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Comparative Study in the Treatment of Renal Stone Less than 2 cm Between Mini-perc and Standard PCNL in Erbil/Iraq

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Abstract

Background and objectives: The management of nephrolithiasis has undergone substantial transformation with the introduction of minimally invasive endourological techniques. The objective of this research is to assess and compare the effectiveness of the two types of treatments of kidney stones mini-percutaneous nephrolithotomy versus conventional percutaneous nephrolithotomy.

Methods: A randomized comparison trial that included 150 patients diagnosed with renal stones from January 2022 to January 2024. Patients who were admitted to the urology department at Rizgary teaching hospital, Zheen international hospital and Zanko hospital were systematically assigned, through a random process, into 2 separate groups: A) mini-percutaneous nephrolithotomy group, or B) standard percutaneous nephrolithotomy. Parameters such as operative time, post operative hemoglobin level, complications, duration of hospitalization and residual stone were compared.

Results: The mean pre-operative hemoglobin was 13.5 ± 1.03 g/dl in patients who underwent standard Percutaneous, and 13.7 ± 0.65 g/dl in those who underwent mini-percutaneous nephrolithotomy ($p>0.05$). However, there was a statistically significant difference between mini-percutaneous nephrolithotomy post-operative hemoglobin (12.9 ± 0.79 g/dl) and standard percutaneous nephrolithotomy post operative hemoglobin (11.7 ± 2.5 g/dl) ($p<0.05$). There was no statistically significant difference in operative time between Group A and Group B. However, the rate of residual stone was significantly higher in standard percutaneous nephrolithotomy vs. mini-percutaneous nephrolithotomy ($p<0.05$).

Conclusions: Mini-percutaneous nephrolithotomy demonstrates enhanced efficacy in handling renal calculi, delivering a higher rate of stone clearance compared to Standard percutaneous nephrolithotomy.

Keywords: Kidney stone, Lithotripsy, Mini- percutaneous nephrolithotomy, Standard-percutaneous nephrolithotomy

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Introduction

Kidney stones stand as the foremost prevalent condition within urology, affecting roughly 10 percent of the population.[1] There has been a global surge in the occurrence and prevalence of nephrolithiasis, influenced by varying climates and socioeconomic conditions.[2,3] These stones demonstrate a notably high recurrence rate, approximately hitting the 70 percent mark. As these stones traverse through the renal system, they trigger episodes of renal colic, potentially obstructing the kidney and leading to compromised kidney function.[4] The approach to treating nephrolithiasis has undergone substantial advancement after the emergence of minimally invasive endourological techniques. As per international guidelines, percutaneous nephrolithotomy (PCNL) is currently advised as the initial treatment for kidney stones larger than 20 mm in size.[5,6] Traditional PCNL utilizes sheath sizes ranging from 24 to 30 F, whereas mini-perc PCNL employs smaller sheath sizes from 14 to 20 F.[7] Mini-perc PCNL is also suitable for conditions like diverticular stones.[4] Standard PCNL occasionally gives rise to complications, notably severe bleeding necessitating blood transfusion, thereby instigating the search for less invasive techniques to diminish the risk of associated health issues.[8] This is often linked to the larger size of the tract required and the necessity for multiple tracts.[9] Implementing Mini-perc PCNL, which involves creating passage for smaller scopes into the kidney by fashioning narrower tracts (≤ 18 Fr), has demonstrated promise in minimizing tissue damage and bleeding.[10] Numerous studies have highlighted the comparable effectiveness of mini-perc PCNL when compared to standard PCNL in managing smaller to medium-sized and less complex stone burdens. Both methods are deemed safe for management of kidney stones; however, the principal advantages of mini-perc PCNL over standard PCNL encompass shorter duration of operation, shorter duration of nephrostomy, fewer instances of bleeding complications, reduced postoperative pain, and a higher potential for performing tubeless PCNL procedures, and shorter duration of hospitalization.[10-12] To thoroughly assess and compare the effectiveness and safety outcomes of mini-perc PCNL versus standard PCNL in treating kidney stones, we undertook a meticulously designed randomized controlled study. This study aimed to provide comprehensive data on both procedures, evaluating their relative benefits and risks. By carefully controlling for various factors and implementing rigorous methodology, we sought to ensure the reliability and validity of our findings, thereby contributing valuable insights to the field of kidney stone treatment.

Patients and methods

Our research involved a randomized comparison that included 150 patients diagnosed with renal stones during the period spanning from January 2022 to January 2024. Patients who were admitted to the urology department at Rizgary teaching hospital from the outpatient clinic, Zheen international hospital, and Zanko hospital, and met the specific inclusion and exclusion criteria were systematically assigned, through a random process, into 2 groups: mini-perc PCNL (Group A) or standard PCNL (Group B), maintaining an equal ratio of 1:1. The allocation process was conducted in a manner that prevented any bias, ensuring blinding.

Ethical approval was obtained from the scientific committee of Kurdistan Higher Council of Medical Specialties. Before participating, all patients were provided with detailed information about the research goals and procedures, and they gave their consent in a written form. Qualified participants encompassed individuals of any age and gender presenting with a solitary, unilateral renal stone measuring under 2 cm. Criteria

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for exclusion involved complicated urinary tract infections, specific congenital renal anatomical anomaly (such as mal-rotated kidneys and horseshoe kidneys), abnormal coagulation profiles, renal stones larger than 2 cm, multiple renal stones, individuals with a history of transplantation or urinary diversion, patients with a single functioning kidney, pregnant women. The procedure was performed with the patient under general anesthesia. It involved inserting a retrograde ureteric catheter using a 5–6-Fr open-ended catheter. The patient was placed under a C-arm image intensifier in prone position. Utilizing fluoroscopic guidance, an 18-gauge needle was inserted laterally to reach the intended lower part of the kidney. Subsequently, a thin wire, was carefully passed through the needle (size: 0.035 or 0.038), after which the skin and underlying tissue was incised, making a small opening. To widen the path, a metal or Teflon dilator was gently introduced along the wire. In certain cases, a single-tract dilation was carried out under continuous fluoroscopic monitoring. An AmPlatz sheath of 14–20-Fr was employed for mini-perc PCNL group, while a 30-Fr AmPlatz sheath was used for standard PCNL group. Subsequently, a nephroscope was introduced through the sheath for mini-perc PCNL group and standard PCNL group, respectively. The procedure involved single-step dilation or where necessary, serial dilation, and a 1.6mm probe of a pneumatic lithotripter was used to fragment the calculus. Stone fragments were then removed using forceps. The assessment of stone clearance was conducted by visually inspecting with C-arm imaging and directly observing during the operation with the nephroscope. Upon completion of the procedure, for patients who underwent Mini-perc PCNL a 10-Fr nephrostomy tube was inserted, whereas for those undergoing Standard PCNL a 22-Fr nephrostomy tube was inserted. When necessary, a double J stent was also inserted for patients of both groups. Following the surgery, patients were given non-steroidal anti-inflammatory drugs such as diclofenac. Typically, 24 hours after the procedure the patients were discharged. Subsequently, during a follow-up appointment, usually scheduled around four weeks post-procedure, the double J (JJ) ureteral stent was removed for all patients who had one. In instances where postoperative leakage persisted beyond 72 hours (equivalent to three days), catheterization was extended. Our assessment involved several factors including operative time (the time from first incision to closure of surgical wound), effectiveness in removing stones, as well as the duration of hospitalization and complications such as occurrence of leakage following the procedure, bleeding, pain and infection. Moreover, Hemoglobin levels were checked. In the follow up session (scheduled 4 weeks pos-operation), ultrasound was performed for all patients to assess for residual stones. The analysis of data was carried out utilizing SPSS® software, version 26 (Statistical Package for Social Sciences). Mean and standard deviation were used to present quantitative data. Percentages were used to show percentages. For comparing qualitative variables, chi-square test was used, as for comparing quantitative variables, independent t-test was applied. A p-value of less than 0.05 was considered statistically significant for the results.

Results

One-hundred and Fifty patients were included in this study. The mean age of patients was 42.6 ±13.3. There were more males (54%) than females (46%). The percentage of illiterate patients was 20%, and those with bachelor's degree or higher education was 30%; in terms of occupation 34% were labor workers and 32% were unemployed. The prevalence of active smokers was 48%. Only 26% of the patients

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had history of stone and 76.9% had undergone URS. Table (1) describes the demographic and baseline data of the study population.

Table (1): Demographic and baseline data of the study population

Variables		n= 150
Age, years ± SD		42.6±13.3
Gender, n (%)	Male	81 (54%)
	Female	69 (46%)
Occupation, n (%)	Private job	33 (22%)
	Labor worker	51 (34%)
	Government job	18 (12%)
	Unemployed	48 (32%)
Educational level, n (%)	Illiterate	30 (20%)
	Read and write	18 (12%)
	Primary school	21 (14%)
	Secondary school	18 (12%)
	High school	18 (12%)
	Bachelor's degree and higher education	45 (30%)
Residency, n (%)	Rural	66 (44%)
	Urban	84 (56%)
Family income, n (%)	Enough for daily	102 (68)
	Not enough	33 (22%)
	Exceeds daily needs	15 (10%)
Smoking status, n (%)	Active smoker	72 (48%)
	For smoker	9 (6%)
	Non-smoker	69 (46%)
HTN, n (%)	Yes	63 (42%)
	No	87 (58%)
DM, n (%)	Yes	21 (14%)
	No	129 (86%)
History of stone, n (%)	Yes	39 (26%)
	No	111 (74%)
History of intervention for stone removal	Yes	39 (26%)
	No	111 (74%)
Type of previous intervention (n=39)	ESWL	3 (7.7%)
	URS	30 (76.9%)
	PCNL	6 (15.4%)

Table (2) show the pre-operative and intra-operative data stratified according to the type of PCNL they underwent. Right kidney stone was found in 48% of those who had standard PCNL and 56% of those who had mini-perc PCNL. Left kidney stone was found in 52 % of those who had standard PCNL and 44% of those who had mini-perc PCNL. The mean stone size was 19.8 ± 1.8 mm in those who underwent standard PCNL, and 19.3 ± 1.1 mm in those who underwent mini-perc PCNL. The most common stone location in the kidney was the lower calyx (52%) in both groups. The mean pre-operative hemoglobin was 13.5 ± 1.03 g/dl in patients who had standard PCNL, and 13.7 ± 0.65 g/dl in those who had mini-perc PCNL. The mean operative time in decimal hours was 1.05 ±

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0.303 in those who had standard PCNL and 1.07 ± 0.27 in those who had mini-perc PCNL. The difference in operative time between the two groups were statistically insignificant (p=0.765). For all of the cases in both groups a double-J was inserted. Nephrostomy was inserted in 96% of those who had standard PCNL and all of those who had mini-perc PCNL.

Table (2): pre-operative and intra-operative patient data in mini-perc vs. standard PCNL

Variables		Standard PCNL n=75	Mini-perc PCNL n=75	p-value
Stone site	Right kidney	36 (48%)	42 (56%)	0.571
	Left kidney	39 (52%)	33 (44%)	
Stone size, mean ± SD (mm)		19.8 ± 1.8	19.3 ± 1.1	0.296
Stone location in the kidney	Upper calyx	9 (12%)	6 (8%)	0.7102
	Middle calyx	18 (24%)	12 (16%)	
	Lower calyx	39 (52%)	39 (52)	
	Renal pelvis	9 (12%)	18 (24%)	
Pre-op HGB, mean ± SD (g/dl)		13.5 ± 1.03	13.7 ± 0.65	0.299
Operative time, decimal hours		1.05 ± 0.303	1.07 ± 0.27	0.765
DJ insertion		75 (100%)	75 (100%)	-
Nephrostomy insertion		72 (96%)	75 (100%)	1.000

Table (3) shows post-operative data of the two groups. The most prevalent complication in both groups was urine leak, however a higher percentage was found in mini-perc PCNL (68%) compared to standard PCNL (44%). A statistically significant difference was found between mini-perc PCNL post-operative hemoglobin (12.9 ± 0.79 g/dl) and standard PCNL post operative hemoglobin (11.7 ± 2.5 g/dl) (p=0.03). Hence 12% of those who underwent standard PCNL had blood transfusion. Hospital stay in both groups was around 1 day. Foley's catheter and nephrostomy were removed 1day post-op in approximately all of the cases of both groups. Double-J was removed 4 weeks post-op in almost all of the cases of both groups. Residual stone was detected in 36% of those who underwent standard PCNL and in only 4% of patients who underwent mini-perc PCNL. This difference between the two groups in terms of residual stone was statistically significant (p=0.005).

Table (3): post-operative patient data in mini-perc vs. standard PCNL

Variables		Standard PCNL n=75	Mini-perc PCNL n=75	p-value
Complications	Bleeding	12 (16%)	12 (16%)	0.152
	Pain (Pain scale of ≥5)	18 (24%)	12 (16%)	
	Infection	12 (16%)	0 (0%)	
	Urine leak	33 (44%)	51 (68%)	
Post-op HGB, mean ± SD (g/dl)		11.7 ± 2.5	12.9 ± 0.79	0.03
Degree of hemoglobin drop		1.82 ± 2.26	0.772 ± 0.43	0.039
Blood transfusion		9 (12%)	0 (0%)	0.235
Duration of hospitalization, days		1.04 ± 0.2	1 ± 0	0.327
Catheter indwelling time, days		1.04 ± 0.2	1 ± 0	0.327
DJ indwelling time, weeks		4.2 ± 0.58	4 ± 0	0.096
Nephrostomy duration, days		0.96±0.2	1 ± 0.2	0.322
Residual stone		27 (36%)	3 (4%)	0.005

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Discussion

In our study, operative time of the two procedures were relatively the same and there was no statistically significant difference between the two groups. This finding is in accordance with studies conducted by Sakr et al., Knoll et al. and Song et al.'s.[11,12,13] However, studies conducted by Refaat et al.,Abdelhafez et al. and Jiang et al.'s reported a significant increase in operative time of cases who had mini-perc PCNL compared to standard PCNL.[14,15,16] They have attributed this difference in operative time to the fact that miniaturized endoscopes provide limited field of vision. Another explanation is that the time needed to break down the caliculi into smaller pieces for easy extraction through the miniature tract.Bleeding presents a significant concern in the standard PCNL procedure, frequently leading to blood transfusion and increased risk to kidney injury. mini-perc PCNL development arose from the necessity to lower morbidity, by minimizing bleeding, which was commonly attributed to the size of nephroscopes (larger nephroscopes are associated with more bleeding) and their access routes.[17] In the current study, the rate of bleeding was similar in both groups (16%), however, the degree of hemoglobin drop was found to be significantly higher in standard PCNL group compared to mini-perc PCNL group. This is in accordance with Refaat et al., Zeng et al. and Elsheemy et al.,'s studies in which they reported bleeding and rate of blood transfusion was higher among the standard PCNL group. [14,18,19] In terms of post-operative complications, we found that pain and infection rates were higher in the standard PCNL group. Moreover, we found that urine leak for more than 3 days was more common in the mini-perc group. In contrast to our finding, Refaat et al., Elsheemy et al., Deng et al.'s studies reported a higher rate of leakage in the standard PCNL compared to mini-perc PCNL.[14,19,20] This difference may be attributed to the fact that most of their mini-perc procedures were performed tubeless. In this study, we observed no notable discrepancy in the length of hospital stay between the two groups. Similarly, Li et al., Sakr et al. and Cheng et al. reported no significant difference in hospital stay between mini-perc PCNL and standard PCNL.[1,11,17] However, several studies have reported significantly shorter hospital stays in the mini-perc PCNL group compared to the standard PCNL group because mini-perc PCNL is typically done with tubeless approach .[12,14,18,19] In our study, the rate of residual stone was significantly higher in the standard PCNL compared to mini-perc PCNL. This finding is in accordance with Refaat et al. and Cheng at al.'s studies in which they reported that stone clearance rate was better in the mini-perc PCNL than standard PCNL.[14,17] Cheng et al. attributed this to using a smaller caliber in the mini-perc PCNL procedure that allows access into different calyces, hence, leading to better clearance.[17] On the other hand, Elsheemy et al. concluded that standard PCNL procedure results in better stone clearance than mini-perc PCNL.[19]

Conclusion

Mini-perc PCNL demonstrates enhanced efficacy in handling renal calculi that are less than 2 cm, delivering a higher rate of stone clearance compared to standard PCNL. Mini-perc PCNL offers the benefit of fewer complications, notably lower rates of postoperative pain. In contrast, Standard-PCNL is associated with higher incidences of bleeding and declines in hemoglobin levels when compared to Mini-perc PCNL.

Conflict of interest

The authors declare no conflict of interest.

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