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Percutaneous Nephrolithotomy in Horseshoe Kidney: Our First Experience

At Nalı Böbrekte Perkütan Nefrolitotomi: İlk Deneyimimiz

Ercan Baş, Muammer Altok, Mehmet Umul, Mustafa Güneş

Süleyman Demirel University Faculty of Medicine, Department of Urology, Isparta, Turkey

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

The safety and success of percutaneous nephrolithotomy (PCNL) was investigated in patients with kidney stones in horseshoe kidney. PCNL in horseshoe kidney is as safe and successful as in normal kidney.

ABSTRACT

Objective

To share our experience in percutaneous nephrolithotomy (PCNL) procedures in patients with horseshoe kidney.

Materials and Methods

The data of 7 patients undergoing PCNL were analyzed retrospectively. Preoperative clinical and laboratory data of patients (including complete urinalysis, complete blood count, serum biochemistry, and coagulation tests) were recorded. The stone surface area (mm^2) was calculated by graph paper tracing of two dimensional projection of the stone on a plain film of the kidneys, ureters and bladder (KUB) in the anteroposterior view by investigators. In addition, per-operative and post-operative findings were evaluated. Success and complication rates (according to the classification of Clavien) were also determined.

Results

The mean stone surface area was 1234 (range 250-2460 mm^2) mm^2. Six patients were treated through a single tract, and one patient required additional access. Access was directed to the middle calyx (n=2), superior calyx (n=4), middle and inferior calyx (n=1) through the supracostal (n=2) and subcostal (n=5) areas. Mean operative time was 131 (range 70-215 minutes) minutes. Stone-free rate after single session PCNL was 71% (n=5) and increased to 86% (n=6) with a post-operative secondary ureterorenoscopy procedure. Complications including bleeding necessitating blood transfusion (Clavien grade 2) and prolonged drainage (Clavien degree 3a) were occurred in only 2 patients (24%).

Conclusion

PCNL is a safe and successful procedure in patients with horseshoe kidney and comparable with PNL procedures in patients with normal renal anatomy.

Key Words

Horseshoe, kidney, nephrolithotomy, percutaneous, stone

ÖZET

Amaç

At nalı böbrek olgularında perkütan nefrolitotomi (PNL) tecrübelerimizi paylaşmak.

Gereç ve Yöntem

PNL operasyonu uygulanmış at nalı böbrekli 7 hastanın verileri retrospektif olarak analiz edildi. Hastaların preoperatif klinik ve laboratuvar verileri (tam idrar analizi, tam kan sayımı, serum biyokimyası ve koagülasyon testleri) kaydedildi. Taş boyutu (mm^2), taşın direkt üriner sistem grafisi üzerine yerleştirilen milimetrik grafik kağıdındaki iz düşümü ile elde edilen boyutlar ile hesaplandı. Ayrıca per-operatif ve post-operatif bulguları değerlendirildi. Başarı ve komplikasyon oranları (Clavien sınıflamasına göre) belirlendi.

Bulgular

Ortalama taş yükü 1234 (dağılım 250-2460 mm^2) mm^2 idi. Altı hastaya tek giriş yapılarken sadece bir hastaya ilave girişe ihtiyaç duyuldu. İki hastaya orta kaliks (n=2), dört hastaya üst kaliks (n=4), bir hastaya orta ve üst kaliks (n=1) girişi yapıldı. İki hastaya suprakostal (n=2), beş hastaya subkostal (n=5) giriş uygulandı. Ortalama operasyon süresi 131 (dağılım 70-215 dakika) dakikaydı. Tek seans PNL sonrası taşsızlık oranı %71 (n=5) idi, fakat üreterde rezidü taş fragmanı saptanan bir hastaya pos-operatif üreterorenoskopi uygulanarak bu oran %86 (n=6) ya yükseldi. Transfüzyon gerektiren kanama (Clavien derece 2) ve uzamış drenaj (Clavien derece 3a) olmak üzere iki hastada komplikasyon gelişti (%24).

Sonuç

At nalı böbrek anomalisi olan hastalarda PNL, normal anatomiye sahip böbreklerle kıyaslanabilecek kadar güvenli ve başarılı bir tekniktir.

Anahtar Kelimeler

At nalı, böbrek, perkütan, nefrolitotomi, taş

Correspondence
Muammer Altok MD, Süleyman Demirel University Faculty of Medicine, Department of Urology, Isparta, Turkey
Phone: +90 246 211 92 66 **E-mail:** muammeraltok@sdu.edu.tr **Received:** 07.01.2015 **Accepted:** 06.02.2015

Introduction

The horseshoe kidney is seen in 1 of every 400 births and is the most common congenital renal fusion anomaly. The incidence is twice as high in males as it is in females (1). In this condition, stone formation is seen in about 21–60% of patients. Renal stones are the most common reason that patients require kidney surgery (2). Abdominal and flank pain (83%) are the most frequently reported symptoms in those who suffer from kidney stones (3). Percutaneous nephrolithotomy (PNL) is the most widely used method in horseshoe kidney patients who have failed other therapy and is the treatment of choice for stones larger than 20 mm (3,4,5). The success and complication rates of PNL in horeshoe kidney patients are within an acceptable range of those for PNL undertaken in kidneys with a normal anatomy (1, 3, 6, 7). In this study, we share our first experience with PNL in horseshoe kidneys.

Materials and Methods

Seven patients with horseshoe kidney with calculi were treated with PNL. Their presenting symptoms were hematuria along with recurrent urinary tract infections (14%), atypical abdominal pain (28%), and loin pain (58%). All patients were evaluated with a detailed medical history and physical examination, complete blood count, serum biochemistry, urinalysis, urine culture, and coagulation tests. Each patient underwent a comprehensive preoperative radiologic assessment, including plain abdominal radiography, urinary tract ultrasonography, and non-contrast computed tomography (CT). The stone sizes (mm^2) were calculated with dimensions obtained by geometric projections from millimetric graph paper placed directly on the urinary system radiography of the stones.

Surgical Technique

An open-ended 5-French (5-Fr) ureteral catheter (Marflow™, Marflow AG, Switzerland) was placed in the ureter and was guided by cystoscopy with the patient in the lithotomy position under general anesthesia. After placement, the patient was moved to a prone position. The anatomy of the pelvicalyceal system was visualized with opaque material that was instilled using a uretheral catheter under C-arm fluoroscopy. A 19.5-gauge percutaneous needle (Percutaneous Access Needle, Boston Scientific Corporation, MA, USA) was introduced into the renal collecting system. Fluoroscopy was used to place a guidewire (Zebra™ Nitinol Guidewire, Boston Scientific Corporation, MA, USA) in the collecting system for access. The tract was dilated up to 30-Fr with semi-rigid amplatz dilators (Boston Scientific Microvasive Amplatz Tractmaster™, Boston Scientific Corporation, MA, USA), and an Amplatz sheath was inserted into the collecting system. Stone disintegration was performed using a pneumatic lithotripter (Calculith™ Lithotripter, PCK, Turkey) through a 26-Fr rigid nephroscope (Karl Storz™ Endoscopy-America Inc.). If necessary, additional input was made, and the process was terminated by inserting a nephrostomy tube (open-ended hole 21-Fr soft drain) into the renal collecting system. Complications were graded according to the classification system used by Clavien (8). Postoperative residual stone fragments were evaluated at the end of the first month with non-contrast spiral abdominal computed tomography (CT) in asymptomatic patients.

Results

The average age of patients was 46 years (range: 32-59 years), and the female-to-male ratio was 1: 6. The stones were located on the left side in five patients and on the right side in two patients. Stones were localized simply in the pelvis in four patients, in the renal pelvis and upper calyx (partial-staghorn) in one patient, and in multiple locations (in the pelvis and lower calyx) in two patients. None of the patients had a history of previous ipsilateral open stone renal surgery or prior unsuccessful extracorporeal shock wave lithotripsy (ESWL) sessions. Only one patient had a history of ipsilateral PNL six years previously. The mean operative time was 131 (range: 70-215) minutes including the preparatory phase (assuming the lithotomy position, intubation, cystoscopy-guided ureteral catheter placement, transfer to the prone position, sterile painting, and surgical equipment preparation after draping the patient). The average stone surface area was 1234 (range: 250-2460) mm^2. Patients' peroperative and postoperative findings along with the clinical and demographic measures are listed in Table 1. Blood transfusion (Clavien grade 2) was required in 1 (14%) patient (with partial-staghorn calculi (2460 mm^2) and a dual access catheter) postoperatively. Bleeding during the post-operative period was controlled by clamping both nephrostomy tubes. Prolonged urinary leakage from the nephrostomy tract (>48 hours) and severe colic pain (Clavien grade 3) was observed in one patient (14%). The ureteral stone was extracted with a semirigid ureterorenoscopic intervention, and double J ureteral stent were placed. After the patient remained stone-free and the prolonged urinary leakage had been treated, the double J ureteral stent was removed three weeks later. None of the patients developed thoracic complications, neighboring organ injuries, or postoperative fever.

In all patients, the ureteral catheter was withdrawn immediately after surgery and is taken urethral foley catheter on the first postoperative day. The mean amount of time that nephrostomy tubes remained in place was 3.14 (range: 2-5) days. The mean hospitalization time was 4.14 days (range: 2-8). All patients who were asymptomatic postoperatively were evaluated with noncontrast CT during the first month after surgery, but one symptomatic patient was assessed on postoperative day 4. Any stones smaller than 4 mm were considered clinically insignificant residual stones upon noncontrast CT.

Our success rate was 5/7 (71%) after one session of PNL. These five patients exhibited no clinically significant or insignificant residual stones upon abdominal CT. Residual stones were detected in only two patients. One of these patients became completely stone-free when treated with ureteroscopy (URS). Thus, our success rate increased to 6/7 (86%). The remaining patient who had a residual kidney stone 12 mm in diameter received SWL. The patient also not have success with SWL was periodically controlled. The patient had no complaints or adverse clinical or laboratory findings at the one-year follow-up visit.

Discussion

The treatment methods for calculi in horseshoe kidneys ranges from minimally invasive surgery to open surgery. Although PNL is the most commonly used technique, SWL, URS, and laparoscopy are other minimally invasive treatment methods employed for calculi

Table 1. Preoperative and postoperative findings, clinical and demographics parameters of the patients

	1. Patient	2. Patient	3. Patient	4. Patient	5. Patient	6. Patient	7. Patient
Age (years)	32	55	59	41	43	35	47
Sex	Male	Female	Male	Male	Male	Male	Male
Stone location	Left pelvic& lower calyx	Left partial staghorn	Left pelvic	Right pelvic	Left pelvic	Left pelvic	Right pelvic & lower calyx
Access location	Subcostal upper calyx	Supracostal upper calyx subcostal middle calyx	Subcostal upper kaliks	Subcostal upper kaliks	Subcostal middle calyx	Subcostal middle calyx	Supracostal upper calyx
Stone surface area (mm2)	1780	2460	250	1560	1150	560	880
Operative time (min)	145	215	70	175	120	95	110
Complication	No	Bleeding	No	Urine leakage	No	No	No
Clavien Grade	0	2	0	3a	0	0	0
Blood Transfusion	–	2 U ES	–	–	–	–	–
NT removal time (days)	4	5	2	3	3	2	3
Hospitalization time (days)	4	6	2	8	3	3	3

ES: Erythrocyte suspension, min: minute, NT: Nephrostomy Tube

in horsehoe kidneys (5). Since 1980, PNL has become the standard treatment for kidney stones after other treatment methods, such as SWL, have failed, particularly for large (>2 cm) and complex stones in horseshoe kidney patients (3,4,5). The stone-free rate (SFR) of SWL for the treatment of small stones (<2 cm) in the horseshoe kidney as reported in the literature ranges from 50-79% (9,10). Yohannes et al. found that SWL produced the best results in the treatment of small renal calculi (<2 cm) in the horseshoe kidney, patients who have failed ESWL therapy and is the treatment of choice for stones larger than 20 mm (2).

The residual stone rate is higher in ESWL and ureterorenoscopy than it is for PNL (2). The ESWL procedure is frequently unsuccessful for large stones in the horseshoe kidney. Furthermore, there is a need for more shock waves due to the abnormal renal anatomy and location in these patients. Therefore, PNL has become the ideal treatment technique to produce successful results in PNL (4). Flexible ureterorenoscopy in patients with horseshoe kidney is a good alternative treatment method when problems arise with ESWL or PNL (11). In several recent studies with a small number of patients, those treated with RIRS (Retrograde Intrarenal Surgery) stones in the horseshoe kidney have reported success rates ranging from 85-90% in selected cases (single lithiasis or lithiasis in only two locations and of a size <30 mm), and RIRS has been proposed as an alternative to PNL (12,13).

Complication rates were reported in the literature to range from 0-16.7% in PNL in patients with horseshoe kidney (5,14,15). These patients did not specifically carry an increased risk of bleeding during PNL because of the anteriomedial localization of their vascular structures and the kidney orientation to the posterior of the calyx (5). In the literature, blood transfusions were necessary for 0–13.3% of the patients (5,7). In the present study, only one patient (14%) required a blood transfusion (Clavien grade 2). In our study, prolonged urinary leakage from the nephrostomy tract (Clavien grade 3a) was observed in only one patient, and both complications 2/7 (28%) were associated with a relatively small number of patients.

In patients with normal renal anatomy, upper pole percutaneous access is frequently gained above the 12th rib, which may cause intrathoracic complications. Upper pole percutaneous access is often essential in horseshoe kidney patients and is relatively safe due to the inferior displacement of the kidneys away from the pleura. Raj et al. reported that in patients with a horseshoe kidney, the pneumothorax rate when establishing upper pole access was 6% (1). Supracostal percutaneous access to a horseshoe kidney is less frequenly applied compared to a normal kidney. In our study, supracostal access occurred in 28% of participants. In the literature, this rate varied from 22-42% (3,5,16).

The risk of retrorenal colon is higher in these patients due to the more anterior localization of the horseshoe kidney. Some authors have stated that CT is the recommended imaging modality before PNL because it can aid in planning the proper access route to avoid complications in horseshoe kidney patients (16,17). If available, three-dimensional abdominal CT can provide even more information (17). All patients in our study underwent non-contrast abdominal CT both preoperatively and during the first month after surgery. We did not observe retrorenal colon in any of our patients, but because the

Journal of Urological Surgery
2015;1: 17-21

posterolateral column is more pronounced in patients with horseshoe kidney, we established percutaneous access from a truly medial position as a precaution. In addition, the pulmonary injury rates in the intercostal percutaneous area are lower in horseshoe kidney patients due to the more caudal placement of their organs compared to a normal kidney (1,16). In our study, none of the patients developed thoracic complications.

Gross et al. established percutaneous access under direct visualization with laparoscopic guidance and reported that this method was effective for avoiding injury of the vessels, bowel, and surrounding tissue (18). The upper pole access tract was recommended, as it allows the physician to reach all calices, the pelvis, and the proximal ureter. Our study created access in the lower calyx, but access can also be established via the upper and middle calyx, which can be used to access the lower calyx. In patients with a difficult-to-reach lower calyx, a sheath was advanced toward the kidney, and the stones were removed using light to moderate manipulation of the nephroscope. Therefore, stones unreachable using a standard nephroscope may require a longer nephroscope (sheath length: 23 cm) or a flexible nephroscope to ensure complete access to the entire length. In our study, two patients who were obese (BMI: 33.6 and 35.7) had a stone in the renal pelvis that could not be reached because the sheath length was too short. In these patients, the sheath was pushed about 2 cm from the skin toward the inside of the intracorporeal and the stones were successfully removed.

Urinary drainage in horseshoe kidney patients is problematic due to the anatomical structure of the lower pole of the kidney. Thus, spontaneous excretion of stones is less likely than it is in normal kidneys (11,19). In a study by Demirkesen et al., 68 renal units in 52 patients who had congenital upper urinary tract abnormalities were treated with ESWL (20). In 25 renal units with clinically insignificant residual fragments after ESWL, recurrence, regrowth, and retreatment rates in the abnormal renal unit were 50%, 37%, and 34%, respectively.

The term "clinically insignificant residual fragments" is controversial because these fragments have the potential to cause ureteral obstruction and are important risk factors for stone growth and recurrence (3,21). In the congenitally anomalous kidney, an outcome with "clinically insignificant fragments" should not be considered a success. Thus, complete removal of the stones from the kidney is generally required to call the procedure a success (3). In addition, stone analysis is recommended to investigate the etiology and to identify the best medical treatment available for inpatients with horseshoe kidney as well as to prevent stone recurrence (22).

In the literature, ultimately stone-free rates following PNL in the horseshoe kidney were reported to be within the range of %72-91% (5,6,14). In our present series, the final stone-free rate was 6/7 (86%). The success rate of our present series was comparable to those of previous studies. Tepeler et al. investigated the success and complication rates of PNL in horseshoe kidney patients and reported the incidence to be 91% and 17%, respectively. Complications are less affected by abnormal anatomy and demographic and operative parameters, while stone complexity and multiplicity have been reported to play an important role in achieving stone-free status (5). Ozden et al. conducted a comprehensive study and concluded that despite the presence of anatomic abnormalities, PNL is a safe and effective treatment modality for calculi both in horseshoe and normal kidneys with similar success and complication rates (3). The main limitations of our study were its retrospective design and small sample size. However, our findings for PNL in horseshoe kidneys confirmed the results of previous studies.

Conclusions

PNL is difficult to carry out in the renal unit in patients with horseshoe kidneys. The success and complication rates of PNL are similiar both in patients with horseshoe kidneys and normal kidneys. Therefore, consistent with the literatüre, PNL is a method that can be safely applied, and its success has been demonstrated in our study in a limited number of patients.

Conflict of interest

There are no conflicts of interest.

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