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Comparison of Efficacy and Safety of Isolated Single Different Calyx Accesses in Percutaneous Nephrolithotomy

Perkütan Nefrolitotomide İzole Tek Farklı Kaliks Girişlerinin Güvenliği ve Etkinliğinin Karşılaştırılması

Mutlu Değer, Volkan İzol, Fesih Ok, Yıldırım Bayazıt, Nihat Satar, İbrahim Atilla Arıdoğan

Çukurova University Faculty of Medicine, Department of Urology, Adana, Turkiye

What's known on the subject? and What does the study add?

We investigated whether there was superiority in different calyceal accesses performed in percutaneous nephrolithotomy operation for renal stone treat.

Abstract

Objective: We aimed to compare the safety and efficacy of upper, middle and lower calyx accesses obtained as isolated and single access in percutaneous nephrolithotomy (PCNL) operation which is performed for treating renal stones.

Materials and Methods: The records of patients who had undergone PCNL via isolated single pole access due to renal stone between September 2007 and June 2018 were retrospectively evaluated. The patients were divided into three groups as isolated single upper calyceal access patients (group 1), isolated single middle calyceal access patients (group 2) and isolated single lower calyceal access patients (group 3). The patient groups were compared in terms of patient characteristics, stone size and location, operative data, postoperative outcomes and complications.

Results: Fifty-seven (2.8%) patients who underwent isolated single calyceal access PCNL were included in group 1 (upper calyx), 542 (26.9%) in group 2 (middle calyx) and 1427 (70.4%) were included in group 3 (lower calyx). The mean age of the patients in groups 1, 2 and 3 was 43.09±15.00, 38.23±22.47 and 39.40±19.93, respectively. A thousand hundred and seventy-six (58%) patients were male and 850 (42%) were female. The mean stone burden was 367.19±266.48, 335.7±301.85 and 353.73±346.47 mm2 in groups 1, 2 and 3, respectively and there was no statistically significant difference between the groups (p=0.45, p=0.77, p=0.29, respectively). The mean operative time, mean fluoroscopy time, and mean nephrostomy time, and the mean length of hospitalization were statistically significantly longer in group 2 than in group 3. Stone-free rates in patients with clinically insignificant stones (SF + CIRF) were 89.5%, 89.6% and 91.6% in group 1, 2 and 3, respectively and there was no statistically significant difference between the groups (p=0.25, p=0.43 and p=0.6 respectively). There was no significant difference between the three groups in terms of postoperative fever, blood transfusion and overall complications.

Conclusion: As a result, different isolated single calyceal accesses do not have superiority over each other in terms of stone-free rate and complications. A proper access is required while performing PCNL to remove the stones, decrease the comorbidity rates and prevent complications and the ideal way is the way that provides the shortest and the smoothest reach all stones.

Keywords: Renal stone, Percutaneous nephrolithotomy, Calyceal access, Upper calyx, Middle calyx, Lower calyx

Öz

Amaç: Böbrek taşı tedavisinde uygulanan perkütan nefrolitotomi (PNL) operasyonunda izole ve tek giriş olarak yapılan üst, orta ve alt kaliks girişlerinin güvenlik ve etkinliklerini karşılaştırmayı amaçladık.

Gereç ve Yöntem: Kliniğimizde Eylül 2007 ve Haziran 2018 tarihleri arasında böbrek taşı nedeniyle izole tek giriş ile PNL yapılan hastalar retrospektif olarak incelendi. Hastalar izole tek üst kaliks girişi (grup 1), izole tek orta kaliks girişi (grup 2) ve izole tek alt kaliks girişi (grup 3) olmak üzere üç gruba ayrıldı. Hastaların demografik özelikleri, taş boyutu ve lokalizasyonu, operasyona ait veriler, postoperatif sonuçlar ve komplikasyonlar açısından karşılaştırıldı.

Correspondence: Mutlu Değer MD, Çukurova University Faculty of Medicine, Department of Urology, Adana, Turkiye
E-mail: drmutludeger@gmail.com **ORCID-ID:** orcid.org/0000-0002-8357-5744
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Bulgular: İzole tek kaliks girişi ile PNL yapılan hastaların 57'si (%2,8) grup 1 (üst kaliks), 542'si (%26,9) grup 2 (orta kaliks), 1427'si (%70,4) ise grup 3'te (alt kaliks) yer almaktaydı. Hasta yaşları sırasıyla 43,09±15,00, 38,23±22,47 ve 39,40±19,93 yıl idi. Bu hastaların 1176'sı (%58) erkek, 850'si (%42) kadın idi. Taş boyutları grup 1, 2 ve 3'de sırasıyla 367,19±26,48, 335,7±301,85 ve 353,73±346,47 mm2 olup istatistiksel olarak anlamlı bir fark yoktu (p=0,45, p=0,77 ve p=0,29). Ortalama Skopi süresi, ortalama nefrostomi çekilme süresi ve ortalama hastanede kalış süresi grup 2 ve 3 kıyaslandığında grup 2'de bu süreler anlamlı derecede yüksek bulundu. Grup 1, 2 ve 3'te klinik önemsiz taşlarla birlikte taşısızlık oranları sırasıyla 51 (%89,5), 486 (%89,6), 1308 (%91,6) idi ve gruplar arası anlamlı fark saptanmadı (p=0,25, p=0,43, p=0,6). Postoperatif ateş, kan transfüzyonu açısından ve total komplikasyon açısından her üç grup arasında anlamlı bir farklılık saptanmadı.
Sonuç: Sonuç olarak izole tek farklı kaliks girişlerinde taşsızlık oranı ve komplikasyon açısından birbirlerine üstünlükleri yoktur. PNL kullanılarak taşların tamamen temizlenmesi, PNL komorbitidesi azaltmak ve komplikasyon oluşmaması için iyi bir erişim şarttır ve ideal yol, tüm taşlara en kısa ve en düz erişimi sağlayan yoldur.
Anahtar Kelimeler: Böbrek taşı, Perkütan nefrolitotomi, Kaliks girişi, Üst kaliks, Orta kaliks, Alt kaliks

Introduction

Nephrolithiasis is a common disease in the world with an overall prevalence of 7-13% in North America, 5-9% in Europe and 1-5% in Asia. This disease has a high level of acute and chronic morbidity (1). Percutaneous nephrolithotomy (PCNL) is considered the gold standard treatment for the management of renal stones larger than 2 cm (2). PCNL is a minimal invasive treatment modality (3). By taking the location of the stone and stone burden into consideration, access to renal collecting system is obtained from different calyceal accesses. A proper access is required to provide complete removal of the stones, to decrease PCNL comorbidity and to prevent complications (4). The upper calyceal access provides excellent access to collect upper pole stones. On the other hand, this particular access may lead to intrathoracic complications (5,6,7,8). Lower calyceal access is particularly used for lower calyx stones. In some cases, due to sharp angles between calyces, it may be challenging to reach renal calyces via a single lower calyceal access and to remove the stones completely. It may also lead to a prolonged operative time, an incomplete removal of the stones and additional operations (9,10,11). Middle calyceal access is optimal for reaching the renal system and it also provides a suitable endoscopic maneuver for accessing upper and lower calyces and the proximal ureter (12).

The aim of this study was to compare the safety and efficacy of upper, middle and lower calyceal accesses obtained as isolated and single access in PCNL operation performed for treating renal stones.

Materials and Methods

The records of patients who had undergone PCNL via isolated single calyceal access due to renal stone between September 2007 and June 2018 were retrospectively evaluated. PCNL was performed for treatment of stones 2.0 cm or larger. Prior to the procedure, direct urinary system graphy, ultrasonography, urine analysis, urine culture, complete blood count, serum biochemistry and coagulation tests were performed. In the pre-operative phase, computed tomography and/or intravenous pyelogram were performed to evaluate the renal anatomy and the location of the stone in terms of percutaneous access. Renal scintigraphy was not performed in a routine fashion; it was done when it was required. Complications were classified according to the modified Clavien classification system. Ethics committee approval of the study was obtained from the ethics committee of the University of Çukurova (approval number: April 5, 2019;87/48).

Operation Techniques

All procedures were performed as PCNL under general anesthesia (GA) by experienced urologists. Prophylactic antibiotics were administered to the patients 1 hour prior to the operation. In the lithotomy position, a 5F open-end ureteral catheter was inserted into the ureter and fixed to a urethral Foley catheter allowing the injection of contrast dye to visualise and distend the collecting system. The patient was placed in the prone position. Then the surgical site was prepared with Betadine. An 18 G needle Percutaneous puncture was done using an 18 G needle through the appropriate calyx by under fluoroscopic guidance while moving the C-arm to observe the calyx in different planes. A 0.038 inch super stiff polytetrafluoroethylene-coated guide-wire was placed into the collecting system, and the tract was dilated to 18-30 F using Amplatz dilators, followed by the placement of a 18-30 F Amplatz sheath (Boston Scientific, USA). A 26 F rigid or flexible nephroscope was used in adult patients while 18 F rigid nephroscope was used in pediatric patients. The stones were fragmented with a pneumatic lithotripter and extracted with percutaneous forceps. At the end of the operation, residual fragments were assessed by fluoroscopic evaluation, and a 10-20 F re-entry catheter was inserted into the renal pelvis. Antegrad nephrostogram was performed in suitable patients 2-3 days after the operation and in patients not having hematuria, fever, extravasation and ureteral obstruction, re-entry catheter was removed.

The patients were divided into three groups as isolated single upper calyceal access patients (group 1), isolated single middle

calyceal access patients (group 2) and isolated single lower calyceal access patients (group 3). Three patient groups were compared in terms of patient characteristics, stone size and location, operative data and postoperative outcomes. Patient-related variables including age, sex, stone burden and location data were collected during preoperative treatment phase. Other variables related to the results included in the study and analysis were operative time, fluoroscopy time, stone-free rate, complication rate, nephrostomy time and length of hospitalization. The maximum two diameters of the stone were measured to calculate stone burden (as mm^2).

Statistical Analysis

SPSS® version 20.0 was used for statistical analyses which were conducted using chi-square test, independent samples t-test and, one-way ANOVA. For descriptive statistics, rates were used for vital variables. Qualitative variables were presented as median (minimum-maximum) for non-parametric tests and as mean ± standard deviation for parametric tests. A p value of less than 0.05 was considered statistically significant.

Results

PCNL was performed in 2660 patients. Two thousand and twenty-six patients underwent isolated single calyceal access. 57 (2.8%) isolated single calyceal access PCNL patients were included in group 1 (upper calyx), 542 (26.9%) included in group 2 (middle calyx), 1427 (70.4%) were included in group 3 (lower calyx). Demographic data of patients are shown in Table 1 and operative data are shown in Table 2. The mean age of the patients in groups 1, 2 and 3 was 43.09±15.00, 38.23±22.47 and 39.40±19.93, respectively. A thousand hundred and seventy-six (58%) patients were male and 850 (42%) were female. The mean stone burden was 367.19±266.48, 335.7±301.85 and 353.73±346.47 mm^2 in group 1, 2 and 3, respectively and there was no statistically significant difference between the groups (p=0.45, p=0.77 and p=0.29, respectiely) (Table 1). According to the location of the stones, middle calyceal access was prefered for staghorn, pelvic and multiple calyceal stones and lower calyceal access for single calyx stones (Table 1).

The mean operative time was found to be longer in isolated single middle calyceal access (p=0.012 and p=0.001) (Table 2). The mean duration of fluoroscopy was significantly longer in group 2 (p=0.000) than in group 3 and there was no statistically significant difference in other comparisons. Stone-free rates in clinically insignificant stones were 89.5% (51 patients), 89.6% (486 patients), and 91.6% (1308 patients) in groups 1, 2 and 3, respectively and there was no statistically significant difference between the groups (p=0.25, p=0.43, p=0.6) (Table 2). When the mean nephrostomy time was statistically significantly longer in group 2 than in group 3 (p=0.000) and there was no statistically significant difference in other comparisons (p=0.20, p=0.20) (Table 2). The mean length of hospital stay was statistically significantly longer in group 2 than in group 3 (p=0.000) there was no statistically significant difference in other comparisons (p=0.20, p=0.20) (Table 2). The number of patient who required perioperative and postoperative blood transfusion was 2 (3.5%), 19 (3.51%) and 42 (2.94%) in groups 1, 2 and 3, respectively. There was no statistically significant difference between the groups in terms of blood transfusion (p=0.27, p=0.81 and p=0.53, respectively) (Table 2). There was no statistically significant difference between the groups in terms of postoperative fever (p=0.65, p=0.58 and p=0.82) (Table 2).

Table 1. Dermographic data on patients

	Group			p		
Characteristics	**Group A**	**Group B**	**Group C**	**A vs B**	**A vs C**	**B vs C**
No. pts	57	542	1427			
Mean Age (year)	43.09±15.75	38.23±22.47	39.4±19.93	0.11	0.17	0.26
No. gender (%)						
M	37 (69.9)	326 (60.1)	813 (57)	0.48	0.23	0.20
F	20 (35.1)	216 (39.9)	614 (43)			
BMI kg/m^2	26.27±5.87	25.56±6.38	26.18±6.58	0.43	0.92	0.06
Mean ± SD stone burden (mm^2)	367.2±266.4	335.7±301.8	353.7±346.4	0.45	0.77	0.29
Stone location n (%)						
Staghorn	1 (1.8)	62 (11.4)	75 (5.2)	0.02	0.20	0.0001
Pelvic	8 (14)	180 (33.2)	459 (32.2)	0.00	0.002	0.66
Single calyx	31 (54.4)	123 (22.7)	450 (31.5)	0.00	0.0001	0.0001
Multiple calyx	7 (12.3)	35 (6.5)	65 (4.6)	0.13	0.02	0.09
Pelvis + calyx	10 (17.5)	142 (26.2)	378 (26.5)	0.14	0.12	0.90

Table 2. Perioperative variables and surgical outcomes						
	Group			p value		
Characteristics	Group A	Group B	Group C	A vs B	A vs C	B vs C
Mean ± SD operative time (mins)	63.96±38.61	76.28±34.5	61.73±32.35	0.012	0.61	0.001
Mean ± SD scopy time (mins)	10.23±5.90	10.95±6.20	9.28±6.03	0.40	0.24	0.001
Mean ± SD nephrostomy time (days)	2.04±2.07	2.49±2.4	1.81±1.21	0.20	0.20	0.001
Mean ± SD hospital stay (days)	3.66±2.84	4.26±4.22	3.50±2.53	0.33	0.66	0.001
SF + CIRF n (%)	51 (89.5)	486 (89.6)	1308 (91.6)	0.25	0.43	0.6
Blood transfusion n (%)	2 (3.51)	19 (3.51)	42 (2.94)	0.27	0.81	0.53
Clavien score n (%)						
II	0	2 (0.4)	6 (0.4)	0.64	0.62	0.87
IIIA	0	3 (0.6)	4 (0.3)	0.57	0.68	0.36
IIIB	0	4 (0.7)	6 (0.4)	0.51	0.62	0.37
IVA	0	0	0			
IVB	0	0	0			
V	0	0	0			
Total complication n (%)	0	9 (1.7)	16 (1.1)	0.32	0.75	0.34
SD: Standart deviation						

When we evaluated the complications in patients with isolated single middle calyceal access in group 2, 2 patients developed hematuria (Clavien II) and follow-up protocol was implemented. Due to urine leakage, a DJ stent was inserted under local anesthesia in 2 patients and angioembolization was performed due to hematuria (Clavien IIIA) in 1 patient and DJ stent was inserted under GA due to urine leakage (Clavien IIIB) in 4 patients. In Group of isolated single lower calyceal access, 3 patients were followed up due to urine leakage and long-term hematuria was present in 3 patients but they did not require intervention (Clavien II). A DJ stent was inserted under local anesthesia due to urine leakage in 1 patient and due to resistant fever + urinoma in 1 patient (Clavien IIIA). Due to ureter stone, ureterorenoscopy was performed in 1 patient under general anesthesia. There was extravasation caused by ureteropelvic junction during antegrad nephrostogram in 1 patient and a DJ stent was placed under general anesthesia. A DJ stent was inserted due to urine leakage under GA in 2 patients. Angioembolisation was performed due to resistant hematuria in 2 patients (Clavien IIIB). When groups were compared in terms of total complications, there was no statistically significant difference (p=0.32, p=0.75 and p=0.34, respectively).

Discussion

The standard treatment modality for large renal stones is PCNL (13). Conventionally, PCNL is performed in the prone position which is considered the safest approach for kidney by many specialists. This position enables posterior access to the collecting system through Brodel's avascular renal plane without significant risk of parenchymal bleeding, peritoneal perforation and visceral injuries. Furthermore, prone PCNL approach provides a large surface area for instrument manipulation and facilitates the selection of perforation site (14). In this study, PCNL was performed in the prone position in each patient. Sampaio and Aragao (15) defined the anatomical relationship between the intrarenal arteries and the renal collecting system. Investigators have suggested that each puncture to the collecting system should be performed periferically via calyx fornix (15). In this study, access to kidney was obtained by single upper, middle and lower calyceal accesses.

According to Song et al. (12), posterior middle calyceal access is optimal for reaching the renal system because it provides the closest and shortest distance from the skin to renal pelvis. Furthermore, they stated that it provides the proper endoscopic maneuver to reach lower, upper calyces and proximal ureter (12). Upper calyceal access is on the longitudinal axis of renal pelvis and it provides direct access to the upper calyx, renal pelvis, ureteropelvic junction and proximal ureter (6,9,16). However, this access increases the risk of intrathoracic complications (6,9). In this study, no intrathoracic injury was observed in patients undergoing isolated upper calyceal access PCNL. Renal parenchyma located next to the lower calyx is rich of arterioles. Lower calyceal access requires oblique and longer surgical approaches. To reach the renal pelvis, nephroscope should be adjusted frequently and this increases the risk of laceration of the renal parenchyma (17).

In their study, Song et al. (12) indicated that the mean operative time was shorter in middle calyx access patients when compared

lower and upper calyx access patients. In their study related to supine position, Falahatkar et al. (18) indicated that the mean operative time in patients who underwent middle calyceal access PCNL was shorher than those undergoing lower calyceal access PCNL (12). On the other hand, the mean operative time in the study of Aron et al. (16) were 48 and 74 minutes in upper and lower calyx access respectively (16). In this study, when compared to other calyceal accesses, the mean operative time was longer in isolated single middle calyceal access PCNLwas.

In their study, Song et al. (12) found a significantly higher stone-free rate in middle pole access group. Falahatkar et al. (18) showed that stone-free rate was higher in middle calyceal access patients than in lower calyceal access patients. In this study, stone-free rate was found to be similar between the three groups.

The study of Tan et al. (17) reported that severe post-operative bleeding after PCNL wa associated with renal puncture via the lower calyx. multiple renal stones and solitary kidney stones. In this study, 3 patients in isolated single middle calyceal access group developed postoperative bleeding and angioembolisation was performed in 1 of them. Four patients who underwent lower calyceal access PCNL developed severe postoperative bleeding and angioembolisation was performed. However, no severe postoperative bleeding was present in upper calyx access patients.

Clavien et al. (19) proposed general principles for the classification of surgical complications in 1992. At the same time, they modified this classification in order to focus on life-threatening complications and long-term impairments. Spleen, liver and pleural injuries may be observed more frequently according to the anatomic connections (20,21). However, in this study, no visceral organ injury was present in upper pole access patients. In terms of total complication rates, there was no statistically significant difference between three groups.

In this study, we compared the perioperative and postoperative outcomes of lower, middle and upper calyceal accesses. There was no statistically significant difference between three groups in terms of age, sex, body mass index, stone burden, fever, blood transfusion requirement and complications. However, the mean operative time was found to be longer in isolated single middle calyceal access group. The mean scopy time, the mean nephrostomy time, and the mean length of hospital stay were found to be longer in patients undergoing middle calyceal access than in lower calyceal access groups. Isolated middle calyceal access was preferred more frequently in staghorn, pelvis and multiple calyx localized stones.

Conclusion

As a result, different isolated single calyx accesses do not have superiority over each other in terms of stone-free rate and complications. An appropriate access is required when performing PCNL for stone removal, to decrease the comorbidity rates and prevent complications and the ideal way is the way that provides the shortest and the smoothest reach to all stones.

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Ethics committee approval of the study was obtained from the ethics committee of the University of Çukurova (approval number-April 5, 2019;87/48).

Ethics

Ethics Committee Approval: Ethics committee approval of the study was obtained from the ethics committee of the University of Çukurova (approval number: April 5, 2019;87/48).

Informed Consent: Consent form was filled out by all participants.

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Authorship Contributions

Concept: M.D., V.İ., İ.A.A., Design: M.D., V.İ., İ.A.A., Data Collection or Processing: M.D., F.O., Analysis or Interpretation: M.D., F.O.,F.O., Y.B., N.S., Literature Search: M.D., F.O., V.İ., Writing: M.D., V.İ.

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