

Two Different Renal Dilatation Techniques in Percutaneous Nephrolithotomy: One-Shot Dilation vs. Sequential Dilation

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ABSTRACT

Objective: In this study, we aimed to compare the results in patients undergoing the one-shot dilatation (OD) technique and the conventional serial dilatation (SD) technique with amplatz dilators in percutaneous nephrolithotomy (PNL) operations.

Methods: We retrospectively evaluated the data of 213 patients who had undergone PNL between January 2016 and June 2018. The patients who had undergone SD were classified as Group 1 and the patients undergoing OD as Group 2. All of the patients had undergone contrast-free computed tomography (CT) before the operation. The PNL procedure was performed by experienced endo-urologists. Follow-up CT was performed in the 3rd post-operative month. The PNL procedure was considered unsuccessful in patients who had a stone larger than 4 mm on the CT scan. The patients were accepted as 'stone free' when there was no residual stone or there was a stone less than 4 mm in diameter on the CT scan. The groups were compared concerning demographic characteristics, operation duration, fluoroscopy duration, amount of hemoglobin change, complication rate (according to the modified Clavien classification), length of hospital stay and the operation success rate.

Results: There was no statistically significant difference between the groups concerning operation data, rate of stone-free patients and complication rates. The mean length of hospital stay was shorter in the OD group ($p < 0.001$).

Conclusion: The conventional SD procedure is similar to the OD procedure with amplatz dilators concerning the total fluoroscopy time, complication rates and the surgical success rate.

INTRODUCTION

Today, percutaneous nephrolithotomy (PCNL) is a safe, minimally invasive method that provides a high success rate, low morbidity and short hospital stay in selected patients. In the US and European urology guidelines (AUA/EUA), PCNL is recommended as the first treatment option for the treatment of renal calculi greater than 2 cm.^[1,2]

Two important steps in PCNL operations are critical. These are as follows: providing percutaneous access of a needle to the kidney collecting system, and dilatation of the percutaneous access route. These two important steps are directly related to the procedure success and complications of PCNL.^[3] The access and dilatation technique to be used usually depends on the surgeon's preference. The main goal of the surgeon at this stage is to reach the kidney collecting system in a controlled and safe manner. Each technique has advantages and disadvantages regarding the procedure cost and complications. The ideal method is the

technique that is completed in the shortest time, with the lowest cost and without any complication. While different methods, such as fluoroscopy, computed tomography (CT) and ultrasound (USG), are used for guidance for accessing into the collecting system, the most frequently preferred method is fluoroscopy.^[4-6] The use of fluoroscopy poses a risk of exposure to radiation for both the patient and the surgical team. Therefore, it is important to complete the operation in the shortest fluoroscopy period. In the literature, it has been reported that the one-shot kidney dilatation technique is a safe method that has lower radiation exposure with less cost.^[7,8] The goal of one-shot dilatation is to provide percutaneous canal formation in a single step without the need for serial dilatations.

Dilatation can be performed using the amplatz dilators, metal accessory dilators, or balloon dilators.^[9,10] In our clinic, semi-rigid amplatz dilators are used in PCNL operations. In this study, we aimed to compare the treatment success and complication rates of conventional serial di-

latation (SD) technique and the one-shot dilatation (OD) technique using amplatz dilators.

MATERIALS AND METHODS

We retrospectively evaluated the data of 213 patients undergoing PCNL between January 2016 and June 2018. This study was in compliance with the Helsinki Declaration and authorized by the ethics committee (App No: 71522473/050.01.04/25). The patients who had undergone SD were classified as Group 1 and those who had undergone OD as Group 2. Patients with missing data, cases under 18 years of age, patients with urinary tract anomalies, the patients undergoing multiple accesses and patients with morbid obesity (BMI >30) were not included in this study.

All patients were evaluated using contrast-free computed tomography (CT) before the operation. The PCNL procedure was performed by experienced endo-urologists under general anesthesia in all patients. In the lithotomy position, the open-ended ureteral catheter was advanced to the renal pelvis or the upper end of the ureter. Following ureter catheter insertion, the patients were placed in the prone position. Access to the kidney using an 18 G metal needle was provided under C-arm fluoroscopy guidance. The guide wire was advanced through the accessing needle into the kidney collecting system. In patients undergoing the SD technique (Group 1), dilatation with 30F was carried out, consequently following the fascia dilatation using the amplatz dilatation kit and the 10F dilator. The renal access sheath was then placed and dilatation was completed to 30F. In the OD technique, the co-axial dilator was advanced over the guide wire, followed by directly advancing a single 30-F Amplatz dilator over the co-axial dilator and a 30F access sheath was placed in the calyceal system. After the introduction of the collecting system, the stones were fragmented by ultrasonic and pneumatic lithotripters. After the removal of stones, the procedure was terminated by insertion of an 18F re-entry nephrostomy catheter in all patients.

The patients had then undergone a follow-up CT scan in the 3rd postoperative month. The PCNL procedure was considered unsuccessful in patients who had a stone greater than 4 mm on CT scan. The groups were compared concerning demographic characteristics, operation duration, fluoroscopy duration, amount of hemoglobin change (preop Hg – postop Hg \pm SD g/dL), complication rate (according to the modified Clavien classification), length of hospital stay and the operation success rate.

Statistical analysis

Numerical variables were given as mean \pm standard deviation or median (min-max) depending on the assumptions; categorical variables were presented as frequency (n) and percentage (%) in the descriptive statistics. The normality test was carried out using the Kolmogorov-Smirnov test and the homogeneity of the group variances was tested using the Levene's test. In the analysis

of the differences between the SD and the OD groups concerning numerical variables, the Student's t-test was used if parametric test assumptions were provided; the Mann-Whitney U test was used if the parametric test assumptions were not provided. In the analysis of the categorical data, the Pearson Chi-square or the Fisher-Freeman-Halton Exact test was used as appropriate; the Logistic regression analysis was used to determine the independent variables affecting the success of the procedure. In all analyses, the Type I error probability was accepted as 0.05. All statistical analyses were performed using the IBM SPSS V22 software.

RESULTS

There were 108 patients in Group 1 undergoing the SD procedure and 105 patients in Group 2 undergoing the OD procedure. The mean age of the whole study population was 48.26 \pm 12.78 years. Eighty-six (40.4%) of the patients were female and 127 (59.6%) were male. The groups were similar concerning gender. In both groups, the rate of men was higher than in women. There was a statistically significant difference between the groups in terms of stone localization ($p < 0.001$). Pelvic stones were higher in the location in both groups (47.4%). Of the patients in Group 1, 7 had a history of previous PCNL procedure and one patient had a history of open surgery. In group 2, 5 patients had a history of previous PCNL procedures. The demographic data of the groups have been presented in Table 1.

There was no statistically significant difference between the groups concerning operation data, stone-free patient rates and complication rates. The patients in Group 1 had a longer hospital stay. These parameters have been presented in detail in Tables 2 and 3. We found that the initial stone size had a statistically significant effect on the achievement of 'stone-free' patients ($W = 46.39$; $p < 0.001$). We found that each 1-unit increase in stone size increased the risk of procedure failure by 1-fold (95% confidence interval = 1.003–1.006).

DISCUSSION

The dilatation step of the access tract is very important in the PCNL procedure and is closely related to the complications. In their study with 143 patients, Davidoff et al. reported that amplatz dilators caused more bleeding than balloon dilators.^[11] It has been suggested that exchanging each dilator relieves the tamponade effect on the renal parenchyma and may lead to more blood loss during the dilator exchange process. Kukreja et al.^[12] compared amplatz dilators, metal dilators and balloon dilators and reported less blood loss with amplatz dilator compared to other dilators. Furthermore, they showed that the use of amplatz and balloon dilators were comparable concerning blood loss. During the SD procedure with Amplatz dilators, insertion and removal of each dilator are time-consuming and bleeding, which are important disadvantages.

Table 1. Comparison of the patients' demographic data

	Group 1 (n=108) (Serial dilatation)	Group 2 (n=105) (One-shot dilatation)	p
Mean age, years	48.55±11.93	47.85±13.68	0.691 ^a
Gender, female/male, n (%)	38 (35)/70 (65)	48 (46)/57(54)	0.117 ^b
Stone involvement (right/left)	37 (34)/71 (66)	34 (32.4)/71(67.6)	0.771 ^b
Mean stone size, mm ²	350 (155–2950)	384 (148–2859)	0.514 ^c
Stone location, n (%)			
Stag-horn	3 (2.8)	22 (21)	<0.001 ^b
Pelvic	56 (51.9)	45 (42.9)	
Upper calyx	18 (16.7)	3 (2.9)	
Lower calyx	22 (20.4)	14 (13.3)	
Multiple	9 (8.3)	21 (20)	
Hydronephrosis, n (%)			
None	27 (25)	29 (27.6)	0.269 ^b
Mild	33 (30.6)	25 (23.8)	
Moderate	25 (23.1)	32 (30.5)	
Severe	23 (21.3)	19 (18.1)	
BMI (kg/m ²)	27 (22.1–29.3)	27 (21–29.7)	0.593 ^c

a: Student's t-Test; b: Pearson Chi-Square Test; c: Mann-Whitney U Test.

Table 2. Comparison of perioperative data of groups

	Group 1 (n=108) (Serial dilatation)	Group 2 (n=105) (One-shot dilatation)	p
Access location, n (%)			
Upper	17 (15.7)	15 (14.3)	0.927 ^b
Mid	57 (52.8)	58 (55.2)	
Lower	34 (31.5)	32 (30.5)	
Mean fluoroscopy duration, sec	130 (45-360)	120 (60–320)	0.146 ^c
Mean stone-skin distance, mm	1020 (850–1395)	1085 (960–1520)	<0.682 ^c
Mean operation duration, min	65 (30–150)	70 (70–160)	<0.761 ^c
Mean Hg change (preop-postop Hg), g/dL	1.5 (0–5.1)	1.6 (0–6.6)	0.953 ^c
Mean length of hospital stay, day	3 (2–10)	2 (1–12)	<0.001 ^c
Rate of 'stone-free' patients, n (%)	82 (75.9)	81 (77.1)	0.834 ^b

Hg=hemoglobin; BMI: Body mass index; b: Pearson Chi-Square Test; c: Mann-Whitney U Test.

Table 3. Comparison of complication rates of the study groups according to the Modified Clavien Classification

Complications	Group 1 (n=108) (Serial dilatation)		Group 2 (n=105) (One-shot dilatation)		p
	n	%	n	%	
Grade 1	8	7.4	9	8.6	0.991 ^d
Grade 2	13	12	11	10.5	
Grade 3a	9	8.3	9	8.6	
Grade 3b	4	3.7	4	3.8	
Grade 4a	0	0	1	1	

d: Fisher-Freeman-Halton Exact Test.

During the SD procedure, the rotational movement of the sheath moves the kidney, and the guide wire may become malpositioned during the channel formation.

The OD technique has been developed to reduce the blood loss during the recurrent insertion of larger dilators and to skip this step quickly. The OD technique aims to access the kidney collecting system in one step. Travis et al.^[13] were the first to describe a single-step dilatation method that reached 25–30 Fr after dilatation with 6 Fr. For the first time, Frattini et al.^[14] reported access to the kidney collecting system with 30F Amplatz dilator at one step in their study with 26 patients. According to the results of this study, they stated that OD was a feasible, safe, faster and less costly technique. Recent studies have shown that OD is safe and effective for access to the collecting system of the kidney. Li et al.^[15] reported a low complication rate, a slighter decrease in hemoglobin level and shorter fluoroscopy duration with the OD method. Dehong et al.^[16] showed that the decrease in hemoglobin level was significantly lower in patients undergoing OD. On the other hand, Amirhassani et al.^[7] reported no difference between the OD and conventional SD methods concerning the 'stone-free' patient rate and complication rates. In our study, no difference was found between the groups concerning the hemoglobin change.

The need for fluoroscopic control for the insertion and checking of each dilator during the SD procedure increases the amount of radiation-exposed.^[14] In a prospective study with 49 patients, Nour et al.^[17] compared the standard metallic telescopic dilatation (Alken) and the OD procedure with Amplatz dilators. In this study, the operation time was shorter, and the total radiation exposure was lower in the OD group. They reported no difference in complication rates and surgical outcomes. There was no significant difference in the total fluoroscopy time and the operation duration between the groups in our study. We believe that the groups had similar total fluoroscopy time and the operation duration because these parameters were affected by many factors besides the dilatation technique.

PCNL is inherently a complication-prone surgery. In an analysis of the international prospective database of more than 5.800 cases, de la Rosette et al. reported low-grade complications (grade 1 and grade 2) in 16.4% of cases, grade 3a and 3b complications in 3.6% of cases, and severe complications in 0.5% of the cases, while there were no complications in 79.5% of the cases.^[18] Girisha et al.^[8] reported a 20% complication rate in 332 patients who underwent OD-alone, and there were no major complications. Injury to the kidney collecting system was reported in 5.2% of the cases, while urinoma formation was determined in only 0.2% of the cases.^[19,20] There was no urinoma formation complication resulting from pelvicalyceal system rupture among our patients. In our study, blood transfusion was required in a total of 21 patients, four of whom required the transfusion intra-operatively and 17 required it in the postoperative period. These results were consistent with the previous studies in the literature.

Pneumothorax developed in two patients of the SD group and one patient of the OD group. In addition, selective embolization was needed in two patients undergoing the OD procedure. Nephrectomy was performed in one patient due to hemorrhage, which could not be managed despite selective embolization. These two patients were secondary cases with a history of previous intervention. History of previous renal intervention results in inflammation, and neovascularization in the renal parenchyma and fragile vascular walls.^[21] More radial force is applied to the renal parenchyma in cases undergoing OD.^[22] This may be a factor that increases the risk of bleeding in patients undergoing secondary intervention. In addition, the presence of staghorn stones in these two patients is a risk factor for bleeding.^[19] However, in their study comparing OD procedure in cases undergoing primary intervention and secondary intervention, Selzgen et al.^[23] reported no difference between the groups concerning bleeding complications. Considering these major complications, it should be re-emphasized that PCNL has a significant complication potential, regardless of the dilatation technique used. In our study, there was no statistically significant difference in complication rates between the study groups. The length of hospital stay was longer in the SD group. We believe that this result was because post-operative pneumonia, urinary tract infection requiring antibiotics and the need for parenteral treatment was more frequent in the SD group. The mean length of hospital stay was 2.75 days in the whole study population.

Limitations

The retrospective design of our study was the most important limitation. In addition, another limiting aspect was that the fluoroscopy time was not calculated separately for the dilatation stage (the step from the insertion of the guide wire into the collecting system, to the placement of the amplatz sheath). Among the patients included in this study, the low number of secondary cases precluded for discussing the results of both techniques in secondary cases.

CONCLUSION

According to our results, the conventional SD procedure was similar to the OD procedure with amplatz dilators concerning the total fluoroscopy time, complication rates and the surgical success rate. Depending on the surgeon's preference and experience, both dilatation techniques can be used safely. Preparation of kits, including 10F and 30F dilators, may only help decrease the cost of the procedure for physicians who prefer the OD technique.

Ethics Committee Approval

Approved by the local ethics committee.

Informed Consent

Retrospective study.

Peer-review

Internally peer-reviewed.

Authorship Contributions

Concept: H.A., F.H.; Design: H.A.; Supervision: F.H.; Fundings: H.A.; Materials: H.A.; Data: H.A.; Analysis: F.H.; Literature search: H.A., F.H.; Writing: H.A.; Critical revision: F.H.

Conflict of Interest

None declared.

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Perkütan Nefrolitotomi De İki Farklı Renal Dilatasyon Tekniği: One-Shot Dilatasyon ve Ardışık Dilatasyon

Amaç: Perkütan nefrolitotomi operasyonlarında, amplatz dilatatörlerle yapılan one shot dilatasyon tekniği ile konvansiyonel ardışık dilatasyon tekniği uygulanan hastaların sonuçlarını karşılaştırmayı amaçladık.

Gereç ve Yöntem: Ocak 2016 ile Haziran 2018 tarihleri arasında perkütan nefrolitotomi operasyonu yapılan 213 hastanın verileri retrospektif olarak değerlendirildi. Ardışık dilatasyon yapılan olgular Grup 1, one shot dilatasyon yapılan olgular ise Grup 2 olarak ayrıldı. Tüm hastalar operasyondan önce kontrastsız bilgisayarlı tomografi ile değerlendirildi. Perkütan nefrolitotomi işlemi deneyimli endourologlar tarafından gerçekleştirildi. Hastalara postoperatif 3. ayda bilgisayarlı tomografi ile kontrol yapıldı. Bilgisayarlı tomografide 4 mm'den büyük taş kalan hastaların perkütan nefrolitotomi işlemi başarısız kabul edildi. Bilgisayarlı tomografi de hiç rezidü olmaması veya 4 mm'den küçük taş varlığı taşsızlık olarak kabul edildi. Gruplar demografik özellikleri, operasyon süresi, skopi süresi hemoglobin değişim miktarı, komplikasyonları (modifiye clavien sınıflaması ile), hastanede kalma süresi ve operasyon başarısı yönünden karşılaştırıldı.

Bulgular: Gruplar arasında operasyon verileri, taşsızlık oranları ve komplikasyonlar açısından istatistiksel olarak anlamlı farklılık yoktu. One shot dilatasyon grubunda ortalama hastanede kalış süresi daha kısa olarak tespit edildi ($p<0.001$).

Sonuç: Konvansiyonel ardışık dilatasyon tekniği, toplam floroskopi zamanı, komplikasyon oranları ve cerrahi başarı oranı açısından amplatz dilatörlü one shot dilatasyon tekniğiyle benzerdir.

Anahtar Sözcükler: Böbrek taşı; one shot dilatasyon; perkütan nefrolitotomi.