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# Comparison of outcomes of percutaneous nephrolithotomy on patients with normal and malformed kidneys

**Aim:** To compare outcomes (stone-free rates, complications) of percutaneous nephrolithotomy (PCNL) in patients with kidney malformations and normal subjects having similar stone characteristics(surface area, configuration).

**Materials and Methods:** Data of 170 patients who underwent PCNL were analyzed. Stone burden was 100-1564 mm2, stone configuration was pure pelvic, pure caliceal or complex (pelvic + caliceal) in Group 1 with renal anomalies (n = 18, 19 renal units, 20 sessions). Patients with similar stone characteristics without any renal anomaly comprised Group 2 (n = 152, 158 renal units, 161 sessions). Groups were compared regarding therapy success, outcomes, and complications. Stones ≤ 4 mm were considered as clinically insignificant.

**Results:** Group 1 comprised: 9 horseshoe kidneys, 1 pelvic kidney, 1 ptotic kidney, 1 polycystic kidney, 3 duplex renal system, 2 malrotated kidneys, and 2 with a prior history of open partial nephrectomy. No significant differences were detected in terms of stone-free rates, clinical insignificant residual stone rates, residual stone rates, mean operation times, fluoroscopy times, and complications between the 2 groups ($P > 0.05$). Although no significant differences were detected regarding pure caliceal and complex stones concerning above parameters between the 2 groups, lower stone-free and higher residual stone rates were detected in Group 1 having pure pelvic stones compared to normal subjects ($P = 0.028$).

**Conclusions:** PCNL is a safe and effective procedure in patients with kidney malformations. Patients with anomalous kidneys bearing pure pelvic stones might have lower stone-free and higher residual stone rates compared to normal subjects after PCNL in this preliminary study.

**Key words:** Complications, kidney malformations, outcomes, percutaneous nephrolithotomy, success rate

## Normal böbreği ve böbrek malformasyonu olan olgularda perkutan nefrolitotomi sonuçlarının karşılaştırılması

**Amaç:** Normal böbreği ve böbrek malformasyonu olup, benzer taş özellikleri (taş yüzey alanı, konfigürasyon) olan ve perkutan nefrolitotomi (PCNL) yapılan olgularda sonuçların (taşsızlık oranı,komplikasyon) karşılaştırılması.

**Yöntem ve Gereç:** PCNL yaptığımız 170 olgunun verileri değerlendirildi. Renal anomalileri olan Grup 1'de (n = 18, 19 renal ünite, 20 seans) taş yükü 100-1564 mm2, taş konfigürasyonu yalnızca pelvik, yalnızca kaliksial ya da kompleks (pelvik + kaliksial) idi. Grup 2'de benzer taş özelliklerine sahip ve renal anomalisi olmayan olgular vardı (n = 152, 158 renal ünite, 161 seans). Gruplar PCNL başarısı ve komplikasyonlar açısından karşılaştırıldı. Boyutu ≤4 mm olan taşlar klinik olarak anlamı olmayan taşlar olarak kabul edildi.

**Bulgular:** Grup 1'de 9 atnalı böbrek, 1 pelvik böbrek, 1 pitotik böbrek, 1 polikistik böbrek, 3 dubleks renal sistemi olan böbrek, 2 malrote böbrek ve 2 daha önce parsiyel nefrektomi yapılmış böbrek bulunmaktaydı. Gruplar arasında taşsızlık oranları, klinik olarak anlamsız taş kalma oranları, rezidüel taş kalma oranları, ortalama operasyon süreleri, floroskopi süreleri ve komplikasyon süreleri açısından fark saptanmadı ($P > 0.05$). İki grup arasında bu parametreler açısından yalnızca kaliksial ya da kompleks taşı olan olgular arasında fark saptanmasa da; yalnız pelvik taşı olan Grup 1'de, normal böbreği olan olgularla karşılaştırıldığında, daha az oranda taşsızlık ve daha yüksek oranda rezidüel taş kalma oranları elde edilmiştir ($P = 0.028$).

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**Sonuç:** Böbrek malformasyonu olan olgularda PCNL güvenle ve etkili olarak yapılabilir. Bu ön çalışmanın sonuçları, renal anomalisi olup birlikte yalnız pelvik taşı olan olgularda PCNL yapılmasının, normal böbreği olan olgularla karşılaştırıldığında, daha az oranda taşsızlık ve daha yüksek oranda rezidüel taş kalma oranları ile sonuçlanabileceğini göstermektedir.

**Anahtar sözcükler:** Komplikasyonlar, böbrek malformasyonları, sonuçlar, perkutan nefrolitotomi, başarı oranı

## Introduction

Urinary tract stones might be seen in anomalous kidneys and could lead to technical difficulties or complications during surgery for stones particularly if the endourologist is inexperienced (1-6). Shock wave lithotripsy (SWL), ureteroscopy (URS), and percutaneous nephrolithotomy (PCNL) are the treatment modalities currently being used in these patients.

Although publications exist regarding the use of PCNL in the treatment of stone disease in patients with kidney malformations, studies comparing outcomes of PCNL in patients with kidney malformations and normal subjects are very limited in the literature. We therefore examined our data to compare these 2 groups with similar stone characteristics (surface area and configuration) in terms of outcomes (stone-free rates and complications).

## Materials and methods

Between September 2004 and January 2008, 257 sessions of PCNL procedures were performed in 253 renal units (244 patients) at our institution. Between March 2006 and January 2008, 18 consecutive patients with renal anomalies with a mean age of 45.6 ± 16.6 (range, 14-73) underwent overall 20 sessions of PCNL for kidney stone disease in our department (Table 1) (Group 1). The mean stone size was 449 $mm^2$ (range, 100-1564) in this group. In order to compare the outcomes and complications of PCNL in patients with kidney malformations and normal subjects, we included patients with normal kidneys who underwent PCNL with similar stone characteristics (surface area and configuration) and patient characteristics in Group 1. Patients older than 14 years of age having stone surface areas between 100-1564 $mm^2$ who had undergone PCNL after March 2006 were selected as control group (n = 152) (Group 2). Overall, 161 sessions of PCNL were performed in 157 renal units in Group 2 (Table 1).

PCNL procedures were performed in a standard 1-session technique under fluoroscopy in all patients. Residual stone fragments were evaluated after the PCNL procedures with intraoperative fluoroscopy, nephrostography, and postoperative abdominal x-ray. Stone burden was calculated as multiplying the stone length by width (in square millimeters) on preoperative kidneys-ureters-bladder (KUB) x-rays.

Patients' demographics and characteristics are summarized in Tables 1 and 2. Groups were compared regarding therapy success, outcomes, and complications. Stones ≤4 mm were considered as clinically insignificant. Student's t test was used in order to compare mean operation times (min). Chi-square and Fisher's exact tests were used in order to compare stone-free rates, clinical insignificant residual stone rates, and residual stone rates. Fisher's exact test was used in order to compare the complications between the 2 groups. $P < 0.05$ was considered statistically significant.

## Results

Group 1 comprised patients with renal anomalies (Table 2). Comparison of outcomes and complications of PCNL in patients with kidney malformations and normal kidneys are summarized in Tables 3 and 4. In Group 1, 70% success rate was achieved when success rate was calculated according to number of sessions performed after inclusion of both stone-free and

Table 1. Comparison of demographics, interventions, and stone configurations of patients with kidney malformations and normal kidneys who underwent PCNL (Complex stones: stones with pelvic + caliceal components).

| Age | Patients with kidney malformations 45.6 ±16.6 (range, 14-73) | Patients with normal kidneys 45.4 ±13.4 (range, 14-80) |
|---|---|---|
| Male / female | 14/4 | 94/58 |
| Right / left kidney | 8/11 | 78/83 |
| Number of patients | 18 | 152 |
| Stone burden ($mm^2$) | 449 (range, 100-1564) | 444 (range, 100-1500) |
| Number of renal units | 19 | 158 |
| Number of sessions | 20 | 161 |
| *1. Unilateral* | *16* | *144* |
| *2. Bilateral* | *1* | *5* |
| *3. Unilateral (2 sessions)* | *1* | *2* |
| *4. Bilateral (2 renal units, 3 sessions)* | - | *1* |
| Stone configuration (pure pelvic, pure caliceal and complex) | | |
| *Pure pelvic stones* | *3 (16.6%)* | *22 (13.9%)* |
| *Complex stones* | *5 (27.7%)* | *28 (17.7%)* |
| *Pure caliceal stones* | *11 (61.1%)* | *108 (68.4%)* |

Table 2. Distribution of patients with kidney malformations who underwent PCNL for kidney stones.

| Kidney malformation type | N |
|---|---|
| Horseshoe kidney[a] | 9 |
| Pelvic kidney | 1 |
| Pitotic kidney | 1 |
| Polycystic kidney | 1 |
| Kidney with duplex renal system | 3 |
| Malrotated kidney[b] | 2 |
| Kidney with past history of partial nephrectomy[c] | 2 |

[a]: One of the patients with horse-shoe kidneys had bilateral kidney stones.
[b]: One patient had severe kyphoscoliosis,
[c]: Previous partial nephrectomy was performed for renal cancer and for hydronephrosis, respectively in these patients.

clinically insignificant stone rates (out of 20 sessions, we had success in 14 sessions). However, when calculation was made according to the number of renal units, the success rate increased to 74% (out of 19 renal units, we had success in 14 renal units). Residual stones were detected in the following 5 patients with kidney malformations after PCNL: horseshoe kidney (n = 1), ptotic kidney (n = 1), malrotated kidney (n = 1), patient with a past history of partial nephrectomy (PN) due to renal cancer (n = 1), and patient with rotation anomaly of the kidney with concomitant kyphoscoliosis (n = 1). Among these patients, pure pelvic stone was present in patient with malrotated kidney and after 2 sessions of PCNL two 5 mm sized residual stones were detected in this patient.

In Group 2, 160 sessions of PCNL were performed in 157 renal units excluding the patient who had undergone open surgery for kidney stones. Overall, 84.4% success rate was achieved when calculated according to number of sessions performed after inclusion of both stone-free and clinically insignificant stone rates (out of 160 sessions, we had success in 135 sessions). However, when calculation was made according to the number of renal units, the success rate increased to 86% (out of 157 renal units, we had success in 135 renal units).

Table 3. Comparison of outcomes and complications of PCNL in patients with kidney malformations and normal kidneys.

| | Patients with kidney malformations | Patients with normal kidneys | P |
|---|---|---|---|
| Number of procedures | n = 20 | n =161[a] | |
| Stone-free rate | 11 (55%) | 114 (71.3%) | 0.24 |
| Clinical insignificant residual stone rate | 3 (15%) | 21 (13.1%) | |
| Residual stone rate | 6 (30%) | 25 (15.6%) | |
| Mean operation time (min) | 103 ± 44.8 | 96.9 ± 41.2 | 0.54 |
| Mean fluoroscopy time (min) | 4.3 ± 2.8 | 4.2 ± 2.9 | 0.80 |
| Common Complications | | | |
| 1. Prolonged drainage (>48 h) | - | 6 (3.8%) | 1.0 |
| 2. Blood transfusion | 2 (10%) | 26 (16.1%) | 0.74 |
| 3. Fever (>38 °C) | 5 (25%) | 38 (23.6%) | 1.0 |
| Rare Complications | 1 (5%) | 12 (7.5%) | 1.0 |
| 1. Creatinine elevation | 1[b] | 2[c] | |
| 2. Conversion to open surgery due to massive bleeding | - | 1 | |
| 3. Postoperative bleeding controlled by embolisation | - | 1 | |
| 4. Abortion of operation due to bleeding | - | 1 | |
| 5. Fluid extravasation into peritoneum managed by drain insertion | - | 1 | |
| 6. Stone migration into ureter | - | 2[d] | |
| 7. Massive postoperative scrotal edema managed by conservative treatment or drainage | - | 2 | |
| 8. Abortion of operation due inability to access to the stones | - | 1 | |
| 9. Acute myocardial infarction | - | 1 | |

[a]: One patient required open surgery which was not included in the analysis of stone-free rate;
[b]: Patient with polycystic kidney whom responded to medical therapy;
[c]: One patient had solitary kidney and underwent hemodialysis; [d]: Stones were removed by URS.

Table 4. Comparison of outcomes of PCNL in patients with kidney malformations and normal kidneys in terms of stone configurations (One patient required open surgery and was not included in the stone free analysis. This table was organized according to the number of sessions performed).

| | Patients with kidney malformations | Patients with normal kidneys | P |
|---|---|---|---|
| **Pure pelvic (n)** | 4 | 22 | |
| Stone-free rate | 1 (25%) | 19 (86.4%) | 0.028 |
| Clinical insignificant residual stone rate | - | - | |
| Residual stone rate | 3 (75%) | 3 (13.6%) | |
| **Complex stone (n)** | 5 | 27 | |
| Stone-free rate | 3 (60.0%) | 20 (70.1%) | 0.796 |
| Clinical insignificant residual stone rate | 1 (20.0%) | 3 (11.1%) | |
| Residual stone rate | 1 (20.0%) | 4 (14.8%) | |
| **Pure caliceal (n)** | 11 | 111 | |
| Stone-free rate | 7 (63.6%) | 75 (67.6%) | 0.966 |
| Clinical insignificant residual stone rate | 2 (18.2%) | 18 (16.2%) | |
| Residual stone rate | 2 (18.2%) | 18 (16.2%) | |

## Discussion

Horseshoe, ectopic, malrotated kidneys and duplex systems are the most commonly seen congenital renal abnormalities involving kidneys (5). Based on our results (Tables 1-3), PCNL seems to be a safe and effective procedure in patients with kidney malformations with similar outcomes and complications compared to normal kidneys having similar stone characteristics.

Although stone configuration might have an impact on the outcomes of PCNL in patients with kidney malformations (Table 4), the number of patients with kidney malformations having pure pelvic stones is very limited (n = 4). Therefore, we can not make a strict conclusion based on these findings and one should interpret these results cautiously, which is one of the limitations of our study (Table 4). Although the number of patients with kidney malformations are limited in our study, one explanation might be related with the presence of anatomical differences existing in kidneys with malformations that might lead to lower stone-free and higher residual stone rates in this group with pure pelvic stones. Because we do not have a flexible nephroscope in our department, we used a rigid nephroscope in our procedures, which might be another reason why we found lower stone-free and higher residual stone rates. Certainly, experience of the endourologist might have an important impact on the outcomes of the PCNL procedures performed.

Overall, 3 patients had pure pelvic stones with kidney malformations and they were a patient with a horseshoe kidney (stone-free after 1 session of PCNL), a patient with a past history of PN (underwent SWL after PCNL), and a patient with a malrotated kidney (underwent 2 sessions of PCNL). Of these patients, the patient with a horseshoe kidney was stone-free after PCNL; however, others had residual stones. Although it is not easy to draw a strict conclusion due to the limited number of patients in our series, presence of a pure pelvic stone particularly in patients with kidneys who had undergone PN due to tumor or patients with malrotated kidneys might have an increased risk of having residual stones after PCNL. Interestingly, patients with horseshoe, pelvic, or polycystic kidneys having pure pelvic stones do not seem to have increased risk for residual stones after PCNL. Therefore, endourologists should pay particular attention to these patients during PCNL and patients must be informed regarding the risk of having postoperative residual stones before the PCNL procedure.

In patients with anatomically normal kidneys, upper pole calyxes are above the $11^{th}$ and $12^{th}$ ribs therefore, entering the kidneys needs a supracostal approach which might lead to pneumothorax (7). On the other hand, horseshoe kidney is anatomically located in a lower level thus supracostal approach is not needed. The collecting system might be displaced anteriorly; the ureters may arise high from the renal pelvis and descend anterior to the isthmus (5). Most of the calices point dorso-medial or dorso-lateral directions and blood vessels were shown to enter the horseshoe kidneys from antero-medial surface excluding some minor vessels supplying the istmus in most cases (8).

Shokeir et al. reported a series of 34 patients with 45 stone bearing horseshoe kidneys having a mean stone burden of 664 $mm^2$ (range, 264-2408) which they performed PCNL using a rigid nephroscope. Major complications were reported in 6 procedures (13.3%) including significant hematuria requiring blood transfusion in 3, septicemia in 1, ureteral obstruction in 1, and colonic injury in 1 patient. The stone-free rate was 82% at discharge including auxiliary procedures, such as ureteroscopy, second-look PCNL, and SWL (9). In our series, we performed PCNL in 8 patients (overall 9 renal units, 1 patient had bilateral kidney stones). Mean patient age was 38.8 (range, 14-58) and mean stone burden was 405.1 $mm^2$ (range, 141-705). One patient had pure pelvic stone (11.1%), 3 had complex stones (33.3%), and 5 patients had pure caliceal stones (55.6%). Mean operation time was 93.3 min (range, 60-150). Mean fluoroscopy time was 2.9 min (range, 1-4.5). Only 2 patients (22.2%) had postoperative fever (<39 °C) which was managed by conservative treatment. No other complications occurred including need for blood transfusion in these patients. Stone-free rate was 66.7% (n = 6), clinically insignificant residual stone rate was 22.2% (n = 2), and residual stone rate was 11.1% (n = 1, patient with a complex stone). Therefore, 88.9% of the patients with stone bearing horseshoe kidneys who underwent PCNL had either postoperative stone-free

kidneys or kidneys with clinically insignificant residual stones at discharge. Renal access via an upper pole calyx seems to be safe due to inferior localization of the kidney and due to presence of sufficient distance from pleura in these patients (1,10).

Raj et al. reported 87% stone-free rate in 24 patients aged between 21-74 years with stone bearing horseshoe kidneys who underwent PCNL which they used flexible nephroscope in most of the cases (1). In their series, minor complications occurred in 4 patients (16.7%); however, major complications occurred in 3 patients (12.5%) including significant bleeding necessitating early cessation of the operation, nephropleural fistula, and pneumothorax.

Desai et al. performed PCNL in 9 patients with pelvic ectopic kidneys with complete stone clearance in all cases without any notable complications thus recommended the PCNL as a safe and effective minimally invasive procedure in patients with pelvic ectopic kidneys (11). Matlaga et al. reported their experience with laparoscopic-assisted PCNL in 6 patients with pelvic ectopic kidneys having a 100% postoperative stone-free rate without any complications (12). However, Gupta RC et al. reported complications, such as bowel injury, perinephric hematoma, and prolonged ileus (13). We performed PCNL in a patient with a right ectopic pelvic kidney having two 15 mm sized stones located in the pelvis and upper calyx who had a previous history of right nephrolithotomy, right inguinal hernia repair and appendectomy. We did not use laparoscopic assistance in our case and preferred a standard posterior approach in the prone position and directed the access needle to the upper pole of the kidney just above the iliac crest. The stones were removed successfully without any complications and without residual stones (14). Recently, laparoscopy gained great popularity among the urologists worldwide. Although we did not use laparoscopic assistance in our series, laparoscopy might be helpful in order to avoid bowel or vessel injuries and also in puncturing the kidney transperitoneally under direct vision particularly in patients with kidney malformations, such as pelvic ectopic kidneys (4).

Ng et al. reported PCNL in 2 patients with polycystic kidney disease with complete stone removal and without any complications (15). In our series, we performed PCNL in a 67 year old female patient with a complex left renal stone. Operation time was 40 min, fluoroscopy time was 1.5 min and the patient was stone-free after PCNL without any complications.

Although very limited literature exists regarding the procedure, PCNL after PN can also be performed successfully. In our series, we performed PCNL in 2 patients who previously underwent PN due to renal cancer and due to hydronephrosis, respectively. First patient was a 57 year-old male with a pure pelvic stone in the left kidney. Stone burden was 1564 $mm^2$, operation time was 115 min and fluoroscopy time was 10 min. Postoperative residual stones remained without any complications. Double-J stent was inserted and SWL was performed for the clearance of residual stones. Second patient was a 43 year-old male with a pure calyx stone in the left kidney. PCNL was performed without complications and with no residual stones postoperatively. Operation time was 80 min and fluoroscopy time was 6.5 min.

## Conclusions

PCNL seems to be a safe and effective minimally invasive procedure in patients with kidney malformations having stones. Performing PCNL in patients with stone-bearing anomalous kidneys seems to have similar outcomes and complications compared to normal subjects. However, stone configuration and particularly presence of a pure pelvic stone might affect the success rate and outcomes of the PCNL procedure, which needs to be investigated by further studies including greater number of patients.

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