Percutaneous Nephrolithotomy for Renal Calculi:A Single Surgeon Experience

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ABSTRACT:

BACKGROUND:

Percutaneous nephrolithotomy (PCNL) for renal calculi is one of the more challenging endourologic procedures.PCNL remains the procedure of choice for most stones that are more than 2 cm in size, complex staghorn calculi, some lower-pole stones, stones in caliceal diverticuli, and larger renal stones that are refractory to shock wave lithotripsy(SWL).

OBJECTIVE:

The purpose of this study was to evaluate the outcomes and complications in patients who were undergoing PCNL for renal calculi at our center.

PATIENTS AND METHODS:

From January 2011 to December 2012, a total of 216 patients who had renal stones underwent PCNL by the same surgical team at our institution. All patients were evaluated preoperatively with intravenous urography (IVU) and/or computerized tomography(CT). Data analysis included procedure time, length of hospital stay, number of access tracts, transfusion rates, other complications, and stone-free status. Percutaneous access was performed using C-arm fluoroscopy with patients in the prone position. The access tract was dilated with a balloon dilator or Amplatz dilators. Fragmentation of the stone burden was accomplished using an Ultrasonic lithotripter. No patients in this series underwent a tubeless technique. Nephrostomy tube was placed at the end of procedure and nephrostogram done in all patients on 2nd postoperative day.

RESULTS:

Mean age was (42.43±13.17) yrs. The mean stone burden was (6.91±4.47)cm^2 .The average procedure time was(57.40±21.05) minutes. Mean pre and postoperative hemoglobin(Hb) levels were(13.43±1.34) and (11.71±1.86) g/dl respectively and Hb drop was (1.76±1.10) g/dl.PCNL via a single access tract was accomplished in(93.51%) of procedures, while multiple tracts and intercostal access were used in(4.62%) and (1.85%) respectively of procedures.Mean fluoroscopy time during the whole procedure was (1.75±0.90) minutes.Mean hospitalization was (3.52±0.86) days. Stone-free rates at hospital discharge and at 3 months follow-up were (81.44%) and (92.07%), respectively. 30 patients received blood transfusion (13.88%).

CONCLUSION:

PCNL is a safe and effective procedure for the management of renal stones. It has the advantages of lower morbidity, shorter hospital stay. The full of array of endourologic equipment and expertise remains essential to achieving a successful outcome.

KEY WORDS: kidney stone, percutaneous nephrolithotomy .

INTRODUCTION:

The management of urolithiasis has evolved significantly over the last 20 years. Minimally invasive techniques are the reference standard for treating urinary stone disease, and open surgery is required in only 0.7%-4% of cases at centers of excellence.[1,2]

The description of successful percutaneous renal stone removal in a series of 25 patients by Castenada-Zuniga and colleagues[3] heralded a new era in minimally-invasive stone management. The original recommendations for this procedure were limited to high-risk surgical candidates, recurrent stone formers after previous open renal surgery, or patients with retained or missed stone fragments.

Since this landmark study was published, the efficacy of PCNL has become well established.[4] Currently, the recommendations for PCNL have expanded, and although SWL and ureteroscopy have roles in the management of upper tract calculi, PCNL remains the procedure of choice for most stones that are more than 2 cm in size, complex staghorn calculi, some lower-pole

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stones, stones in caliceal diverticuli, and larger renal stones that are refractory to SWL.

Although the technical challenges increase with anatomic variations, stone size, obesity, or age, PCNL can be carried out in high-risk patients and children in a satisfactory manner[5,6] . The only absolute contraindications are uncorrected coagulopathy[7] and an untreated urinary infection.

This high success rate is attributable to more experience,advances in endoscopic equipments, and also advanced devices for destruction of stones.[8]

Complication rates in PCNL are reported from 29% to 83%,[9-10]and in a recently completed PCNL Global Study analysis, the overall complication rate was 15%, which commonly involved bleeding.[11]

In our country, upper tract endourology is just developing, PCNL has been used in some centers, but most Urologists still perform open nephrolithotomy or SWL for this condition.The purpose of this study was to evaluate the outcomes and complications in patients who were undergoing PCNL for renal calculi at our center.

PATIENTS AND METHODS:

From January 2011 to December 2012, a total of 216 patients who had renal stones underwent PCNL by the same surgical team at our institution. All patients were evaluated preoperatively with IVU and/or CT.

Preoperative factors that were analyzed were patient age, sex, history of ipsilateral open renal surgery, SWL treatment, side and type of the stone, stone burden, the degree of hydronephrosis. The operative factors analyzed were calyx of puncture, number of access tracts, operative times, and intraoperative complications, fluoroscopy time and method of dialatation.

Preoperative laboratory tests included serum creatinine, hemoglobin measurements, platelet counts, coagulation tests, and urine cultures. All patients included in the study had sterile urine cultures, and patients with urinary tract infections were treated with a complete course of culture-specific antibiotics. Stone types were categorized as either staghorn calculi (partial or complete) or other types, including pelvic stones and multiple or isolated calyceal stones. Complete staghorn calculi were defined as stones occupying ≥ 80%of the renal pelvis and all of the caliceal system or occupying the renal collecting system.Partial staghorn calculi were defined as stones occupying the renal pelvis or occupying at least two calyces[12] The characteristics of the patients are summarized in Table I.

Table 1: Demographic Values of Patients and Stone-Related Parameters.

Patients (n)	216
Mean age (y)	42.43±13.17
Gender M/F (n) Male Female	155(71.75%) 61(28.24%)
History of open surgery	+ 35(16.20%) - 181(83.79%)
History of shock wave lithotripsy	+ 71(32.87%) - 145(67.12%)
Mean stone size (cm^2)	6.91±4.47
Stone location Staghorn (%) Other (%)	63(29.16%) 153(70.83%)
Side (%) (right / left)	124(57.40%) / 92(42.59%)
Degree of hydronephrosis(%) Nil or mild Moderate or severe	185(85.64%) 31(14.35%)
Presence of solitary kidney(%)	2(0.92%)

Patients were initially placed in the lithotomy position under general anesthesia, Prophylactic antibiotics were given before surgery in every case(ceftriaxone 1 gm i.v). A 5F or 6F ureteral catheter was inserted by cystoscope. Percutaneous access was performed using C-arm fluoroscopy with patients in the prone position, with all pressure points padded.

Urologist obtained access to the selected calyx by using an 18-gauge needle under fluoroscopic guidance . Once the needle is properly placed into the calyx, a 0.035 in hydrophilic angled-tip guidewire is inserted through the needle into the intrarenal collecting system.

The access tract was dilated with a balloon dilator (Nephromax,_ Microvasive Boston Scientific Corporation, Natick, MA) or the tract was dilated with Amplatz dilators up to 30 F, and a 30F Amplatz sheath was routinely inserted in all cases (figure1). Nephroscopy was performed with a rigid 26F nephroscope(figure2,3). Fragmentation of the stone burden was accomplished using a Ultrasonic lithotripter (CALCUSON KARL STORZ-figure4). Grasping Forceps were used to remove stone fragments(figure5). Additional tracts were created when indicated during the same session. A 16F nephrostomy tube was placed within the renal pelvis or the involved calyx at the end of operation . No patients in this series underwent a tubeless technique. Double J stents are not routinely placed .

Blood loss was estimated by the postoperative decrease in hematocrit and hemoglobin (measured 24 hours before and 48 hours after the procedure) factored by the blood transfusion level.

It was considered that a 1-unit blood transfusion increased the hemoglobin (Hb) level by 1 g/dL and hematocrit (Hct) by 3%. Therefore, drops in hemoglobin and hematocrit levels were calculated as follows:

([preoperative Hb(Hct) - postoperative Hb (Hct)] – [number of units transfused 1g/dL (3% for Hct) Hb per unit transfused]).[13]

A radiograph of the kidney, ureter, and bladder (KUB) was taken on postoperative day 1, and the Foley and ureteral catheters were removed if the urine was not hematuric. On postoperative day 2, the nephrostomy tube was removed after antegrade pyelography had confirmed ureteral drainage to the bladder.

Follow-up and outcome measures

Follow-up stone-free rates were determined in an out patient clinic setting at 3 months postoperatively with (KUB) radiography and renal ultrasonography. The procedure was considered successful if the patient was either stone free or had only clinically insignificant residual fragments (CIRFs), and unsuccessful (residual stones) at the third month of the follow-up. CIRFs were considered to be ≤ 4mm, nonobstructing, noninfectious, and asymptomatic residual fragments.[14]

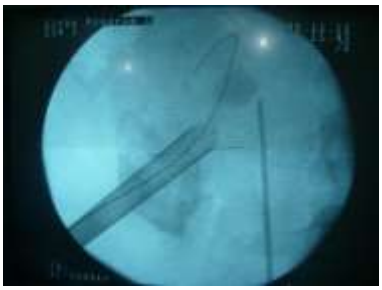

Figure 1: Working sheath was inserted under fluoroscopic guidance into the lower-pole collecting system over the working guidewire.Note the radiopaque renal stone with ureteric catheter.

Figure 2: Nephroscope introduced through the working sheath to the renal PCS.

Figure 3: Nephroscopic view of a calculus in the renal pelvis.

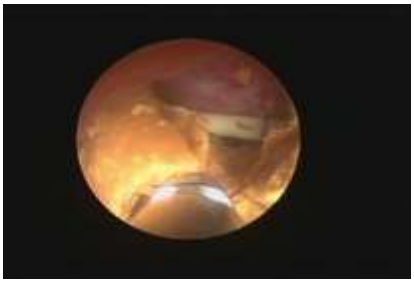

Figure 4:Nephroscopic view of a renal pelvic stone, which has been fragmented with ultrasounic probe.Note the ureteric catheter seen in the place.

Figure 5: Renal stone fragments at the end of operation.

RESULTS:

216 patients underwent PCNL procedures for renal calculi at our center. Mean age was 42.43±13.17 (range 20-75 yrs). The average procedure time was 57.40±21.05 minutes (range 30–120 min) defined as the the period from cystoscope insertion of ureteric catheter to placement of the flank dressing.Mean pre and postoperative hemoglobin levels were(13.43±1.34) and (11.71±1.86) g/dl respectively and Hb drop was(1.76±1.10) g/dl.

PCNL via a single access tract was accomplished in 93.51% of procedures, while multiple tracts and intercostal access were used in(4.62%) and (1.85%) respectively of procedures.Initial stone free rate 81.44% and final success rate of 92.07%,including CIRFs , was achieved after one session of PCNL. The intraoperative and postoperative outcome variables are shown in Table 2 and Table 3.

Table 2. Intraoperative Data.

Calix of puncture Lower Middle Upper	 206(95.37%) 4(1.85%) 6(2.77%)
Dilation method balloon dilator Amplatz dilators	 18(8.33%) 198(91.66%)
Access Single Multiple Intercostal access	 202(93.51%) 10(4.62%) 4(1.85%)
Mean flouroscopy time (min)	1.75±0.90
Mean operative time (min)	57.40±21.05

Table 3. Postoperative Data.

Stone-free rate after PCNL Percentage Initial stone –free rate(%) Final stone-free rate (%)	 (81.94%) (92.07%)
Hemoglobin drop (g/dl)	1.76±1.10
Nephrostomy time (d)	3.38±0.70
Hospitalization time (d)	3.52±0.86
Complications (n) Fever Blood transfusion Urine leakage Double-J placement for urine leakage Wound infection Nephrostomy tube slipping TURP Massive hematuria	 17(7.87%) 30(13.88%) 40(18.51%) 7(3.24%) 26(12.03%) 3(1.38%) 1(0.46%) 1(0.46%)

DISCUSSION:

PCNL plays an important role in the management of upper urinary tract stones and has been found to result in decreased mortality, shorter hospital stays, and decreased time lost from work. American Urological Association and European Association of Urology (EAU) guidelines specifically recommend PCNL for stones > 2 cm or staghorn calculi.[12,15]

Traditionally, KUB in combination with IVU are sufficient instruments to plan access to the collecting system. Bowel displacement may be present in patients with a history of open renal stone surgery.[16] This may pose a challenge for the surgeon, because of the increased risk of bowel perforation during the development of the percutaneous tract. In our opinion, preoperative noncontrast hel ical CT scan (NCCT) should be performed in these patients to ascertain any possible bowel displacement, which in turn would change the access site. Also, we perform

NCCT to better demonstrate the relations between the stone and the renal parenchyma.

The traditional way of performing PCNL, as described in the first publication by Alken et al, was in the prone position[17] . The traditional prone position provides access to the posterior calyx without causing significant parenchymal bleeding, peritoneal perforation, or visceral injuries[18]. Furthermore, the position eases the creation of multiple accesses whenever needed and offers almost unlimited instrument excursion to the surgeon[18]. Valdivia et al first described the supine position, considering anesthesiologic advantages for patients at higher risk.[19]

PCNL is an endoluminal procedure that is performed through a gate—the parenchymal access—therefore, obtaining proper access to the renal collecting system plays a key role in the success of the PCNL. The formation of a renal access includes the selection of the proper calix, the initial puncture, tract dilation, and insertion of the access sheath. Failure or inefficiency in one of these steps may lead to unfavorable results or failure of the entire procedure.Although C-arm fluoroscopy, CT, and Ultrasonography (US) can be used as guidance techniques for obtaining access to the intrarenal collecting system, C-arm fluoroscopy is the most commonly used[20,21,22,]. The believe that the lower caliceal approach is the most appropriate and that supracostal puncture is valuable when stones branch into the upper calix[23] ,in our practice,we use lower calyx access using upper and middle calyx in minority of cases.

During PCNL, a large percutaneous tract into the kidney is established using pneumatic dilation (balloon dilation), rigid coaxial metal sheaths (passed over one another), or semirigid plastic sheaths (sequentially performed) that are inserted incrementally until the tract is dilated.[3,24-25]

More recently, a single-step technique involving the use of an Amplatz serial dilator over a metallic telescopic dilator (‘‘one-shot’’) has become accepted as a safe and effective technique.[26]

The PCNL success rate has progressively increased since the technique was first used because of the many advances in endoscopic equipment and techniques. The PCNL success rate varies from 72% to 98%, with acceptable complication rates reported for large series.[27-28]

In our study,the stone-free rates at discharge and at 3 months were in 177/216(81.94%) and 186/202(92.07%), respectively.At the 3rd month of follow up, complete information on stone-free rates was available in 202 of 216 (93.51%) patients. Residual stones can be observed for 3 months postoperatively for spontaneous passage. Schulze et al reported that 66% of patients with CIRFs became stone-free at 3 months of followup.[29]

Despite technologic advances and growing experience with PCNL, complications from this technique include blood loss, perforation of the pelvicaliceal system, injuries to adjacent organs, sepsis, urine leakage from the nephrostomy tract, renal loss; even mortality can still be seen.[30] In our study, no major complication has been reported like pleural injury or bowel perforation,30 patients received blood transfusion 13.88%. The incidence of blood transfusion after percutaneous procedures has been 2% to 45% among different series[27].However one patient developed massive hematuria one week postoperative which was managed by blood transfusion and heavy antibiotics.The urine leak observed for 24 hours and improved in majority of cases otherwise double J stent inserted.In three patients slipping of nephrostomy tube has occured which was managed by delaying removal of ureteric catheter for 24 hours .One patient developed persistant urine retension till transurethral resection of prostate(TURP) was done .

Because PCNL is known as a procedure with a high risk of infection, antibiotic prophylaxis is recommended for all patients with a negative urine culture.[15]

Infectious complications related to PCNL are reported in up to 32.7% of cases. In most, it is limited to postoperative fever, but, although rare, postoperative septicemia or severe sepsis can induce life-threatening situations.[11]Traditionally, a nephrostomy tube is inserted after the PCNL with the intention of both draining the urine and tamponading the access tract.[31]

Many studies conducted in adults have confirmed that totally tubeless PCNL is safe and feasible in the management of kidney stone in adults.[32-33]

Traditionally, post-PCNL radiographic imaging studies have been used to detect residual fragments(RF). The method for detecting RF in our study was a combination of Ultrasonography and plain radiography(KUB).Most of the authors use sonography or KUB (sensitivity for residual fragments: 47%), and only a few use CT as the most sensitive tool.[34] it was not performed in

the present study because of fragments ≤4 mm have a high likelihood of passing spontaneously.

CONCLUSION:

PCNL is a safe and effective procedure for the management of renal stones. It has the advantages of lower morbidity, shorter hospital stay and earlier return to work.The full of array of endourologic equipment remains essential to achieving a successful outcome. However, training Programs is needed to learn the procedure .

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