evenly divided into two groups of 25 patients each. The M-PCNL group comprised 13 females (52%) and 12 males (48%), with a mean age of 36.87 ± 8.62 years. The S-PCNL group included 8 females (32%) and 17 males (68%), with a mean age of 46.19 ± 11.52 years.

The operation time was longer for M-PCNL (130.64±27.23 min) than for S-PCNL (50.7±16.85 min), as stone fragmentation took longer (p<0.05*). In the M-PCNL group, stones had to be broken into smaller pieces for removal through the narrow nephrostomy tract. However, puncture and dilatation steps took the same time in both groups. The mean drop in hemoglobin levels was significantly (P<0.05*) lower in the M-PCNL group (0.22±0.01 g/dL) compared to the S-PCNL group (0.92±0.03g/dL). Neither supracostal nor multiple accesses were performed in either group. [Table 1]

Auxiliary procedures were needed for 12 cases in Group B, including catheterization for more than three days and JJ insertion in 3 cases (p>0.05). In Group A, postoperative leakage was observed in 3 patients who were conservatively managed with catheterization for two days (Grade I), whereas in Group B, leakage occurred in 22 cases, with 12 requiring ureteric catheterization for more than 72 h (4 days in 8 cases, four days in 2 cases, and six days in 2 cases), demonstrating a significant difference between the two groups (p<0.05*). For these 12 cases, catheterization was considered an auxiliary procedure. JJ insertion was performed in 3 cases from Group B (S-PCNL), but it was not needed in M-PCNL cases (p>0.05). [Table 1]

Success rates (SFR %) differed significantly (p<0.05*) between the two groups, with 100% in the M-PCNL group and 88% in the S-PCNL group. In the S-PCNL group, 3 cases had residual stones and were later treated with ESWL (Grade III), with the DJ stent removed within two months after confirming no residual stones following ESWL. [Table 1]

Complications

Challenges were faced in M-PCNL due to the use of an ureteroscope instead of a miniperc scope. These included stone migration, limited movement of the ureteroscope due to its length, and sufficient but reduced irrigation compared to S-PCNL. A few complications occurred and were classified according to the Modified Clavien Score. These included intraoperative bleeding (Grade I) in 2 cases from Group B, which was controlled with a nephrostomy tube and JJ insertion; postoperative fever (Grade II) in 2 cases from Group A and 7 cases from Group B; intraoperative pelvic injury (Grade III) in 2 cases from Group B; and mild collection in 3 cases from Group A and 22 cases from Group B. [Table 1]

Table 1: The comparison of mean value of variables in Mini-PCNL vs. Standard-PCNL

Variables	Group A (M-PCNL) (n=25)	Group B (S-PCNL) (n=25)	P value
Mean (SD)			
Operation time (min)	130.64±27.23	50.7±16.85	<0.05*
Fluoroscopy exposure time (min)	2.97±0.76	3.09±0.82	>0.05
Stone burden (cm)	1.62±0.45	1.78±0.55	>0.05
Preoperative Hemoglobin, g/mL	13.12±1.03	13.46±1.45	>0.05
Postoperative Hemoglobin, g/mL	12.90±1.02	12.54±1.48	>0.05
Hemoglobin drop, g/dL	0.22±0.01	0.92±0.03	<0.05*
Hospital stay (Days)	1.3±0.66	3.43±1.19	<0.05*
No. of NSAID ampoules used to control postoperative pain	1.55±0.57	4.3±0.98	<0.05*
Catheter indwelling time (days)	1.4±0.66	3.25±0.97	<0.05*
DJ indwelling time (months)	0	1.46±0.56	>0.05
Nephrostomy duration (days)	0	1 (0)	>0.05
Postoperative VAS pain score	1.42±0.46	3.59±0.66	<0.05*
Clearance (SFR) n (%)	25 (100%)	22 (88%)	<0.05*
Auxiliary procedures n (%)			
(a) Catheterization for more than 72 h	0 (0)	12 (48%)	>0.05
(b) Double J insertion	0 (0)	3 (12%)	>0.05
(c) Nephrostomy tube	0 (0)	3 (12%)	>0.05
Complication (Clavien score) n (%) Grade I			
Leakage (follow-up)	3 (12%)	22 (88%)	<0.05*
Bleeding	0 (0)	2 (8%)	>0.05
Grade II			
Fever (SIRS)	2 (8%)	7 (28%)	>0.05
Grade III			
Pelvic injury	0 (0)	2 (8%)	>0.05
ESWL postoperative	0 (0)	3 (12%)	>0.05

DISCUSSION

The primary goal in treating renal calculi is to utilize a procedure that is highly safe, effective, and associated with fewer complications. Regarding operation time, we found a statistically significant increase in cases using M-PCNL compared to S-PCNL. These findings are consistent with some publications.[3,12-14] This significant difference in operation time resulted from the highly limited field of vision due to miniaturized endoscopes and the time required to fragmentize the stones into smaller pieces for easy removal through the small tract. On the other hand, some studies, such as,[15,16] reported no significant difference in operative time.

In our study, the clearance achieved in M-PCNL was 100%, while it was 88% in S-PCNL. These clearance results align with the trial conducted by Cheng et al. 2010, who reported that using a small-caliber uretero-scope facilitates access to different calyces, leading to increased clearance.[12] However, these results contradict Elsheemy et al.'s study, which concluded that clearance is higher in PCNL.[10] Some other authors, such as,[15,16] published that there was no difference between M-PCNL and S-PCNL regarding the stone-free rate. In contrast, Abdelhafez et al. 2016 revealed that the stone-free rate (SFR) significantly decreased for large- sized stones ($\geq$ 2 cm) compared to smaller ones (76.3% vs. 90.8%) when M-PCNL was applied.[14]

M-PCNL had a considerable advantage in terms of postoperative pain and hospital stay. Our study showed significantly shorter hospital stays and reduced postoperative pain in the M-PCNL group, similar to other studies by.[10,15] Sakr et al,[8] Cheng et al,[12] and Li et al,[13] noted that hospital stay results showed no significant difference between M-PCNL and S-PCNL. Hospital stays were shortened in M-PCNL patients because it typically employs a tubeless approach, and patient com- fort was improved post-M-PCNL.[8]

There was a statistically significant difference in NSAID doses between our groups, as patients treated with M-PCNL used fewer NSAID vials than those in the S-PCNL group. This result aligns with Zeng et al. study, which found higher VAS scores and more patients needing analgesics in the S-PCNL group.[17]

Hemorrhage is a significant risk of the S-PCNL procedure, resulting in the need for blood transfusion and increased susceptibility to renal damage. The development of M-PCNL emerged from the need to reduce morbidity (particularly bleeding) associated with the use of large nephroscope and their access tracts.[12] In our study, the hemoglobin drop was found to be lower after M-PCNL than after S-PCNL. This result is consistent with several studies, such as Elsheemy et al. 2019, Zeng et al. 2021, Cheng et al. 2010, and Zhu et al. 2015, which found bleeding and blood transfusion rates to be lower in the M-PCNL group.[10,12,17,18] Our present study agreed with Elsheemy et al. 2019 in that there was a statistically significant difference in postoperative fever between cases using M-PCNL and S-PCNL, with 6.7% of cases using M-PCNL having post- operative fever, compared to 26.7% of S-PCNL cases.[10]

CONCLUSION

In conclusion, M-PCNL is effective for managing renal calculi, offering a longer operative time and a higher stone-free rate compared to S-PCNL. Another significant benefit of M-PCNL over S-PCNL is the ability to use a ureteroscope when a miniperc scope is unavailable. S-PCNL is associated with higher leakage and postoperative fever. Bleeding and hemoglobin drop rates are higher in S-PCNL than in M-PCNL. M-PCNL is partially limited by the need to break down stones into smaller fragments to fit through the small sheath, resulting in increased operation duration.

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ISSN (O): 2687-5365; ISSN (P): 2753-6556

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