International Journal of Endorsing
HEALTH SCIENCE RESEARCH

IJEHSR

Original Article

Comparison of stone clearance rate and need of nephrostomy in conventional versus mini percutaneous nephrolithotomy.

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Doi: 10.29052/IJEHSR.v10.i4.2022.416-421
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Received 02/08/2022
Accepted 25/10/2022
First Published 11/11/2022

OPEN ACCESS

Abstract

Background: The increased renal stone size affects the stone clearance rate and the need for nephrostomy in (Percutaneous nephrolithotomy) PCNL. Also, complete stone clearance of bulky renal calculi causes blood loss during PCNL, resulting in hemoglobin drop and sometimes requiring transfusion. This is a frequently encountered phenomenon and is quite problematic for urologists and patients. This study aimed to determine the rate of stone clearance and nephrostomy needed in Mini-PCNL over Conventional PCNL.

Methodology: A comparative study was conducted at the urology department of PIMS, Islamabad. A total of eighty (n=80) adult patients of either gender between ages 18-65 years were enrolled. Subjects enrolled had radiographic evidence of renal stones of > 1cm. Group A patients underwent conventional PCNL procedures, and Group B patients underwent Mini PNCL. The rates of stone clearance nephrostomy needed were compared between the two study groups.

Results: The mean age of study participants in group A was (33.7 ± 12.1) and in group B (36.5 ± 11.1). The mean sizes of the stone were 2.4 cm and 2.7 cm in groups A and B, respectively. X-rays were used to assess the stone clearance rate on the first operative day in both study groups. Stones were cleared in group-A at 87.5% (n=35) and in group B at 82.5% (n=33). Nephrostomy was needed in group A at 50.0% (n=20) and in group B at 47.5% (n=19).

Conclusion: The stone clearance rate and the need for a nephrostomy tube were nearly similar in both intervention groups.

Keywords

Percutaneous Nephrolithotomy, Mini PCNL, Renal Stones, Nephrostomy.

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Introduction

Nephrolithiasis is one of the severe diseases of the urinary system. It has an unfavorable recurrence rate; about half of the patients encounter recurrence[1]. The goal of stone treatment strategies aim at getting maximum stone clearance, short procedure time, and minimum need for nephrostomy placement. A renal calculus can be removed through open surgery, extracorporeal shockwave lithotripsy, retrograde intrarenal surgery, and percutaneous nephrolithotomy[2].

Percutaneous nephrolithotomy was introduced by Fernstorn and Jhonson in 1976 and became a standard surgical procedure for renal calculi[3]. Jackman et al. introduced the Minimally Invasive Percutaneous Nephrolithotomy, which gained popularity because of lower morbidity compared to Conventional percutaneous nephrolithotomy due to the use of miniaturized instruments[4]. Tract size has been reported as a key variable affecting bleeding, parenchymal losses, need for nephrostomy, and complication rate. Miniaturization may, however, contribute to such benefits[5]. PCNL miniaturization was developed to reduce the procedure's morbidity[6].

The mini-PCNL has improved the role of PCNL due to its advantages in removing impacted lower pole stones and difficult-to-access calculi compared with Conventional PCNL. With a larger consensus in the literature, Conventional PCNL is the one in which an access sheath of > 22FR is used, while when ≤ 22 FR access sheath is used, it is termed Mini-PCNL. Moreover, Ultra-Mini (11-13FR), Mini-Micro (8FR), and Micro-PCNL (< 5FR) are also in practice[7,5].

In terms of functional tissue loss or post-operative renal scarring, some researchers found no statistically significant difference between Conventional PCNL and Mini-PCNL. However, decreased intraoperative blood loss in smaller access sheaths has been reported[8].

A comparative study of Mini-PCNL versus Conventional PCNL showed no difference in stone-free rate (SFR)[9]. Moreover, a meta-analysis by Wei Zhu and colleagues concluded that Mini-Percutaneous Nephrolithotomy resulted in less bleeding, fewer transfusions, reduced need for nephrostomy with lesser pain, and shorter hospitalization[10]. The present study results help compare the effectiveness of conventional and Mini PCNL for managing renal stones of more than 1 cm in size in terms of stone clearance rate and need for nephrostomy in Pakistan. This study aimed to compare the stone clearance rate and nephrostomy needed in Mini-PCNL over Conventional PCNL.

Methodology

A comparative study was conducted at the urology department of PIMS, Islamabad. This study was commenced after approval from the institute's ethical board (ERB#: 1-1/2015/ERB/SZABMU/340), and the study was conducted between March 2019 and February 2020. Subjects aged 18-65 of both genders with radiographic evidence of renal stones of sizes greater than 1 cm undergoing PCNL Conventional or Mini were enrolled after taking written informed consent. However, patients who were not willing for the procedure, PT/APTT above the reference range, platelets < 50,000/ml, subjects with a horseshoe kidney, positive urine cultures, pregnancy, and morbid obesity (BMI > 30) were excluded from the study.

The sample size was estimated using WHO Open Epi software using the power of test 80%, Level of significance of 5%, and population standard deviation of 3.5[10]. A total of eighty (n = 80) subjects, fulfilling the inclusion and exclusion criteria, were enrolled using the non-probability purposive sampling method. The subjects in Group A (n = 40) received Conventional PCNL, and Group B (n = 40) underwent Mini PNCL. The principal investigator used a computer-generated random allocation sequence to recruit and assign the subjects to the respective study groups. Patient's demographic and preoperative parameters, including age, sex, size of the stone, and laterality, were recorded on predesigned proforma. Both procedures were done under general anesthesia (GA). After the patient was given GA, a cystoscopy was performed,

and a 6 FR soft ureteric catheter was inserted in the lithotomy position under fluoroscopic guidance.

Prone position was used for percutaneous access to the kidney via an 18-gauge spinal needle under fluoroscopic guidance with the help of radio-opaque dye instilled through the ureteric catheter. For Conventional PCNL (Group A), the tract was dilated with sequential dilators over the guide wire with ≥ 22Fr amplatz sheath. Stones were fragmented with a pneumatic lithoclast and removed using a rigid nephroscope with forceps. For Mini-PCNL (Group B), the tract was dilated with a single-step dilator or sequential dilatation and by placing ≤ 22Fr amplatz sheath. A rigid nephroscope was used to fragment stones with pneumatic lithoclast and remove them with small forceps or by using an active washout. A rigid nephroscope was used to fragment stones with pneumatic lithoclast and remove them with small forceps or by using an active washout. A nephrostomy tube was placed in either procedure depending upon bleeding, pelvicalyceal system injury, and residual stone fragments. Ureteric and foley catheters are generally left in place for a minimum of one day. If a tube for tamponade of bleeding or drainage of the kidney was placed in the tract, the need for nephrostomy was recorded. Post-operative stone clearance was assessed on X-ray kidney ureter bladder (KUB) on the first post-operative day.

The data were entered and analyzed through SPSS version 20.0. For the participant's age and stone size mean and standard deviation and for categorical variables (gender, laterality, and nephrostomy placement), frequency and percentages were calculated. To compare the stone clearance between the study groups Chi-square test was used. Effect modifiers like age, gender, stone size, and laterality were controlled by stratification.

Results

Group A included 25 male and 15 female subjects, and group B constituted 21 males and 19 females. The mean age in group A patients was 33.7 ± 12.1 years, and group B patients was 36.5 ± 11.1 years. (Table 1).

In group A the mean size of the stone was 2.4 cm, whereas, in group B, it was 2.7 cm. In group A patients, 42.5% had stones under 2 cm, while the remaining had stones over 2 cm. In group B, 27.5% of the patients had stone sizes under 2 cm, and 72.5% had stone sizes over 2 cm. In group A, 60.0% (n=24) patients had right-sided stones, and 40.0% (n=16) had left-sided stones. In group B, 62.5% (n=25) patients had right-sided stones, and 37.5% (n=15) had left-sided stones (table 2).

Both intervention groups assessed the stone clearance status on X-ray or USG KUB on the first operative day. Stones were cleared in 87.5% of group A and 82.5% of group B (p=0.531. Nephrostomy was needed in 50.0% (n=20/40) in group A and 47.5% (n=19/40) patients in group B (p=0.823, table 3). Stone clearance and nephrostomy rates were found to be similar in both intervention groups.

Table 1: Age and gender distribution in both groups.

Variables		Group		Total	p-value
		PCNL Conventional	PCNL Mini		
Gender	Males	25(62.5)	21(52.5)	46(57.5)	0.366
	Females	15(37.5)	19(47.5)	34(42.5)	
Age (years); Mean ± SD		33.7±12.1	36.5±11.1	35.1±11.6	0.290
Age Group	18-40 years	30(75.0)	27(67.5)	57(71.3)	0.459
	41-65 years	10(25.0)	13(32.5)	23(28.8)	

Table 2: Stone size and laterality in both study groups.

Variables		Group		Total	p-value
		PCNL Conventional	PCNL Mini		
Stone Size	≤2 cm	17(42.5)	11(27.5)	28(35.0)	0.160
	>2 cm	23(57.5)	29(72.5)	52(65.0)	
	Total	40(100.0)	40(100.0)	80(100.0)	
Stones size (cm); Mean ± SD		2.4±0.83	2.7±0.99	2.55±0.91	0.111
Laterality	Right	24(60.0)	25(62.5)	49(61.3)	0.818
	Left	16(40.0)	15(37.5)	31(38.8)	
	Total	40(100.0)	40(100.0)	80(100.0)	

Table 3: Stone clearance rate and nephrostomy in both study groups.

Variables		Group		Total	p-value
		PCNL Conventional	PCNL Mini		
Stone Clearance	Yes	35(87.5)	33(82.5)	68(85.0)	0.531
	No	5(12.5)	7(17.5)	12(15.0)	
	Total	40(100.0)	40(100.0)	80(100.0)	
Nephrostomy	Yes	20(50.0)	19(47.5)	39(48.8)	0.823
	No	20(50.0)	2152.5)	41(51.3)	
	Total	40(100.0)	40(100.0)	80(100.0)	

Discussion

In recent years, Mini-PCNL has gained popularity, bridging the therapeutic gap between conventional PCNL and less-invasive procedures such as Shockwave lithotripsy or flexible ureteroscopy. The present study compared the effectiveness of mini-PCNL with conventional PCNL. A total of eighty (n = 80) adult patients of either gender between ages 18-65 years were enrolled. All the enrolled subjects had radiographic evidence of renal stones of > 1 cm. The enrolled patients were randomly assigned to two treatment groups by lottery method. Group A patients underwent the conventional PCNL procedure, and Group B patients underwent Mini PNCL. Stone clearance rate and need for nephrostomy compared in both groups. Our results showed that baseline demography and patient characteristics were similar in both groups. In terms of stone clearance and nephrostomy rate, there were no significant differences between the two study groups. The present study findings were found to be in line with the studies conducted earlier.

Khadgi et al. reported the duration of the procedure (50.17 ± 18.73 min), and fifteen study subjects reported complications. The authors concluded that Mini-PCNL, in contrast to standard PCNL is safe for stone removal in anomalous kidneys with SFR[11]. Li et al. compared SFRs in standard and mini PCNLs with comparable complication rates[12]. Mishra et al. reported that tubeless procedures reduce the duration of hospitalization from 4.8 ± 0.6 to 3.2 ± 0.8, with an additional benefit of the reduced drop in hemoglobin level[13]. According to Zeng et al., between 1992 and 2011, 10,000 Mini-PCNL were performed, including 21.2% simple calyceal stones and 58.8% complex calyceal stones. The burden of simple calyceal stones was lower at 1018.6 mm as opposed to 1763.0 mm ($p < 0.05$). Mini-PCNL one session significantly lowered the operative time, a drop in hemoglobin, with an increase in SFR for simple stones (77.6% vs. 66.4%) ($p<0.05$). The differences diminished in the following relook and/or auxiliary procedures (86.7% versus 86.1%). The complication rate was insignificant in the blood

transfusion rate (p>0.05)[14]. Akbulut et al. reported that in patients who received laser lithotripsy, SFR was higher compared to ultrasound, but the difference was not statistically significant (81.8% vs. 68.2%, p=0.296)[15].

In another study, Güler et al. compared the Mini-PCNL and standard-PCNL for renal stones ≥ 2 cm, and they found a significantly shorter duration of nephrostomy and hospital stay in Mini-PCNL. Also, the procedural success in the Mini PCNL was higher but statistically insignificant between Mini PCNL and standard-PCNL[16]. El Sheemy et al. compared the outcome of Mini-PCNL versus standard-PCNL for renal stones. The study finding reported that Mini-PCNL and standard-PCNL nearly matched in terms of patients (3.77 ± 2.21) and stone criteria, and a stone burden (3.77 ± 2.43). Neither the number of tracts nor supracostal punctures were significantly different. Tubeless PCNL rates were significantly higher in mini-PCNL. In standard-PCNL, a higher complication rate was reported, and in Mini-PCNL, it was found to markedly lower SFR[17]. In a recent systematic review, Thapa, and colleagues compared the outcome of Mini-PCNL with standard PCNL. They included 19 original articles in their analysis. Neither Mini-PCNL nor standard PCNL showed any significant difference in stone-free rates. However, due to the size of the sheath and the retrieval of stone fragments, the overall operative time is increased in Mini-PCNL[7].

Jackman performed a Mini-PCNL for the first time on an adult patient in 1997, using a ureteroscope size of 6.9 F/7.2 F or a pediatric cystoscope of 7.7 F. An SFR of 89% was achieved in the first mini-PCNL. The recovery speeds up with Miniperc by reducing operating time (60 ± 19 min), morbidities (4.7%), and hospitalization time (2.8 ± 1 day)[4]. Apart from the miniaturization of access sheath, Mini-PCNL also differs from the Conventional PCNL in removing kidney stones. Instead of relying on forceps and baskets, as is the case with Conventional PCNL, Mini-PCNL employs irrigation flow through a natural calcaneal system. This makes the procedure more desirable as it offers the same stone-free rates as the Conventional PCNL while decreasing morbidity simultaneously[18].

Research studies involving other Miniaturized PCNL procedures, such as Ultra-Mini, Mini-Micro, and Micro-PCNL, have also yielded better outcomes than conventional PCNL. In their RCT, Haghighi et al. found a decrease in outcomes such as blood loss, the need for a transfusion, post-operative pain, and hospital stay associated with Ultra-Mini PCNL compared to Standard PCNL[19]. Similar results were observed in a systematic review of the pediatric population, where it was found that miniaturized PCNL techniques can result in higher SFRs with fewer associated complications[20]. Miniaturised PCNL, compared with other surgical options for stone removal, such as retrograde intrarenal surgery (RIRS), also demonstrated significantly higher SFRs in the same population, indicating the adequacy of the procedure in removing renal stones in different age groups[21]. In the present study, comparative design and the stringent inclusion and exclusion criteria were adopted, it provides evidence of the efficacy of this procedure, paving the way for further comparative investigations.

Conclusion

The study results revealed that the stone clearance rate and the need for a nephrostomy tube were similar in both Mini-PCNL and conventional PCNL. There are a few limitations to the present study; the sample size was relatively smaller but sufficient to draw the inference; secondly, our follow-up period was shorter (24 hours), and hence we could not consider the complications associated with both the techniques as the outcome variable. We recommend future studies with longer duration of follow-ups while taking into account the associated complication rate as an outcome variable.

Conflicts of Interest

The author(s) declare that they have no competing interests.

Acknowledgment

We acknowledge all the study participants and the Urology Department of Pakistan Institute of Medical Sciences, Islamabad, Pakistan.

Funding

The authors received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors for this article.

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