Original Article

One-shot dilation versus metallic dilation technique for access in percutaneous nephrolithotomy: comparison of efficacy, access time and fluoroscopic time

Somboon Phaijitwichian

Division of Urology, Department of Surgery, Nakornping Hospital, Chiang Mai, Thailand

Keywords: Percutaneous nephrolithotomy, one-shot dilation, telescopic metal dilatation, efficacy, access time, fluoroscopic time

Abstract

Objective: The aim of this study was to compare the efficacy, access tract dilation time and fluoroscopic time between the one-shot dilation technique and telescopic metal dilatation technique in patients undergoing percutaneous nephrolithotomy in Nakornping Hospital.

Materials and Methods: Sixty-six patients who underwent percutaneous nephrolithotomy from January 2020 to July 2021 were included in the study and they were randomly divided into two groups. In group 1 (32 patients), telescopic metal dilation was used, in group 2 (33 patients), the one-shot technique was used. Success rates of dilation, access tract dilation time and fluoroscopic time were evaluated.

Results: The success rate of dilation was 100% in both groups. The access tract dilation time was 835.63 ± 309.68 seconds in group 1 and 569.42 ± 314.75 seconds in group 2 ($p = 0.001$). The fluoroscopic time was 48.16 ± 22.16 seconds in group 1 and 41.97 ± 23.99 seconds in group 2 ($p = 0.29$). The access tract dilation time of the one-shot dilation technique was statistically significantly shorter than that in the telescopic metal dilatation group. The mean fluoroscopic time of the one-shot dilation technique was shorter than in telescopic metal dilatation but was not statistically significant.

Conclusion: One-shot dilation technique is as effective as telescopic metal dilatation, with a significant reduction in access tract dilation time.

Insight Urol 2021;42(2):154-9. doi: 10.52786/isu.a.38

Corresponding author: Somboon Phaijitwichian
Address: Division of Urology, Department of Surgery, Nakornping Hospital, Chiang Mai 50180, Thailand
E-mail: somboon0746@gmail.com
Manuscript received: August 30, 2021
Revision received: October 6, 2021
Accepted after revision: October 22, 2021

Introduction

Percutaneous nephrolithotomy (PCNL) is an effective and safe method of management of large renal calculi.[1,2] One of the most important steps in PCNL is access tract creation. Currently, access tract creation can occur by three techniques: Alken telescopic metal dilation, Amplatz serial fascial dilation and high-pressure balloon dilation. Telescopic metal dilation, and Amplatz fascial dilation are serial dilation methods. The disadvantages of these methods are that they are more time-consuming and involve longer exposure time to x-ray.[3,4] Balloon dilation is the most accepted option and perceived as being the safest method but its high cost limits its routine use.[5,6] The recognized link between exposure to x-rays and some risk of cancer necessitates limitation of exposure during the procedures.[7] To reduce the x-ray exposure time the one-shot dilation technique was introduced. This technique consists of single tract dilation of the access tract with a 25-30 Fr Amplatz dilator.[8]

In Nakornping Hospital, urologists have usually used the telescopic metal dilation technique with fluoroscopic guidance for access tract creation in PCNL. Many studies have shown that the one-shot dilation technique is as effective as telescopic metal dilatation and also significantly reduces x-ray exposure during access tract dilation. However, this technique has not been studied in the patients in our hospital. The aim of this study was to evaluate and compare the efficacy between one-shot dilation and telescopic metal dilation techniques in terms of success rate, access time and fluoroscopic time.

Materials and Methods

This randomized controlled trial was approved by the Institutional Ethics Committee of Nakornping Hospital (IRB Number 067/63). The study was conducted at Nakornping Hospital from January 2020 to July 2021. Inclusion criteria included all patients aged over 18 years with renal calculi who had indications for PCNL surgery. Exclusion criteria were patients who were contraindicated for PCNL, patients who refused to participate in the study and patients who required more than one tract access. The sample size was calculated using the n4Studies application to test non-inferiority of two independent means. Sixty-six patients were enrolled onto this study. A single urologist carried out all operations. Patients were divided by permuted-block randomization into two groups; group 1 telescopic metal dilation (33 patients) and group 2 one-shot dilation (33 patients). After randomization, information concerning the study was explained to the patients and informed consent forms were signed.

Under general anesthesia the patients were put in the lithotomy position. A 6 Fr ureteral catheter was placed via a cystoscope then patient was turned into the prone position and the puncture was performed using fluoroscopic guidance. A guidewire was inserted into the collecting system. In group 1 the telescopic metal dilation technique was used by insertion of the Alken guide followed by a telescopic dilator between 10 Fr to 30 Fr, then an Amplatz sheath 30 Fr was advanced over the dilator which was then removed, leaving the Amplatz sheath in the collecting system (Figure 1). A nephroscope was inserted and the stone was disintegrated by ultrasonic and pneumatic lithotripsy. A nephrostomy tube was inserted at at the end of operation in all cases. In group 2 the one-shot dilation technique was used by insertion of an 8 Fr fascial dilator first, then a 30 Fr Amplatz dilator was advanced overriding the 8 Fr fascial dilator and an Amplatz sheath 30 Fr was advanced over the dilator (Figure 2). The next steps of the procedure were followed as in group 1.

Figure 1. Telescopic metal dilator

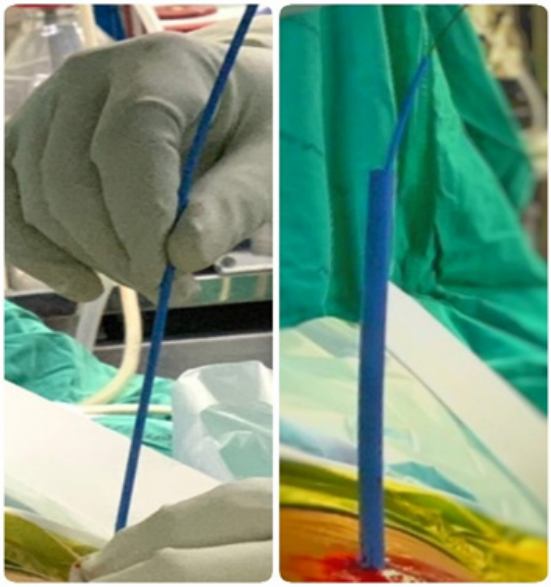

Figure 2. 8 Fr Fascial dilator and 30 Fr Amplatz dilator

Statistical analysis

Results are reported as mean ± standard deviation for quantitative variables. To compare the outcome of telescopic metal dilation and one-shot dilation technique, the data were analyzed statistically using Fisher's exact probability test for categorized data and Student-T test for numerical data. All data were analyzed with software STATA version 14.1. The access time in this study was defined as the duration recorded in seconds captured from renal puncture to successful placing of the nephroscope in the collecting system. The fluoroscopic time was total fluoroscopic time, defined by the number of seconds of radiation exposure that had elapsed, based on the dose summary of the fluoroscopy machine at the end of each procedure. The rate of stone-free status was defined by no stone fragments larger than 5 mm from being found from examination of plain film KUB in the period 48-72 hours postoperative. A p-value of less than 0.05 was considered statistically significant.

Results

A total of 66 patients underwent PCNL and were randomly divided into two groups according to the technique of dilation: group 1 telescopic metal dilation (33 patients) and group 2 one-shot dilation (33 patients). One patient in group 1 (telescopic metal dilation) was excluded due to requiring more than one tract access leaving 32 patients in this group. There were no significant differences in demographic data between the groups as shown in Table 1. Mean age of patients was 57.13 ± 7.15 years in group 1 (telescopic metal dilation) and 58.21 ±10.89 years in group 2 (one-shot dilation). The imaging modality used to define stone characteristics was intravenous pyelography in normal kidney function and retrograde pyelography in renal insufficiency. Stones were graded into grade 1 to 4 according to the Guy stone score system.[9] Mean stone size was 39.97 ± 14.41 mm in group 1 (telescopic metal dilation) and 46.21 ± 17.22 mm in group 2 (one-shot dilation). No mortality occurred in this study. Complications were reported as grades 1-5 in accordance with the modified Clavien Classification.[10] One patient in group 1 (3.13%) had hydrothorax requiring intercostal drainage in the post-operative period. In group 2 one patient had hydrothorax requiring intercostal drainage (3.03%) and another had respiratory failure (3.03%) requiring ventilation in the post-operative period due to heart failure.

The success rate was 100% in both groups. The mean access time in group 1 was 835.63 ± 309.68 seconds and 569.42 ± 314.75 seconds in group 2 (p = 0.001). The fluoroscopic time was 48.16 ± 22.16 seconds in group 1 and 41.97 ± 23.99 seconds in group 2 (p = 0.29). The access tract dilation time of the one-shot dilation technique was significantly shorter than telescopic metal dilatation. The mean fluoroscopic time of the one-shot dilation technique was shorter than in telescopic metal dilatation but did not reach statistical significance. The others clinical outcomes are shown in Table 2. There was no significant difference in operative time, decrease in hemoglobin, transfusion rate, complication and stone clearance.

Discussion

Several studies have been conducted to compare one-shot dilation and telescopic metal dilation technique in PCNL. The majority have reported that one-shot dilation technique is effective and can significantly reduce the access time and x-ray exposure time.[11-17] A recent systematic review and meta-analysis of one-shot dilation versus serial dilation technique for access in PCNL has reported a shorter access time in the one-shot dilation group than in the serial dilation group. Seven randomized controlled trials showed that one-shot dilation significantly decreased fluoroscopic time compared with serial dilation

Table 1. Baseline characteristics of the one-shot dilation and the telescopic metal dilation groups

Variable	Telescopic metal dilation n=32	One shot dilation n=33	P-value
Sex			0.21
Male	17 (53.12%)	23 (69.7%)	
Female	15 (46.88%)	10 (30.3%)	
Age (years), mean±SD	57.13 ± 7.15	58.21 ± 10.89	0.64
BMI (kg/m^2), mean±SD	22.78 ± 4.03	23.52 ± 3.30	0.41
Side			0.14
Left	14 (43.75%)	21 (63.64%)	
Right	18 (56.25%)	12 (36.36%)	
Stone size (mm), mean±SD	39.97 ± 14.41	46.21 ± 17.22	0.12
Guy stone score*			0.25
Grade 1	11 (34.38%)	8 (24.24%)	
Grade 2	3 (9.38%)	0 (0%)	
Grade 3	3 (9.38%)	4 (12.12%)	
Grade 4	15 (46.88%)	21 (63.64%)	
History of previous surgery			1.0
Yes	4 (12.5%)	5 (15.15%)	
No	28 (87.5%)	28 (84.84%)	
Puncture site			0.10
Upper pole, supracostal	13 (40.62%)	8 (24.24%)	
Upper pole, subcostal	17 (53.12%)	17 (51.52%)	
Lower pole	1 (3.12%)	7 (21.21%)	
Middle pole	1 (3.12%)	1 (3.03%)	

*Guy stone score comprises 4 grades: grade1, solitary stone in mid/lower pole or solitary stone in the pelvis with simple anatomy; grade 2, solitary stone in upper pole or multiple stones in a patient with simple anatomy or a solitary stone in a patient with abnormal anatomy; grade 3, multiple stones in a patient with abnormal anatomy or stones in a caliceal diverticulum or partial staghorn calculus; grade 4, staghorn calculus[9]

Table 2. Baseline characteristics of the one-shot dilation and the telescopic metal dilation groups

Variable	**Telescopic metal dilation n=32**	**One shot dilation n=33**	**P-value**
Success rate (%)	100	100	1.0
Access time (seconds), mean±SD	835.63 ± 309.68	569.42 ± 314.75	0.001
Fluoroscopic time (seconds), mean±SD	48.16 ± 22.16	41.97 ± 23.99	0.29
Operative time (minutes), mean±SD	59.59 ± 27.0	58.36 ± 28.91	0.86
Decrease in Hb (g/dL), mean±SD	1.45 ± 1.19	1.35 ± 0.87	0.71
Transfusion rate, n (%)	3 (9.38)	0 (0)	0.11
Complications*, n (%)			0.12
Grade 0	17 (53.12)	25 (75.76%)	
Grade 1	2 (6.25)	2 (6.06%)	
Grade 2	12 (37.5)	4 (12.12%)	
Grade 3	1 (3.12)	1 (3.03%)	
Grade 4	0 (0)	1 (3.03%)	
Grade 5	0 (0)	0 (0%)	
Stone free, n (%)	18 (56.25)	16 (48.48)	0.62

*In accordance with the modified Clavien classification: grade 1, any deviation from the normal postoperative course without the need for pharmacological treatment or surgical intervention also includes wound infections opened at the bedside; grade 2, complications requiring pharmacological treatment with drugs, blood transfusions and total parenteral nutrition; grade 3, complications requiring surgical, endoscopic or radiological intervention; grade 4, life-threatening complications requiring ICU management; grade 5, death[10]

and none of the six randomized controlled trials found significant differences in success rate and stone-free rate between one-shot dilation and serial dilation techniques.[18]

In this study, we evaluated the success rate of access tract dilation as the primary outcome and the access time, fluoroscopic time as the secondary outcome. The success rate of dilation was 100% in both groups and the access time of the one-shot dilation group was significantly shorter than in the telescopic metal dilatation group. The mean fluoroscopic time of the one-shot dilation technique was shorter than in telescopic metal dilatation but not statistically significant. Our results showed the same trends in success rate and access time as reported by other studies.

Trisakul Y reported a fluoroscopic time ranging from 60-130 seconds (mean 90 seconds) in 60 patients with standard PCNL with fascial dilation technique, obviously longer than our results.[19] Amirhassani et al. reported a mean fluoroscopic time in telescopic metal dilation of 48.4 ± 15 seconds and 41.2 ± 17 seconds in one-shot dilation, timings very close to our results. However, their study had a larger sample size and there was a significant difference in the mean fluoroscopic time between two groups ($p = 0.03$).[14] These findings warrant further investigation with a larger sample size to examine this correlation further. The overall stone free rate in this study was 52.3%. Comparing this with other studies in Thailand, a 67% stone free rate was reported in 2020 by Trisakul Y in standard PCNL with fascial dilation technique.[19] In standard PCNL with metallic dilation, Amornratananont et al. reported a 54.8% stone free rate in 2019[20] and another study was reported by Ahmadmusa N in 2020 with a 74.6% stone free rate.[21]

In our experience the one-shot dilation technique is simple, easy to carry out and does not require any extraordinary equipment. It can decrease access time and fluoroscopic time thus decreasing the risk of x-ray exposure to both the surgical team and patient. Minimizing x-ray exposure during percutaneous renal access is challenging. To date many techniques other than the one-shot dilation technique have been developed to decrease x-ray exposure[22]. Some techniques, such as a specific protocol for fluoroscope use and ultrasound guided access, could potentially be initiated in our hospital in the future.

There are some limitations in this study. The first is the limited number of patients due to it being conducted in a single-center. A large multicenter randomized controlled trial will definitely increase the information with regard to these initially very promising findings. Second, from the peer review there are some variations in the carrying out of the one-shot dilation technique in some studies. A standardization of approach could be a useful recommendation in the future. Finally, the definitions of access time and fluoroscopic or x-ray exposure time varied in the different studies which may affect the results.

Conclusion

The results of this study show that the one-shot dilation technique is as safe and effective as the telescopic metal dilatation method with a significant reduction in access tract dilation time. The one-shot dilation technique may be beneficial in reducing fluoroscopic time.

Conflict of Interest

The author declares no conflict of interest.

References

1. Abdelhafez M, Bedke J, Amend B, ElGanainy E, Aboulella H, Elakkad M, et al. Minimally invasive percutaneous nephrolitholapaxy (PCNL) as an effective and safe procedure for large renal stones. BJU Int 2012;110:E1022-6.
2. Santanapipatkul K. Factors associated with urosepsis following percutaneous nephrolithotomy. Insight Urol 2021;42:56-62.
3. Wu Y, Xun Y, Lu Y, Hu H, Qin B, Wang S. Effectiveness and safety of four tract dilation methods of percutaneous nephrolithotomy: A meta-analysis. Exp Ther Med 2020;19:2661-71.
4. Xiong J, Shi Y, Zhang X, Xing Y, Li W. Chinese one-shot dilation versus sequential fascial dilation for percutaneous nephrolithotomy: a feasibility study and comparison. Urol J 2019;16:21-6.
5. Jin W, Song Y, Fei X. The Pros and cons of balloon dilation in totally ultrasound-guided percutaneous Nephrolithotomy. BMC Urol 2020;20:82.
6. Peng P-X, Lai S-C, Seery S, He Y-H, Zhao H, Wang X-M, et al. Balloon versus Amplatz for tract dilation in fluoroscopically guided percutaneous nephrolithotomy: a systematic review and meta-analysis. BMJ Open 2020;10:e035943.
7. Mastrangelo G, Fedeli U, Fadda E, Giovanazzi A, Scoizzato L, Saia B. Increased cancer risk among

surgeons in an orthopaedic hospital. Occup Med (Lond) 2005;55:498-500.
8. Frattini A, Barbieri A, Salsi P, Sebastio N, Ferretti S, Bergamaschi E, Cortellini P. One shot: a novel method to dilate the nephrostomy access for percutaneous lithotripsy. J Endourol 2001;15:919-23.
9. Thomas K, Smith NC, Hegarty N, Glass JM. The Guy's stone score--grading the complexity of percutaneous nephrolithotomy procedures. Urology 2011;78:277-81.
10. Zuazu JR, Hruza M, Rassweiler JJ, de la Rosette JJ. The Clavien classification system to optimize the documentation of PCNL morbidity. Arch Ital Urol Androl 2010;82: 20-2.
11. Chiancone F, Meccariello C, Fedelini M, Giannella R, Fedelini P. Four dilation techniques in percutaneous nephrolithotomy: a single-institute comparative analysis. Minerva Urol Nephrol 2021;73:253-9.
12. Srivastava A, Singh S, Dhayal IR, Rai P. A prospective randomized study comparing the four tract dilation methods of percutaneous nephrolithotomy. World J Urol 2017;35:803-7.
13. Nour HH, Kamal AM, Zayed AS, Refaat H, Badawy MH, El-Leithy TR. Single-step renal dilatation in percutaneous nephrolithotomy: A prospective randomised study. Arab J Urol 2014;12:219-22.
14. Amirhassani S, Mousavi-Bahar SH, Kashkouli AI, Torabian S. Comparison of the safety and efficacy of one-shot and telescopic metal dilatation in percutaneous nephrolithotomy: a randomized controlled trial. Urolithiasis 2014;42:269-73.
15. Aminsharifi A, Alavi M, Sadeghi G, Shakeri S, Afsar F. Renal parenchymal damage after percutaneous nephrolithotomy with one-stage tract dilation technique: a randomized clinical trial. J Endourol 2011;25:927-31.
16. Falahatkar S, Neiroomand H, Akbarpour M, Emadi SA, Khaki N. One-shot versus metal telescopic dilation technique for tract creation in percutaneous nephrolithotomy: comparison of safety and efficacy. J Endourol 2009;23:615-8.
17. Amjadi M, Zolfaghari A, Elahian A, Tavoosi A. Percutaneous nephrolithotomy in patients with previous open nephrolithotomy: one-shot versus telescopic technique for tract dilatation. J Endourol 2008;22:423-5.
18. Peng P-X, Lai S-C, Ding Z-S, He Y-H, Zhou L-H, Wang X-M, et al. One-shot dilation versus serial dilation technique for access in percutaneous nephrolithotomy: a systematic review and meta-analysis. BMJ Open 2019;9:e025871.
19. Trisakul Y. Percutaneous Nephrolithotomy in Patients with Renal Calculi at Yasothorn Hospital during 2012-2013 and Nakhonphanom Hospital during 2017-2019. J Dep Med Serv 2020;3:13-17.
20. Amornratananont N, Sangkum P, Phengsalae Y, Leenanupunth C. The impact of body mass index on perioperative outcomes in patients undergoing percutaneous nephrolithotomy. Lampang Med J 2019;2:71-9.
21. Ahmadmusa N. Treatment of renal stones by standard percutaneous nephrolithotomy versus modified mini percutaneous nephrolithotomy in Yala Hospital: A comparative study. Insight Urol 2021;41:57-62.
22. Baralo B, Samson P, Hoenig D, Smith A. Percutaneous kidney stone surgery and radiation exposure: A review. Asian J Urol 2020;7:10-7.