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# Feasibility of percutaneous nephrolithotomy after urology residency training in the 2nd stage state hospital

## *Uzmanlık eğitimi sonrasi perkütan nefrolitotominin 2. basamak ilçe devlet hastanesinde uygulanabilirliği*

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**Abstract**

**Purpose:** It was aimed to evaluate the results and complications of percutaneous nephrolithotomy (PCNL) in a second stage state hospital by a surgeon after Urology residency.

**Materials and methods:** Between January 2019 and January 2020, PCNL was applied to 102 renal units in 97 patients with kidney stones in a second stage state hospital. Standard PCNL was performed in all patients in the prone position with a 26 Fr rigid nephroscope and pneumatic lithotripter. The data of the patients were collected retrospectively. Success rates, length of stay, and complications were evaluated in the light of the literature.

**Results:** The average age of 97 patients who underwent PCNL was 41.7±10.5 (8-71) and 54 (55.7%) of these patients were male and 43 (44.3%) were female. Access was provided to 102 renal units. 42 (41.2%) of them were left and 60 (58.8%) were right. The mean stone surface area was 8.3±5.5 (2-34) cm2 and the number of stones per patient was 2.4. Operation time was measured as 85>32 (40-170) minutes. The duration of fluoroscopy was observed as 1.2±0.2 (0.5-9) minutes. The stone free rate was achieved in 86 (84.3%) of 102 cases. Including clinically insignificant residual fragments (>4 mm), the overall success rate was 93.1%. The hospital stay of the patients was 2.7 (1-11) days. The number of patients with major and minor complications was 21 (20.6%).

**Conclusion:** We thought that PCNL can be applied safely and effectively in 2nd stage state hospitals with acceptable complications and success rates in line by the literature.

**Key words:** Percutaneous nephrolithotomy, kidney stone, complication.

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**Öz**

**Amaç:** Bu çalışmada; uzmanlık eğitimi sonrasında perkütan nefrolitotomiyi (PNL) 2. basamak ilçe devlet hastanesinde gerçekleştiren bir cerrahın başarı oranları ve karşılaşılan komplikasyonları değerlendirmek amaçlandı.

**Gereç ve yöntem:** Ocak 2019 ile Ocak 2020 tarihleri arasında böbrek taşı olan 97 hastadaki 102 renal üniteye 2. basamak devlet hastanesinde PNL uygulandı. Tüm hastalara standart PNL 26 Fr rijit nefroskop ve pnömotik litotriptör kullanılarak prone pozisyonda uygulandı. Hastaların verileri retrospektif olarak toplandı. Başarı oranları, yatış süreleri, karşılaşılan komplikasyonlar literatür eşliğinde değerlendirildi.

**Bulgular:** PNL yapılan 97 hastanın yaş ortalaması 41,7±10,5 ve bu hastaların 54'ü (%55,7) erkek, 43'ü (%44,3) kadındı. 42'si (%41,2) sol, 60'ı (%58,8) sağ böbrek olmak üzere 102 renal üniteye giriş sağlandı. Ortalama taş yükü 8,3±5,5 cm2 ve ortalama taş sayısı 2,4 olarak tespit edildi. Operasyon süresi ortalama 85±32 dakika olarak ölçüldü. Skopi süresi ortalama 1,2±0,2 dakika olarak izlendi. Toplam 102 vakanın 86'sında (%84,3) taşsızlık sağlandı. Klinik önemsiz rezidüel fragmanlar (>4 mm) da dahil edildiğinde genel başarı oranı %93,1 idi. Hastaların hastanede kalış süresi 2,7 (1-11) gün olarak izlendi. Majör ve minör komplikasyon görülen hasta sayısı 21 (%20,6)'di.

**Sonuç:** PNL uzmanlık eğitimi sonrası 2. basamak ilçe devlet hastanelerinde literatürle uyumlu komplikasyon ve başarı oranları ile güvenli ve etkin bir şekilde uygulanabileceğini düşünmekteyiz.

**Anahtar kelimeler:** Perkütan nefrolitotomi, böbrek taşı, komplikasyon.

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## Introduction

Percutaneous nephrolithotomy (PCNL) is commonly used in the management of large upper renal tract stones since it was first described in 1976, and it has replaced open stone surgery as a minimally invasive method [1]. Along with the development of PCNL techniques and equipment over the years, it has now become a feasible option that is successfully applied in the treatment of kidney stones with appropriate indications, with its advantages such as high treatment success, shorter length of hospital stay, small surgical incision and short recovery time [1]. Although the success rates are affected by many factors such as the size, location and structure of the stone, anatomical factors of the patient, surgical technique and experience, and surgical possibilities, it has a high success rate in general and is recommended as the first option especially in the treatment of kidney stones larger than 2 cm [2]. However, it should not be forgotten that in addition to cases where simple interventions or clinical follow-up will be sufficient, complications at various sizes that may result in mortality may also occur in PCNL like every surgical procedure. PCNL is considered to be the most complex and difficult to learn surgery among stone surgeries. The main reason for the difficulty of learning is the difficulty in obtaining renal access. This difficulty can only be eliminated with a sufficient number of cases. In the studies, it was reported that competence was achieved in performing PCNL in 60 cases [3]. In this study, we evaluated the safe and effective feasibility of PCNL, which we learned during urology residency, in a second stage state hospital in the district, and the complications encountered.

## Materials and methods

Between January 2019 and January 2020, PCNL was applied to 102 renal units in 97 patients with kidney stones in a second stage state hospital. All patients included in the study were retrospectively analyzed after obtaining the ethics committee approval. The patients were evaluated with hemogram, biochemistry, bleeding parameters, and urine culture before the operation. The patients with positive urine culture were taken into the operation after providing adequate duration and appropriate antibiotic therapy and negative urine cultures were observed. Prophylaxis was provided with the first generation cephalosporin administered before anesthesia induction for the patients who had no growth in their urine cultures. The treatment of the patients using antiaggregants or anticoagulants was discontinued preoperatively and surgery was planned. All patients were evaluated preoperatively with computed tomography (CT). The stones were categorized as simple stones (pelvis or single calyx stones) and complex stones (coralliform, pelvis + calyx stones, partial coralliform, multiple calyx stones, etc.) to categorize the localizations of the stones, as in the study of Bayar et al. [4]. In the calculation of the stone surface area, the value obtained by multiplying the largest axis diameter of the stone with the diameter of the largest axis perpendicular to it was recorded as the stone surface area. In multiple stones, the stones were measured one by one, and the total value obtained was recorded as the stone surface area [4, 5].

**Surgical technique:** After general anesthesia was administered to all patients in the supine position, they were placed in the lithotomy position, and following the appropriate region cover, a 5 F open-ended straight ureteral catheter was inserted into the collecting system, where the surgical procedure would be performed, by inserting into the meatus urethra with a 9 F Ureteroscope (Karl Storz, Tuttlingen, Germany). Previously, if the patients had a ureteral stone, the necessary procedure was also applied to them. Then, a urethral catheter was inserted and the straight ureteral catheter was fixed to the catheter. The patient was placed in the prone position. The body parts that might have pressure were supported with silicone pillows. Then, the collecting system was opacified by administering a maximum of 1/3 diluted contrast material (Urografin® 76%) through the ureteral catheter, and the collecting system was entered through the targeted calyx with an 18 G diamond-tipped percutaneous access needle, accompanied by biplanar C-arm fluoroscopy. Intercostal or subcostal access was performed according to the location of the calyx planned to be entered. It was performed during the expiration of the patient by talking with access anesthesia in all patients with intercostal access, and attention was paid to prefer the upper limit of the 11th or 12th level according to the access location to minimize the risk of intercostal vessel-nerve damage

and bleeding. A 0.035-inch guidewire was advanced through the access needle. Attention was paid to ensure that the guidewires would be passed into the ureter as much as possible in eligible patients. Then, dilatation up to 30 F was achieved with the Amplatz dilatation set under fluoroscopy control, and the 30 F Amplatz sheath was placed in the collecting system. Then, the collecting system was accessed with a 26 F nephroscope (Karl Storz, Tuttlingen, Germany). Two renal accesses were performed for the stones that could not be accessed from a single access. The stones were crushed with pneumatic lithotripter (Vibrolith-Elmed, Ankara, Turkey) and removed with the help of stone forceps. During the surgical procedure, the ureteral catheter of all patients was removed and a 16 F re-entry malecot nephrostomy catheter was inserted. During the placement of the nephrostomy catheter, nephrostograms were taken by giving opaque through the catheter to see the correct placement of the nephrostomy, to observe the preservation of renal integrity, and to get an idea about possible injuries. In cases with hemorrhage, the patient's nephrostomy was clamped intermittently. Nephrostomy of the patients without active bleeding was left open. Ureteral catheters of the patients were removed during the case, urethral catheters were removed on the first postoperative day, and nephrostomy catheters were removed in the first 3 days, mostly on the first postoperative day. The patients were called to the outpatient clinic control examination after 3 months and the entire abdomen was evaluated with CT for the presence of residual stones. While the presence of stones of ≥4 mm was considered as residual stones, and smaller stones were considered as clinically insignificant residual stones. The operation time was calculated as the time from the start of anesthesia induction until the patient was extubated. The complications that occurred during or within the first month after surgery were evaluated using the validated Clavien classification for PCNL [6].

### Statistical analysis

In this study, the IBM Statistical Package for the Social Science version 11.0 (SPSS Chicago, Illinois, USA) program was used for statistical analysis. Continuous variables were expressed as mean ± standard deviation (SD). Categorical variables were shown as percentages.

## Results

The average age of 97 patients who underwent PCNL was 41.7±10.5 (8-71) and 54 (55.7%) of these patients were male and 43 (44.3%) were female. Since five patients had bilateral stones, two sessions of PCNL were performed with an interval of 3 months, and access was provided to 102 renal units, and 42 (41.2%) of them were left and 60 (58.8%) were right. Two renal accesses were performed in 5 (4.9%) patients, and single access was performed in all other cases. Renal anomalies were present in a total of 7 (6.9%) patients, including horseshoe kidney in 1 patient, malrotated kidney in 2 patients, and double collecting system in 4 patients. The solitary kidney was present in 2 (1.9%) patients. Including 5 patients who underwent double access, while 78 of a total of 107 renal accesses were performed from the lower calyx, 25 and 4 of them were performed from the middle calyx and the upper calyx, respectively. While subcostal access was performed in patients with lower calyx access, intercostal access was performed in others. The mean stone surface area was 8.3±5.5 cm², and the number of stones per patient was 2.4. The mean Hounsfield Unit (HU) was 1059±314 (Table 1).

When evaluated according to the location of the stones, 31 (30.4%) and 71 (69.6%) of them were simple and complex stones, respectively. Concerning simple stones, while 1 (0.9%) of them was located in the isolated upper calyx, 21 (20.6%) and 9 (8.8%) of them were located in the isolated pelvis and isolated lower calyx, respectively. Concerning complex stones, while 3 (2.9%) of them were in the staghorn localization, 9 (8.8%) of them were in the partial staghorn localization, 5 (4.9%) of them were located in the pelvis and upper calyx, 36 (35.3%) of them were located in the pelvis and lower calyx, 10 (9.8%) of them were located in the pelvis and multiple calyces, and 8 (7.9%) of them were located in the multiple calyces. Since 11 (10.8%) patients had ureteral stones in addition to kidney stones, their stones were broken and extracted by ureteroscopy (Table 2).

Ureteral catheters of all patients who underwent PCNL were removed intraoperatively, and 16 F re-entry malecot nephrostomy catheters were inserted in all of them. The duration of the nephrostomy after PCNL was 1.8 (1-3) days. The mean operation time was measured

**Table 1.** Patients and stone characteristics

| | n (%) |
|---|---|
| **Number of patients** | 97 |
| **Number of renal units** | 102 |
| **Number of Renal Accesses** | 107 |
| **Average age** | 41.7±10.5 |
| **Gender** | |
| **Female** | 43 (44.3%) |
| **Male** | 54 (55.7%) |
| **Side** | |
| **Right** | 60 (58.8%) |
| **Left** | 42 (41.2%) |
| **Stone radiopacity** | |
| **Opaque** | 83 (81.4%) |
| **Semiopaque** | 19 (18.6%) |
| **Radiolucent** | 0 |
| **Mean stone surface area (cm²)** | 8.3±5.5 |
| **Mean Number of Stones** | 2.4 |
| **Mean Hounsfield Unit** | 1059±314 |

n: Number

**Table 2.** Localization of stones

| | n (%) |
|---|---|
| **Simple Stones** | 31 (30.4%) |
| **Isolated Upper Calyx** | 1 (0.9%) |
| **Isolated Pelvis** | 21 (20.6%) |
| **Isolated Lower Calyx** | 9 (8.8%) |
| **Complex Stones** | 71 (69.6%) |
| **Staghorn** | 3 (2.9%) |
| **Partial Staghorn** | 9 (8.8%) |
| **Pelvis + Upper Calyx** | 5 (4.9%) |
| **Pelvis + Lower Calyx** | 36 (35.3%) |
| **Pelvis + Multiple Calyx** | 10 (9.8%) |
| **Multiple Calyx** | 8 (7.9%) |
| **Patients with ureteral stones** | 11 (10.8%) |

n: Number

as 85±32 minutes, and the mean duration of fluoroscopy was measured as 1.2±0.2 minutes. The hospital stay of the patients was 2.7 (1-11) days (Table 3).

While complications were observed in a total of 21 (20.6%) cases, more than one complication was observed in some cases. No vital complication that required the termination of the procedure was observed during the operation. No additional surgical procedures (open, laparoscopic, etc.) were performed during the operation in any of the patients. No adjacent organ injury requiring invasive procedure was observed. Urinary extravasation was observed in 5 (4.9%) patients and they were followed up without any intervention. Blood transfusion was performed in 7 (6.9%) patients who had a decrease in hemoglobin values observed postoperatively. After the procedure, 3 (2.9%) patients developed a fever that decreased with antipyretics and did not recur, and 4 (3.9%) patients developed fever and complicated urinary tract infection although the preoperative urine cultures were negative. Two of these patients were diagnosed with diabetes mellitus. These patients were consulted with infectious diseases department and treated with broad-spectrum antibiotics in the urology service, and septic shock was not observed in these patients. It was needed to insert a Double J catheter in a total of 4 patients (3.9%), due to the descent of the residual stone into the ureter after the removal of the postoperative nephrostomy catheter in 2 patients, and due to the prolonged urinary discharge from the nephrostomy tract in 2 patients (Table 4).

Abdominal CT was performed at the 3rd-month follow-up of the patients and the stone-free rates were checked. During the controls of the patients who underwent PCNL, the presence of residual stones and clinically insignificant residual stone fragments were detected in 7 (6.9%) and 9 (8.8%) of them, respectively. It was observed that 4 of 7 patients with residual stones had multiple calyx stones filling the pelvis, and 1 patient had staghorn stones. The complete stone-free rate in 102 cases was 84.3% (86), and the overall success rate, which we calculated as clinically insignificant residual fragments (>4 mm) and complete stone-free, was 93.1% (95) (Table 3). ESWL was recommended for 1 patient and PCNL was recommended again for 1 patient. 5 patients were followed up clinically.

## Discussion

Despite the developments in endourology, PCNL keeps its place in the treatment of kidney

**Table 3.** Perioperative data

| | |
|---|---|
| **Mean duration of fluoroscopy (min)** | 1.2±0.2 |
| **Operation time (min)** | 85±32 |
| **Duration of the nephrostomy (day)** | 1.8 (1-3) |
| **Length of hospital stay (day)** | 2.7 (1-11) |
| **Complete stone-free rate** | 84.3% (86) |
| **Overall success rate** | 93.1% (95) |

min: Minute

**Table 4.** Complications according to the Clavien classification system

| **Clavien Grade 1** | **n (%)** |
|---|---|
| Fever | 3 (2.9%) |
| Urinary extravasation (reversible with conservative treatment) | 5 (4.9%) |
| **Clavien Grade 2** | **n (%)** |
| Bleeding requiring transfusion | 7 (6.8%) |
| urinary tract infection | 4 (3.9%) |
| Urine discharge from the nephrostomy tract lasting less than 12 hours | 6 (5.8%) |
| **Clavien Grade 3A** | **n (%)** |
| D/J catheter placement due to prolonged urine discharge from the nephrostomy tract | 2 (1.9%) |
| **Clavien Grade 3B** | **n (%)** |
| URS + D/J catheter placement due to stone falling into the ureter | 2 (1.9%) |

stones. Nowadays, PCNL is recommended as the first-line treatment for kidney stones of >2 cm in the European Association of Urology (EAU) urolithiasis guideline [2]. Even for smaller-sized stones, mini, ultra-mini, and micro PCNL methods are available at minimalized sizes. In large-series studies on PCNL, it was reported that 3 main factors affecting the success were appropriate patient selection, sufficient surgical experience, and equipment adequacy [7]. In a multicenter study, stone-free rates after PCNL were shown to be 75.7% [8]. It was reported that stone-free rates with PCNL varied between 51% and 100% in different series, and that the rate of minor and major unwanted side-effects was between 0-38% [9]. The success rate was reported as 80% in the study conducted in the 2nd stage state hospital by Benli et al. [10]. In the study conducted by Bıçaklıoğlu et al. [5], this rate was observed to be 83.3%. In our study, the stone-free rate was observed to be 84.3% when clinically insignificant residual fragments and the presence of residual stones were excluded. The overall success rate was 93.1%. It was reported that the success rate with PCNL was more than 70% in cases with staghorn stones [11]. We consider that operating more eligible patients affects the success and complication rates. This may be a result of more complicated patients being able to go to tertiary hospitals instead of the 2nd stage state hospital when necessary. When staghorn, partial staghorn, and multiple calyceal stones, which have a higher probability of remaining residual, were evaluated as isolated, we observed that the overall success rate in our study was 83.3%. In our study, this rate was observed to be slightly lower than the overall success rate. We considered that this rate was caused by the lack of surgical experience and the rigidity of the nephroscope we used. Although there are many factors affecting success after PCNL, one of the most important factor is surgical experience. Therefore, we think that with the acquisition of surgical experience, the success rates will increase and the complication rates will decrease.

In The Clinical Research Office of the Endourological Society (CROES) global PCNL study, the overall complication rate was observed to be 20.5%, and Clavien Grade 1-2 was observed in 16.4% of them, Clavien Grade 3 was observed in 3.6% of them, and Clavien Grade 4 and Clavien Grade 5 were observed in 0.5% and 0.03% of them, respectively [8, 12, 13]. Considering all patients, unwanted side-effects were observed by 20.6% (21 cases). Clavien

grade 1 complication occurred in 8 patients, including fever that responded to antipyretics and did not recur in 3 (2.9%) patients, and urinary extravasation in 5 (4.9%) patients. Transient fever is a complication that can be encountered frequently after PCNL application [6]. Since the urine and blood cultures of the patients were mostly sterile and there was no deterioration in hemodynamics, it was thought that the source of the fever was not an infection. Urinary extravasation may occur due to renal access and displacement of the Amplatz tube during surgery. After the removal of the nephrostomy, urinoma may occur due to urine extravasation and collection from the percutaneous tract to the retroperitoneal space. In our study, urinary extravasations were followed conservatively and no additional surgical intervention was required. Clavien Grade 2 complications occurred in a total of 17 patients, including bleeding requiring transfusion in 7 (6.8%) patients, urinary tract infection that responded to broad-spectrum antibiotics and did not develop sepsis in 4 (3.9%) patients, and urinary discharge that occurred following the removal of the nephrostomy and usually lasted for less than 12 hours in 6 (5.8%) patients. Another common complication is hemorrhage. Although hemorrhage constitutes a serious problem for the hemodynamics of the perioperative patient, it may also lead to early termination of the operation by preventing the image during surgery. Blood transfusion are related to the stone surface area of the patient, the operation time, the number of entries and the Amplatz diameter, and the incidence varies between 0.4-24% in the literature [6, 14]. Although it is performed by evaluating with routine bleeding parameters, there are case reports or series with a small number of patients showing that PCNL can be performed in rare bleeding disorders such as coagulation factor deficiencies or von Willebrand disease [15]. Patients with bleeding disorders should only be operated in hospitals where a multidisciplinary team, including a surgeon and an experienced hematologist, exists [15]. We also did not operate the patients with bleeding disorders in the second stage state hospital due to the absence of a hematologist and it was not possible to obtain coagulation factors when necessary. We referred these patients to the university hospital. Fresh blood from the nephrostomy and/or urethral catheter, pulsatile bleeding, enlarging retroperitoneal hematoma that occurs with hemodynamic deterioration should bring to mind serious vascular complications such as AV fistula and pseudoaneurysm. In the studies, AV fistula or pseudoaneurysm was observed to be less than 0.5% during PCNL [16]. No serious vascular complication was observed in our study.

Clavien Grade 3 complication requiring ureteroscopy (URS) and DJ catheter placement occurred due to prolonged urinary discharge from the nephrostomy tract in two (1.9%) patients, and the stones falling into the ureter in 2 (1.9%) patients. While urine coming from the nephrostomy tract is generally a condition that can be followed conservatively, its prolongation should bring to mind the reasons that may lead to ureteral obstruction. No Clavien grade 4 or higher complications were observed in our study.

It is reported that the average length of hospital stay after PCNL varies between 3 and 11.4 days [17]. In some kidney stones, daily and ambulatory PNL can also be performed in selected cases [18, 19]. In our study, the length of stay of the patients was 2.7 (1-11). We see that this period is prolonged in patients with high stone surface area, long surgical time, or unwanted side-effects and requiring additional treatment.

In our study, we revealed the results of PCNL in 102 renal units performed by a single physician after urology residency. Based on these study data, we think that PCNL can be applied safely and effectively in 2nd stage state hospitals with acceptable complications and success rates in line by the literature. However, we think that the controlled randomized prospective studies should be conducted in second stage state hospitals with a larger number of patients in order to reveal the results more clearly.

**Conflict of interest:** The authors declare that there is no conflict of interest.

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**Ethics committee approval:** This study was initiated by obtaining the permission of Kutahya Health Science University Ethics Committee dated 18.02.2021 and numbered 2020/03-11.

**Contributions of the authors to the article**

M.S. set up the main idea and hypothesis of the study. O.A., M.S. and B.A. developed the theory and edited the material method section. M.S., O.A., I.G.K. made the evaluation of the data in the results section. The discussion part of the article was written by M.S., O.A., B.A., I.G.K. have reviewed and made the necessary corrections and approved. In addition, all authors discussed the entire study and approved its final version.