

Results of percutaneous nephrolithotomy for the treatment of renal stones larger than 2cm

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Summary

Objective: This study aims to evaluate the results of percutaneous nephrolithotomy (PCNL) for the treatment of renal stones larger than 2cm. **Subject and method:** A prospective study carried out on 139 patients with renal stones larger than 2cm treated by percutaneous nephrolithotomy (PCNL) from December 2009 to December 2016 at 108 Military Central Hospital. **Result:** Among 139 patients studied, the mean age of patients was: 50.6 ± 10.7 years. The mean stone size was 3.97 ± 1.46 cm. The mean operative time was 107.8 ± 31.1 minutes. The PCNL procedure was successfully completed in all patients. The success rate (stone-free status) was 77% (107/139). The mean post-operative hospital stay was 6.2 ± 2.7 days. The overall complications were observed in 22.3% of cases (31/139). According to the Clavien-Dindo classification: Grade 1 (12.9%), grade 2 (7.2%), grade 3 (2.8%), grade 4 (0.7%), grade 5 (0%). **Conclusion:** PCNL is a minimally invasive, safe and effective choice of treatment for renal stone larger than 2cm with high success rate.

Keywords: Renal stones, percutaneous nephrolithotomy.

1. Background

Urinary stone diseases are common urological disorders account for from 1 to 15% of the world population with prevalence of kidney stone estimated approximate 40%. Vietnam is located in the region of the stone belt on the world with high stone prevalence, however, until recently, there has not been a comprehensive report about the overall prevalence and incidence of renal stone in Vietnam. With the development of minimally invasive procedures, including ureteroscopic lithotripsy (URS), extracorporeal shock wave lithotripsy (ESWL), or percutaneous

nephrolithotomy (PCNL) resulted in high success rate and decreased post-procedure complications, treatment indication for open surgery is currently only 1 - 5.4% of the cases in developed countries [5]. The rate of open stone surgery remains high due to stone compositions and socioeconomic burden. The choice of an appropriate treatment is associated with minimally invasive, safe and effective interventions. Patients with renal stone of > 2cm in diameter are currently recommended using PCNL as the first line therapy [5], [6]. PCNL was introduced in the 108 Military Central Hospital since December 2013 to date. The present study is to evaluate the results of percutaneous

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nephrolithotomy for treatment of renal stones with a diameter larger than 2cm.

2. Subject and method

2.1. Subject

139 patients with renal stones larger than 2cm treated with percutaneous nephrolithotomy from December 2009 to December 2016 at 108 Military Central Hospital. All patients were given informed consent prior to the surgical procedure and the protocol of this study was approved by the ethical committee.

Inclusion criterias: The inclusion criteria were patients presenting a single renal stone or multiple stones with a largest diameter > 2cm, measured on kidney-ureter-bladder X-ray (KUB) in the anteroposterior view. The kidney was still functioning.

Exclusion criterias: Patients with abnormal kidney anatomy (Ectopic or malrotated kidney), skeletal deformities (especially spinal), pelvicaliceal or uterostenosis and elderly patient with co-morbidities.

2.2. Method

Prospective, cross-sectional descriptive study.

Treatment procedure

Patients were assessed before surgery included clinical examination, laboratory tests. Surgical process and monitoring of perioperative and postoperative complications were recorded according to the standardized study protocol.

Surgical technique: Patients were underwent spinal or general anesthesia.

The first step: A cystoscopy was performed and a open ureteral catheter was placed into the ureter to access the renal stone position. The patient was then turned in the prone.

The second step: Calyceal puncture was performed under fluoroscopic guidance.

The third step: Tract dilatations were performed by Alken dilators. After the tract was dilated, a 26-30Fr Amplatz sheath was inserted.

The fourth step: The rigid 24Fr nephroscope was used. Stone fragmentation was obtained with [Swiss Lithoclast](#) Master (combination of ultrasonic and pneumatic lithotripsy). Fragments was aspirated or extracted. At the end of the procedure, the nephrostomy drainage tube was placed.

Follow-up and assess the outcomes after surgery

Assessment criteria including stone size, intra-operative and post-operative parameters, the stone clearance rate or incomplete procedure (converted to open surgery). Success was defined as either stone-free or residual fragments < 4mm on post-operative X-ray KUB, based on the study by Raman [7]. The intra-operative and post-operative complications were assessed according to the Clavien-Dindo classification system.

Statistical analysis

Data was recorded and reported as mean values with standard deviation (SD) or frequency (percentage) using SPSS 22.0 software. Student's t test was used for group comparison with $p < 0.05$ were considered as statistical significance.

3. Result

3.1. The patient and stone characteristics

A total of the 139 patients, including 78 males and 61 females. The mean patient age was 50.6 ± 10.7 years (range 21 - 74 years). There were 78 (53.2%) patients presented left kidney stones and 65 (46.8%) patients with the right kidney stones observed. The mean stone size was 3.97 ± 1.46 cm (range 2.1 - 9cm).

3.2. Intra- and post-operative PCNL outcomes

Anesthesia method: 32 (23%) patients underwent general anesthesia, whereas 107 (77%) cases received spinal anesthesia. Three patients, who underwent second - look, received spinal anesthesia. All the cases, PCNL was performed in the prone position. The mean operation time was 107.8 ± 31.1 minutes (range

45 - 190 minutes). The PCNL procedure was successfully completed in all patients, no case was required an open surgical intervention. Of these patients, 136 (97.8%) patients had the primary procedure and 3 (2.2%) cases required the secondary surgery.

The mean post-operative hospital stay was 6.2 ± 2.7 days (range 3 - 22 days). with 111 (81.3%) patients had the length of stay ≤ 7 days.

Table 1. The number of access tracts and renal puncture site (n = 139)

No. tracts	Renal puncture site	No. of patients	Rate (%)
1 access tract	Lower pole	127	91.4
	Middle pole	6	4.3
	Upper pole	2	1.4
2 access tracts	Lower pole + Lower pole	1	0.7
	Lower pole + Middle pole	1	0.7
	Lower pole + Upper pole	2	1.4
Total		139	100

PCNL via a single access tract was accomplished in 135 (96.9%) patients while two tracts were used in 4 (3.1%) patients.

Table 2. Stone clearance rate according to study criteria (n = 139)

Results	No. of patients	Rate (%)
Success	107	77
Residual stone (Residual fragments ≥ 4 mm)	32	23
Total	139	100

32 patients, who had significant residual fragments (≥ 4 mm), were indicated for auxiliary interventional procedures post operatively (ESWL).

Table 3. Comparison of stone sizes between success group versus residual stone group (n = 139)

Group	No. of patients	Stone size (cm) (mean $\pm$ SD)	p
Success	107	3.8 ± 1.5	0.048
Residual stone	32	4.4 ± 1.3	

The preoperative stone size in the residual stone group was significantly bigger than in the success group ($p = 0.048$, independent sample t-test).

Table 4. Complications (n = 139)

Complications	No. of patients	Rate (%)	Clavien-Dindo score
Bleeding managed using IV fluid without need for blood transfusion	2	1.4	1

Bleeding requiring blood transfusion	9	6.5	2
Bleeding managed by angioembolisation	1	0.7	3b
Postoperative fever (> 38°C) managed by observation	16	11.5	1
Acute pyelonephritis managed using antibiotics	1	0.7	2
Septic shock	1	0.7	4b
Colon perforation managed conservatively using controlled colocutaneous fistula	1	0.7	3a
Urine leakage managed by ureteric stenting without general anaesthesia	1	0.7	3a
Perirenal abscess managed by percutaneous drainage	1	0.7	3a

Table 5. Classification of complications according to Clavien-Dindo system

Grade	1	2	3a	3b	4a	4b	5
Rate (%)	12.9	7.2	2.1	0.7	0	0.7	0

A total of 33 complications were encountered in 31 (22.3%) patients. According to Clavien-Dindo, most complication were minor complications, the rate of major complications was low. Postoperative fever and bleeding were the most common complications of PCNL [4].

4. Discussion

4.1. Indications and stones size

Renal stones size is an important factor in choosing the treatment methods. Theoretically, percutaneous nephrolithotomy can be for other sizes of stone types. European Association of Urology recommended that percutaneous nephrolithotomy as the standard of care for the treatment of renal stones with a diameter greater than 2cm because of the high rate of stone clearance [5], [6]. In the present study, the mean stone size was 3.97cm in diameter (range 2.1 - 9cm). As compared with the other authors in Vietnam, Vo Phuoc Khuong (2012) showed that the moderate -sized stone of 3.3cm (2.2 - 5.5cm) [3], whereas Truong Van Can (2014) reported that the larger stones with a diameter of 6.24cm (2.6 - 13.4cm) [2]. In the meanwhile, Vu Nguyen Khai Ca (2010) indicated that in some cases, percutaneous nephrolithotomy could be failed in patients with the stones diameter was smaller than 2cm [1]. In 2018, Melo PA investigated on 891 patients with 1096 percutaneous nephrolithotomy procedures and

showed the average stones diameter was 2.9cm [10]. Rizvi SAH (2017) reviewed 3042 patients also provided that mean stones size was 2.9cm [8].

4.2. Surgical technique

Patient positioning: There are three main surgical positions for this procedure: Prone position, supine position, and lateral decubitus position. Each position has its own advantages and disadvantages. In our study, all patients were on prone position. The other authors such as Vu Nguyen Khai Ca (2010), Vo Phuoc Khuong (2012), Truong Van Can (2014), Rizvi SAH (2017) reported that their patients were on prone position [1], [3], [8]. Rossette JJ (2011) analyzed data on 5,803 patients of The Clinical Research Office of the Endourological Society (CROES) registries from 2007 to 2009 which, included patients from 96 endourological centers showed that 80.3% patients were prone; 19.7% were supine [9]. Melo PA et al (2018) reported only 9.8% was in prone, the left 90.2% was supine [10].

The number of access tracts: In our study we used mainly single access tract in 135 patients (96.9%), only 4 patients (3.1%) with two tracts (Table 1). Compared to the other authors, Can et al used 95.3% cases with single tract [2]. Truong Van Can et al and Vo Phuoc Khuong et al utilized 100% of single tract [1], [3]. In study of CROES the percentage of using single access tract was 92%

[9], Rizvi SAH (2017) used in 99% cases [8]. Melo PA (2018) reported the average number of access tracts was 1.3 [10].

Table 6. Comparison of operative time, open surgery rate, stone free rate and the length of hospital stay with other reports

Reports (Years)	No. of patients	Operation time (minutes)	Open surgery rate (%)	Stone free rate (%)	Length of hospital stay (days)
Vu Nguyen Khai Ca (2010) [1]	78	98.9	7.6	78.2	6.8
Vo Phuoc Khuong (2012) [3]	47	64.7	0	82.9	4.9
Truong Van Can (2014) [2]	107	78.6	1.9	86.7	4.9
Rosette JJ (2011) [9]	5803	-	-	75.7	-
Rizvi SAH (2017) [8]	3042	138	1.8	75	3.4
Melo PA (2018) [10]	891	108	-	54.4	2.3
This study	139	107.8	0	77	6.2

In our study, the success rate of percutaneous nephrolithotomy was 100% with the average procedural time was 107.8 minute. The results were similar to the other authors reported (Table 6).

4.3. Criteria for stones clearance

We used criteria for stone clearance to assess success rate described by Raman JD et al: Stone-free or clinically insignificant fragments were smaller than 4mm [7]. These criteria were also used by the other authors such as Truong Van Can, Vu Nguyen Khai Ca, Vo Phuoc Khuong and Rizvi SAH in their studies for assessment of renal stones on the KUB films after operations [1], [3], [8]. The other method to do this was ultrasound or the best was CT scan without contrast as in the Melo's study [10].

Renal stones clearance: The results of stones clearance in different studies depended on patients' characteristics (Table 6). In our study, the success rate was 77%, 32 (23%) patients remain existing stones larger than 4mm, which needed auxiliary treatment (Table 2). The size of renal stones in the success group was smaller than that of residue stone group, which needed further intervention, the difference was statistically significant (Table 3).

4.4. Complications of procedure

According to the recent studies, the rate of complications was 13.3 - 38.46%, the percentage of postoperative fever was 8.6 - 21.8%, bleeding required blood transfusion was 4.8 - 8.2%, vascular sealing as a result of artery - venous fistula or renal arteries pseudo-aneurysm was 0.2 - 1.3%, the rate of severe complications (grade 4 or 5 according to Clavien–Dindo classification) was low from 1 - 2.3% [1], [2], [8], [9], [10]. The mortality rate was 0.09 - 0.4% [8], [10]. The complications in our study were presented in Table 4 and 5, which were similar to the other authors reported. The most common complications after surgery were fever, which used to last for few days than disappeared subsequently, no need for special intervention, none of mortality occurred during this study.

5. Conclusion

PCNL is a minimal invasive, safe and effective choice of treatment for renal stone larger 2cm with high stone free rate obtained in 77% of cases. This method had a lower rate of major complications.

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