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The Effects of Dilation Technique in Percutaneous Nephrolithotomy: One-Shot Versus Sequential Dilation

Perkütan Nefrolitotomide Dilatasyon Tekniklerinin Karşılaştırılması; Tek Basamaklı ve Sıralı Dilatasyon

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ABSTRACT

Objectives: In this study, the authors aimed to compare the results of one-shot dilation (OD) and sequential dilation (SD) techniques which are used to access in patients who had undergone percutaneous nephrolithotomy (PCNL).

Methods: The authors retrospectively evaluated the data of 159 patients who had undergone PCNL between July 2017 and December 2020 in our clinic. The dilation methods were compared concerning demographic characteristics, operation time, fluoroscopy time, hemoglobin decrease, creatinine increase, complication rate, length of hospital stay, and operation success rate.

Results: While OD was applied to 79 patients, SD was applied to 80 patients. The mean length of operation time and fluoroscopy time were shorter in the OD group than SD group (51.14±22.33 vs. 60.19±18.91 min, 119.70±51.03 vs. 136.54±44.24 s, p<0.001 p=0.028, respectively). The mean operation time was found to be statistically significantly lower in the OD group (51.14±22.33 and 60.19±18.91 min, respectively) (p<0.01). Although the duration of fluoroscopy was lower in the OD group than in the SD group, no statistically significant difference was found (119.70±51.03 and 136.54±44.24 s, respectively) (p>0.01). No differences were found between OD and SD groups in terms of success and complication rate (91% vs. 85.0% and 11.3% vs. 15%) p≥0.05 (p>0.01).

Conclusion: The OD technique is a successful access method that can be utilized safely in patients considered for PCNL operation, contributing directly to the reduction of entry, operation, and fluoroscopy times without increasing complication rates.

Keywords: Dilation; fluoroscopy; operative time; percutaneous nephrolithotomy.

ÖZET

Amaç: Bu çalışmada, perkütan nefrolitotomi uygulanan hastalarda akses için kullanılan tek basamaklı dilatasyon ve sıralı dilatasyon tekniklerinin sonuçlarının karşılaştırılması amaçlandı.

Yöntem: Çalışmada, Temmuz 2017 ile Aralık 2020 tarihleri arasında perkütan nefrolitotomi uygulanan 159 hastanın verileri retrospektif olarak değerlendirildi. Dilatasyon yöntemleri; demografik özellikler, ameliyat süresi, floroskopi süresi, hemoglobin düşüşü, kreatinin artışı, komplikasyon oranı, hastanede kalış süresi ve ameliyat başarı oranı açısından karşılaştırıldı.

Bulgular: Yetmiş dokuz hastaya tek basamaklı dilatasyon, 80 hastaya sıralı dilatasyon uygulandı. Ortalama operasyon süresi tek basamaklı dilatasyon grubunda istatistiksel olarak anlamlı düşük saptandı (sırasıyla 51,14±22,33 ve 60,19±18,91 dakika) (p<0,01). Floroskopi süresinin ise tek basamaklı dilatasyon grubunda sıralı dilatasyon grubuna göre daha düşük olduğu görülse de istatistiksel olarak anlamlı fark saptanmadı (sırasıyla 119,70±51,03 ve 136,54±44,24 saniye) (p>0,01). Başarı ve komplikasyon oranı açısından tek basamaklı dilatasyon ve sıralı dilatasyon grupları arasında fark bulunmadı (%91-%85,0 ve %11,3-%15) (p>0,01).

Sonuç: Tek basamaklı dilatasyon tekniği, perkütan nefrolitotomi operasyonu düşünülen hastalarda güvenle kullanılabilen; komplikasyon oranlarını artırmadan doğrudan giriş, operasyon ve floroskopi sürelerinin azalmasına katkı sağlayan başarılı bir giriş yöntemidir.

Anahtar sözcükler: Ameliyat süresi; dilatasyon; floroskopi; perkütan nefrolitotomi.

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Percutaneous nephrolithotomy (PCNL) is one of the first preferred minimally invasive methods in the treatment of kidney stones larger than 2 cm, especially due to its high success rate, short length of hospital stay, rapid post-operative recovery, and minimal renal parenchymal damage compared to open surgery.[1,2] Although PCNL has been described, as a minimally invasive methods, such as extravasation, bleeding requiring blood transfusion, fever, sepsis, colon injury, and pleural injury are serious complications that can be encountered in PCNL.[3] Investigations are still ongoing to minimize complications of PCNL.

The kidney access stage plays a major role in the occurrence of complications. Different entry and dilation methods have been utilized to reduce morbidity in PCNL. Plastic dilators (Amplatz), metal dilators (Alken), and balloon dilators can be used for dilation.[4] All dilation techniques can be used depending on the possibilities, preferences, and experience of the surgeon who will perform PCNL.[5] The usage of Amplatz dilators is more common, which can be preferred in conventional sequential dilation (SD) or single-step techniques.[6] Although PCNL has been used for a long time for the treatment of nephrolithiasis, there is still contradictory information about usage of the dilation method.[7,8] For this reason, in this study, the authors aimed to compare the treatment success and complication rates of conventional SD and the one-shot dilation (OD) techniques using Amplatz dilators in our clinic for PCNL.

Methods

One hundred fifty-nine patients who had undergone PCNL due to kidney stones in our clinic between July 2017 and December 2020 were included in the study. The study was approved by Kutahya Health Sciences University Ethical Committee on January 20, 2021 with 2021/01-20 decision number. The patients were chosen and dilation techniques were performed randomly. Demographic and clinical data of patients were collected retrospectively. Patients who had urinary system radiography and abdominal computed tomography (CT) in the hospital system were included in the study. The stone size was calculated as "cm^2" by multiplying the longest diameter and vertical diameter of the stone in the CT section. Blood tests and urine cultures were routinely performed before surgery. Patients with positive urine cultures were taken into operation after their urine was sterilized with appropriate antibiotic treatments. Patients with incomplete data, urinary tract abnormalities, morbid obesity (body mass index >30), previous renal surgery, and patients under 18 years of age were excluded from the study.

The procedure was started by placing a 5 F open-end ureter catheter with a 21 F 30° cystoscope in supine position on a stretcher under general anesthesia. The patient was placed on the operating table in a prone position by inserting a urethral catheter and fixing it to the ureter catheter. After the surgical area was cleaned and covered, the stone was localized under biplanar C-arm fluoroscopy. The collecting system was visualized by retrograde pyelography taken from the ureter catheter with 1/3 diluted opaque solution. The desired and determined calyx group was accessed with an 18 G percutaneous access needle. A 0.035-inch Guidewire was advanced through the puncture needle. Guidewires were sent to the collecting system. After approximately 1 cm of skin incision, in Group OD, 8 F co-axial was placed in the collector system and reached the kidney with a 30 F Amplatz dilator over it and an access sheath was placed in the collecting system (Fig. 1). In Group SD, 5-step SD starting from 12 F dilator up to 30 F was performed sequentially, and an access sheath was placed over it (Fig. 2). Later, kidney access was performed with a 26 F rigid nephroscope in

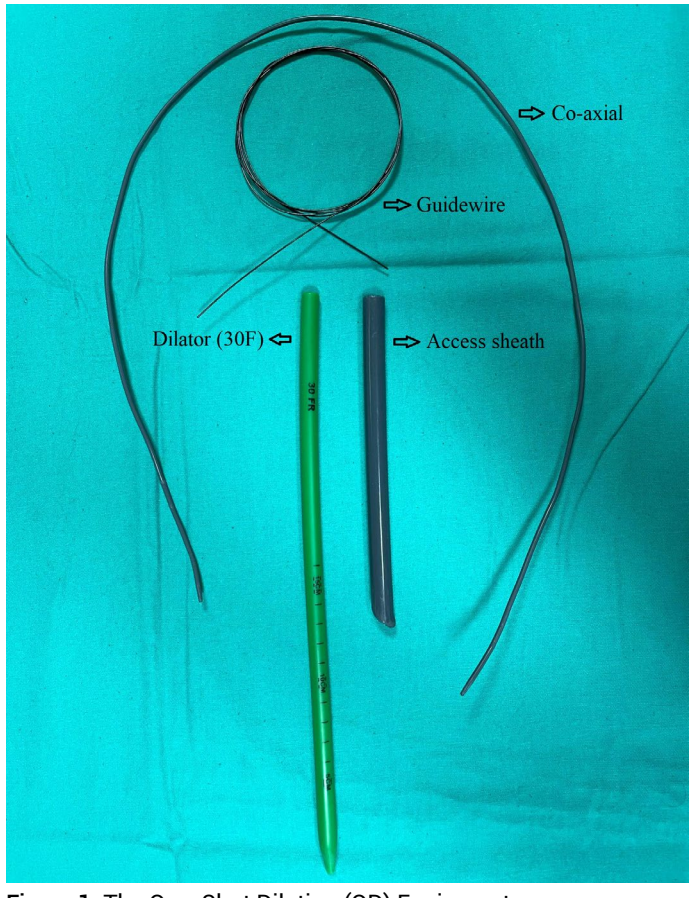

Figure 1. The One-Shot Dilation (OD) Equipment.

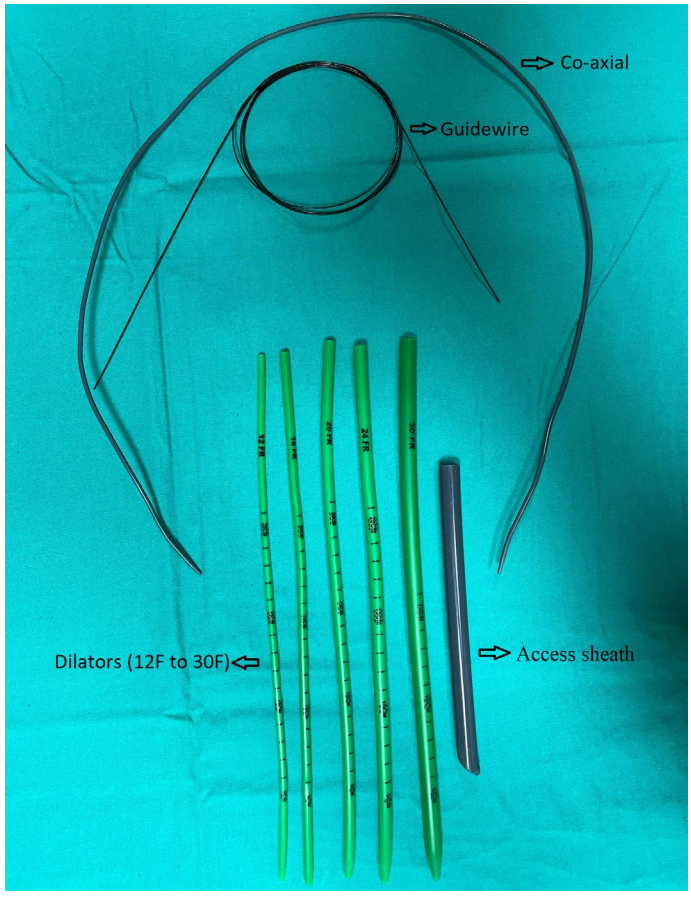

Figure 2. The Sequential Dilation (SD) Equipment.

both groups. The stones were fragmented with pneumatic and ultrasonic lithotriptors and taken out of the body. During the operation, the ureter catheters of all patients were withdrawn and 14 F nephrostomy catheters were placed in the pelvicalyceal system over the Guidewire. Catheter location and the presence of perirenal leak were evaluated by performing anterograde pyelography. Foley catheters of all patients were removed on post-operative day 1.

The time between placing the patient in the prone position, completion of the surgery, and insertion of the nephrostomy was calculated as the operation time. The fluoroscopy time used throughout the whole case was recorded as the fluoroscopy time. After surgery, the blood values of the patients were checked. Hemoglobin decrease was evaluated by comparing the last pre-operative hemoglobin level with the 24-h post-operative counterpart. Overall renal function was assessed by comparing the last pre-operative and the 24-h post-operative serum creatinine concentration level. The nephrostomy catheters of the patients who did not have renal colic and who were thought to have an open passage were removed within the first 3 days. Complications in the 1st post-operative 30 days were classified according to the modified Clavien grading system.[9] The presence of residual stones was evaluated with abdominal CT after 3 months. Stones of 4 mm size and larger were considered as residues. The patients who had the OD technique and the patients who had the SD technique were compared in terms of their demographic characteristics and perioperative and post-operative outcomes.

Statistical Package for the Social Sciences (SPSS, Chicago, US) for Windows 22.0 program was used for statistical analysis. The normal distribution of the data was tested with the Kolmogorov–Smirnow/Shapiro–Wilks test. Numbers, percentages, mean, and standard deviation expressions were used for descriptive statistics. Mann–Whitney U-tests were used for data that did not show a normal distribution in comparing the mean between two independent groups. Chi-square/Fisher exact test was used to compare categorized data. Chi-square/Fisher exact test, Student t-test, and Mann–Whitney U-tests were used to analyze univariate analyzes. For statistical significance, $p<0.05$ was accepted.

Results

The OD technique was utilized in 79 of the patients, and the SD technique was utilized in 80 of the patients in terms of access in PCNL. In the comparison of demographic and stone characteristics between the two groups, a statistically significant difference was found only in terms of gender ($p=0.024$) (Table 1).

The operation time in the OD group was 51.14±22.33 min and it was 60.19±18.91 min in the SD group ($p\leq0.001$). While the fluoroscopy time was 119.70±51.03 s in group OD, it was 136.54±44.24 s in Group SD ($p=0.02$). According to the modified Clavien grading system, only Grade 1 and 2 complications were observed in both groups. While post-operative complications were observed in 9 (11.3%) patients in OD, it was observed in 12 (15%) patients in SD ($p=0.502$). Additional surgical procedures (open, laparoscopic, etc.) were not performed on any patient during the operation. None of the patients in any of the groups had abdominal or intrathoracic adjacent organ injuries that required invasive procedures. Blood transfusion was performed on four patients in OD group and it was done in six patients in SD group ($p\geq0.05$). The authors found that the rate of post-operative serum creatinine increase was significantly higher in Group OD ($p<0.001$). When stone-free rates were examined, residual stones were observed in 13 (16.5%) patients in Group

Table 1. Comparison of the patients' demographic data and stone characteristics

	One-shot dilation (n=79)	Sequential dilation (n=80)	p
Age (years) (mean+SD)	50.0±13.28	47.4±10.21	0.084
Gender (n) (%)			
Male	49 (62.0)	63 (78.7)	0.024
Female	30 (38.0)	17 (21.3)	
BMI (kg/m^2) (mean+SD)	27.10±3.68	27.58±4.46	0.415
Side (n) (%)			
Right	44 (55.7)	39 (48.8)	0.429
Left	35 (44.3)	41 (51.2)	
Stone size (mm) (mean+SD)	2.96±0.88	2.93±1.116	0.822
Number of stones (n) (%)			
Single	47 (59.5)	45 (56.2)	0.749
Multiple	32 (40.5)	35 (43.8)	
Stone location (n) (%)			
Upper calyx	1 (1.3)	1 (1.3)	
Lower calyx	22 (27.8)	27 (25.0)	
Pelvic	24 (30.4)	23 (28.8)	
Multiple	29 (36.7)	32 (40.0)	
Staghorn	3 (3.8)	4 (5.0)	

n: Number; SD: Standard deviation.

OD and 21 (26.3%) patients in Group SD (p=0.176). In Group OD, seven of 13 patients with residual stones had retrograde intrarenal surgery (RIRS), four had extracorporeal shock wave lithotripsy (ESWL), and then stone-free was achieved in eight patients. The other two patients were followed up without any auxiliary procedures. In Group SD, nine of 21 patients were followed up without any auxiliary procedures. While ESWL was performed in three of the other 12 patients, nine of them had RIRS in group SD. Stone-free was achieved in nine patients after the additional procedure. None of the patients needed retreatment procedure. Eventually, there were no significant differences in terms of re-treatment and auxiliary procedure rate between the OD and SD group. Hence, overall stone-free rates were 91.1% in Group OD, and 85% in Group SD (p=0.233) (Table 2).

Discussion

There is still conflicting information about safety of the PCNL, which is used as a standard in treatment of large kidney stones.[10] Access is one of the most important steps of the PCNL in occurrence of complications and morbidity development.[11] The results of our study show that the OD technique can be used safely in PCNL without sacrificing success, without increasing the complication rate, by reducing the time of surgery and fluoroscopy. Different dilation methods have been described over the years to increase the success of the operation and shorten its duration. One of them is the "one-shot" dilation technique described by Frattini et al.[12] They first sent the 8 F Amplatz dilator over the Guidewire and then utilized a single 25 F or 30 F Amplatz dilator and 34 F sheath over it.[13] In their study, they showed

Table 2. Comparison of perioperative data and complication rates of groups

	One-shot dilation (n=79)	Sequential dilation (n=80)	p
Operation time (minute) (mean+SD)	51.14±22.33	60.19±18.91	<0.001
Fluoroscopy time (second) (mean+SD)	119.70±51.03	136.54±44.24	0.028
Hospital stay (day) (mean+SD)	2.72±1.21	2.65±0.73	0.654
Blood transfusion	4	6	0.527
Hemoglobin decrease (mg/dL) (mean+SD)	1.43±0.76	1.33±0.88	0.307
Creatinine increase (mg/dL) (mean+SD)	0.06±0.08	0.15±0.12	<0.001
Stone-free (first procedure) (n) (%)	66 (83.5)	59 (73.7)	0.176
Auxillary procedure (n) (%)	11 (13.9)	12 (15.0)	0.847
Overall stone-free (n) (%)	72 (91.1)	68 (85.0)	0.233
Complications (n) (%)	9 (11.3)	12 (15.0)	0.502
Grade 1	5	6	
Grade 2	4	6	
Grade 3	-	-	
Grade 4	-	-	

n: Number; SD: Standard deviation.

that the one-shot technique was used safely and effectively in PCNL by reducing the radiation time. These data are supported by other studies successively and the use of one-shot technique in daily practice has gradually increased.[14,15]

It is thought that changing each dilator during this conventional SD method alleviates the tamponade effect on the renal parenchyma and may cause more blood loss during surgery.[16] This seems to be the major disadvantage of the SD technique. Peng et al.[17] compared the OD and SD techniques in a meta-analysis and found a greater post-operative hemoglobin decrease in the SD group at an average amount of 2.3 g/L. However, they did not find a difference between blood transfusion rates.[17] Contrary to this information, in our study, no difference was found between the post-operative hemoglobin decreases and blood transfusion rates between the two methods. We also found that the increase in serum creatinine level was higher in the SD group. Together with other results, it was determined that the OD technique is more advantageous than the SD technique.

It can be thought that more intraoperative and post-operative complications may develop due to the nature of application of the OD technique. However, this hypothesis has been refuted in studies in terms of techniques. Aydemir et al.[18] reported in their study that there were no differences between the two techniques in terms of bleeding or kidney and pelvis injuries. Furthermore, Amjadi et al.[19] found that there were no differences between short-term and long-term complications. Our study showed that both methods could be used safely in PCNL in accordance to the literature. It was also determined that the OD technique does not have a disadvantage in terms of complications.

One of the most important factors in the selection of dilation technique is the stone-free rate that can be achieved. In general, studies have reported that the choice of dilation does not have a significant effect on stone-free rates. Although it was not statistically significant in our study, stone-free rate was achieved at a higher rate in the OD group. The reason for this may be the selection of the SD method in more complex cases, although random preference was made in patient selection. Contrary to expectations, the high post-operative creatinine increase in the SD group may also be due to this choice.

Urologists are in search of reducing the level of radiation exposure in their operations. In our study, it was determined that the level of fluoroscopy exposed to in the OD technique was lower than in the SD technique. This important advantage has been demonstrated by several different researchers. Li et al.[20] reported shorter fluoroscopy time in OD than SD. The need for fluoroscopic control to place and control each dilator during the SD procedure increases the amount of radiation exposure. A single dilation in the OD technique shortens fluoroscopy time and simplifies the procedure. Considering the fact that surgeons can learn simple procedures quickly, with the OD technique, surgeons will adapt to PCNL faster and become masters more easily.

In addition, low morbidity in the OD technique is also encountered in our study with the short hospital stay. A recent study reported that the duration of hospital stay was shorter in patients who underwent OD compared to patients who underwent SD, but there was no statistically significant difference between the groups.[17] Frattini et al.[12] stated that the cost of OD was much lower than the SD method due to shorter hospital stay. Reduction of treatment costs is important in improving the allocation of medical resources. It is very important to evaluate the cost-effectiveness of the dilation technique in clinical practice, especially in developing countries.[21]

The retrospective design of our study was the most important limitation. Besides, another limiting aspect was that the pure access time was not calculated separately for the dilation stage. Another limitation was that this study could not be performed with a larger number of patients. However, authors believe that these outcomes can be guiding for the urologists to choose the dilation method.

Conclusion

The success of PCNL is directly related to patient preference, equipment, access techniques, and surgical experience. The OD technique is a successful access method that can be applied safely in patients considered for PCNL operation, contributing directly to the reduction of entry, operation, and fluoroscopy time without increasing complication rates.

Disclosures

Ethics Committee Approval: The study was approved by Kutahya Health Science University Ethics Committee on 20.01.2021 with 2021/01-20 decision number.

Peer-review: Externally peer-reviewed.

Conflict of Interest: None declared.

Authorship Contributions: Concept – M.S.; Design – M.S., O.A.; Supervision – B.A., F.U.; Materials – I.G.K., O.A.; Data collection &/or processing – M.S., O.A.; Analysis and/or interpretation – M.S., B.A., F.U.; Literature search – M.S., O.A., I.G.K.; Writing – M.S., O.A., I.G.K.; Critical review – B.A., F.U.

References

1. Turk C, Petřík A, Sarica K, Seitz C, Skolarikos A, Straub M, et al. EAU guidelines on interventional treatment for urolithiasis. Eur Urol 2016;69:475–82.
2. Ibrahim A, Wollin D, Preminger G, Andonian S. Technique of percutaneous nephrolithotomy. J Endourol 2018;32:S17–S27.
3. Heinze A, Gozen AS, Rassweiler J. Tract sizes in percutaneous nephrolithotomy: Does miniaturization improve outcome? Curr Opin Urol 2019;29:118–23.
4. 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.
5. Knoll T, Daels F, Desai J, Hoznek A, Knudsen B, Montanari E, et al. Percutaneous nephrolithotomy: Technique. World J Urol 2017;35:1361–8.
6. Ozok HU, Sagnak L, Senturk AB, Karakoyunlu N, Topaloglu H, Ersoy H. A comparison of metal telescopic dilators and Amplatz dilators for nephrostomy tract dilation in percutaneous nephrolithotomy. J Endourol 2012;26:630–4.
7. Dehong C, Liangren L, Huawei L, Qiang W. A comparison among four tract dilation methods of percutaneous nephrolithotomy: A systematic review and meta-analysis. Urolithiasis 2013;41:523–30.
8. Peng PX, Lai SC, Seery S, He YH, Zhao H, Wang XM, et al. Balloon versus Amplatz for tract dilation in fluoroscopically guided percutaneous nephrolithotomy: A systematic review and meta-analysis. BMJ Open 2020;10:e035943.
9. Dindo D, Demartines N, Clavien PA. Classification of surgical complications: A new proposal with evaluation in a cohort of 6336 patients and results of a survey. Ann Surg 2004;240:205–13.
10. Chen H, Wedam Atogebania J. An invited commentary "Day care surgery versus inpatient percutaneous nephrolithotomy: A systemic review and meta-analysis". Int J Surg 2020;84:154–5.
11. Wei C, Zhang Y, Pokhrel G, Liu X, Gan J, Yu X, et al. Research progress of percutaneous nephrolithotomy. Int Urol Nephrol 2018;50:807–17.
12. Frattini A, Barbieri A, Salsi P, Sebastio N, Ferretti S, Bergamaschi E, et al. One shot: A novel method to dilate the nephrostomy access for percutaneous lithotripsy. J Endourol 2001;15:919–23.
13. 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.
14. Ziaee SA, Karami H, Aminsharifi A, Mehrabi S, Zand S, Javaherforooshzadeh A. One-stage tract dilation for percutaneous nephrolithotomy: Is it justified? J Endourol 2007;21:1415–20.
15. 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.
16. 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.
17. Peng PX, Lai SC, Ding ZS, He YH, Zhou LH, Wang XM, 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.
18. Aydemir H, Halis F. Two different renal dilatation techniques in percutaneous nephrolithotomy: One-Shot dilation vs. sequential dilation. South Clin Ist Euras 2020;31:21–5.
19. 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.
20. Li Y, Yang L, Xu P, Shen P, Qian S, Wei W, et al. One-shot versus gradual dilation technique for tract creation in percutaneous nephrolithotomy: A systematic review and meta-analysis. Urolithiasis 2013;41:443–8.
21. El Harrech Y, Abakka N, El Anzaoui J, Goundale O, Touiti D. One-shot dilation in modified supine position for percutaneous nephrolithotomy: Experience from over 300 cases. Urol J 2014;11:1575–82.