Efficacy of a percutaneous antegrade approach for the treatment of large upper ureteral stones: single-center experience

Büyük üst üreter taşlarının tedavisinde antegrad perkütan yaklaşımın etkinliği: Tek merkezin deneyimi

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Abstract

Objective: To evaluate the safety and efficacy of antegrade percutaneous nephrolithotomy (PCNL) in patients with upper ureteral calculi ≥1.5 cm.

Materials and methods: From November 2006 to May 2009, 44 consecutive patients with upper ureteral stones who were treated in our center were evaluated. In all cases, stones were located in the ureteropelvic junction (UPJ) or in 5 cm of proximal ureter and had greatest diameter ≥1.5 cm. Ultrasonography (USG) and intravenous urography (IVU) were performed in all patients before surgery. After the operation, radiography, USG, and IVU were conducted. The stone-free rate, mean operative and fluoroscopy time, complications, and hospital stay were assessed.

Results: Mean patient age was 41.2 years, and mean stone size was 2.3 cm (range 1.5-3.0 cm). The stone-free rate was 81.8% at the end of the procedure. When 4 patients with clinically insignificant residual fragments <4 mm were considered, the success rate reached to 90.9%. Open surgery was performed in 2 (4.4%) patients. One (2.2%) patient underwent shock wave lithotripsy, and one (2.2%) patient was treated with ureterorenoscopy postoperatively for residual stones. A double-J stent was intraoperatively inserted into 6 (9.5%) patients because of small mucosal perforations in the pelvicaliceal system and presence of residual stones. The mean operating time, fluoroscopy time, and hospital stay were 47 min, 2.4 min, and 2.8 days, respectively.

Conclusion: PCNL is a safe and effective option for upper ureteral calculi larger than 1.5 cm, providing a high stone-free rate.

Key words: Calculi; percutaneous nephrolithotomy; upper ureter.

Özet

Amaç: Büyük üreter taşlarının (≥1.5 cm) tedavisinde antegrad perkütan yaklaşımın (PCNL) etkinlik ve güvenliliğini değerlendirmek.

Gereç ve yöntem: Bu çalışmada Kasım 2006-Mayıs 2009 tarihleri arasında üst üreter taşı nedeniyle kliniğimizde tedavi edilen 44 hasta değerlendirildi. Tüm hastalarda taşlar üreteropelvik bileşkede (UPB) veya proksimal üreterin 5 cm'lik bölümünde olup, taş boyutu 1.5 cm'den büyüktü. Girişimden önce tüm hastalar üriner ultrasonografi (USG) ve intravenöz piyelografi (IVP) ile değerlendirildi. Operasyon sonrası direk üriner sistem grafisi, USG ve IVP yapıldı. Taşsızlık oranı, ortalama operasyon ve floroskopi zamanı, komplikasyonlar ve hastanede kalış zamanı değerlendirildi.

Bulgular: Ortalama hasta yaşı 41.2 ve ortalama taş boyutu 2.3 cm (dağılım 1.5-3.0 cm) idi. Girişim sonunda taşsızlık oranı %81.8 olup, 4 mm'den küçük klinik önemsiz rezidü taşları olan 4 hasta göz önüne alındığında toplam taşsızlık oranı %90.9'a ulaşmıştır. İki (%4.4) hastada açık cerrahi girişime geçilmiş, rezidü taşları olan 1 (%2.2) hasta şok dalga litotripsi, 1 (%2.2) hasta ise üreterorenoskopi ile tedavi edilmiştir. Altı (%9.5) hastaya toplayıcı sistemdeki küçük mukozal perforasyonlar ya da rezidü taş nedeniyle double-J stent yerleştirilmiştir. Ortalama ameliyat süresi 47 dakika, floroskopi zamanı 2.4 dakika ve hastanede kalış zamanı 2.8 gün olarak bulunmuştur.

Sonuç: PCNL, 1.5 cm'den büyük üst üreter taşlarının tedavisinde yüksek taşsızlık oranları sağlayan etkin ve güvenli bir yöntemdir.

Anahtar sözcükler: Perkütan nefrolitotomi; taş; üst üreter.

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The aim of surgical treatment for ureteral calculi is to achieve complete clearance with minimal morbidity. The preferred method of treatment for large upper ureteral calculi continues to be debated. Open surgery and blind basketing are methods that are rarely used currently. Instead, extracorporeal shockwave lithotripsy (ESWL)[1] and rigid and flexible ureteroscopy[2] have greatly improved the urologist's ability to treat ureteral calculi. However, the success rate of ESWL for upper ureteral calculi larger than 1.5 cm size is reported to be low.[3] The availability of smaller ureteroscopes and the development of intracorporeal lithotriptors such as the holmium:YAG laser are the most important technical advances improving the efficacy of ureteroscopic lithotripsy.[2] However, large calculi are mainly located in the upper ureter and result in significant hydronephrosis, a condition characterized by tortuous and unusual angulations of the ureter, and inflammatory and edematous mucosa often accompanies the calculi. Consequently, calculi are difficult to approach using retrograde ureterorenoscopy.[4] Occasionally, open surgery,[5] laparoscopic ureterolithotomy,[6] or antegrade percutaneous nephrolithotomy (PCNL)[7-9] can be used in patients with large ureteral calculi.

Although using PCNL to treat large calculi in the upper urinary tract is not a completely new concept, few studies have investigated this procedure.[7-9]

In this study, we evaluated the efficacy and safety of percutaneous antegrade treatment for upper ureteral calculi larger than 1.5 cm and compared our results with other treatment modalities in the literature.

Materials and methods

From November 2006 to May 2009, 44 consecutive patients with urinary stones of the upper ureter were included in the study. In all cases, the stones were located in the ureteropelvic junction (UPJ) or at 5 cm length of the proximal ureter. PCNL was not performed to remove the stones located more distally. We enrolled only patients with stones that had a greatest diameter ≥1.5 cm. Of the 44 patients, 10 had stones that could not be effectively fragmented by ESWL previously, and 10 patients also had renal stones. Patients with only one kidney or azotemia, significant obstruction of the urinary tract, and non-opaque stones were excluded from the study. Informed consent was obtained prior to surgery.

The operative evaluation included a medical history, clinical examination, routine laboratory tests (serum creatinine, complete blood count, coagulation profile, and liver function), urinalysis, and urine culture. Urinary tract infections that were detected preoperatively were managed vigorously while considering antibiotic sensitivity, and the procedures were postponed until the urine became sterile. Radiologic investigations included ultrasonography (USG) and intravenous urography (IVU). A computed tomography (CT) scan was performed if necessary. If the contrast medium could not pass through the stone to the distal ureter on the IVU, this was taken as evidence of impaction (Fig. 1). Impacted upper ureteral stones were detected in 24 patients. Stone size was determined by measuring the largest diameter of the stone on preoperative plain film.

PCNL was performed with the patients under general anesthesia. One dose of a first-generation cephalosporin was administered during the anesthesia induction. At the beginning of the procedure, a 5F ureteral access catheter was inserted into the ureter in the lithotomy position.

The distal end of a 5F ureteral access catheter was fixed to a 18F Foley bladder catheter. The patient was then turned prone.

Standard techniques were used for the puncture and placement of the tract. The pelvicaliceal system was opacified by the injection of contrast through the ureteral catheter, and an 18-gauge access needle was then inserted under fluoroscopic guidance. When the needle was safely positioned in the collecting system, a 0.038-inch guidewire was inserted through

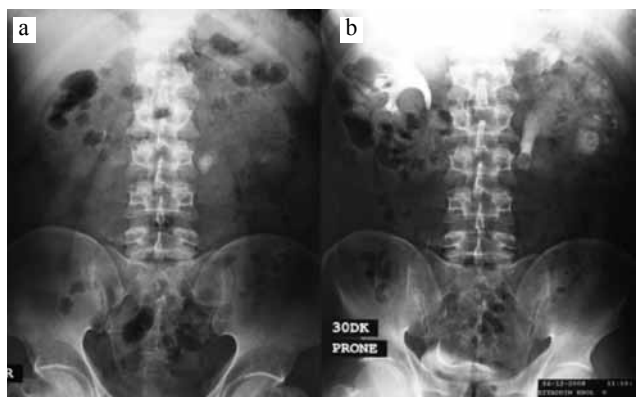

Figure 1 (a, b) Complete ureteral obstruction due to an impacted ureteral stone and hydronephrosis.

the needle into the collecting system. After making a small skin incision, the needle was removed. The nephrostomy tract was dilated to 28F with Amplatz or telescopic dilators, and an Amplatz sheath (28F) was placed. The dilatation procedure was performed under fluoroscopic guidance, and isotonic saline was used for irrigation and visualization. A 22F and 26F semirigid nephroscope (Olympus, Tokyo, Japan) was used for the nephroscopy. Because a holmium:YAG laser lithotriptor was not available at our institution during the study period, an ultrasonic and/or pneumatic lithotriptor (EMS, Swiss Lithoclast Master, Switzerland) was used for stone fragmentation in all cases. In 18 patients, the stones were taken back to the renal pelvis from the UPJ with a basket catheter, and stone fragmentation was then performed. However, in 26 patients, stone fragmentation was performed in the ureter. Small stone fragments were removed by aspiration, and larger fragments were removed with stone forceps. Intermittent manual pumping of irrigation through the ureteral catheter was performed to facilitate fragment removal and prevent the stone fragments from dropping into the distal ureter. A 9.6F flexible nephroscope (Olympus, Tokyo, Japan) was used with 3F zero-tip nitinol retrieval baskets in some patients if the rigid nephroscope could not reach to the fragments that had migrated distally. At the end of the procedure, a 16F Foley catheter was left in place through the peel-away sheath, and a double-J stent was inserted antegrade into patients with small ureteral lesions. Furthermore, a 16F reentry malecot catheter was inserted into 12 patients who had severe edema in the UPJ and/or ureter. The operating time was calculated from insertion of the needle to placement of the nephrostomy tube.

A blind access procedure was performed in patients whose pelvicaliceal system was not imaged by injection of the contrast through the ureteral catheter due to impacted stones. In these patients, the lumbar notch area, which has been described by Bellman et al.[10] and Chien and Bellman,[11] was preferred over percutaneous access. An 18-gauge access needle was inserted into the lumbar notch at a 30-45° angle to the skin, pointed cephaled, and advanced under the 12th rib to a depth of approximately 4 to 5 cm. The obturator was then removed, and a 5-mL syringe was applied to the needle. After this, contrast was injected from the needle, the pelvicaliceal system became visible and the targeted calyx was punctured with another needle (Fig. 2).

Calculus clearance was assessed on postoperative day 1 with a plain film of the kidney, ureter, and bladder (KUB) region as well as USG. Complete clearance was defined as the absence of any fragments on the KUB film and USG. Patients who had residual fragments were referred for an ancillary procedure (e.g., ESWL or ureterorenoscopy).

Patients who had an upper caliceal access procedure underwent a chest film to detect any chest complications. A complete blood count was performed before and 24 hours after surgery to quantify the decrease in hemoglobin level. For postoperative analgesia, the patients were given intramuscular pethidine HCl (1 mg/kg) every 6 hours on request.

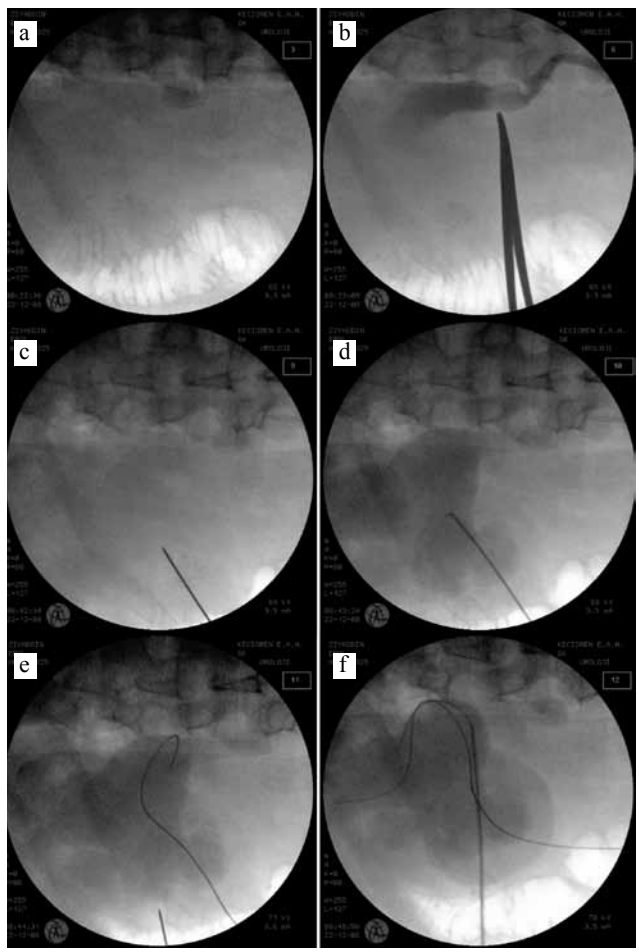

Figure 2 (a-f) Fluoroscopic imaging of the blind access to the pelvicalyceal system. After contrast was given from the needle, the pelvicaliceal system became visible, and the targeted calyx was punctured with another needle.

Mean hemoglobin decrease, operating time, fluoroscopy time, complications, and hospital stay were assessed. An IVU was performed 3 months after PCNL (Fig. 3). The mean follow-up duration was 12 months (range 3-30 months). All data were analyzed using standard statistical software.

Results

Basic characteristics of study patients were summarized in Table 1. The mean operating time was 47 min (range 35-70 min), and the mean fluoroscopy time was 2.4 min (range 1.6-5.5 min). The stone-free rate was 81.8% at the end of the procedure. When 4 patients with clinically insignificant residual fragments (CIRF) <4 mm are considered, the success rate becomes 90.9%.

Two patients (4.5%) required open ureterolithotomy because of a fixed angulation above the calculus that precluded the direct identification of the stone using an antegrade percutaneous approach. One patient (2.2%) underwent ESWL, and 1 patient (2.2%) was treated with ureteroscopic lithotripsy postoperatively for residual stones.

The pelvicaliceal system was entered through the middle calyx in 24 patients. An intercostal approach was performed in 12 patients for whom upper caliceal access was required. Blind access from the lumbar notch area was performed in 8 patients.

Small ureteral perforations resulting from the disintegration and retrieval of stone fragments occurred in 4 (9%) patients, all of which were stented successfully. In addition, a double-J stent was needed in 2 (4.5%) patients intraoperatively because of residual stones. No other significant intraoperative complications were encountered. One (2.2%) patient who underwent intercostal upper caliceal access had a pleural effusion and was treated conservatively. Urinary leakage from the nephrostomy tract continued for more than two days in 2 (4.5%) patients, and they were managed by insertion of a double-J stent insertion. The mean drop in hemoglobin was 0.8 g/dL (range 0.2-4.8 g/dL), and 2 (4.5%) patients required blood transfusion. Transient fever was observed in 5 (11.3%) patients, which resolved with conservative treatment. All of the patients with febrile episodes in the postoperative period had negative urine cultures.

Table 1. Patient, stone, and operative characteristics

	n	Mean±SD	Range
Age (years)		41.2±5.6	35-66
Female/male	15/29		
Stone side (left/right)	25/19		
Mean stone size (cm)		2.3±0.7	1.5-3.0
Hydronephrosis degree			
Grade 1	4		
Grade 2	25		
Grade 3	12		
Grade 4	3		
Operative time (min)		47.0±5.4	35-70
Mean fluoroscopy time (min)		2.4±0.8	1.6-5.5
Method of dilatation			
Amplatz	30		
Telescopic	14		
Access			
Middle calyx	24		
Upper calyx	12		
Blind	8		
Required double-J stent	6		
Stone-free rate	36/44 (81.8%)		
Secondary procedure requirement			
Open procedure	2		
ESWL	1		
Ureterorenoscopy	1		
Required double-J stent	2		
Hospitalization time (days)		2.8±0.8	1-4
Complications			
Pleural effusion	1		
Bleeding requiring transfusion	2		
Fever	5		
Urinary leakage >2 days	2		

ESWL: Extracorporeal shockwave lithotripsy.

The mean hospital stay was 2.8 days (range 1-4 days). Double-J stents were removed after 4 weeks in all patients. Thirty-nine patients were available for follow-up, and postoperative IVU revealed no clinically significant stricture in the upper ureter or UPJ.

Discussion

The surgical options for large proximal ureteral calculi include ESWL, ureteroscopy, PCNL, and rarely open or laparoscopic surgery.[1-6] There is still sig-

Figure 3 IVU imaging at three months after the operation.

nificant debate among urologists regarding the most appropriate management modality for upper ureteral stones. Extracorporeal lithotripsy is the primary approach for calculi <1 cm in the proximal ureter.[12] Although ESWL seems to be the least invasive option for small ureteral stones, its efficacy is debatable for large upper ureteral calculi.[13] The stone-free rate dramatically decreases when ESWL is used for stones larger than 1 cm.[12] Moreover, large stones that are almost impacted in the ureter are known to be less responsive to ESWL. Some studies have demonstrated that compared with ESWL, ureteroscopy may achieve more favorable results for upper ureteral calculi larger than 1 cm; consequently, some researchers have suggested this procedure as the first-line therapy for large proximal ureteral stones.[13-15] Whereas ESWL is less invasive and can be used in multiple sessions, the rapid and high success rate of ureteroscopy makes it a significant competitor for ESWL.[16,17] Park et al.[18] compared the results of ESWL and ureteroscopy and showed that the efficacy of ESWL dropped significantly for calculi >1 cm (83.6% vs. 42.1%), while the calculus-free rate with ureteroscopy did not depend on calculus size (88.9% vs. 86.6%).

Retrograde ureteroscopic lithotripsy has some difficulties in treating large proximal ureteral calculi.[4] Large calculi located in the upper ureter may result in a significantly tortuous ureter and are difficult to approach using retrograde ureteroscopy. The edematous mucosa or fibroepithelial polyp that is sometimes present can often impede calculus exposure and reduce the efficacy of lithotripsy. Large impacted calculi often cause significant hydronephrosis and dilatation of the proximal ureter. If the ureteroscope can overcome the tortuous ureter and edematous mucosa to reach the stone, the stone or stone fragments may be washed back to the renal pelvis or calices by outflow of the irrigant, making them unreachable and irremovable with a rigid or semirigid ureteroscope.[4] Because these reports have shown that the success of ESWL on ureteral stones is dependent on stone size and is not very effective for stones larger than 1 cm, we focused on large (≥1.5 cm in the greatest diameter) upper ureteral stones.

Laparoscopic ureterolithotomy has a high success rate in patients with a large stone burden, and complete clearance can be achieved in a single session, similar to PCNL.[6,8] However, a laparoscopy requires three small incisions instead of the one that suffices for PCNL, and laparoscopy requires dissection into the retroperitoneum to expose the ureter, which is similar to open surgery.[7] In addition, PCNL does not require any special equipment or unique skills.

In a comparison between antegrade and retrograde ureteroscopy for large impacted upper ureteral calculi, Maheshwari et al.[19] achieved complete clearance in all patients who underwent the antegrade percutaneous approach, while retrograde ureteroscopy was successful in only 55% of the patients. Currently, PCNL is mainly recommended for selected cases of staghorn calculi, complex or large renal pelvic stones, and moderate to large lower pole stones. Although PCNL is an acceptable treatment choice for stones >1 cm in the proximal ureter, few studies have investigated its efficacy. Goel et al.[7] reported complete clearance of impacted upper ureteral stones in 98.5% of patients, with no requirements for any ancillary procedures. In a comparison of antegrade with retrograde ureteroscopy for large impacted upper ureteral calculi, Karami et al.[8] achieved complete clearance in all patients with the antegrade percutaneous approach, while retrograde ureteroscopy was successful in only

51.4% of patients. Basiri et al.[9] reported the stone-free rates of 76%, 90%, and 86% for patients with large proximal ureteral stones who were treated with antegrade and retrograde ureteroscopy and laparoscopic ureterolithotomy, respectively.

Kumar et al.[20] achieved a stone-free rate of 86% using traditional PCNL for bulky impacted upper ureteral calculi, and they concluded that antegrade lithotripsy is more effective than ESWL. In our study, we used a percutaneous technique and a nephroscope to treat large proximal ureteral stones. Our findings were similar to those of the previous reports. In the present study, 90.9% of patients were free of stones after the procedure. All of these patients achieved complete clearance in a single session, and none of them required more than one tract.

Conversion to open surgery was necessary for 2 patients with stones that had a greatest diameter ≥2.5 in this study. We did not attempt the retrograde ureteroscopic procedure for these patients because a holmium: YAG laser was not available at our institution during the study period.

Four patients had CIRF <4 mm in our study. Because fragments <4 mm have a high likelihood of passing spontaneously, we think that a second-look nephroscopy and/or ureteroscopy for such fragments would add to patient morbidity. All of these patients were stone free at the follow-up investigation. Large residual calculi can be safely managed by ESWL or ureteroscopy during the postoperative period. One (2.2%) patient underwent ESWL, and 1 (2.2%) patient was treated with ureteroscopic lithotripsy postoperatively for residual stones.

We believe that blind access to the collecting system can be performed in the presence of hydronephrosis. In our study, blind access was conducted in 8 patients for whom the pelvicaliceal system was not imaged by the injection of the contrast medium through the ureteral catheter due to impacted stones. After this, contrast was given from the needle, the pelvicaliceal system became visible and the targeted calyx was punctured with another needle. Thus, we were able to gain appropriate access for this procedure.

Small ureteral perforations during the disintegration and retrieval of fragments can occur with this procedure, especially in patients with a high stone burden. A double-J stent was used intraoperatively in 4 (9%) patients to manage small perforations. In addition, two patients who had residual stones were also stented intraoperatively. One patient who underwent upper caliceal access had a pleural effusion and was treated conservatively in our study. Two patients required blood transfusion. The hospital stays for our patients after the operation were similar to those reported in the literature.[7,8]

Because of the technologically invasive nature of proximal ureteral calculus management, the availability of equipment and the surgeon's preference and experience with technology affects the treatment method. Pneumatic ureterolithotripsy has a back pressure effect and can push the calculi back into the renal pelvis. Thus, this procedure does not provide satisfactory results for the treatment of upper ureteral calculi. Flexible ureteroscopy and laser lithotripsy are expensive and not readily available in most developing countries. No special instruments are required for antegrade percutaneous removal, and this study demonstrates that a high success rate can be achieved in a single session, with minimal morbidity and short operating times.

As a conclusion, although different treatment modalities have been used for large impacted ureteral stones, the optimal treatment for these stones remains controversial. Our study shows that percutaneous antegrade removal of large upper ureteral calculi can achieve high stone-free rates. The advantages of this method are the retrieval of the entire stone in one session, a low rate of serious complications, and short hospitalization times.

Conflict of interest

No conflict of interest was declared by the authors.

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