Original Research Report

PERCUTANEOUS NEPHROLITHOTOMY (PCNL) IN OLDER AND YOUNGER PATIENTS AT A TERTIARY HOSPITAL IN SURABAYA, INDONESIA

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ABSTRACT

Percutaneous nephrolithotomy (PCNL) for renal and proximal ureteral stone treatment among the elder population is considered challenging due to the complication risk associated with comorbidity and lower functional reserve. Patients older and younger than 60 years old were compared for efficacy and safety in following PCNL procedures. Consecutive patients who underwent PCNL from 2019-2021 in a single center were divided into patients aged at least 60 years (group I) and patients aged under 60 years (group II). Single stage fluoroscopic-guided PCNL were used for the entire study population. Patients' habitus, stone-related, and operative characteristics were compared. The two groups' PCNL success and complication rates were evaluated. A total of 245 patients, comprising 65 in group I and 180 in group II, were included for analysis. Diabetes mellitus prevalence was higher in group I (30.8% vs 18.9%). However, the study population did not show a significant difference in regard to comorbidity. Operative time, success rate (80% vs 74.4%), and complication rate (16.9% vs 15.6%) did not statistically differ (p>0.05). Transfusion rate was higher among patients aged at least 60 years (p=0.018). Based on the multivariate analysis, stones located in the renal pelvis was the factor which contributed to the success rate. In conclusion, percutaneous nephrolithotomy is a safe and effective procedure for treating renal and proximal ureteral stones in the older population. Blood transfusions are more frequently given, in part, due to bleeding risk among older patients.

Keywords: Percutaneous nephrolithotomy (PCNL); renal stone; nephrolithiasis; older adults; life expectancy

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Highlights:

1. Percutaneous nephrolithotomy (PCNL) in older patients is as effective and safe as in younger patients.
2. It is a viable option for managing renal stones in older patients with indications, although blood transfusions are frequently required.

INTRODUCTION

Nephrolithiasis, commonly referred to as kidney stones, is a urological disease that causes high morbidity. One problem that arises from nephrolithiasis is the high comprehensive and long-term treatment cost. In addition to the expensive cost, advanced nephrolithiasis might result in death due to kidney failure (Tang & Lieske 2014). In Indonesia, 6 out of 1,000 people have kidney stones, indicating the prominence of the disease given the country's population of more than 250 million people. This places kidney stones as the third most frequent urological disease. Considering the high incidence rate of kidney stones among people aged 30-50 years, it is clear that this age group is particularly prone to the disease, and the incidence in men is three times that of women (Kurniawan et al. 2020). Furthermore, considering that calcium oxalate is responsible for the majority of stone occurrences, it demonstrates that environmental factors have a significant impact. In Indonesia, there

is a region known as the "stone belt", which has a high incidence of kidney stones. This phenomenon has occurred due to the high calcium levels in the drinking water (Lestari et al. 2019, Kurniawan et al. 2020).

Percutaneous nephrolithotomy (PCNL) is one of the therapeutic modalities that can be considered to destroy stones in the kidneys and the renal pelvis (Wicaksono et al. 2022). The advantage of PCNL over kidney stone therapy is that it can destroy stones larger than 20 mm, which lithotripsy cannot (Ziemba & Matlaga 2017).

According to demographic data, the age at which kidney stones occur varies substantially among older and younger patients (Rule et al. 2014). Because PCNL is an invasive procedure, the patient's age is important to consider, especially if the patient is very old and demonstrates changes in body structure and posture. Until recently, no known research had investigated the relationship between age and PCNL, so it was still unclear whether the PCNL method could be performed safely for all ages. Therefore, this research investigated the relationship between age and the PCNL procedure.

MATERIALS AND METHODS

This research was a descriptive study with a retrospective cohort design. Data were obtained in single sampling period at the Central Medical Record Unit, Department of Urology, and the Operating Room of Dr. Soetomo General Academic Hospital, Surabaya, Indonesia. The sample in this study was the medical records of all patients with a diagnosis of kidney stones who received PCNL treatment at the Urology Department of Dr. Soetomo General Academic Hospital from January 2019 to December 2021. The sampling technique used was total sampling.

The data collection was carried out by tracing the patients' polyclinical status and medical records at Dr. Soetomo General Academic Hospital. The data were then gathered based on the inspection and actions performed. Data collected included the number of patients, age, comorbidities, complications, and outcomes of PCNL measures. The information gathered comprised the number of patients, their ages, comorbidities, complications, and the outcomes of the PCNL procedure. IBM SPSS Statistics for Windows Version 21.0 (IBM Corp., Armonk, N.Y., USA) was used to examine the statistical data. Tables, figures, and narratives in this article are used to present the research findings in a descriptive manner.

RESULTS

From January 2019 to December 2021, 245 patients who underwent PCNL procedure at Dr. Soetomo General Academic Hospital provided complete data and met the inclusion criteria of this study. The PCNL was performed in accordance with established procedures at Dr. Soetomo General Academic Hospital, and the evaluation occurred two weeks to three months after the procedure. The patients were then divided into two age groups: the older (≥60 years old) and the younger (<60 years old). A total of 245 patients met the inclusion criteria for this study. Table 1 shows the preoperative characteristics of the research sample.

Table 1. Preoperative characteristics of the patients in the older andyounger age groups.

Characteristics	≥60 y.o. (n=65)	≤60 y.o. (n=180)	p-value
Age			
Average (SD)	65.02 (4.01)	45.51 (12.10)	
Range (min-max)	60-80		
Comorbidity			
Diabetes mellitus	20 (30.8%)	34 (18.9%)	0.071
Hypertension	36 (55.4%)	114 (63.3%)	0.328
BMI			
Average (SD)	20.84 (2.96)	20.99 (2.95)	0.842
Stenting & nephrostomy			0.393
Stenting	6 (9.2%)	26 (14.4%)	
Nephrostomy	5 (7.7%)	13 (7.2%)	
Side			0.886
Right	38 (58.5%)	110 (61.1%)	
Left	27 (41.5%)	70 (38.9%)	
Size			0.822
Average (cm) (SD)	2.45 (1.6)	2.39 (1.5)	
Location			0.691
Staghorn	14 (21.5%)	37 (20.6%)	
Renal pelvis	17 (26.2%)	60 (27.8%)	
Caliseal	23 (35.4%)	50 (33.3%)	
Renal pelvis & caliseal	8 (12.3%)	28 (15.6%)	
Ureteropelvic junction	1 (1.5%)	4 (2.2%)	

According to Table 1, there were 65 patients (26.5%) aged 60 and older, and 180 patients (44.08%) under the age of 60. The patients' average

age in the older group (≥60 years old) was 65.02±4.01, while it was 45.51±12.10 in the younger group (<60 years old). Diabetes mellitus was the comorbidity that exhibited a significant difference between the older and younger age groups, with 30.8% of the older patients having diabetes mellitus compared to 18.9% in the younger age group (p=0.071).

There was a substantial difference in postoperative characteristics, with 16.9% of the older patients requiring blood transfusions compared to 6.1% of the younger patients (p=0.018) (Table 2). According to the data presented above, the stone-free rates were 73.8% (48 out of 65 cases) in the older age group and 68.3% (123 out of 180 cases) in the younger age group. There was no significant difference in the stone-free rates between the older and younger groups, according to the results of statistical analysis using the Chi-square test (p=0.501).

Table 2. Postoperative characteristics of the patients in the older and younger age groups.

Characteristics	≥60 y.o. (n=65)	≤60 y.o. (n=180)	p-value
Success rate	52 (80%)	134 (74.4%)	0.466
Stone-free rate	48 (73.8%)	123 (68.3%)	0.501
Complication rate	11 (16.9%)	28 (15.6%)	0.952
Bleeding	11 (16.9%)	20 (11.1%)	
Blood transfusion	11 (16.9%)	11 (6.1%)	0.322
Decreased Hb			0.018
Average (SD)	1.34 (0.75)	1.17 (0.62)	0.261
Stone size			
Average (SD)	2.45 (1.57)	2.39 (1.50)	0.822
Puncture number			0.909
3	32 (49.2%)	93 (51.7%)	
4	21 (32.3%)	53 (29.4%)	
5	12 (18.5%)	34 (18.9%)	
Operation duration			
Average (SD)	114.51 (43.78)	116.31 (34.16)	0.472

In the older age group, 32 patients (49.2%) received three punctures, 21 (32.3%) received four punctures, and 12 (18.5%) received five punctures. Among the younger patients, 93 (51.7%) received three punctures, 53 (29.5%) received four punctures, and 34 (18.9%) received five punctures. The statistical analysis using the Chi-Square test revealed that the number of punctures was not significantly different between the older and younger age groups (p=0.909) (Table 2).

Table 2 shows that complications occurred in 11 (16.9%) of the 65 cases among the older patients. Complications were reported in 39 (15.9%) of 180 cases among the younger patients. The statistical analysis using the Chi-Square test showed no significant difference in the post-PCNL complications between the older and younger groups (p=0.796). The average duration of PCNL procedure in the older age group was 114.5±44.1 minutes, while it was 116.3±34.3 minutes in the younger age group. Statistical analysis employing the Mann-Whitney test revealed no statistically significant difference between the duration of the PCNL procedure in the older and younger groups (p=0.472).

Table 2 shows that the average stone sizes were 2.45±1.57 cm in the older age group and 2.39±1.50 cm in the younger age group. The results of statistical analysis using the Mann-Whitney test revealed no significant difference in the stone sizes between the older and younger groups (p=0.822).

DISCUSSION

Kidney stone (nephrolithiasis) is the most common type of urinary tract stone. Nephrolithiasis is caused by the formation of crystals in the kidneys (Alelign & Petros 2018). The prevalence of this condition varies with geography. Epidemiology study suggests that this disease is linked to a nation's socioeconomic welfare and development. It is more common in developed countries due to the influence of the population's nutritional status and daily activities. It also depends on the climate and temperature of an area (Purnomo 2016). Seasonality is associated with temporary changes in urine composition. When the air temperature rises, urine production decreases. Reduced urine production causes the ions in the urine to become concentrated, facilitating stone formation (Eisner et al. 2012).

Some Indonesian areas, known as the "stone belt", have a higher incidence rate of kidney stones than other areas. Those who reside in hot areas with high UV exposure tend to experience dehydration, increased vitamin D production that triggers higher excretion of calcium and oxalate, and profuse perspiration that can reduce urine production (Purnomo 2016). The prevalence of kidney stones in Indonesia is 0.6%, indicating that 6 out of every 1,000 people suffer from the disease (Minister of Health of the Republic of Indonesia 2013). The prevalence of nephrolithiasis is also increasing as a result of global warming, which elevates global

temperatures by 1-3 degrees Celsius (Goldfarb & Hirsch 2015). One of the modalities for nephrolithiasis is percutaneous nephrolithotomy (PCNL), which is the standard procedure for the endourological management of large nephrolithiasis. Many other aspects of surgical techniques and endoscopic equipments have improved since the introduction of this approach in 1976 (Carrion et al. 2018).

Data for this study were collected from 245 patients who met the inclusion criteria and underwent the PCNL procedure at Dr. Soetomo General Academic Hospital, Surabaya, Indonesia, from January to December 2019. The PCNL was performed in accordance with standard operating procedures at Dr. Soetomo General Academic Hospital, and the follow-up was conducted two weeks to three months later. The patients were categorized into two age groups: the older (≥60 years) and the younger (<60 years).

In this study, 65 of the 245 patients with kidney stones were over 60 years old, whereas 180 were under 60. Diabetes mellitus was the comorbidity that exhibited a significant difference between the older and younger age groups, with 30.8% of the older patients having diabetes mellitus compared to 18.9% of the younger patients (p=0.071). Similar findings were discovered in two prior studies by Abedali et al. (2019) and Buldu et al. (2015), in which diabetes mellitus was shown to be considerably more prevalent in the older age group investigated. In a study conducted by Wei et al. (2015), diabetes was found to be significantly associated with an increased frequency of postoperative and infectious complications following PCNL. Clinicians should note that approximately 50% of older patients present their first kidney stone episode at admission to emergency rooms, and the risk increases with the presence of diabetes mellitus (Arampatzis et al. 2012). A study even found that type 2 diabetes increased the risk of chronic kidney disease, especially in patients with high blood pressure and low high-density lipoprotein (Sutadji et al. 2023).

Blood transfusion were required in 16.9% of cases in the older age group compared to 6.1% in the younger age group (p=0.018). Abedali et al. (2019) found that preoperative hemoglobin (Hb) was considerably lower in the older age group (above 80 years) than in the other two groups (20-59 years and 60-79 years) (p<0.0001). Another study discovered that, when compared to other groups, people over the age of 80 had a 2 to 4 times higher risk of requiring blood transfusions post-surgery (Abedali et al. 2019). Although the majority of bleeding in PCNL procedures could be managed conservatively, severe bleeding in about 0.8% of cases required renal arteriography and selective embolization (Usawachintachit et al. 2016). The renal calyx was the most common location for PCNL based on the location of kidney stones. There was no statistically significant difference in the location of the stones between the two groups. Caliceal stones are typically accumulated in the major or minor calyces. Caliceal stones may be asymptomatic until they migrate to the ureters and induce ureteral colic pain (Gross et al. 2014).

The stone-free rates after the PCNL procedure did not differ significantly between the older and younger age groups, with 73.8% of the older patients and 68.3% of the younger patients being stone-free (p=0.501). This is similar to a study by Morganstern et al. (2015), in which stone-free rates were attained without a statistically significant difference (p=0.23) between the groups aged above 80 years (78%) and under 65 years (82%). For long-term management of kidney stones, clinicians must be aware that patients with kidney stones may have genetic, environmental, and nutritional risk factors that contribute to kidney stone recurrence. As a result, kidney stones are more likely to recur if the patients do not implement lifestyle adjustments (Han et al. 2015). On the other hand, poor renal function and more than seven days of bed rest were risk factors for malnutrition (particularly protein deficiency) in older patients (Zurriyani et al. 2020). Following the PCNL procedure, residual stone may also be present and should be removed with an additional procedure, such as extracorporeal shock wave lithotripsy (Sawal & Soebadi 2020).

The frequencies of complications following the PCNL were 16.9% in the older age group and 15.6% in the younger age group. There was no significant difference in the occurrence of post-PCNL complications between these two groups. Nakamon et al. (2013) discovered no significant difference in post-PCNL complications between the older age group (over 65 years) and the younger age group (less than 65 years), with the exception of sepsis, which occurred at 6.56% in the older age group and only 1.3% in the younger age group (p=0.007). Another study found that patients over the age of 80 who underwent PCNL had no long-term complications or fatalities (Meng et al. 2019).

In this study, the average durations of PCNL procedure were 114.5±44.1 minutes in the older patients and 116.3±34.2 minutes in the younger patients. The Kolmogorov-Smirnov test results revealed that the data were normally distributed. A study by Nakamon et al. (2013) also reported no difference in the duration of surgery between the older age group (over 65 years) and the younger age group (under 65 years). There was no significant difference in stone complexity between the older and younger age groups in terms of the affected

kidney (p=0.886), size (p=0.822), or location (p=0.691).

Strength and limitations

Because the two groups' stones were similar in complexity, this study could provide a statistically valid comparison of postoperative outcomes. The limitations of this study were attributable to the nature of a retrospective study and the minimal number of samples included. Further prospective research with a larger sample size may strengthen the findings of this study.

CONCLUSION

Percutaneous nephrolithotomy (PCNL) in older patients is as effective and safe as in younger patients, albeit with a higher probability of comorbidities in older age. PCNL is a viable management option for older adults with indications. However, older patients may require more blood transfusions during a PCNL procedure than younger patients. Further studies, particularly with a prospective approach and a larger sample size, are important to support the findings of this study and reduce the likelihood of bias.

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Conflict of interest

None.

Ethical consideration

This study was approved by the Health Research Ethics Committee at Dr. Soetomo General Academic Hospital, Surabaya, Indonesia, with reference number 1101/LOE/301.4.2/X/2022.

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Author contribution

MWA, YAA, T, and DMS conceptualized the study, conducted the investigation and validation, as well as wrote, reviewed, and edited the manuscript. MWA and YAA conducted the data curation and formal analysis, as well as drafted the original manuscript. MWA, T, and DMS contributed to the methodology, while MWA also provided the resources. T and DMS supervised the study.

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