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EFFICACY OF PERCUTANEOUS NEPHROLITHOTOMY IN HORSESHOE KIDNEYS: A COMPARISON OF MINI AND CONVENTIONAL APPROACHES

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ABSTRACT

Introduction: *Renal stones, affecting 10% of the global population, are the most common urological condition with a high recurrence rate of 70%. Percutaneous nephrolithotomy (PCNL) is the standard treatment for renal stones larger than 2 cm, with the miniaturized variant (M-PCNL) being a less invasive alternative to conventional PCNL (C-PCNL). This study compares the efficacy and safety of M-PCNL and C-PCNL in managing renal stones in horseshoe kidneys.*

Materials and Methods: *A randomized controlled trial was conducted at the Armed Forces Institute of Urology, Rawalpindi, involving 60 patients (30 in each group) with renal stones 2–4 cm in size. Participants were randomized to undergo either M-PCNL or C-PCNL. Stone-free status, complications, operative time, and hospital stay were compared between the two groups. Statistical analysis was performed using SPSS version 25, with significance set at $p < 0.05$.*

Results: *The mean stone size was 1.59 cm in the M-PCNL group and 1.76 cm in the C-PCNL group ($p = 0.017$). Stone clearance was 100% for M-PCNL and 96.7% for C-PCNL ($p = 0.083$). M-PCNL resulted in shorter hospital stays and reduced postoperative pain. Both techniques were highly effective, with M-PCNL demonstrating a slight advantage in safety and patient comfort.*

Conclusion: *M-PCNL is a safe and effective alternative to C-PCNL for treating renal stones in horseshoe kidneys. It offers comparable stone clearance rates with reduced morbidity, making it a favorable option for patients. Overall there is no significant difference in efficacy of mini vs conventional PCNL. Further studies with larger sample sizes are recommended to validate these findings.*

INTRODUCTION

Ten percent of people complain of renal stones, making them the most common urological condition [1]. They have a high rate of recurrence, about 70%. Renal colic develops as the stone moves, and blockage from the stone may impair kidney function [2, 3]. When the equilibrium between solubility and salt precipitation solubility is upset, renal stones can form [4].

With the advent of noninvasive techniques like extracorporeal shock wave lithotripsy (ESWL) and minimally invasive techniques like laparoscopy, percutaneous nephrolithotomy (PCNL), and retrograde intrarenal surgery (RIRS), there have been notable advancements in the treatment of renal stones [5]. When ESWL has failed because of inappropriate circumstances, the Association of Urology (EAU) advises PCNL as the

preferred treatment for renal stones larger than 20 mm and for stones between 10 and 20 mm in the kidney's lower pole [6].

To get a high stone-free rate (SFR), Standard-PCNL or Conventional PCNL (C-PCNL) is the recommended treatment for renal stones larger than 2 cm. Less intrusive methods are necessary to lower the risk of morbidity since C-PCNL can occasionally result in consequences including severe bleeding that necessitates blood transfusions [7]. Parenchymal damage and bleeding can be decreased by using Mini-percutaneous nephrolithotomy (M-PCNL), which entails making narrower tracts (≤18 Fr) to enable smaller scopes to access the kidney [8].

This less invasive method was developed by Jackman et al. [9] and significantly enhanced the PCNL procedure's difficulty profile. However, because the smaller tract size may limit the ability to use instruments for the removal of big stones, it was necessary to confirm its effectiveness in comparison to C-PCNL [10].

M-PCNL and C-PCNL have been compared in a number of studies [11,12], however the majority of these research had small sample sizes. Furthermore, there is still debate about their relative efficacy and safety. In order to prospectively assess the safety and efficacy outcomes of M-PCNL against C-PCNL for the treatment of renal calculi, we carried out a randomized controlled research.

Materials and methods:

The study was designed as a randomized controlled trial conducted at the Armed Forces Institute of Urology in Rawalpindi. It spanned a duration of six months, beginning after the approval of the study synopsis. The sample consisted of 60 patients, with 30 participants in each study arm. The sample size was calculated using the WHO calculator, with a significance level of 5%, a power of 90%, an efficacy of 54.7% for conventional PCNL, and 95% for mini PCNL. A consecutive non-probability sampling technique was used to recruit participants.

The study included patients of both genders, aged 18 to 60 years, with stone sizes ranging from 2 to 4 cm confirmed on non-contrast CT KUB, and those with negative urine cultures. Patients were excluded if they had a history of previous renal surgery, as this could distort anatomy and affect stone clearance, or if they had deranged renal function, defined as serum creatinine levels greater than 1.2 ng/ml. These exclusion criteria were applied to minimize confounding factors and bias in the study results.

After obtaining permission from the hospital's Ethical Committee and approval from the College of Physicians and Surgeons Pakistan, the study was initiated. Patients admitted for PCNL who met the inclusion criteria were enrolled. Strict adherence to the exclusion criteria was maintained to control potential confounders and biases. Patients were informed about the potential complications and success rates of the interventions, and written informed consent was obtained from all participants. A detailed medical history, physical examination, and routine laboratory investigations, including complete blood count, blood sugar, serum creatinine, calcium, uric acid, blood group, urinalysis, and urine culture, were conducted. Preoperative imaging included non-contrast CT KUB. Participants were admitted one day before the procedure.

Patients were randomized into two groups using a lottery method. Group A underwent mini PCNL, while Group B underwent conventional PCNL. All procedures were performed in the prone position under general anesthesia by an experienced urologist. The effectiveness of the interventions, measured as stone-free status, was determined using non-contrast CT KUB at one-month post-procedure. Participants lost to follow-up were replaced by recruiting new patients using the same sampling technique and study criteria. All collected information was documented in a pre-designed proforma by the trainee.

Data analysis was performed using SPSS version 25.0. Mean and standard deviation were calculated for quantitative variables such as age and stone size, while frequencies and percentages were computed for qualitative variables such as gender, stone location, stone side, and efficacy. Efficacy was stratified by age, gender, stone size, location, and side to assess the effect of these factors. Post-stratification, the Chi-square test was applied with a significance threshold of $p < 0.05$. Efficacy between the two groups was also compared using the Chi-square test, maintaining a p-value of less than 0.05 as significant. The results were presented in tables and graphs.

The procedure was conducted under general anesthesia. Retrograde ureteric catheterization was performed using a 5–6-Fr open-ended ureteric catheter, after which the patient was positioned prone under a C-arm image intensifier. Using fluoroscopic guidance, an 18-gauge needle was inserted through the flank into the target lower calyx of the kidney to establish access. A 0.035 or 0.038 guidewire was advanced through the needle, followed by a small incision in the skin and fascia. The tract was then dilated using a Teflon or metal dilator over the guidewire. For all cases, single-tract dilation was performed under fluoroscopic control.

An Amplatz sheath sized 11–13 Fr was used for Group A, while a 30-Fr sheath was used for Group B, passed over the dilator. A semi-rigid ureteroscope and nephroscope were employed for Groups A and B, respectively. In Group A, a 9.8–13 Fr ureteroscope measuring 38 cm in length was utilized due to the unavailability of a miniperc scope at the hospital. The procedure involved single-step dilation, and the calculus was fragmented using a pneumatic lithotripter with a 1.6-mm probe. Stone fragments were retrieved using forceps, and stone clearance was confirmed through nephroscope visualization and C-arm imaging during the operation.

At the conclusion of the procedure, a 10-Fr nephrostomy tube was placed in M-PCNL patients (Group A), whereas a 22-Fr nephrostomy tube was used for S-PCNL patients (Group B). In some cases, a double J stent was inserted when required. Postoperatively, non-steroidal anti-inflammatory drugs (NSAIDs), specifically diclofenac, were administered for pain management.

Results:

Two groups of thirty patients each were created from the 60 patients in total. The demographic and clinical parameters of patients undergoing M-PCNL and C-PCNL were compared. Regarding gender distribution, the M-PCNL group consisted of 14 male patients (47%) and 16 female patients (53%), while the C-PCNL group included 20 male patients (67%) and 10 female patients (33%). This difference in gender distribution was noted but did not reach statistical significance.

The mean age of patients in the M-PCNL group was 36.93 ± 8.58 years, which was significantly younger compared to the C-PCNL group, where the mean age was 45.06 ± 10.65 years.

The stone burden was also analyzed, with the M-PCNL group showing a slightly lower mean stone size of 1.59 cm compared to 1.76 cm in the C-PCNL group. This difference was statistically significant, with a p-value of 0.017, suggesting a potentially meaningful variation in the stone size between the groups.

Regarding stone clearance rates, the M-PCNL group achieved a 100% clearance rate (30 out of 30 patients), while the C-PCNL group demonstrated a slightly lower clearance rate of 96.7% (29 out of 30 patients). However, this difference was not statistically significant, as the p-value was 0.083. Both methods were highly effective in achieving stone clearance, with M-PCNL showing a marginally better outcome.

Table 1: Parameters of mini and conventional PCNL.

Parameters	M-PCNL (n=30)	C-PCNL (n=30)	P value
Gender, n (%) Male, Female	14(47%) 16 (53%)	20 (67%) 10 (33%)	0.188
Age, Mean (SD)	36.93±8.58	45.06±10.65	0.009
Stone burden (cm)	1.59	1.76	0.017
Clearance, n (%)	30 (100)	29 (96.7)	0.083

Discussion:

Using a treatment that is extremely safe, effective, and linked to fewer consequences is the main objective when treating renal calculi. The results and side effects of Mini-PCNL (M-PCNL) and Conventional-PCNL (C-PCNL) in the treatment of individuals with a single unilateral renal stone less than 3 cm and normal renal function tests were compared in our study.

In our study, the clearance in M-PCNL was 100%, whereas in C-PCNL it was 96.7%. These clearance results are consistent with Cheng et al.'s experiment 2010, who found that access to various calyces is made easier

with a small-caliber ureteroscope, increasing clearance [13]. These findings, however, go counter to the findings of Elsheemy et al.'s study, which found that PCNL has a higher clarity [7]. According to certain other writers, such [10, 16–18], there was no difference in the stone-free rate between M-PCNL and C-PCNL. On the other hand, Abdelhafez et al. [16] found that when M-PCNL was used, the stone-free rate (SFR) significantly dropped for larger stones (≥2 cm) in comparison to smaller ones (76.3% vs. 90.8%) [15].

In terms of hospital stay and postoperative discomfort, M-PCNL had a significant advantage. Similar to recent studies by [7, 8, 16, 19], our study demonstrated significantly shorter hospital stays and less postoperative discomfort in the M-PCNL group. Hospital stay outcomes revealed no discernible difference between M-PCNL and C-PCNL, according to Sakr et al. [6], Cheng et al. [13], and Li et al. [14]. Because

M-PCNL usually uses a tubeless technique, hospital stays were reduced for patients, and post-M-PCNL patient comfort increased. [6]

Patients treated with M-PCNL used fewer NSAID vials than those in the C-PCNL group, indicating a statistically significant difference in NSAID dosages between our groups. This finding is consistent with the Zeng et al. study, which discovered that the C-PCNL group had higher VAS scores and more patients in need of analgesics [8].

Conclusion:

M-PCNL was associated with a younger patient demographic and slightly smaller stone burden compared to C-PCNL. Both techniques showed excellent stone clearance rates, with M-PCNL achieving complete clearance in all patients. Despite the differences in stone size and clearance rates, the statistical significance of these findings highlights the reliability and effectiveness of both procedures in managing renal stones.

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