# COMPLICATIONS OF MINIMALLY INVASIVE PERCUTANEOUS NEPHROLITHOTOMY IN THE TREATMENT OF KIDNEY STONES AT MILITARY HOSPITAL 103

*Le Huy Ngoc[1*], Tran Van Hinh[2], Pham Quang Vinh[2], Lanh My Duyen[3]*

## Abstract

***Objectives:*** To evaluate the complications of the minimally invasive percutaneous nephrolithotomy (mini-PCNL) in treating kidney stones at Military Hospital 103. ***Methods:*** A prospective, longitudinal study on 286 kidney stone patients operated using the mini-PCNL technique at Military Hospital 103 from July 2017 to July 2019. ***Results:*** After mini-PCNL, most patients had no complication (77.62%). Bleeding and fever after mini-PCNL were the two most common complications; there were 35 patients with intraoperative bleeding and no need for blood transfusion (12.24%) and 15 patients with fever after surgery and no chills (5.24%). The stone size affected its clearance rate but did not affect fever and bleeding after mini-PCNL. After mini-PCNL, the mean values of Red Blood Cell (RBC), Hemoglobin (HGB), and Hematocrit (HCT) decreased from 4.75 ± 0.53 T/L, 140.38 ± 15.38 g/L, and 0.42 ± 0.04 L/L to 4.25 ± 0.44 T/L, 125.05 ± 13.36 g/L, and 0.38 ± 0.04 L/L, respectively. ***Conclusion:*** After mini-PCNL, the complication rate was 22.38%. Bleeding and fever after mini-PCNL were the two most common complications, with 46 patients (16.08%) and 18 patients (6.29%), respectively. The residual stone fragments were 19.58%. The stone size affected its clearance rate but did not affect fever and bleeding after mini-PCNL

**Keywords:** Mini-PCNL; Complications.

**[1]Nghe An Friendship General Hospital**

**[2]Military Hospital 103, Vietnam Military Medical University**

**[3]Vietnam Military Medical University**

**[*]Corresponding author: Le Huy Ngoc (ngocngoainieu@gmail.com)**

**Ngày nhận bài: 19/10/2023**

**Ngày được chấp nhận đăng: 21/11/2023**

**http://doi.org/10.56535/jmpm.v48i9.556**

## INTRODUCTION

The mini-PCNL technique (24 - 30Fr) was introduced in 1976 and was considered a very effective method of treating kidney stones > 2cm in size [1]. Over more than 20 years, along with the development of science and technology and the experience of urologists, there have been continuous improvements, such as changes in patient position, techniques to approach the excretory system, improvement in equipment, development of different types of stone crushing energy, and especially the trend of "shrinking" the size of the tunnel into the kidney [2].

To reduce complications and shorten hospital stay, methods to reduce the size of the kidney tunnel to ≤ 22Fr (mini-percutaneous nephrolithotomy/ mini-PCNL) and even smaller than 4.8 - 8Fr (micro-percutaneous nephrolithotomy) have been introduced [3].

Since July 2017, Military Hospital 103, Vietnam Military Medical University has begun applying mini-PCNL method to treat kidney stones with high-power laser lithotripsy energy of 80W. With the experience gained while using this method, we conducted this study: *To evaluate the complications of mini-PCNL at Military Hospital 103.*

## MATERIALS AND METHODS

### 1. Subjects

286 patients diagnosed with kidney stones were operated using the mini-PCNL technique at Military Hospital 103 from July 2017 to July 2019.

* *Inclusion criteria:* Patients with complete medical records; Patients who completed pre- and post-operative tests and were operated using mini-PCNL technique.

* *Exclusion criteria:* Patients with insufficient data or refusal to participate in the study.

### 2. Methods

* *Research design:* A prospective, longitudinal study was conducted.

* *Clinical and paraclinical variables:*

Technical aspects: Anesthesia method, mean operative time, lithotripsy time, lavage fluid volume, and hospital stay.

Blood test indices before and after surgery: RBC, HGB, HCT, Na+, Creatinine.

Complications were classified according to the Clavien-Dindo classification table applied to patients with percutaneous lithotripsy (according to author Tefekli 2008) [4] *(Table 1).*

**Table 1.** Clavien-Dindo classification of surgical complications.

| Grade | Definition |
|---|---|
| I | Any deviation from the ordinary post-operative course without needing pharmacological treatment or surgical, endoscopic, and radiological interventions.<br>Allowed therapeutic regimens are drugs such as antiemetics, antipyretics, analgetics, diuretics, electrolytes, and physiotherapy. This grade also includes wound infections opened at the bedside. |
| II | They are requiring pharmacological treatment with drugs other than such allowed for grade I complications. Blood transfusions and total parenteral nutrition are also included. |
| III | Requiring surgical, endoscopic or radiological intervention |
| IIIa | Intervention not under general anesthesia |
| IIIb | Intervention under general anesthesia |
| IV | Life-threatening complication (including CNS complications) requiring IC/ICU managenment |
| IVa | Single organ dysfunction (including dialysis) |
| IVb | Multiorgan dysfunction |
| V | Death |

* *Data analysis:* Statistical software for medical research SPSS 26.0.

### 3. Ethics

Patients were fully informed before voluntarily participating in the study. The principles of medical ethics were guaranteed to be strictly implemented. We affirm that our research was conducted with absolute impartiality and has no conflicts of interest.

## RESULTS AND DISCUSSION

### 1. Technical characteristics

**Table 2.** Technical characteristics (n = 286).

| Indices | $\overline{X}$ ± SD | Min | Max |
|---|---|---|---|
| Mean operative time (minutes) | 67.60 ± 30.60 | 25 | 175 |
| Lithotripsy time (minutes) | 43.64 ± 29.01 | 10 | 150 |
| Mean volume of lavage fluid (liters) | 20.85 ± 9.36 | 8 | 45 |
| Post-operative hospital stay (days) | 5.33 ± 2.11 | 3 | 17 |

Mean operative time: 67.60 ± 30.60 minutes (25 - 175 minutes). Lithotripsy time: 43.64 ± 29.01 minutes (10 - 150 minutes). Mean volume of lavage fluid: 20.85 ± 9.36 liters (8 - 45 liters). Mean post-operative hospital stay: 5.33 ± 2.11 days (3 - 17 days); 261/286 patients (91.26%) were hospitalized ≤ 7 days.

### 2. Complications of mini-PCNL

**Table 3.** Changes of blood test indices after surgery (n = 286).

| Indices | $\overline{X}$ ± SD | | p |
|---|---|---|---|
| | Before surgery | After surgery | |
| RBC (T/L) | 4.75 ± 0.53 | 4.25 ± 0.44 | < 0.05 |
| HGB (g/L) | 140.38 ± 15.38 | 125.05 ± 13.36 | < 0.05 |
| HCT (l/L) | 0.42 ± 0.04 | 0.38 ± 0.04 | < 0.05 |
| Na+ (mmol/L) | 139.67 ± 4.15 | 139.37 ± 4.54 | > 0.05 |
| Creatinine (µmol/L) | 92.17 ± 42.14 | 91.98 ± 24.85 | > 0.05 |

After surgery, the mean values of RBC, HGB, and HCT decreased with statistical significance.

**Table 4.** Complications (n = 286).

| Types of complication | | | Number | Rate (%) | Clavien-dindo classification |
|---|---|---|---|---|---|
| No complications | | | 222 | 77.62 | 0 |
| Bleeding | Intraoperative | No blood transfusion | 35 | 12.24 | I |
| | | Blood transfusion | 5 | 1.75 | II |
| | | Conservative treatment, no blood transfusion | 3 | 1.05 | I |
| | Postoperative | Conservative treatment, blood transfusion | 1 | 0.35 | II |
| | | Embolization, blood transfusion | 2 | 0.7 | IIIb |
| Fever after surgery | Fever, no chills | | 15 | 5.24 | I |
| | Fever and chills | | 2 | 0.7 | II |
| | Sepsis | | 1 | 0.35 | II |
| Perforation, tear of renal pelvis | Conservative medical treatment | | 3 | 1.05 | I |
| | Fluid collection in the peritoneum required percutaneous drainage | | 1 | 0.35 | IIIa |
| The stone fragment fell into the ureter and Double-J stent but not into the bladder. Endoscopic retrograde lithotripsy was performed, and the Double-J stent was re-inserted. | | | 1 | 0.35 | IIIb |

Bleeding and fever after surgery were the two most common complications; there were 35 patients with intraoperative bleeding and no need for blood transfusion (12.24%) and 15 patients with fever after surgery and no chills (5.24%).

**Table 5.** Classification of complications according to Clavien-Dindo (n = 286).

| Grade | 0 | I | II | IIIa | IIIb | IVa | IVb | V |
|---|---|---|---|---|---|---|---|---|
| Rate (%) | 77.62 | 19.58 | 3.15 | 0.35 | 1.05 | 0 | 0 | 0 |

After surgery, the majority of patients had no complication (77.62%). Most complications (22.73%) were mild (grade I, II).

**Table 6.** The relationship between stone size and complications (n = 286).

| Stone size (L) (cm) | Stone clearance | | Bleeding | | Fever | |
|---|---|---|---|---|---|---|
| | Yes (%) | No (%) | Yes (%) | No (%) | Yes (%) | No (%) |
| $L \leq 2$ | 54 (18.88) | 0 | 0 | 54 (18.88) | 1(0.35) | 53(18.53) |
| $2 < L \leq 3$ | 110 (38.46) | 7 (2.45) | 3(1.05) | 114 (39.86) | 8 (2.80) | 109 (38.11) |
| $3 < L \leq 4$ | 43 (15.03) | 31 (10.84) | 3(1.05) | 71 (24.83) | 8(2.80) | 66 (23.07) |
| $4 < L \leq 5$ | 20 (6.99) | 13 (4.55) | 1(0.35) | 32 (11.19) | 1(0.35) | 32 (11.19) |
| $L > 5$ | 3 (1.05) | 5 (1.75) | 1(0.35) | 7 (2.44) | 0 | 8 (2.80) |
| Total | 230 (80.42) | 56 (19.58) | 8(2.80) | 278 (97.20) | 18(6.30) | 268 (93.70) |
| p | < 0.001 | | 0.310 | | 0.235 | |

The stone clearance results in the stone groups were statistically different, $p < 0.001$ ($\chi 2$ Test). The stone clearance rate is highest in the size group $L \leq 3$ (cm).

Stone size is not related to bleeding and fever. The difference is not statistically significant with $p > 0.05$ ($\chi 2$ Test).

## DISCUSSION

Technically, our patients were placed in the prone position and received endotracheal anesthesia. This is a favored position because the working space is the most convenient and spacious and, at the same time, the safest way. The total time for our technique was 67.60 ± 30.60 minutes. The mean operative time is quite different among studies. The mean operative time was 86.1 ± 28.3 minutes in the study of Nguyen Thanh Tung (2018) [5]; 69.1 ± 27.7 minutes in the study of Vu Ngoc Quyet (2021) [6]; 70.6 ± 14.5 minutes in the study of Bui Truong Giang (2021) [7]. In our study, the mean post-operative hospital stay

was 5.33 ± 2.11 days (3 - 17 days), with 91.26% patients stayed less than seven days. Vu Ngoc Quyet (2021) reported the mean post-operative follow-up time of 6.6 ± 2.02 days; the longest was 14 days, and the shortest was 4 days [6]. Meanwhile, the mean post-operative hospital stay in the study of Nguyen Thanh Tung (2018) was 3.81 ± 1.49 days (3 - 11 days) [5].

In post-operative hematological tests, we found a significant decrease in the mean values of all RBC, HGB, and HCT. Although there might be slight differences in absolute mean values, the trends in hematological changes were similar between domestic and international studies. Bui Truong Giang (2021) found a statistically significant decrease in RBC, HGB, and HCT after surgery. The mean hemoglobin lost during surgery was 21.4 ± 1.8 g/L [7]. Basiri (2014) reported in a study of 30 PCNL patients that the mean HGB reduction was 18.8 ± 12 g/L [8]. Blood loss depended on many factors, such as long lithotripsy time on large stones, kidney dilatation, etc. Regarding biochemical tests, the Na+ and Creatinine concentrations of the research group did not decrease significantly after surgery. Vu Ngoc Quyet (2021) found that Na+, K+, and Urea concentrations after surgery decreased compared to those before surgery; the difference was statistically significant with $p < 0.05$ [6]. Nguyen Thanh Tung's results also showed that the mean Na concentration before surgery (139.2 ± 2.81 mmol/L) was higher than that after surgery (134.3 ± 2.75 mmol/L), with a statistically significant difference ($p < 0.001$). The mean K+ concentration before surgery (4.41 ± 0.43 mmol/L) and after surgery (3.94 ± 0.3 mmol/L) did not have a statistically significant difference ($p = 0.103$) [5].

Many studies have reported complications of the mini-PCNL method. A unified classification of complications will help make the assessment more accurate. As presented in the overview, the Clavien-Dindo classification table *(Table 1)* was first applied to the PCNL method by Tefekli A. and et al. (2008) and then widely used in other studies [4]. However, as the classification is very general, there are differences in its application and evaluation between studies. This has been proven in the research by Rosette J. and et al. (2012). The authors specifically classified Clavien-Dindo by providing a comprehensive classification table of 68 complications-treatment complexes based on the consensus results of many experts. The above research results are

recommended by the EAU [9]. In this study, we found that during and after mini-PCNL, the majority of patients had no complications (77.62%). 22.73% of patients with complications were primarily mild (grade I, II); 1 patient (0.35%) with grade IIIa; and 3 patients (1.05%) with grade IIIb. There were no cases of grades IV and V. Bleeding and fever after lithotripsy were the two most common complications, accounting for 16.08% (46 patients) and 6.29% (18 patients), respectively *(Tables 4, 5).* This result is consistent with most domestic and foreign studies, such as the study by Nguyen Thanh Tung (2018) (76.7% Clavien-Dindo 0, 11.4% Clavien-Dindo 1) [5] and Vu Ngoc Quyet (2021) (82.5% Clavien-Dindo 0, 5.6% Clavien-Dindo 1) [6]. Dong Hyuk Kang and et al. (2022) synthesized 289 studies published up to December 2020 on the databases PubMed and EMBASE and found that the rate of complications of the mini-PCNL technique is lower than that of S-PCNL, with a complication rate of 19% among 675 patients undergoing mini-PCNL, of which the majority are grade I and II according to the classification. Clavien-Dindo accounted for 87.5%, 12.5% of patients had complications of grade III and IV [10]. Sarwar Noori Mahmood and et al. (2022) found that mini-PCNL surgery is a safe treatment method. After surgery, mild and moderate complications can occur, with no patients having severe complications. The rate of patients with grade I complications was 8.3%, and grade II complications were 7.4%; no patients had grade III or grade IV complications [11]. Sanjay Khadgi and et al. (2021) also noted that after mini-PCNL surgery, mild and moderate complications are the most common, including 7.2% of grade I, 2.4% of grade II, and 2.4% of grade IIIa complications [12]. The stone clearance rate after the first min-PCNL was highest in the group of stones ≤ 3cm in size, the difference was statistically significant *(Tables 6)*. Our results are consistent with the research of some domestic authors such as Nguyen Thanh Tung (2018) [5], Vu Ngoc Quyet (2021) [6], and Bui Truong Giang (2019) [7].

When evaluating the impact of stone size, we found that stone size is not related to complications (bleeding and fever). To assess the effect of stone size, authors Xue W. and et al. (2012), based on the CROES database, selected patients with only one kidney stone > 2cm in size with multiple kidney stones. Coral pellets and pebbles were excluded. Research results show that stone size was related

to the rate of post-lithotripsy fever, blood transfusion, and prolongation of lithotripsy time. The stone-free rates in group 1, group 2, and group 3 were 90%, 83.3%, and 84.1%, respectively. The difference was statistically significant, with p = 0.015.

## CONCLUSION

Studying the complications of the mini-PCNL method in treating 286 kidney stone patients at Military Hospital 103, we found that mini-PCNL is a safe technique in treating kidney stones with a low rate of complications. After mini-PCNL, the complication rate was 22.38%. Bleeding and fever after mini-PCNL were the two most common complications, with 46 patients (16.08%) and 18 patients (6.29%), respectively. The residual stone fragments were 19.58%. The stone size affected its clearance rate but did not affect fever and bleeding after mini-PCNL.

## REFERENCES

1. Fernstrom I, Johansson B. Percutaneous pyelolithotomy: A new extraction technique. *Scand J Urol Nephrol*. 1976; 10(3):257-259.

2. Kallidonis P, Tsaturyan A, Lattarulo M, Liatsikos E. Minimally invasive percutaneous nephrolithotomy (PCNL): Techniques and outcomes. *Turk J Urol*. 2020 Nov; 46(1):S58-S63. DOI: 10.5152/tud.2020.20161. Epub 2020 Jun 5. PMID: 32525477; PMCID: PMC7731950.

3. Xiao B, Ji CY, Su BX, Hu WG, Fu M, Li JX. Needle-perc: A new instrument and its initial clinical application. *Chin Med J (Engl)*. 2020 Mar 20; 133(6):732-734. DOI: 10.1097/CM9.0000000000000692. PMID: 32049746; PMCID: PMC7190226.

4. Tefekli A, Ali Karadag M, Tepeler K, et al. Classification of percutaneous nephrolithotomy complications using the modified clavien grading system: looking for a standard. *Eur Urol*, 2008; 53(1): 184-190.

5. Nguyen Thanh Tung. Evaluating the results of percutaneous kidney stone dissolution using the small tunnel method - Patient lying prone at Hanoi Medical University Hospital. *Thesis of specialist level II*, Hanoi Medical University. 2018.

6. Vu Ngoc Quyet. Evaluating the results of percutaneous kidney stone dissolution using the mini-PCNL technique at Ha Giang Provincial General Hospital. *Thesis of specialist level II*, Hanoi Medical University. 2021.

7. Bui Truong Giang. Evaluating the results of mini-PCNL technique for kidney stone treatment at Duc Giang General Hospital in the period 2017-2021. *Thesis of Specialist level II*, Hanoi Medical University. 2021.

8. Basiri A, Tabibi A, Nouralizadeh A, et al. Comparison of safety and efficacy of laparoscopic pyelolithotomy versus percutaneous nephrolithotomy in patients with renal pelvic stones: A randomized clinical trial. *Urol J*. 2014; 11(6):1932-1937.

9. de la Rosette JJ, Opondo D, Daels FP, et al. Categorisation of complications and validation of the Clavien score for percutaneous nephrolithotomy. *Eur Urol*. 2012; 62(2):246-255.

10. Kang DH, Cho KS, Chung DY, et al. Stone-free rates of mPCNL, PCNL, and RIRS: A systematic review and network meta-analysis. *Urogenital Tract Infection*. 2022; 17(1):14-25.

11. Mahmood SN, Ahmed CJ, Tawfeeq H, et al. Evaluation of mini-PCNL and RIRS for renal stones 1-2 cm in an economically challenged setting: A prospective cohort study. *Ann Med Surg (Lond)*. 2022; 81:104235.

12. Khadgi S, El-Nahas AR, El-Shazly M, et al. Comparison of standard - and mini-percutaneous nephrolithotomy for staghorn stones. *Arab J Urol*. 2021; 19(2):147-151.