

Complications of Mini-Percutaneous Nephrolithotomy and Standard Percutaneous Nephrolithotomy: A Comparative Study

Rawaz Azad Hamad Sharif, Nihad Rifaat Jawad

Department of Surgery, College of Medicine, Hawler Medical University, Erbil, Iraq

Abstract

Background: Percutaneous nephrolithotomy (PCNL) is a major surgical procedure and the preferred treatment of choice for renal calculi (medium and large) size. **Objectives:** The study aims to determine complications between mini-PCNL and standard-PCNL, which is a comparative study to show which one has fewer complications and is safer for a patient with better outcomes. **Materials and Methods:** In a 1-year prospective study, clinical data from 44 patients who underwent PCNL (standard and mini) type between February 2021 and March 2022 for renal stones in Erbil city. Inclusion criteria included patients with renal stones (stag-horn, partial stag-horn, and non-stag-horn) and who are performing PCNL procedures. The exclusion criteria included patients who have a contraindication for doing PCNL. **Results:** Forty-four patients participated in the study, 17 underwent mini-PCNL, and 27 underwent standard PCNL. The mean hospital stay among the standard PCNL group (2.5 days) was significantly ($P = 0.005$) higher than that of the mini-PCNL group (1.7 days). Postoperative fever, infection, and sepsis (25%), bleeding (15.9%), hematuria (65.9%), and retained stone (20.5%). However, the differences in these rates were not significant between the groups. The rate of extravasation in the standard PCNL group (25.9%) was significantly ($P = 0.032$) higher than that of the mini-PCNL group (0%). Around two-thirds (64.7%) of the mini-PCNL group had no pain, compared with only 11.1% of the standard PCNL group ($P = 0.001$). **Conclusion:** The effectiveness of mini-PCNL is still under observation. Mini-PCNL postoperatively with less pain and limitation of blood loss, and less hospitalization for patients, with excellent results for stone free in comparison with standard PCNL.

Keywords: Complications of PCNL-mini, PCNL-PCNL, standard

INTRODUCTION

Percutaneous nephrolithotomy (PCNL) is the preferred treatment of choice for renal calculi (medium and large) size. PCNL has started remarkably since the eighties of the 20th century. With the introduction of additional techniques like flexible ureteroscopy and extracorporeal shockwave lithotripsy (ESWL), indications changed over time. In previous concepts, large-size stones were treated with PCNL, and smaller ones were left for ESWL.

The concepts have changed in settings to miniaturization of instruments and advancements in energy and optics now even smaller stones are treated with PCNL with minimal complications and better stone clearance rates. PCNL is the gold standard for stones larger than 2.0cm stag-horn, partial stag-horn calculi.^[1] Stone-free rates of up to 95% are achieved by PCNL. Staghorn calculi can

be treated with PCNL, as recommended by American Urology Association guidelines.

The contraindications for PCNL include pregnancy, bleeding disorders, and uncontrolled urinary tract infections. However, major complications are possible; studies have demonstrated the overall safety and effectiveness of this technique for complex calculi.^[2] In addition, full investigations and close evaluation of the patient for operation need basic preparation and evaluation for the operation process to increase safety and success rate of outcome and decrease the complications

Address for correspondence: Dr. Rawaz Azad Hamad Sharif,
Department of Surgery, College of Medicine,
Hawler Medical University, Erbil, Iraq.
E-mail: dr.rawaz14@gmail.com

Submission: 18-May-2023 **Accepted:** 07-Jun-2023 **Published:** 27-Sep-2023

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: WKHLRPMedknow_reprints@wolterskluwer.com

How to cite this article: Sharif RAH, Jawad NR. Complications of mini-percutaneous nephrolithotomy and standard percutaneous nephrolithotomy: A comparative study. Med J Babylon 2023;20:608-13.

Access this article online

Quick Response Code:



Website:
<https://journals.lww.com/mjby>

DOI:
10.4103/MJBL.MJBL_582_23

during the operation and postoperations. These include care and sterilization of instruments and radiation safety. Fluoroscopy or ultrasound is used to gain access, which can be done while supine or prone. In all cases, a ureteric catheter is inserted, regardless of the access method chosen.

The conventional PCNL is performed in prone positions. As a result, the posterior calyx can be accessed directly. The bowels should not be in the path of the puncture when the patient is lying down. Prone position for PCNL is a technique that radiologists use for the percutaneous nephrostomy procedure in order to drain hydronephrotic kidneys. In fact, they used to put the patient in a prone position because they could puncture the renal pelvis directly without going through the parenchyma.^[3]

Recently endoscopy-guided puncture has also been described. Traditionally the tract size for PCNL is used to be 30 Fr and more for the standard type, the mini-PCNL tract size 14–22 Fr. Even though the stone clearance rate was good, there were complications such as bleeding with the advent of excellent optics and advances in stone fragmentation the tract size has reduced to a great extent which has reduced the complications without compromising the stone clearance. The complications related to access might be an injury to the pleura and other visceral organs. The other complications are bleeding, pain, infection, and incomplete stone clearance.

The majority of post-PCNL complications are minor. Fever and leaking urine are minor complications. Access or the removal of stones can cause major problems because it has been demonstrated that the rate of complications decreases dramatically with experience; every urologist must be aware of these problems.

The importance of this study is to know the comparison between mini-PCNL and standard PCNL in complications. This study was to justify which type of PCNL is safer for patients with less complications and better outcomes.

MATERIALS AND METHODS

Study design

This was a Hospital-based prospective cross-sectional study. The study was conducted in the urology department of Rizgary teaching hospital and Zanko private hospital in Erbil city. Consent was acquired verbally and in writing from all the participants of this research. The study was conducted for one year (February 2021–March 2022), including data collection and entering, analysis, writing, discussion, and presentation.

Patients

The clinical data of 44 patients who indicated PCNL would be included in this study. Mini-PCNL (17) and standard-PCNL (27), aged between 10 and 69 years, were analyzed. All patients were treated by PCNL for

renal stones. A full medical and surgical history and physical examination were achieved from all patients. Preoperatively the characteristics of the stone(s), including the site, size, and location with the anatomy of the kidney, were assessed with the aid of radiological evaluation CT, KUB, abdominal/pelvic U/S, and routine laboratory investigations (complete blood count, viral screen, bleeding profile, renal function test, and general urine examination). Routinely the preoperative prophylactic antibiotic was given before the procedure to all patients.

Inclusion and exclusion criteria

Inclusion criteria included patients with renal stones (stag-horn, partial stag-horn, and non-stag-horn) and who are performing PCNL procedures (mini-PCNL and standard-PCNL) type, while the exclusion criteria included groups of patients who have a contraindication for doing PCNL: (1) pregnancy, (2) bleeding disorder, and (3) uncontrolled urinary tract infections.

Study procedure

Data to be collected included patient's information (including age and gender), past surgical history, laboratory and radiological investigations for assessment of the patient's situation before deciding PCNL operation, and serum virology and random blood sugar as a part of laboratory tests which required for any surgical procedure.

Statistical analysis

Data were analyzed using SPSS version 25.0 (SPSS, IBM Company, Chicago, IL). The Chi-square test of association was used to compare proportions. Fisher's exact test was used when the expected frequency (value) was less than 5 or more than 20% of the cells of the table. A Student's *t*-test of two independent samples (unpaired *t*-test) was used to compare the means of two samples. A *P*-value of ≤ 0.05 was considered statistically significant.

Data analysis

For the patients who are candidates for performing PCNL operations, the data of each patient are separately collected (before operation and after operation). The collected data will be recorded into an EXCEL sheet for observing the data; after that, these data enter SPSS (Statistical Packages for Social Sciences) program, and statistical tests will apply for data analysis, showing relations and associations between categorical variables. The analyzed outcome of the statistical process compared with a *P* value, a *P* value of less than 0.05, will be statistically significant.

Ethical considerations

The Ethical Committee of Hawler Medical University, Iraq, examined and approved the study protocol and patient permission forms under reference number BMS 533/016 on April 11, 2022. The entire study protocol was

completed according to the principles of the Helsinki Declaration.

RESULTS

Forty-four patients participated in the study; 17 underwent mini-PCNL, and 27 underwent standard PCNL. The mean age (SD) of the studied sample was 35.6 (15.1) years, the

median was 33 years, and the age range was 10–69 years. The age distribution is presented in Table 1, which shows no significant difference between the two operation types regarding the age distribution, but the mean age of patients in the mini-PCNL group (28.9 years) was significantly ($P = 0.019$) less than the mean age of the standard PCNL group (39.7 years). The majority (70.5%) of the patients were males, and there was no significant difference between the groups in the gender distribution ($P = 0.180$) [Table 1].

Although 52.3% of the stones were of the partial staghorn variety, there was no significant difference in stone type between the groups ($P = 0.574$). More than one-third (34.1%) of the patients had a history of renal operation, but the difference was not significant between the groups in this respect ($P = 0.431$), and it was also not significant ($P = 1.000$) regarding the type of the operation. The JJ stent had been put in all the patients. Nephrostomy was done for the majority (84.1%) of patients, but the difference was not significant ($P = 0.089$). More than one quarter (27.3%) of the patients needed more than 2 days of hospital stay after the operation (11.8%) of the mini group versus 37% of the standard group, but the difference was not significant ($P = 0.090$). The mean hospital stay among the standard PCNL group (2.5 days) was significantly ($P = 0.005$) higher than that of the mini-PCNL group (1.7 days) [Table 2].

Table 1: Age and gender distribution

	Mini-PCNL	Standard PCNL	Total	P
	No. (%)	No. (%)	No. (%)	
Age (years)				
10–19	4 (23.5)	3 (11.1)	7 (15.9)	
20–29	6 (35.3)	5 (18.5)	11 (25.0)	
30–39	3 (17.6)	5 (18.5)	8 (18.2)	
40–49	3 (17.6)	6 (22.2)	9 (20.5)	
≥50	1 (5.9)	8 (29.6)	9 (20.5)	0.274*
Mean (SD)	28.9 (12.4)	39.7 (15.3)	35.6 (15.1)	0.019†
Gender				
Male	10 (58.8)	21 (77.8)	31 (70.5)	
Female	7 (41.2)	6 (22.2)	13 (29.5)	0.180**
Total	17 (100.0)	27 (100.0)	44 (100.0)	

*By Fisher's exact test

**By Chi-square test

†By unpaired *t*-test

Table 2: Surgical history and operation details by type of the operation

	Mini-PCNL	Standard PCNL	Total	P
	No. (%)	No. (%)	No. (%)	
Type of renal stone				
Staghorn	1 (5.9)	5 (18.5)	6 (13.6)	
Partial staghorn	9 (52.9)	14 (51.9)	23 (52.3)	
Non-staghorn	7 (41.2)	8 (29.6)	15 (34.1)	0.574*
Total	17 (100.0)	27 (100.0)	44 (100.0)	
History of renal operation				
Yes	7 (41.2)	8 (29.6)	15 (34.1)	
No	10 (58.8)	19 (70.4)	29 (65.9)	0.431**
Type of the previous operation (<i>n</i> = 11)				
Open renal surgery	1 (14.3)	1 (12.5)	2 (13.3)	
PCNL	1 (14.3)	1 (12.5)	2 (13.3)	
URS	5 (71.4)	6 (75.0)	11 (73.3)	1.000*
JJ stent				
Yes	17 (100.0)	27 (100.0)	44 (100.0)	NA
Nephrostomy				
Yes	12 (70.6)	25 (92.6)	37 (84.1)	
No	5 (29.4)	2 (7.4)	7 (15.9)	0.089*
Post-op. hospitalization				
1–2 days	15 (88.2)	17 (63.0)	32 (72.7)	
3–5 days	2 (11.8)	10 (37.0)	12 (27.3)	0.090*
Mean (SD)	1.7 (1.0)	2.5 (0.7)		0.005†
Total	17 (100.0)	27 (100.0)	44 (100.0)	

*By Fisher's exact test

**By Chi-square test

†By unpaired *t*-test

Table 3: Complications by type of the operation

	Mini-PCNL	Standard PCNL	Total	P
	No. (%)	No. (%)	No. (%)	
Postoperative fever, infection, sepsis				
Yes	5 (29.4)	6 (22.2)	11 (25.0)	0.724*
No	12 (70.6)	21 (77.8)	33 (75.0)	
Bleeding				
Yes	2 (11.8)	5 (18.5)	7 (15.9)	0.689*
No	15 (88.2)	22 (81.5)	37 (84.1)	
Hematuria				
Yes	10 (58.8)	19 (70.4)	29 (65.9)	0.431**
No	7 (41.2)	8 (29.6)	15 (34.1)	
Retained stone				
Yes	2 (11.8)	7 (25.9)	9 (20.5)	0.445*
No	15 (88.2)	20 (74.1)	35 (79.5)	
Urinary leakage				
Yes	0 (0.0)	7 (25.9)	7 (15.9)	0.032*
No	17 (100.0)	20 (74.1)	37 (84.1)	
Pain				
None	11 (64.7)	3 (11.1)	14 (31.8)	0.001*
Mild	4 (23.5)	11 (40.7)	15 (34.1)	
Moderate	1 (5.9)	10 (37.0)	11 (25.0)	
Severe	1 (5.9)	3 (11.1)	4 (9.1)	
Death				
No	17 (100.0)	27 (100.0)	44 (100.0)	NA
Total	17 (100.0)	27 (100.0)	44 (100.0)	

NA: Not applicable

*By Fisher's exact test

**By Chi-square test

The rates of the following complications were as follows: postoperative fever, infection, and sepsis (25%), bleeding (15.9%), hematuria (65.9%), and retained stone (20.5%), but all the differences in these rates were not significant between the groups ($P = 0.724$, $P = 0.689$, $P = 0.431$, and $P = 0.445$ respectively). The rate of extravasation in the standard PCNL group (25.9%) was significantly ($P = 0.032$) higher than that of the mini-PCNL group (0%). Around two-thirds (64.7%) of the mini-PCNL group had no pain, compared with only 11.1% of the standard PCNL group ($P = 0.001$) [Table 3].

DISCUSSION

The goal of the PCNL (standard and mini) type is to get the best Stone clearance rate with minimal morbidity, with less complications, shorter hospital stays, and less blood transfusion requirements. Clayman *et al.*^[4] reported the safety and feasibility of PCNL for staghorn stone treatment. Recently, PCNL is a proper selection for renal stones (stag-horn and non-stag-horn).

The age distribution is presented in our study, which shows no significant difference between the mini-PCNL and standard PCNL, is presented in Table 1, which was the mean age of patients for the mini-PCNL group (28.9 years) and standard PCNL group (39.7 years). In comparison with

other studies, which were made in different age groups, which show there was no difference between the groups in terms of stone-free and complication rates. These findings suggest that PCNL can be safely performed in any age group.^[5,6]

In PCNL, the standard procedure for draining the kidney, preventing urine and fluid extravasation, plugging the access, and facilitating a secondary nephrostomy procedure is the placement of a nephrostomy tube. However, the tube may make the hospital stay longer, causing the urologist to improve this procedure.^[7]

There are two types of modifications: the first is minimally invasive, which involves narrowing the diameter of the percutaneous renal puncture passage, resulting in a smaller caliber nephrostomy. The second is no tube (tubeless technique), which restricts patients who do not require a nephrostomy tube to those who have undergone surgery with an indwelling ureteral stent.^[8]

A meta-analysis study to compare the roles, safety, and effectiveness of standard PCNL and tubeless PCNL. According to the findings, tubeless PCNL has the potential to significantly shorten the duration of an operation, reduce postoperative pain, and provide analgesia. Symptoms following stone removal and the fate of residual calculi detected on postoperative imaging are important considerations for tubeless PCNL. Additionally, our analysis demonstrated that tubeless PCNL was a risk-free option that did not increase bleeding, fever, urine leakage, or other complications.^[7] However, we cannot give clear results because the small sample size in our study for comparison with other studies in our study does not show a significant result. Nephrostomy was done for the majority (84.1%) of patients in total, but for those patients who didn't have nephrostomy (15.9%) they are discharged earlier than those patients with nephrostomy and they had less pain and less painkiller uses the majority of those cases which they don't have nephrostomy was mini-PCNL type.

Complications of PCNL, in general, will elongate hospitalization until subsiding or improving the patient; in our study, there is a significant difference between mini-PCNL and standard PCNL in the days of hospital stay, which is related to that mini-PCNL is fewer complications than standard PCNL and the patients were more stable. More than one quarter (27.3%) of the patients needed more than 2 days of hospital stay after the operation (11.8%) of the mini group vs. 37% of the standard group. The mean hospital stay among the standard PCNL group (2.5 days) was significantly ($P = 0.005$) higher than that of the mini PCNL group (1.7 days), as presented in Table 2. A number of recent studies have also shown that mini-PCNL results in significantly shorter hospital stays than the standard procedure, typically due to lower blood loss. After mini-PCNL, the hospital stay was significantly

shorter (3.8 and 3.2 days, as opposed to 6.9 and 4.8 days, respectively).^[9-11]

The idea behind mini-PCNL was that the conventional method would have fewer complications and rate morbidity if smaller tracts were used. During and after the procedure, complications related to renal access and stone removal may occur.^[12] Additionally, it had been proposed that many of the low-grade complications could be attributed to any surgical procedure or anesthesia and not just in PCNL procedures.^[13] It is interesting to note that there were no Grade IV or V complications and that the total complication rate was not significantly different between patients who underwent mini-PCNL for small (20 mm) or large (>20 mm) renal stones (19.4% vs. 26.9%).^[14]

In our study, the rates of the following complications were as follows: Postoperative fever, infection (25%), bleeding (15.9%), hematuria (65.9%), and retained stone (20.5%), but all the differences in these rates were not significant between the groups may be due to small sample size but if it compares and focuses on numbers hematuria in percentage much higher in standard PCNL than mini type which was 70.4% vs. 58.8% respectively, and that's due to that standard PCNL more invasive with larger tract and nephrostomy sheath size for renal access which make more trauma during procedure. For residual retained stone during PCNL, differences of these rates were not significant between the groups (mini and standard) PCNL, that means in this complication, mini-PCNL had not any difference with standard PCNL but statically may be due to small sample size will not show magnified good result to see an obvious difference between them.

A nephrostomy catheter is inserted into the nephrostomy tract after the PCNL procedure, which improves hemostasis and prevents extravasation of urine and prevents the formation of urinoma. However, extravasations from the site of the drain after removal are a common problem. In our study, the rate of urinary leakage in the standard PCNL group (25.9%) was significantly ($P = 0.032$) higher than that of the mini-PCNL group (0%). Prolonged urinary leakage after nephrostomy tube removal leads to increased morbidity of PCNL and increased hospitalization. The size of the tract seems to influence the nature of complications, with higher hematuria and renal extravasation with increasing tract size.^[15] Our present study is going in the same direction statistically if we compare with it.

Regarding pain after the PCNL operation, despite the fact that it is a minimally invasive procedure for removing renal calculi, many patients experience acute pain ranging from moderate to severe despite receiving analgesia. Those patients with the smaller nephrostomy tube noted significantly lower pain (3.75 vs. 5.3; $P = 0.03$). Although

the pain was lower for the 10-F catheter group, the difference was not statistically different (1.9 vs. 2.9 and 1.25 vs. 1.9, respectively; both $P > 0.05$). The patients having the 10F catheter required fewer narcotics: 78 vs. 91 mg, although the difference was not statistically significant.^[16]

CONCLUSION

Mini-PCNL appears to be a reasonable alternative for patients with stones ranging in size from small to medium. Mini-PCNL is safe and does not cause any serious problems. In certain situations, PCNL should be performed to avoid nephrostomy-related complications.

Data availability

The data associated with this paper are available upon reasonable request from the corresponding author.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

- Karakoyunlu N, Goktug G, Şener NC, Zengin K, Nalbant I, Ozturk U, *et al.* A comparison of standard PCNL and staged retrograde FURS in pelvis stones over 2cm in diameter: A prospective randomized study. *Urolithiasis* 2015;43:283-7.
- Preminger GM, Assimos DG, Lingeman JE, Nakada SY, Pearle MS, Wolf JS. AUA Nephrolithiasis Guideline Panel). Chapter 1: AUA guideline on management of staghorn calculi: Diagnosis and treatment recommendations. *J Urol* 2005;173:1991-2000.
- Proietti S, Rodríguez-Socarrás ME, Eisner B, De Coninck V, Sofer M, Saitta G, *et al.* Supine percutaneous nephrolithotomy: Tips and tricks. *Transl Androl Urol* 2019;8:S381-8.
- Clayman RV, Surya V, Miller RP, CastenedaZunega WR, Amplatz PH, Lange PH. Percutaneous nephrolithotomy; an approach to branched and staghorn renal calculi. *JAMA* 1983;250:73-5.
- Haberal HB, Dogan HS, Citamak B, Hazir B, Altan M, Bilen CY, *et al.* Outcomes of percutaneous nephrolithotomy in preschool age group: A single-center study. *J Endourol* 2020;34:1001-7.
- Karami H, Mazloomfard MM, Golshan A, Rahjoo T, Javanmard B. Does age affect outcomes of percutaneous nephrolithotomy? *Urol J* 2010;7:17-21.
- Chen ZJ, Yan YJ, Zhou JJ. Comparison of tubeless percutaneous nephrolithotomy and standard percutaneous nephrolithotomy for kidney stones: A meta-analysis of randomized trials. *Asian J Surg* 2020;43:60-8.
- Türk C, Petřík A, Sarica K, Seitz C, Skolarikos A, Straub M, *et al.* EAU guidelines on diagnosis and conservative management of urolithiasis. *Eur Urol* 2016;69:468-74.
- Ferakis N, Stavropoulos M. Mini percutaneous nephrolithotomy in the treatment of renal and upper ureteral stones: Lessons learned from a review of the literature. *Urol Ann* 2015;7:141-8.
- Knoll T, Wezel F, Michel MS, Honeck P, Wendt-Nordahl G. Do patients benefit from miniaturized tubeless percutaneous nephrolithotomy? A comparative prospective study. *J Endourol* 2010;24:1075-9.
- Mishra S, Sharma R, Garg C, Kurien A, Sabnis R, Desai M. Prospective comparative study of mini perc and standard PNL for

treatment of 1 to 2cm size renal stone. BJU Int 2011;108:896-9; discussion 899.

12. Taylor E, Miller J, Chi T, Stoller ML. Complications associated with percutaneous nephrolithotomy. Transl Androl Urol 2012;1:223-8.
13. Zeng G, Zhao Z, Wan S, Mai Z, Wu W, Zhong W, *et al.* Minimally invasive percutaneous nephrolithotomy for simple and complex renal caliceal stones: A comparative analysis of more than 10,000 cases. J Endourol 2013;27:1203-8.
14. Abdelhafez MF, Amend B, Bedke J, Kruck S, Nagele U, Stenzl A, *et al.* Minimally invasive percutaneous nephrolithotomy: A comparative study of the management of small and large renal stones. Urology 2013;81:241-5.
15. Jones P, Bennett G, Aboumarzouk OM, Griffin S, Somani BK. Role of minimally invasive percutaneous nephrolithotomy techniques- micro and ultra-mini PCNL (<15F) in the pediatric population: A systematic review. J Endourol 2017;31:816-24.
16. Pietrow PK, Auge BK, Lallas CD, Santa-Cruz RW, Newman GE, Albala DM, *et al.* Pain after percutaneous nephrolithotomy: Impact of nephrostomy tube size. J Endourol 2013;17: 411-4.