Derleme (Review)

Percutaneous Nephrolithotomy: Indications and Technique

Perkütan Nefrolitotomi: Endikasyonlar ve Teknik

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Abstract
Percutaneous nephrolithotomy is widely accepted and effective treatment modality for renal stone disease. When compared with other surgical interventions such as open renal surgery, percutaneous nephrolithotomy has lower morbidity and postoperative patient discomfort, so percutaneous nephrolithotomy mostly replaced open surgery in most of the urology clinics in Turkey and worldwide. In this review it is aimed to discuss indications and limitations of percutaneous nephrolithotomy that mean the proper patient selection and also to discuss important points of surgical technique and devices for intrarenal lithotripsy and instruments for kidney drainage after the procudure that all will offer the physicians successfull outcome.

Key Words: **Lithotripsy; Kidney Calculi; Percutaneous nephrolithotomy.**

Özet
Perkutan nefrolitotomi böbrek taşı hastalıklarının etkin tedavi seçeneğidir ve yaygın olarak kullanılır. Açık böbrek cerrahisi gibi diğer cerrahi girişimler ile karşılaştırıldığı zaman, perkutan nefrolitotominin daha az morbidite ve girişim sonrası hasta rahatsızlığına sahip olması nedeniyle bu girişim, Türkiye ve dünyadaki üroloji kliniklerin çoğunda sıklıkla açık cerrahiye tercih edilir. Bu derlemede, perkutan nefrolitotominin edikasyonları ve sınırlamalarının tartışılması, uygun hasta seçimi, tümü başarılı bir tıbbi müdahale için önemli olan intrarenal litotripsi cihazları, prosedürden sonra böbrek drenajını sağlayan cihazlar ve ayrıca cerrahi tekniğin önemli noktalarını tartışmak amaçlanmıştır.

Anahtar Kelimeler: **Böbrek taşı; Litotripsi; Perkutan nefrolitotomi.**

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Introduction

Since Fernstrom and Jahonsson first removed renal calculi through a nephrostomy tube, percutanoeus nephrolithotomy (PCNL) has emerged and been a surgical treatment option for renal stone disease (1). PCNL is widely accepted and effective treatment modality for renal stone disease (2). When compared with other surgical interventions such as open renal surgery, PCNL has lower morbidity and postoperative patient discomfort, so PCNL mostly replaced open surgery in most of the urology clinics worldwide (3, 4). Indications and limitations of PCNL have been well established (5). The most important criteria for treating renal stone disease is the stone burden (6). Many options are available for the management of renal calculi such as extracorporeal shock wave lithotripsy (SWL) is the first management choice for renal stones smaller than 2 cm (7). The success of SWL decreases inversely with increasing renal stone burden and the presence of more than one stone in the kidney also decreases SWL success (8).

PCNL can be safely applied to both elderly and children (9, 10). But some patient groups still require specific consideration such as morbidly obese patients, patients with solitary functioning kidney, patients with previous open renal surgery and patients with existing renal failure. We discuss indications and limitations for PCNL as well as some points of surgical technique in this review.

Indications and Limitations of Percutenaous Nephrolithotomy. Percutanoeus nephrolithotomy is widely accepted as an effective treatment modality for renal calculi (11). PCNL as a single intervention in removal of renal stone has excellent results with minimal morbidity (12). The limit of being a large stone is accepted as 2 cm or larger (11). Extracorporeal shock wave lithotripsy is the first management choice for renal calculi smaller than 2 cm (7). However the presence of complete or partial staghorn renal stones may require more than one intervention or combination of PCNL and SWL known as 'sandwich therapy' (13).

The management of lower pole stones has been a debate. In lower pole stones smaller than 10 mm, PCNL and SWL have similiar success rates. However in the presence of lower pole stones larger than 10 mm, PCNL (91 %) was more successfull than SWL (21 %) in a previous randomized trial (14). Retrograde intrarenal lithotripsy (ureterorenoscopic surgery) has been shown as an alternative surgical option for lower pole renal stones (15). A prospective randomized trial comparing SWL and ureteroscopy for lower pole stones failed to show any significant difference in stone free rates (16). A randomized trial comparing PCNL and ureteroscopic manipulation of lower pole stones is warrented to show any difference.

PCNL can be safely applied to children (10). Pediatric stone disease is rare in many industrialized countries, however it is still a common problem in some parts of the world as in Turkey (17). About 20 % of stone disease patients have been reported to be in the pediatric age group in Turkey (18). SWL has been shown to be safe and effective in treatment of upper urinary tract stone disease in children. However success rates for SWL with complex and larger stones decrease and rate of significant residual stones increase (19, 20). PCNL was established in children with high success rate and minimal morbidity with using the same instruments for tract dilation as in adults (21). PCNL is advised in children when SWL or ureterorenoscopy fails, and with complex stone or when anatomical abnormality is present (22).

Becuase of high risk for urinary tract infections and rate of renal detoriation, stone disease in elderly patient should be treated. PCNL has been shown to be safe and effective in elderly patients even with the presence of complex stones and solitary kidney (23).

PCNL has been shown to be done safely in patients with a history of open nephrolithotomy without a higher risk of complications such as bleeding and sepsis and with a success rate similar to that of PCNL in patients with no prior open intervention (24).

Morbidly obese patients, who are unable to have SWL because of their body weight, can be treated successfully with PCNL with efficacy comparable to that in patients of normal weight (25). The main limiting factor is the length of the standard nephroscope and renal sheath in these sort of patients. Modification of the technique with using longer Amplatz access sheaths and a 30F gynecologic laparoscope has been performed with high success in these morbidly obese patients (26).

Horseshoe kidneys, kidneys with anterior malrotation anomaly, pelvic and transplanted kidneys with stone disease should be treated with caution. The main issue in

these kidneys is the site and technique for renal access. Mainly upper pole access is chosen to eliminate undue complications such as organ injury and bleeding (27). Percutaneous access may be done with the ultrasonographic guidance in selected cases (28). Iliac fossa and anterior nature of transplanted kidneys offer easy access and tract dilation (29).

PCNL had no adverse effect on renal functions of solitary kidneys treated for renal calculi (30). Studies on animals have shown that PCNL is associated with minimal scarring and has no adverse effect on renal functions (31). So, PCNL can be safely performed in solitary kidneys with upper tract stone disease.

Bilateral renal stone disease often posses challenge to the surgeons. SWL and other auxillary procedures are time consuming and with high cost. However simultaneous bilateral PCNL is not wide spread, there are some reports in the literature (32, 33, 34). These series have shown that stone free rates, rate of complications, analgesic requirement and renal function impairment were not significantly different between bilateral simultaneous PCNL and PCNL at two sessions.

The selection and preperation of patients prior to PCNL is an important issue to minimize complications and gain high success. All patients should undergo diagnostic work-up such as measurement of stone size and imaging of the collecting system, urine culture, serum creatinin and clothing parameters. In case of existing urinary tract infection, patients have to be treated with suitable antibiotics prior to procedure (35).

Percutaneous Nephrolithotomy: Technique

Anesthesia. Percutaneous nephrolithotomy is particularly performed with the patient under general anesthesia (35). General anesthesia is suitable for proper positioning of the patient and increases operative comfort of the surgeon and also minimizes complications such as bleeding and other organ injury. In recent years, physicians has reported their experiences with PCNL under local anesthesia (36, 37, 38). The most important reason for performing PCNL under local anesthesia is the severe comorbidity of the patients having high risk for general anesthesia. It is believed that pain during PCNL is due to renal capsular distention and not the intrarenal stone manipulation (37). So renal capsular block with the local anesthetic agent is the way of pain control during these operations. However one must consider the stone burden as an important factor since the effect of these local anesthetic agents are time limited so PCNL under local anesthesia should be done by highly experienced surgeons thus risk of open surgery is always present due to the complications seen during PCNL procedures.

Positioning of the patient. Percutaneous nephrolithotomy is usually done in the prone position. Some physicians prefer to put specifically designed cushions to gain a deflected position to place the patient flat on the operative table (35). Prone positioning has some disadvantages such as postoperative patient discomfort and adverse effects on circulatory and ventiolatory system during the operation (39). In case of severe obesity and pulmanory disorders, supine or lateral decubitus positions may be a safe alternative (39). Shoma et al. recently published the safety and efficacy of supine position in a nonrandomized study (40). However the punctures through the anterior calices were more frequently reported with the supine position so a higher incidence of anteromedial displacement of the kidney during tract dilation was reported with this approach. The overall success rate and the complication rates were similar in both groups. None of the patients experienced organ injury in the supine position.

Imaging. Most of the physicians worldwide use fluoroscopy to assist proper puncturing of the collecting system. In some circumstances, ultrasonography (freehand technique , fully guided system) may be used for monitoring access into the kidney (35). There are only a few reports on computed tomography (CT) guided puncture (40). Patients with aberrant anatomy may be candidates for CT guided puncture due to increased risk of damage to surrounding structures. In these situations cross-sectional anatomical imaging may facilitate safe percutaneous access. But in my opinion this technique is time consuming and with high cost, so it may be useful in situations such as ectopic kidneys, severe spinal dysraphism or organomegaly when ultrasonographic guided puncture fails.

Renal access and tract dilation. The crucial step in performing successfull PCNL is the right and atraumatic access to the kidney. In most of the cases it is performed with a subcostal access. The number and type of accesses depend on the calyceal anatomy and complexity of the stones. Some authors prefer only lower pole access with auxillary procedures for stones that cannot be reached

via this access (41, 42). However in the presence of staghorn calculi or complex stones, supracostal accesss is preferable (43). Supracostal access offers optimal control and manipulation of stones in the mid and lower calyx but this approach has a slightly high incidence of complications such as plevral injury (43). Munver et al. reported increased risk for punctures above 11th rib (34.6 %) compared to punctures above 12th rib (1.4%) (43). After proper and atraumatic puncture into the collecting system, tract dilation is necessary for entering into the collecting system. Tract dilation is usually done using Amplatz polyurethane fascial dilators (44). The metal telescoping dilators of Alken and balloon dilation may be used according to the preference of the physician (45, 46). Balloon dilation is regarded as the most modern and safest system, but it has the disadvantage of relatively high cost (45). Frattini et al. demonstrated their unique technique called 'one-shot' which consists of a single dilation of the tract with a 25F or 30F Amplatz dilator in a randomised study, they reported that this technique was less expensive and less time consuming (46). However more randomized studies are warranted to show efficacy and safety of this new technique.

Lithotripsy. For stone disintegration, there are various types of lithotripsy devices. Ballistic, ultrasonic, holmium laser or combination of ballistic and ultrasonic devices are present (35, 47). Pneumatic LithoClast (Electro-Medical Systems, Nyon, Switzerland), a combination of ballistic and ultrasonic devices was shown to be superior to the ballistic or ultrasonic fragmentation alone (48). Holmium laser lithotripsy was shown to be a superior technology compared to ballistic lithotripsy in terms of stone clearance and complications in ureteric stones (49). However, insertion and manipulation of laser fibers through nehroscope under continious saline flow during PCNL procedure is not as proper as rigid ballistic and/or ultrasonic fibers. New studies comparing laser and other lithotripsy devices for stone disintegration during PCNL is warrented to show efficacy and safety of the laser device.

Renal drainage. Nephrostomy tubes in different sizes are usually prefered for kidney drainage after PCNL. Nephrostomy tubes are inserted through collecting system for proper drainage and in some cases assesing tamponade for bleeding (50). After complicated procedures such as mucosal perforation, residual stones, significant bleeding, specially designed tubes 'Kaye tamponade' are recommended by the authors (51).

There are some reports about tubeless PCNL, especially after uncomplicated cases (52, 53, 54). The aferomentioned studies recommended tubeless renal surgery for selected cases. However, we performed tubeless PCNL in a randomized study (55). In our randomized clinical study tubeless PCNL was associated with less postoperative pain and a shorter hospital stay than a standard nephrostomy tube. Also, tubeless PCNL can be safely done in patients with a history of open nephrolithotomy and in those having a supracostal puncture without increased morbidity. The only limitation for this technique may be due to inability to access the kidney in situations of large residual stones. There also are reports on the placement of a hemostatic agent along the percutaneous tract (56, 57). Shah et al. retrospectively compared the perioperative outcomes of 17 patients who underwent tubeless PCNL with the use of fibrin glue with those in a control group of 25 patients who underwent tubeless PCNL without fibrin glue. Patients undergoing tubeless PCNL with fibrin glue required less analgesia postoperatively but were discharged an average of only 7 hours earlier. There was no difference in transfusion requirements or complications in the two groups. We did not use any hemostatic agent along the nephrostomy tracts. I think that new randomized studies are needed to evaluate the clinical role and any benefit of hemostatic agents.

Conclusion. With the development of new devices for renal access, lithotripsy and renal drainage systems after the procedure, PCNL has become the first choice treatment modality for renal stones larger than 2 cm by the urologists worldwide and also in Turkey. To avoid complications during the procedure and to gain successfull outcomes after the procedure, proper patient selection, maintanence of available instruments, training and experience of the physicians are critical.

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