Safety and Efficacy of Percutaneous Nephrolithotomy in Patients with Severe Skeletal Deformities

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Purpose: Treatment of renal calculi in patients with severe skeletal deformities can be challenging. We present our experience in order to provide an assessment of technical difficulties, associated complications, and outcomes of percutaneous nephrolithotomy (PCNL) as a treatment option in this special patient group.

Materials and Methods: Our study included eight patients treated with PCNL for renal stones. All had severe skeletal deformities including six with severe kyphoscoliosis, one with osteogenesis imperfecta, and another with rickets. After pre-operative evaluation the procedure was performed under fluoroscopic and/or ultrasonic guidance. In all but one case, PCNL was performed with the patient in the prone position. Silicone rolls and soft padded bolsters were used to obtain the best positioning for the procedure. Clearance rates and complications were assessed.

Results: Complete stone-free rate was achieved in six patients (75%) after first-PCNL. The two patients with residual stones underwent a second-look PCNL, after which one was completely cleared. The overall complete stone-free rate after second PCNL was 87%. Only minor complications were seen in two patients (25%).

Conclusion: We found PCNL to be safe and effective for managing kidney stones in patients with severe skeletal deformities.

Keywords: kyphoscoliosis; osteogenesis imperfecta; percutaneous nephrolithotomy; renal Calculi; rickets.

INTRODUCTION

Performing surgical, anesthesiologic, and technical procedures in patients with skeletal deformations can be very challenging.[1] Percutaneous nephrolithotomy (PCNL) is well established in the modern era as the treatment of choice for large renal calculi even in cases with risk factors such as renal anatomical abnormality, morbid obesity, and a past history of renal surgery.[2, 3] There are few reports in the literature regarding the management of renal stones in patients with skeletal abnormality and most are focused on morbidly obese patients or patients with spinal cord injury.[4, 5] The aim of this study was to present our experience of technical difficulties, associated complications, and outcomes of PCNL in patients with skeletal abnormalities and renal stones. We present our experience to provide an assessment of technical difficulties, associated complications, and outcomes to evaluate PCNL as an option for urolithiasis treatment in this patient population.

PATIENTS AND METHODS

Study Population

Our study included eight patients treated with PCNL for renal stones. PCNL was performed by one surgeon in our hospital between the years 2008 and 2014. All patients had severe skeletal deformities including six with severe kyphoscoliosis, one with osteogenesis imperfecta, and another with rickets. The mean age of our patients was 43.2 years (range: 6-58) and three patients were female (**Table 1**). One patient had history of failed shockwave lithotripsy (SWL), two patients had past history of ureteroscopy and open nephrolithotomy. Pre-operative diagnostic imaging of the urinary tract, including intravenous urography (IVU), was performed in all patients to evaluate urinary tract abnormalities and to identify the anatomic location of the stones. For evaluation of intra abdominal organs, spinal deformity and assessing percutaneous approach we used computed tomography (CT scan) and ultrasound.

Prior to surgery, all patients were evaluated by an anesthesiologist who used the Mallampali score to predict intubation comfort. Prophylactic antibiotics (first- or second-generation cephalosporin or fluoroquinolone) were administrated to all patients and all procedures were performed with the patient under general anesthesia. We estimated the stone burden via CT-scan with coronal section reconstruction. The entire procedure was performed by an experienced endourologist.

Inclusion criteria

Inclusion criteria were patients with renal stone and skeletal deformities.

Exclusion criteria

Exclusion criteria consisted of pregnancy, untreated coagulopathy and any contraindication for anesthesia.

PCNL Procedure

Cystoscopy was performed on all patients; a 5-F ure-

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Table 1. Detailed parameters of patients

Number	1	2	3	4	5	6	7	8
Age; year	56	6	47	53	41	47	38	58
Sex	F	F	F	M	M	M	M	M
Stone location	Multiple stones	Proximal of ureter	Renal pelvis	Renal pelvis	Renal pelvis	Renal pelvis & lower calyx	Renal pelvis & lower calyx	Renal pelvis
Hydronephrosis	Severe	Moderate	Mild	Mild	Mild	Moderate	Mild	Mild
Clearance after initial PCNL	Yes	Yes	Yes	Yes	Yes	Yes	No	No
Stone residue (mm)	----	----	----	----	----	----	10	14
Clearance after redo- PCNL	----	----	----	----	----	----	Yes	No
Stone burden (mm^2)	216	55	272	132	750	456	190	572
Operative time (min)	60	75	95	30	210	180	125	120

Abbreviations: F, Female; M, Male.

teric catheter was advanced up to the renal pelvis then ureteral catheter was fixed to a foley catheter (10-16F). In all but one patient, PCNL was performed in the prone position. Soft padded bolsters and silicone rolls were used to obtain the best position for the procedure (**Figure 1**). We used fluoroscopic guidance to obtain percutaneous access in all patients; in one case we needed to perform PCNL under ultrasonic guidance in combination with fluoroscopy. Under direct fluoroscopic-guidance (ultrasound), an 18-gauge needle was used to puncture the collecting system; a hydrophilic guidewire (0.038 inch) was then pushed through the needle until it reached renal system. Depending on the existence of hydronephrosis, the working tract was dilated using Alken dilators or the one-shot technique.[6–8] Nephroscopy was performed using a rigid nephroscope (standard nephroscope 26F) in the all cases; a flexible nephroscope was available for the last 2 cases (Number: 7, 8). A pneumatic device (Swiss Litho Clast Master, EMS, Nyon, Sz) was used for lithotripsy.
Grasping forceps were used for removal of stone fragments. Stone-free status was evaluated at the end of the procedure by fluoroscopy;[9] then a double-j was inserted antegradely if necessary. Reentry nephrostomy (22-F) were placed.

Evaluations

Symptoms, physical examination, lab-data and ultrasound were used to evaluate complications. Patients had a follow-up via kidney-ureter-bladder (KUB) x-ray and ultrasound 2 to 6 months after the procedure. The nephrostomy tubing was removed when patients were discharged, after we ruled out residual stones via KUB or ultrasound.

Statistical Analysis

For our study, we collected and analyzed the clearance and complication rates. The necessary data was analyzed with SPSS software (the Statistical Package for the Social Sciences, Version 16.0, SPSS Inc, Chicago, Illinois,USA).

Figure 1. Prone position

Table 2: Stone burden and clearance rate after PCNL

Study	Number of patients	Mean patient age (year)	Average stone burden (mm^2)	Clearance after first-PCNL (%)	Clearance after redo-PCNL(%)	Require SWL (%)	Required nephro-Ureteroscopy (%)	Never cleared or lost follow-up (%)	Complication (%)
Our study	8	43.2	330	75	87	12.5	0	0	25
Alisinnawi et al. [15]	5	28	940	60	80	20	0	0	100
Kara et al.[16]	5	36.8	475	60	80	0	20	0	60
Goumas et al.[2]	9	46	372	55.5	66.6	22	11	11	41
Symons et al.[3]	29 (10 spina **bifida)**	44	13 had staghorn	62	-----	13	6.8	24	48

RESULTS

Patients parameters are summarized in **Table 1**. We collected and evaluated patient demographic data from the medical records. Percutaneous renal access was achieved via upper-pole tract (n:1), mid-pole tract (n:1) and lower-pole tract (n:6). Complete stone clearance was achieved in 6 patients (75%) after the first-PCNL; two patients had residual stones. These two underwent a second-look PCNL that resulted in complete stone clearance in one case. The complete stone-free rate after second PCNL was 87% (**Table 2**). The mean operative time was 111.8 min (range, 30–210 min) and the mean hospital stay was 3 days (range, 2–5 days). There were no anesthetic complications and no admissions to the intensive care unit. We evaluated surgical complications by using a modified Clavien grading system.[10] Overall, we had 2 complications in 8 PCNLs (25%). The first was a patient with transient fever (T: 38.2ºC oral) who only required routine antibiotics (grade 1 Clavien). The second complication was a patient with acute blood loss requiring one unit of blood transfusion (grade 2 Clavien). No instances of vascular trauma, bowel injury, hematoma formation or septicemia were evident. The mean hemoglobin drop was 1.5 mg/dL (range, 0.8–2.2). With the exception of one patient who was treated by an anterior approach, PCNL was performed in prone position. Five patients underwent antegrade ureteric double-j placement. The left kidney was affected in two patients and the right in six. Post-operatively, one patient (Number: 8) underwent SWL. One patient (Number: 5) underwent tubeless PCNL while the remaining patients had nephrostomy tubes placed. A second procedure was performed for remnant stones in 2 cases (Numbers: 7 and 8). We present the imaging from case number 7. He had 190 mm2 stones in the renal pelvis and lower calyx (**Figure 2**); his first PCNL was performed under fluoroscopic guidance. The renal pelvis was cleared but the lower calyx was not (**Figure 3**); therefore, we performed redo-PCNL with flexible nephroscope from another tract, resulting in complete clearance (**Figure 4**).

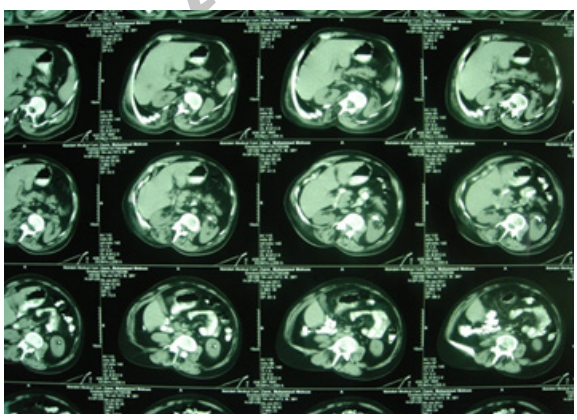

Figure 2. Stones in the left renal pelvis and lower calyx

DISCUSSION

Severe skeletal anomaly is a problem that affects the quality of life. Spinal deformities including scoliosis and kyphosis impair respiratory function,[11] and these patients present a challenge during surgical, anesthesiological and technical procedures.[12] Before the introduction of PCNL and SWL, open surgery was the only method of therapy with major complications including paralytic ileus and wound infection.[13] Patients with skeletal deformities often have other comorbidities for example renal stone formation. On the other hand, interventional treatment in these patients is a large challenge for urologists. In normal populations without skeletal deformities we have several non-medical therapeutic methods available for surgical treatment of renal stones, for example: nephrolithotomy, SWL, ureteroscopy and PCNL. In patients with skeletal deformities, open surgery and retroperitoneal approach is difficult and the risk of wound infection is high and the time for wound repair is longer than other patients. The other commonly used method is SWL; SWL is often unsuccessful and with high re-treatment rate in this patient population since proper positioning is hard to achieve makeing wave focus on target difficult. Even if SWL is feasible and successful, the endourologist is faced with the problem of how to remove stone fragments because fragment passage can be hindered by aberrant renal locations. Passage of the stone fragments from the ureter is challenging since ureteroscopy, especially rigid

Figure 3. Renal pelvis was cleared.

ureteroscopy, is difficult. Our research has found that in these conditions the best method for treatment of renal stones in patients with severe skeletal deformities is PCNL. Open surgery and ureteroscopy (URS) have difficult restrictions due to anatomic variations. Patients with musculoskeletal deformity, such as kyphosis and scoliosis, can have associated urinary tract problems including infection and stone formation.[14] Prolonged anesthesia in the prone position, combined with the respiratory and cardiac dysfunction, necessitates detailed monitoring of the respiratory and cardiovascular system during surgery.[15] In our study, all patients required a single tract access in first PCNL. All patients had a CT scan of the abdomen & pelvis before the procedure to avoid colonic injury and to delineate anatomy. It is also useful to plan the choice of calyx and the orientation of the tract. In an active endourology department that performs many PCNL procedures each week, a wide variety of patients undergo PCNL; the endourologist should consider the individual when making decisions about treatment. The prone position, if possible with the patient's body habitus, may offer a wider space for percutaneous access. The patient's position is crucial for PCNL; in our cases the desired positioning was accomplished by using pillows to maintain upper body support. Stabilization of the patients head and cervical spine was achieved with a horseshoe head support and the table was tilted to a reverse trendelenburg position to avoid cerebral edema. PCNL as monotherapy assists in eradicating large stones and yields excellent results with minimal morbidity even in difficult cases such as those involving renal anatomic variations, children, and morbidly obese patients. There are few reports about the management of kidney calculi in patients with skeletal abnormalities. Alsinnawi et al.[11] reported clearance rate of 60% with complication rate of 100% (Clavien 1&2). Goumas-kartalas et al.[2] reported a 44% complication rate and clearance rate of 55.5%. Kara et al. [12] reported a first-PCNL clearance rate of 60% with a complication rate of 60% in their 5 patients. Symons et al.[3] reported 39 PCNL procedures in 29 patients with 48% complication rate including 2 post-operative deaths. In our study, the stone clearance rate was 75% after one session PCNL and 87% after redo- PCNL and complication rate was 25%.

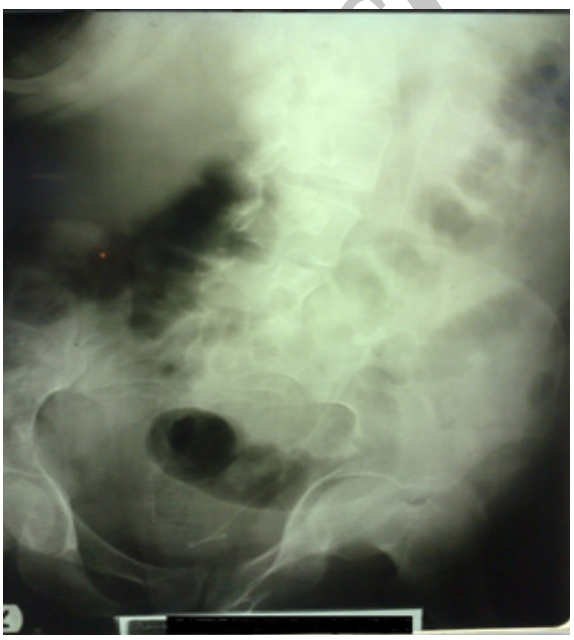

Figure 4. complete clearance after redo-PCNL.

CONCLUSIONS

The restricted number of cases makes it impossible to get definitive conclusions and recommendations. However, our research has found PCNL to be safe and effective for managing renal stone disease in patient with severe skeletal deformities. In the end, respiratory and cardiac dysfunctions are common in patients with skeletal deformities; therefore, an extensive analysis should be performed.

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CONFLICT OF INTEREST

The authors of this manuscript have no conflicts of interest to disclose as described by the Urology Journal.

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