Original Article

Perioperative Outcomes of Percutaneous Nephrolithotomy in Septuagenarians and Beyond

Chinnakhet Ketsuwan MD[1], Charoen Leenanupunth MD[1], Wachira Kochakarn MD[1], Yada Phengsalae MSc[1], Premsant Sangkum MD[1], Wisoot Kongchareonsombat MD[1]

[1] Division of Urology, Department of Surgery, Faculty of Medicine, Ramathibodi Hospital, Mahidol University, Bangkok, Thailand

Background: Life expectancy has continuously risen worldwide. Because the elderly may tolerate complications poorly, the risks and benefits of percutaneous nephrolithotomy (PCNL) in those patients should be discussed thoroughly.

Objective: To analyze utility and operative outcomes of PCNL with respect to age.

Materials and Methods: A retrospective study of PCNL was performed at Ramathibodi Hospital between 2011 and 2020. The patients were divided into two age groups, 1) below 70 years old and 2) 70 years old and above. Comparison of demographics, operative data, and postoperative outcomes were analyzed.

Results: Of the 253 patients, the overall stone-free rate (SFR) was 59.7%. The SFR in younger groups and older groups were 59.4% (126/212) and 61.0% (25/41), respectively, which was not significantly different (p=0.999). There was a similar in-stone burden between the two groups (p=0.573). Patients in the older group had worse renal function, higher American Society of Anesthesiologists score, and more comorbidities, including hypertension and ischemic heart disease. However, estimated blood loss, length of hospital stay, operative time, percent change in eGFR, and complications were comparable between the groups.

Conclusion: PCNL is a safe and effective treatment of kidney calculi in septuagenarians and older patients, even with the risk of higher comorbidities and poorer renal function than in younger patients.

Keywords: Percutaneous nephrolithotomy; Renal calculus; Stone-free status; Septuagenarians

Received 5 April 2021 | Revised 23 July 2021 | Accepted 23 July 2021

J Med Assoc Thai 2021;104(9):1497-502

Website: http://www.jmatonline.com

The Average life expectancy globally has increased in the last few decades. Longer lifespans have been recognized in many countries, including the United States, other developed countries[(1)], and Thailand[(2)]. Though, elderly patients correlate with decrement of organ function and decreased physiologic reserve, advancements in healthcare technology have enabled physicians to overcome these problems. The benefits of percutaneous nephrolithotomy (PCNL) over open urinary stone surgery include shorter hospitalization, a smaller incision, and more rapid convalescence[(3)]. Evidence on whether these advantages carry over to geriatric patients, especially septuagenarians and older, is less explored. The aim of the present study was to evaluate the perioperative results of patients underwent PCNL over and under the age of 70, and to provide supplementary information to give advice to these aging patients.

Correspondence to:

Kongchareonsombat W.

Division of Urology, Department of Surgery, Faculty of Medicine, Ramathibodi Hospital, Mahidol University, 270 Rama VI Road, Toong Phayathai, Ratchathewi, Bangkok 10400, Thailand.

Phone: +66-2-2011315, **Fax**: +66-2-2794704

Email: wisoot.kongcha@gmail.com

How to cite this article:

Ketsuwan C, Leenanupunth C, Kochakarn W, Phengsalae Y, Sangkum P, Kongchareonsombat W. Perioperative Outcomes of Percutaneous Nephrolithotomy in Septuagenarians and Beyond. J Med Assoc Thai 2021; 104:1497-502.

doi.org/10.35755/jmedassocthai.2021.09.12781

Materials and Methods

A retrospective study protocol was approved by the Institutional Review Board (ID: COA. MURA2020/842). Due to the retrospective nature of the present study, informed consent was waived by the ethical committee. All data were encrypted and kept confidential. Between January 2011 and April 2020, 253 consecutive patients underwent PCNL for kidney stones in a tertiary care hospital were reviewed. The present study inclusion criteria were patients that undergone PCNL between January 2011 and April 2020. The exclusion criteria were 1) pediatric patients below 18 years of age, 2) patients who had coagulation abnormalities or active urinary infections, and 3) patients who had inadequate preoperative

evaluations, medical information, and computerized tomography (CT) imaging. Two urology residents reviewed CT scans, with one assessment per patient. Stone burden was evaluated in the coronal plane. Demographic data, operation parameters, and postoperative findings were recorded in the electronic database. These patients were stratified into Group 1 with the younger than 70 years, and Group 2 with the 70 years or older. Clinical parameters analyzed included body mass index (BMI), the American Society of Anesthesiologists (ASA) classification, operative duration, estimated blood loss (EBL), packed red blood cell (PRC) transfusion, length of hospital stay (LOS), and complication rate including intraoperative and perioperative within 30 days. The final stone-free rate (SFR) was determined within 30 days post-operation, if CT scans revealed the absence of residual stones or only the presence of asymptomatic, non-infectious and non-obstructive residual stone fragments with a diameter of less than 4 mm after performing PCNL for clinically insignificant residual fragments. Post-operative complication data were collected from the electronic patient medical records and radiologic imaging findings and were graded using the modified Clavien classification system[4]. Percentage change in estimated glomerular filtration rate (eGFR) was calculated based on the difference between preoperative eGFR and postoperative eGFR on day one.

All procedures were performed by high-volume endourologists. PCNL was performed using a standard prone position. Under fluoroscopic guidance, the endourologist used an 11.5 cm, 18-gauge diamond-tipped trocar needle (Cook Medical, Bloomington, IN) for selective calyceal puncture using an Eye of the Needle technique. The dilatation of the nephrostomy tract was accomplished, and a rigid nephroscope of 26 F (Karl Storz Endoskope) was used for all stages of the procedure. Then the renal calculi were broken and extracted. A silicone tube of 22 Fr was advanced into the collecting system to serve as a nephrostomy tube, and a 16-Fr urethral Foley catheter was placed into the urethra at the end of the procedure. The patients were given a prophylactic antibiotic (routine, third-generation cephalosporin) or sensitivity drug with microbiological culture at the anesthetic induction time.

Statistical analysis

Stata, version 14.1 (StataCorp LP, College Station, TX, USA) was used for all data analyses, including perioperative demographics data, comorbidities, and complications within the two groups. Categorical factors were assessed using chi-square test or Fisher's exact test, and outcomes were presented as number of subjects (n) and percentage (%). The continuous factors were evaluated using a Wilcoxon rank-sum (Mann-Whitney) test, and the outcomes were demonstrated as medians with interquartile ranges (IQRs), as appropriate. Significance was set at a p-value less than 0.05.

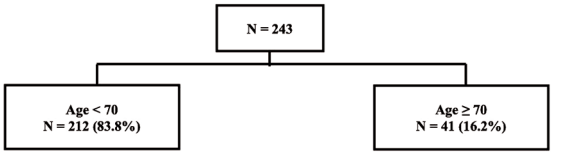

Figure 1. Distribution of patients by aging.

Results

Patient and stone characteristics

Two hundred ninety-one patients presenting renal calculi who underwent PCNL between January 2011 and April 2020 were included in the database. Of that number, 38 were excluded because of inappropriate imaging and loss of patient records. Therefore 253 patients met the inclusion criteria, including 120 males and 133 females. These were distributed between the two age groups, younger than 70 years and 70 years or older (Figure 1). The mean patient age was 58.5±11.7 years with a range of 18 to 90 year, and the average BMI was 25.8±4.8 kg/m² with a range of 14.5 to 50.7 kg/m². The median stone size was 440 mm² (IQR 251 to 720 mm²). Median stone density was 956 HU (IQR 650 to 1270 HU). Median skin to stone distance was 85 mm (IQR 71 to 96 mm).

Patients' characteristics and stone parameters are listed in Table 1. Patients in the older group had more instances of hypertension (HT), ischemic heart disease (IHD), two simultaneous comorbid diseases, and worse renal function, but were comparable to the younger group in gender ratio, BMI, stone size, stone density, laterality of stones, ASA score, and other underlying diseases, including diabetes mellitus (DM), hyperlipidemia, and old cerebral vascular accidents.

Operative findings

Perioperative and postoperative variables are presented in Table 2. Postoperative SFR in the younger group was comparable with those of the older group with 61% in younger and 59.4% in older (p=0.999). Likewise, the operation time in the two groups was not

Table 1. The comparison of patients' characteristics between two age groups

Variables	Age <70 (Group 1: n=212); n (%)	Age ≥70 (Group 2: n=41); n (%)	Overall (n=253); n (%)	p-value
Age (years); median (IQR)	58 (49 to 62)	73 (72 to 77)	60 (51 to 67)	<0.001*
BMI (kg/m^2); median (IQR)	25.5 (23.0 to 28.3)	24.3 (21.9 to 27.4)	25.2 (22.7 to 28.2)	0.127
Sex				0.305
Male	104 (49.1)	16 (39.0)	120 (47.4)	
Female	108 (50.9)	25 (61.0)	133 (52.6)	
Comorbidities				
Diabetes mellitus	53 (25.0)	13 (31.7)	66 (26.1)	0.437
Hypertension	107 (50.5)	28 (68.3)	135 (53.4)	0.041*
Hyperlipidemia	67 (31.6)	19 (46.3)	86 (34.0)	0.074
Coronary artery disease	5 (2.4)	5 (12.2)	10 (4.0)	0.012*
Old cerebral vascular accident	1 (0.5)	1 (2.4)	2 (0.8)	0.298
CKD (eGFR<60)	17 (8.0)	3 (7.3)	20 (7.9)	>0.999
2 comorbid diseases	52 (24.5)	18 (43.9)	70 (27.7)	0.021*
3 comorbid diseases	40 (18.9)	11 (26.8)	51 (20.2)	0.287
Preoperative Hb (mg/dL); median (IQR)	13.2 (12 to 14.5)	13 (11.8 to 13.8)	13 (12 to 14.5)	0.076
Preoperative eGFR (mg/dL); median (IQR)	90 (70.5 to 95)	63 (49 to 86)	86 (65 to 92)	<0.001*
ASA classification				0.071
Class 1	192 (95.0)	35 (87.5)	227 (93.8)	
Class 2	8 (4.0)	5 (12.5)	13 (5.4)	
Class 3	2 (1.0)	0 (0.0)	2 (0.8)	
Stone side: n (%)				0.731
Right	92 (43.4)	16 (39.02)	108 (42.7)	
Left	120 (56.6)	25 (61.0)	145 (57.3)	
Stone size (mm^2): median (IQR)	433 (250 to 723)	475 (260 to 675)	440 (251 to 720)	0.573
Stone density (Hounsfield unit); median (IQR)	950 (643 to 1,267)	1,013 (717 to 1,270)	956 (650 to 1,270)	0.573
Skin-to-stone distance (mm); median (IQR)	85 (71 to 95)	81 (67 to 102)	85 (71 to 96)	0.675

ASA=American Society of Anesthesiologists; BMI=body mass index; CKD=chronic kidney disease; eGFR=estimated glomerular filtration rate; Hb=hemoglobin; IQR=interquartile range

* Statistically significant

Table 2. Perioperative outcomes

Variables	Age <70 (Group 1: n=212); n (%)	Age ≥70 (Group 2: n=41); n (%)	Overall (n=253); n (%)	p-value
Stone-free status	126 (59.4)	25 (61.0)	151 (59.7)	0.999
Operative time (minute); median (IQR)	120 (90 to 150)	120 (90 to 150)	120 (90 to 150)	0.882
Length of stay (days); median (IQR)	6 (5 to 8)	6 (5 to 8)	6 (5 to 8)	0.894
Percent change in eGFR; median (IQR)	3.8 (2.2 to 10.9)	7.9 (2.2 to 20)	4.2 (2.2 to 12.3)	0.028*
Total complication rate				
Clavien I	43 (20.3)	7 (17.1)	50 (19.8)	0.830
Clavien II	22 (10.4)	3 (7.3)	25 (9.9)	0.776
Clavien III	5 (2.4)	1 (2.4)	6 (2.4)	>0.999
Clavien IV	3 (1.4)	2 (4.9)	5 (2.0)	0.186
Estimate blood loss (mL); median (IQR)	200 (100 to 400)	200 (100 to 400)	200 (100 to 400)	0.909
Blood transfusion	22 (10.4)	2 (4.9)	24 (9.5)	0.387
Angioembolization	4 (1.9)	1 (2.4)	5 (2.0)	0.590
Intensive care unit	3 (1.4)	2 (4.9)	5 (2.0)	0.186

eGFR=estimated glomerular filtration rate; IQR=interquartile range

* Statistically significant

significantly different at 120 minutes in younger and 120 minutes in older (p=0.882). The median hospital duration was similar between groups at six days versus six days (p=0.894). Percent change in eGFR was more present in the older group at 7.9 versus 3.8 (p=0.028). An overall adverse event incidence rate of 34.0% was measured with 34.4% in younger and 31.7% in older. Complication analyses according to the modified Claviene Dindo classification grades I, II, III, and IV did not illustrate a statistically significant difference between the two groups (p=0.830, 0.776, >0.999, and 0.186, respectively). Minor complications were mainly acute febrile illness treated with antipyretic drugs and antibiotics. There were no significant differences in the amount of estimated blood loss, blood transfusion, angioembolization, or requirements for intensive care between the groups (p=0.909, 0.387, 0.590, and 0.186, respectively). There were no mortalities in the present study.

Discussion

Urolithiasis remains one of the most challenging diseases for clinicians worldwide, and management of the disease requires both medical and surgical involvement[5]. PCNL has recently become a well-established management option for large or complex renal stones[3]. The best predictors of success for PCNL are stone burden and stone density[6,7]. In general populations, the complications of PCNL include fever, hydrothorax, septicemia, kidney hemorrhage requiring blood transfusion, and late complications, such as infundibular stenosis[8,9]. Physicians are usually unwilling to offer surgical options to aging patients due to the risk of perioperative morbidity and mortality from pre-existing conditions, including cardiac or pulmonary disease[10]. Hence, meticulous preoperative assessments and minimally invasive procedures are essential treatments for the elderly population to reduce life-threatening adverse events.

Multiple countries define citizens 65 years and older as geriatric or elderly[11]. Gentle et al demonstrated that geriatric stone formers comprised 12% of all stone patients[12]. In the present data, the elderly group constituted 16.2% of 253 total cases. The high percentage of cases among geriatric people is thought to be due to increasing life expectancy. However, no significant difference in the severity of calculus disease in younger versus elderly patients was found in the present study, which showed comparable stone burdens at 433 mm² versus 475 mm² (p=0.573). Similarly, in 1994, Stoller et al illustrated in the first published study related to PCNL in elderly patients that that there were a comparable stone burden between the two groups at 3.8 cm versus 4.3 cm (p=0.200)[13]. Some studies have shown a slightly larger stone size in elderly patients, but the difference is not statistically significant at 10,77.92 mm² versus 920.85 mm² (p=0.112)[14].

Elderly populations usually show an upturn in chronic non-communicable disorders. Sahin et al investigated whether aging affects surgical outcomes and found that around 63% of their aging group, which were older than 60 years, had a comorbidity such as HT, DM, or IHD(14). This is comparable to the present study, in which the incidence of these diseases is 68.3%, 31.7%, and 12.2%, respectively. In addition, metabolic disorders have been shown to increase an individual's risk of kidney stone formation, especially uric acid nephrolithiasis[15], as well as morbidity and mortality of surgery. Tefekli et al demonstrated that metabolic syndrome and its components significantly augment auxiliary treatment (p=0.048) and increase complication rates 2.5 to 2.7 times higher than average after PCNL[16]. Obesity also was considered to exert an adverse effect on anesthetic care during the prone position of PCNL, especially in concurrency with aging[17]. The prevalence of overweight patients in the present study older group was 41%, and the maximum BMI in the elderly group was 35.92 kg/m². Despite high rates of obesity in elderly patients, the authors found only 3 in 39 of the patients had a high-grade complication based on the modified Claviene Dindo classification grades III and IV, without fatality. Meticulous monitoring and close collaboration between the surgery and anesthesia teams are necessary for the management of these at-risk patients.

The present study demonstrates the feasibility of PCNL as an equally suitable procedure for kidney calculi in elderly patients when compared with the younger population. Though the authors' incidence of renal calculi in the elderly group was higher than the previous studies[18,19], the effectiveness of the treatment was still the same, with comparable SFRs at 61% versus 59.4% (p=0.999). Buldu et al also confirmed that PCNL is an effective method of stone treatment in the elderly (p=0.718)[18]. Nakamon et al illustrated correspondingly that, in patients older than 65 years, SFRs were not significantly different than in their younger counterparts at 70.49% in 18 to 65 years versus 72.73% in older than 65 years, (p=0.750)[19]. Additionally, Sahin et al reported the results of PCNL for 27 patients older than 60 years and found that the PCNL procedure was equally efficient and safe in the

elderly as in the younger population[14].

Safety of PCNL in elderly patients can be concluded from multiple postoperative determinants. The present study outcomes highlight that those patients who underwent PCNL for kidney stones show no difference in perioperative complications in every modified Claviene Dindo classification grade, regardless of age group. Elderly patients tolerate the PCNL very well in terms of similar estimated blood loss and required RBC transfusion (p=0.909 and 0.387) without terminating the operation, as compared to the younger group. Furthermore, no difference was seen in angioembolization or intensive care unit admission between age groups. The LOS for the older patients that underwent PCNL was no different than for the younger patients at six days versus six days (p=0.894), even though the comorbid conditions reflected by the ASA score were slightly higher in the older group. The present study finding is contrary to the study by Okeke et al, which showed a higher probability of complications at 19.9% versus 6.6% (p<0.001) and longer hospital stays at five days versus 4.1 days (p<0.001)[20]. The present study results might reflect improvements in the medical care of hospitalized geriatric patients and in processing and managing potential pitfalls. The probability of non-fatal in-hospital postoperative adverse events is a crucial factor in estimating the effectiveness of procedures, but Manku and Leung demonstrated that it is less essential than age, preoperative underlying diseases, and new hospitalization after discharge, with respect to impact on long-term quality of life and functional status of the geriatric patient[21]. Thus, holistic care of older patients is vital.

There are several limitations to consider in the present study. First, it is a retrospective, single-institution study, thus, there could be some selection bias in the management strategies. Second, the relatively small sample size may be insufficient to detect potentially significant differences. Last, the data collection from various surgeons may affect the reliability and validity of the study. The effectiveness still needs to be confirmed by multicenter, large-sample studies.

Conclusion

PCNL is safe and effective in patients 70 years of age and older despite the relative increase in underlying diseases. The authors reported no serious morbidity or mortality in septuagenarians and older. Thus, PCNL can be advised for select geriatric patients.

What is already known on this topic?

Average life expectancy globally has increased in the last few decades. Nephrolithiasis remains one of the most challenging diseases for clinicians worldwide. At present time, PCNL has recently become a well-established management option for large or complex renal stones. However, physicians are usually unwilling to offer surgical options to aging patients due to the risk of perioperative morbidity and mortality from pre-existing conditions.

What this study adds?

The authors assessed PCNL in elderly patient and proved that PCNL is safe and effective in patients 70 years of age and older despite the relative increase in underlying diseases.

Acknowledgement

The authors would like to thank the section of Clinical Epidemiology and Biostatistics, Faculty of Medicine, Ramathibodi Hospital for providing a statistics consultation and statistical support.

Conflicts of interest

The authors declare no conflict of interest.

References

1. Crimmins EM. Lifespan and healthspan: past, present, and promise. Gerontologist 2015;55:901-11.
2. Tanthanuch M, Apiwatgaroon A, Pripatnanont C. Urinary tract calculi in southern Thailand. J Med Assoc Thai 2005;88:80-5.
3. Al-Kohlany KM, Shokeir AA, Mosbah A, Mohsen T, Shoma AM, Eraky I, et al. Treatment of complete staghorn stones: a prospective randomized comparison of open surgery versus percutaneous nephrolithotomy. J Urol 2005;173:469-73.
4. de la Rosette JJ, Opondo D, Daels FP, Giusti G, Serrano A, Kandasami SV, et al. Categorisation of complications and validation of the Clavien score for percutaneous nephrolithotomy. Eur Urol 2012;62:246-55.
5. Micali S, Grande M, Sighinolfi MC, De Carne C, De Stefani S, Bianchi G. Medical therapy of urolithiasis. J Endourol 2006;20:841-7.
6. Ketsuwan C, Kongchareonsombat W, Sangkum P, Kijvikai K, Sananmuang T, Leenanupunth C. Perioperative renal calculus factors affecting percutaneous nephrolithotomy outcomes. Insight Urol 2019;40:1-8.
7. Ketsuwan C, Kijvikai K, Kongchareonsombat W, Sangkum P, Rongthong S, Leenanupunth C. A comprehensive comparison of Guy's Stone Score, CROES Nomogram, S.T.O.N.E. nephrolithometry, and the Seoul Renal Stone Complexity Scoring System in

predicting perioperative outcomes after percutaneous nephrolithotomy. J Med Assoc Thai 2020;103:762-6.
8. Netto NR Jr, Ikonomidis J, Ikari O, Claro JA. Comparative study of percutaneous access for staghorn calculi. Urology 2005;65:659-63.
9. Ketsuwan C, Pimpanit N, Phengsalae Y, Leenanupunth C, Kongchareonsombat W, Sangkum P. Peri-Operative Factors Affecting Blood Transfusion Requirements During PCNL: A Retrospective Non-Randomized Study. Res Rep Urol 2020;12:279-85.
10. Margiotta SJ Jr, Horwitz JR, Willis IH, Wallack MK. Cholecystectomy in the elderly. Am J Surg 1988;156:509-12.
11. World Health Organization. Definition of an older or elderly person [Internet]. 2013 [cited 2020 Jun 20]. Available from: http://www.who.int/healthinfo/survey/ageingdefnolder/en/.
12. Gentle DL, Stoller ML, Bruce JE, Leslie SW. Geriatric urolithiasis. J Urol 1997;158:2221-4.
13. Stoller ML, Bolton D, St Lezin M, Lawrence M. Percutaneous nephrolithotomy in the elderly. Urology 1994;44:651-4.
14. Sahin A, Atsü N, Erdem E, Oner S, Bilen C, Bakkaloğlu M, et al. Percutaneous nephrolithotomy in patients aged 60 years or older. J Endourol 2001;15:489-91.
15. DiBianco JM, Jarrett TW, Mufarrij P. Metabolic Syndrome and Nephrolithiasis Risk: Should the Medical Management of Nephrolithiasis Include the Treatment of Metabolic Syndrome? Rev Urol 2015;17:117-28.
16. Tefekli A, Kurtoglu H, Tepeler K, Karadag MA, Kandirali E, Sari E, et al. Does the metabolic syndrome or its components affect the outcome of percutaneous nephrolithotomy? J Endourol 2008;22:35-40.
17. Gravenstein D. Extracorporeal shock wave lithotripsy and percutaneous nephrolithotomy. Anesthesiol Clin North Am 2000;18:953-71.
18. Buldu I, Tepeler A, Karatag T, Bodakci MN, Hatipoglu NK, Penbegul N, et al. Does aging affect the outcome of percutaneous nephrolithotomy? Urolithiasis 2015;43:183-7.
19. Nakamon T, Kitirattrakarn P, Lojanapiwat B. Outcomes of percutaneous nephrolithotomy: comparison of elderly and younger patients. Int Braz J Urol 2013;39:692-701.
20. Okeke Z, Smith AD, Labate G, D'Addessi A, Venkatesh R, Assimos D, et al. Prospective comparison of outcomes of percutaneous nephrolithotomy in elderly patients versus younger patients. J Endourol 2012;26:996-1001.
21. Manku K, Leung JM. Prognostic significance of postoperative in-hospital complications in elderly patients. II. Long-term quality of life. Anesth Analg 2003;96:590-4.