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Original Article

Common Complications of Mini PCNL in Renal Stones more than 3.0cm

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ABSTRACT

Mini PCNL (mPCNL) procedures now often employ miniature nephroscopes that were originally created to treat paediatric kidney stones. There is scarcity of knowledge regarding complications of mPCNL in renal stones larger than 3 cm. **Objective:** To determine the common complications of mini PCNL performed for renal stones larger than 3.0cm. **Methods:** This descriptive case series study was conducted over a period of one year from November 2022 to October 2023 registered patients aging 4 to 14 years undergoing mPCNL with renal stones >3cm. The patients underwent mini PCNL and patients were followed over a period of 4 weeks for early (occurring within 48 hours of procedure) and late complications (occurring after 48 hours). **Results:** A total of 86 cases were analyzed. The age of the participants ranged from 4 years to 14 years. The mean age of the patients was 9.19±2.49 years. Majority of the participants were in the age group 10-14 years 57 (66.3%). Male to female ratio was 1.2: 1. Among the early complications, the most commonly reported was post-pain reported by 24 (28.0%) patients, followed by hematuria in 15(17.4%). Surgical site infection was the most common late complications observed in 9 patients (10.4%) followed by re-do surgery for 2 patients (2.3%) and none of the patient suffered renal dysfunction among our participants. **Conclusions:** MPCNL can be offered as a safe and secure surgical option with excellent results and manageable side effects for treating nephrolithiasis larger than 3cm in children.

INTRODUCTION

The phrase "mini-perc" is often used in scientific publications to refer to a procedure that involves the use of an access sheath with a size ranging from 11 to 20 Fr[1]. The treatment is conducted via an 11 French peel-away vascular access kit. A small needle for access is placed into the target calyx, and afterwards a wire to guide it is inserted. The covering and trocar are advanced along the guidewire under fluoroscopic supervision. After the trocar is removed, the sheath is carefully peeled down in order to get the desired working length [2]. The essential instruments required for mini-percutaneous nephrolithotomy (mini-PCNL) consist of a 7.0 French rigid paediatriccystoscope and a 9.5 French flexible ureterorenoscope. In the context of stone disintegration, two viable options are the use of a holmium laser or a lithoclast. Fragments may be eliminated by the use of irrigation and suction techniques, or alternatively, by using a grabbing device [3]. In a recent research including a cohort of 1368 patients, it was shown that mini-percutaneous nephrolithotomy (mini-PCNL) yielded a substantial stone-free rate (SFR) of 82% when using a 16 French (Fr) tract [4]. In contrast to standard percutaneous nephrolithotomy (PCNL), there was a lower incidence of serious bleeding problems (1.4%) [5]. In comparison to retrograde intrarenal surgery (RIRS), mini-percutaneous nephrolithotomy (mini-PCNL) demonstrated a statistically significant improvement in stone-free rate (SFR) and overall procedural efficiency [6]. Can mini-percutaneous nephrolithotomy (mini-PCNL), a

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less invasive procedure, be considered as a viable substitute for standard percutaneous nephrolithotomy (PCNL) in managing renal stones larger than 3 cm in diameter, given that extracorporeal shock wave lithotripsy (ESWL) and retrograde intrarenal surgery (RIRS) seem to have lower efficacy rates compared to PCNL in this context [7, 8]. Researchers have conducted comprehensive comparisons between percutaneous nephrolithotripsy and different tract sizes [9]. Nevertheless, the quality of the evidence provided was below standard, hence requiring the acquisition of further reliable data derived from randomised controlled trial (RCT) studies [10]. Furthermore, a comparative meta-analysis was not conducted on persons with substantial kidney stone burdens to assess the differences between conventional percutaneous nephrolithotomy (PCNL) and mini-PCNL [11]. Hence, the primary focus of this research was to compare surgical procedures used for the treatment of renal stones above 3 cm in size and the study assessed the safety profile of mini PCNL for kidney stones measuring over 3 cm. Additionally, subgroup analyses were conducted to provide more realistic recommendations for clinical practitioners.

METHODS

The descriptive case series study was carried out at Medical teaching hospital lady reading hospital Peshawar, from November 2022 till October 2023. The study population consisted of 94 individuals diagnosed with renal stones measuring over 3cm. The study included individuals who were aging 4 to 14 years, had normal renal function, had kidney stones larger than 30 mm, and had a documented history of past extracorporeal shock wave lithotripsy (ESWL) treatment failure. Patients with unresolved bleeding diathesis, an active urinary tract infection (UTI), those who had previously had transplant or urinary diversion procedures, and those with congenital anomalies were excluded. Patients were recruited using consecutive (non-probability) sampling technique. Sample size was estimated using WHO sample size calculator. Permission for the conduct of the study was taken vide no. 218/LRH/MTI, dated: 31/10/2022. Comprehensive demographic information of the recruited participants, such as age, sex, body mass index (BMI), and concurrent medical conditions, was collected subsequent to obtaining informed written permission. The preparatory assessment before surgery often involved several diagnostic procedures, including as ultrasonography, plain abdomen and pelvic X-ray (known as KUB), and excretory urography. These tests are primarily used to identify lucent stones and may also include a low-dose non-contrast CT scan with reconstruction confined to the kidneys. Additionally, blood cell counts, assessment of renal function by the measurement of blood urea nitrogen and creatinine levels, as well as urine analysis and culture, were conducted. Patients with positive cultures were given adequate antibiotics and admitted with sterile urine prior to the surgical procedure. All patients were hospitalized six hours before to the surgical procedure and were given parenteral hydration along with a single dose of prophylactic antibiotic. The treatment was performed with general anaesthesia. In the lithotomy or supine position with abducted thigh, a ureteral catheter of either 3 Fr or 4 Fr was introduced into the kidney and secured. Subsequently, the patient underwent a transition to the prone position. Following the appropriate application of padding, the patient's body was finally draped. Subsequently, a contrast solution was administered through a ureteral catheter, and the pelvicalyceal system was visualized. An 18-gauge Chiba needle was used to perform an insertion into the desired calyx. Subsequently, a 0.035 guide wire was introduced through the needle. The procedure of tract dilation was executed via telescopic dilatation devices with a maximum diameter of 18 French. The procedure of nephroscopy was conducted. The lithotripsy procedure was performed using a pneumatic lithoclast, and subsequent removal of the lithotripsy particles was accomplished via forceps. The absence of stones was assessed postoperatively using fluoroscopy and ultrasonography. The outcomes of the study were in terms of early and late complications which were measured as: 1) Early Complications: Complications occurring within 48 hours following the procedure were called early complications. Early complications included hematuria, pain and urosepsis/DIC. 2) Late Complications: Complications occurring between day 3 and 28 following the procedure were called late complications. Late complications included surgical site infection, renal dysfunction and re-do procedure. Means and standard deviation were used to describe continuous variables. Frequencies and percentages were used to illustrate categorical data. The student t test was used to compare the means of continuous variables when the data were normally distributed. The chi-square test and contingency tables were used to compare the categorical data. IBM SPSS version 24.0 was used for all statistical analyses.

RESULTS

A total of 94 patients were enrolled during the study period. 08 patients were lost to follow up. Hence the final sample size comprised of 86 participants. Analysis of 86 patients is presented. As illustrated in Table 1, post-op pain was reported by 24 patients (28.0%) rendering it as the most the common complication, followed by hematuria in 15 patients (17.4%) while urosepsis/DIC was recorded in 04 participants (4.6%). The most common late complication

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was surgical site infection in 09 participants (10.5%) followed by re-do procedure in 2 patients (2.3%). None of the patients included in our study suffered renal dysfunction as presented in Table 1.

Table 1: Frequencies and percentages of common complications (n = 86)

Complications	Types	Frequencies (%)
Early	Post op pain	24 (28.0)
	Hematuria	15 (17.4)
	Urosepsis/DIC	04 (4.6)
Late	Surgical site infection	09 (10.5)
	Re-do procedure	02 (2.3)
	Renal dysfunction	00 (0.0)

The mean age of the patients was 9.19 years with standard deviation of 2.49. Most of the participants were in the age group 10 to 14 years, comprising of 57 (66.3%) patients. The rest of 29 participants (33.7%) had age in the range of 4 to 9 years as shown in Table 2. In the age group 4-9 years (29 patients), the frequencies and percentages of early complications recorded were, post-op pain (07, 24.1%), hematuria (04, 13.8%) and urosepsis in one patient (3.4%). Regarding the late complications, surgical site infection was recorded in 2 patients (6.9%). None of the patient experienced re-do procedure and renal dysfunction in this age group. Among the 57 participants of the age group 10 to 14 years, post-op pain was the most common recorded for 17 participants (29.8%), hematuria in 11 participants (19.3%) and 03 patients experienced urosepsis (5.3%). The observations about late complications were surgical site infection (07, 12.3%) and re-do procedure among two participants (3.5%) as illustrated in Table 2.

Table 2: Subgroup analysis of common complications with age

Age groups (years)	Early Complications	Frequency (%)	Late complications	Frequency (%)
4 – 9 (n = 29)	Post-op pain	07 (24.1%)	Surgical site infection	02 (6.9%)
	Hematuria	04 (13.8%)	Renal dysfunction	0 (0.0%)
	Urosepsis	01 (3.4%)	Re-do procedure	0 (0.0%)
10–14 (n = 57)	Post-op pain	17 (29.8%)	Surgical site infection	07 (12.3%)
	Hematuria	11 (19.3%)	Re-do procedure	02 (3.5%)
	Urosepsis	03 (5.3%)	Renal dysfunction	0 (0.0%)

As shown in Table 3, the number of male participants in the study was 48 (55.8%). The male to female ratio was 1.2: 1. The distribution of early and late complications among the male participants were post-op pain (12, 25.0%), hematuria (09, 18.8%), urosepsis/DIC (2, 4.2%), surgical site infection (04, 8.3%) and re-do procedure was performed in one patient (1, 2.0%). The frequencies and percentages of early and late complications among female participants were post-op pain (12, 31.6%), hematuria (06, 15.8%), urosepsis (2, 5.3%), surgical site infection (5, 13.1%) and re-do procedure was performed in 02 patients (5.3%).

Table 3: Subgroup analysis of common complications with gender

Gender	Early Complications	Frequency (%)	Late complications	Frequency (%)
male (n = 48)	Post-op pain	12 (25.0%)	Surgical site infection	04 (8.3%)
	Hematuria	09 (18.8%)	Renal dysfunction	01 (2.0%)
	Urosepsis	02 (4.2%)	Re-do procedure	0 (0.0%)
Female (n = 37)	Post-op pain	12 (31.6%)	Surgical site infection	05 (13.1%)
	Hematuria	06 (15.8%)	Re-do procedure	02 (5.3%)
	Urosepsis	02 (5.3%)	Renal dysfunction	0 (0.0%)

The mean stone size of the patients was 3.97 cm with standard deviation of 0.59. 51 patients (59.3%) had stone size less than 4.5cm and the remaining 35 patients (40.7%) had stone size above 4.5cm. Complication rate increased as stone size increased. Patients with stone size more than 4.5cm had 13 patients (37.1%) who experienced more post-op pain, followed by hematuria (9, 25.7%), DIC/sepsis (2, 5.7%), surgical site infection in 06 (17.1%), and 1 patient underwent re-do procedure (2.8%). Out of the total 51 participants with stone size less than 4.5 cm, 11 patient experienced excessive post-op pain (21.6%), hematuria in 06 patients (11.7%), sepsis in 02 patients (3.9%). Late complications included surgical site infection 03 patients (5.9%) while one patient had re-do procedure (1.9%) (Table 4). The number of patients with right kidney stone was 45 (52.3%). Rest of the patients 41 (47.7%) had left kidney stone. The frequencies and percentages of complications in right kidney procedures were post op pain 13 (28.9%), hematuria 8 (17.8%), urosepsis 2 (4.4%), surgical site infection 5 (11.1%) and one patient had re-do procedure (2.2%). Other the other hand, the rate of complications in left kidney were 11 (26.8%), hematuria 07 (17.0%), sepsis 2 (4.9%), surgical site infection 04 (9.7%) and re-do procedure in one patient (2.4%).

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Table 4: Subgroup analysis of common complications with stone size

Stone size (cm)	Early Complications	Frequency (%)	Late complications	Frequency (%)
≥4.5cm (n = 51)	Post-op pain	13 (37.1%)	Surgical site infection	06 (17.1%)
	Hematuria	09 (25.7%)	Renal dysfunction	1 (2.8%)
	Urosepsis	02 (5.7%)	Re-do procedure	0 (0.0%)
<4.5cm (n = 35)	Post-op pain	11 (21.6%)	Surgical site infection	03 (5.9%)
	Hematuria	06 (11.7%)	Re-do procedure	01 (1.9%)
	Urosepsis	02 (3.9%)	Renal dysfunction	0 (0.0%)

DISCUCSSION

This research shows that the mPCNL technique had a significant complication risk in kids aged 4 to 14 with renal stones larger than 3 centimeters in size. Rather of relying on open surgery as adults do even for nephrectomy, clinicians are increasingly turning to less invasive techniques like ESWL and PCNL, which have developed to ultra-minimally invasive and laparoscopy [12]. Renal stone therapy with PCNL has evolved and improved since it was first used in 1976 [13]. Radiation exposure for the surgeon and the patient has been reduced by switching from pure fluoroscopic to mixed fluoroscopic/ultrasound and pure ultrasound guided for renal access [14]. Bleeding, infection, leaking into the urinary system, issues in the chest, injuries to surrounding viscera, and postoperative discomfort are all possible after PCNL [15]. mPCNL has been shown to be as effective as conventional PCNL with fewer side effects [16]. The SFR results from these two methods are quite similar. Less blood loss, transfusions, and overnight stays are required in mPCNL. mPCNL has a significantly longer running time. There are less cases of infection, fever, postoperative discomfort, renal damage, and other organ damage with mPCNL [17]. Twenty-three children underwent mPCNL by Wah et al., with median stone load of more than 3cm. Their initial SFR was 83.6%, and after treating the leftover pieces, it grew to 90.5%. Hydrothorax ensued in one patient after surgery, while two more had UTIs [18]. Compared to previous research, our early SFR was about 90% and our overall SFR was 95.3%, with just 5.3% of the original stone still present. Farouk et al., conducted a prospective trial comparing mPCNL with ESWL in children with a renal stone size of 1 to 2 cm. After the first surgical session, those who received mPCNL had an SFR of 88.9%, and after a second look at the procedure, they had an SFR of 92.59% [19]. In contrast, the ESWL group had an SFR of 88.89% after three sessions, with 55.6% achieved during the first session [20]. For kids with stones in their upper urinary system, another research evaluated the success rates of super-mPCNL and retrograde intra-renal surgery (RIRS). Patients who received RIRS required considerably more time in the operating room (76.3 vs. 53.9) and in the hospital (4.2 vs. 2.9 days), had a lower success rate (60.0% vs. 94.4%), and were more likely to need re-treatment (20% vs. 0%) [21]. Another research presented experiences of 163 patients. They found postoperative fever rate of 14.6% [22]. One patient with urosepsis was among the 12.5% of patients who had fever following surgery in our research. Twenty-two young patients who received ultra-miniature PCNL were studied by Zhu et al., [23]. Their patients had 18.2% suffered postoperative fever, and 0% had septicemia. Liu et al., conducted a research to determine what variables increase the likelihood of sepsis after mPCNL. Twenty individuals out of 834 in the study got septic shock. Three of these individuals ultimately passed away from complications related to multiple organ failure. Female gender was observed to increase the risk of postoperative septic shock (OR = 1.055, P 0.001), whereas diabetes mellitus increased the risk by a factor of 4.192 (P = 0.0030) [24]. Antibiotic treatment and other non-invasive methods successfully treated all of our patients. Because of the risk of hyponatremia and hypothermia in children, warm saline should be used for irrigation. While saline is the go-to for treating PCNL in adults, there are studies that demonstrate distilled water is just as effective. In our research, none of our patients had experienced these complications

CONCLUSIONS

Our research shows that MPCNL in children has acceptable complication rates and surgical success rates, making it a relatively safe operation. Renal stones greater than 3 cm in size were successfully treated with mini-PCNL, making it a safe and effective alternative to standard PCNL.

Authors Contribution

Conceptualization: KF
Methodology: KF, IZ, NH
Formal analysis: KF, AA, HH
Writing-review and editing: KF, HH, IAK

All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest

The authors declare no conflict of interest.

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