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Percutaneous Nephrolithotomy: A Mini Invasive Approach for Renal and Pelvic Stones. Initial Experience from a Resource-Limited Setting in Douala Cameroon

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ABSTRACT

Background and Aim: *We present in this paper the technique and results of percutaneous nephrolithotomy as a minimally invasive treatment for large renal and pyeloureteric junction stones at the Centre medico-chirugical d'urologie in Douala, Cameroon.*

Methods: *This was a retrospective study carried out from January 2019 to July 2022. We included 25 patients with calculi in the renal pelvis and pyeloureteric junction treated through percutaneous nephrolithotomy.*

Results: *We included a total of 25 patients (18 men and 7 women) with a median age of 44 [36-48] years. Of the 25 patients, 23(88%) had a single calculus and 3(22%) presented with a Staghorn calculus. The median size of the calculi was 23.5 [20.25–27.75] mm and in 60% of cases; the stone was on the right side of the body. In all cases, the definitive diagnosis was made using abdominal CT scans and in 20 (80%) patients, the diagnosis was made incidentally during a CT scan for other reasons. All patients were treated through percutaneous nephrolithotomy, performed in the prone position in 21(84%) patients. Three patients who had a positive urine culture prior to the procedure benefited from a preoperative double J stent placement and all patients had post-surgery percutaneous drain placement which was left in place for 24 hours. The median surgery duration was 135 [120–165] minutes. Seventeen patients (68%) were stone free after the procedure.*

Conclusion: *Percutaneous nephrolithotomy is an effective mini-invasive technique in the treatment of voluminous kidney and pyeloureteric junction stones. It is reliable, reproducible and has fewer complications and, therefore, proves to be an excellent choice in Sub-Saharan Africa.*

Keywords

Kidney stone, Nephrolithotomy, Prone position, Lithoclast, Double J stent.

Introduction

Renal stone disease is a frequent and recurrent pathology, which affects, depending on the country, 5 to 10% of the general population

in the age group of 20 to 60 years with a male predominance [1]. A disease can evolve over many years subclinically and sometimes requires emergency treatment when the prognosis is vital.

There exist several treatment options for the management of renal calculi. The objective in the management of renal calculi is to obtain a stone-free status while minimizing morbidity and mortality. The choice of the procedure to be employed is determined by the size of the stone, its location and its distribution. These procedures include non-invasive and minimally invasive modalities such as percutaneous nephrolithotomy (PCNL), ureteroscopy (URS), extracorporeal shockwave lithotripsy (ESWL), laparoscopy, and robotic surgery [2]. Invasive methods such as open surgery are indicated where non-invasive and minimally invasive modalities fail or are inexistent. In the treatment of adult patients with ureteral stones, the American Urological Association (AUA) recommends watchful in patients with uncomplicated ureteral stones with sizes ≤ 10 mm, URS in patients with mid- or distal ureteral stones requiring intervention and patients with suspected cystine or uric acid ureteral stones in whom medical expulsive therapy (MET) was unsuccessful. The AUA recommends in the case of adult patients with renal stones, ESWL or URS for symptomatic patients with a total non-lower pole renal stone burden < 20 mm and PCNL or Laparoscopic pyelolithotomy (LPL) for symptomatic patients with a total renal stone burden > 20 mm [2]. However, the PCNL technique remains the gold standard [3]. PCNL first described in 1976 by Fernstrom and Johansson involves direct access to the renal cavities via a path made during a percutaneous puncture of the kidney in order to extract through a nephroscope the kidney stones previously fragmented using a lithoclast or a holmium laser [4].

PCNL was traditionally performed with the patient in the supine position [5]. In recent times, many surgeons prefer placing patients in a prone position or in a lateral decubitus position and have reported better outcomes with these new patient positions [6,7]. The success of PCNL irrespective of the approach or technique used depends on the guidance of fluoroscopy, the C-arm, or ultrasound. The most common techniques include the "bull's eye" technique, the "triangulation" technique, and the Escovar technique [8]. PCNL is usually performed under general anaesthesia. It involves making a perpendicular puncture with a fine spinal needle (20 G) into the target calyx under guidance to measure the exact depth of the calyx based on the length of the needle outside the skin. This is followed by a puncture with an 18G needle to create the desired calyx-infundibulum-pelvis tract. These come after the instillation of contrast or saline through a 7-Fr ureteric catheter. Though PCNL is minimally invasive, like any other surgical procedure, it is prone to complications. Potential complications of this technique include complications of anaesthesia, wound healing complications, surgical site infection, haematoma formation, sepsis or a complicated urinary tract infection, nephrostomy tube leakage, and failure to remove the stone [9,10]. Of 582 patients who underwent percutaneous nephrolithotomy as described by Lee et al, 4% had complications, with the most common complications being fever (23%), extravasation (7%), and transient ureteral obstruction in (6%) [9]. Taylor et al. in a review article showed that the commonest complications were bleeding and pleural injury [10]. PCNL being minimally invasive in nature offers the advantages of reduced postoperative pain, shorter hospital stay and a shorter recovery time [2,3]. Despite these advantages, open surgery for the treatment of nephrolithiasis is still being practiced in many countries in Africa due mainly to a lack of access to new technologies. We thus carried out this study to present this mini-invasive PCNL approach in the management of large kidney stones at the *Centre medico-chirugicale d'urologie* in Douala, Cameroon.

Methods and Materials

Study Design and Study Participants

This was a retrospective study over a period of three years (from January 2019 to July 2022) at the *Centre medico-chirugicale d'urologie*, which is located in Bali, Douala. We consulted the clinical records of 25 patients with calculi at the renal and pyeloureteric junction who were treated through percutaneous nephrolithotomy. We excluded patients with incomplete clinical records. Using pre-tested data extraction forms, we collected data on patients' ages, genders, clinical profiles, relevant medical history, sizes of the calculi, localisation of the calculi as confirmed by imaging, and outcome of surgery. All patients underwent abdominopelvic CT before the procedure to localise the stones, and they all had at least one stone (Figure 1A).

Pre-operative and intraoperative procedures

All patients also consulted an anaesthesiologist and did a pre-operative workup, which included a full blood count, urea, and creatinine, clotting profile, and urine analysis with culture and antibiotic susceptibility profiling. Those with confirmed urinary tract infections prior to the intervention were treated as per the results of culture and antibiotic susceptibility profiles. A second-generation cephalosporin was administered to all patients without confirmed urinary tract infections as a prophylactic antibiotic. All surgical procedures were performed under general anaesthesia.

The first step involved placing a 5 Fr ureteral catheter through which contrast medium (methylene blue diluted with physiological saline) was pushed through the renal excretory pathway. This was followed by the placement of a urethral catheter (16 Fr for women and 18 Fr for men) with the patient in a lateral or lithotomy position. During the second step, the patient was then placed in the prone position or modified supine position (patient placed in a supine position with a water bag under the flank) and the kidney was punctured using a CHIBA needle with C-arm guidance (Figure 1B). Three of the patients needed two punctures each while the rest needed just a single puncture to reach and remove the stone. The third step involved dilation of the percutaneous pathway using dilators of increasing diameter (8 to 26), culminating in the placement of the Amplatz sheath through which the nephroscope would be introduced. The fourth step consisted of stone fragmentation using either the Swiss lithoclast (used on 23 patients) or the Holmium laser fiber and the lithoclast (used on 2 patients because, during fragmentation with the Swiss lithoclast, there was a technical

problem which prompted switching to the Holmium laser fiber). The fragmented stones were extracted using tripod forceps or using a Dormia basket catheter. Double J stents were placed postoperatively when there was a fear of stone migration toward the ureter (Figure 3). In all 25 patients, a percutaneous drain was placed postoperatively. All 25 patients were operated upon by the same two surgeons.

Data Management

The data extracted from patients' clinical records were entered into Microsoft Excel 2016 and then exported to SPSS version 25 for analysis. Continuous data are presented as mean values and standard deviations (for normally distributed data) and medians with interquartile ranges (for skewed data). On the other hand, categorical data are presented as frequencies and percentages. This study was approved by the institutional review board of the Faculty of Medicine and Pharmaceutical Sciences (FMPS) of the University of Douala and by the ethical committee of the *Centre medico-chirugicale d'urologie* in Douala, Cameroon. The requirement for patients' informed consent was waived due to the retrospective nature of the study.

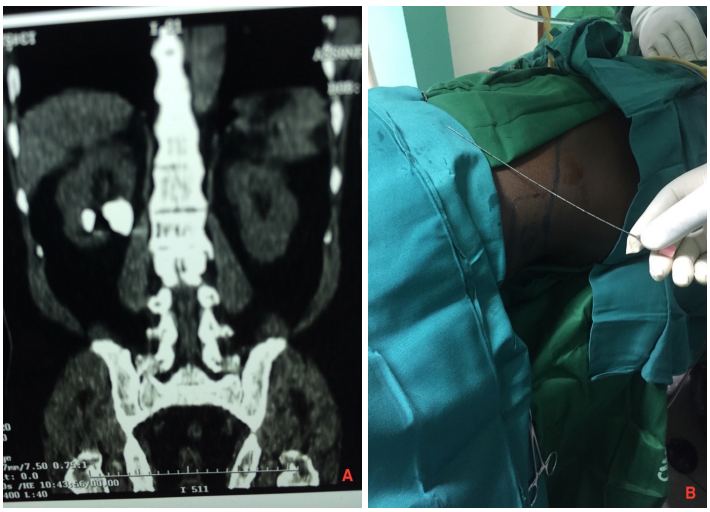

Figure 1: CT scan showing a right renal pelvis stone (A) and a patient in the prone position prior to PCNL (B).

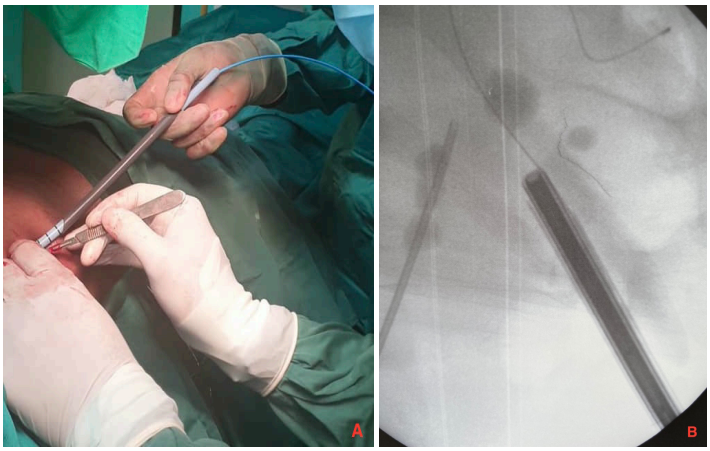

Figure 2: Image of a patient during dilatation (A) and an image showing nephroscope introduction (B).

Figure 3: X-ray showing double J stent post left PCNL.

Results

Of the 25 patients we recruited in our study, 18 (72%) were males and 7 (28%) were females. The ages of the patients ranged from 27 years to 55 years, with a median age of 44 [36–48] years. As concerns the initial clinical presentations of the patients, 2 (8%) patients presented with acute nephritic colic (ANC), 5 (20%) presented with acute nephritic colic and sepsis, and 20 (80%) were asymptomatic. Twenty-two (88%) of the patients had smooth stones while 3 (12%) patients had Staghorn stones. One (4%) patient had two calculi and the rest of the patients had a single calculus. The stones were located on the left side of the body in 10 (40%) cases and on the right in 15 (60%) cases.

Sixteen (64%) stones were in the lower calyx, 2 (8%) in the middle calyx, 3 (12%) in the renal pelvis, 3 (12%) extended from the lower calyx to the pelvis, and 1 (4%) extended from the lower and middle calyx to the pelvis. Data on the clinical presentations of the study participants can be seen in Table 1.

Table 1: Clinical presentations of the patients.

Variables	Males (%)	Females (%)	Total (%)
Clinical presentation			
Asymptomatic	13 (72.22)	7 (100)	20 (80)
Colic only	2 (11.11)	0 (0)	5 (20)
Colic and sepsis	3 (16.67)	0 (0)	3 (12)
Laterality			
Left	6 (33.33)	4 (57.14)	10 (40)
Right	12 (66.67)	3 (42.86)	15 (60)
Localisation of stones			
Lower calyx	10 (55.56)	6 (85.71)	16 (64)
Middle calyx	1 (5.55)	1 (14.29)	2 (8)
Renal pelvis	3 (16.67)	0 (0)	3 (12)
Lower calyx and pelvis	3 (16.67)	0 (0)	3 (12
Lower calyx, middle calyx, and pelvis	1 (5.55)	0 (0)	1 (4)

All the 25 patients were hospitalised and underwent PCNL, which was successful in 17 patients (68% stone-free rate). Of the 62

patients, double J stents were placed preoperatively in 3 (12%) patients who had positive urine cultures for E. coli and Proteus mirabilis. Post-operatively, percutaneous drains were placed in all 25 patients and double J drainage was performed in 9 (36%) patients whose stones migrated toward the ureter. Four (16%) of our patients, all males, were febrile post-operatively, with 1 (4%) developing acute pyelonephritis and 1 (4%) developing acute orchitis. Twenty-one (84%) patients were placed prone on the operation table and 4 (16%) patients were placed in the lateral decubitus position. The duration of the mini-invasive procedure ranged from 80–250 minutes with a median duration of 135 [120–165] minutes. The duration of hospitalization of the patients ranged from 2–5 days, with a mean duration of 2.88 ± 0.93 days. The details of the surgical procedure and postoperative hospitalization of the study participants are presented in Table 2.

Table 2: Details of the surgical procedure and hospitalization of the patients.

Variables	Males (%)	Females (%)	Total (%)
Pre-op double J			
Yes	3 (16.67)	0(0)	3 (12)
No	15 (83.33)	7 (100)	22 (88)
Post-op double J			
Yes	8 (44.44)	1 (14.29)	9 (36)
No	10 (55.56)	6 (85.71)	16 (64)
Post-op Complications			
None	14 (77.78)	7 (100)	21 (84)
Fever	4 (22.22)	0 (0)	4 (16)
Fever + Acute pyelonephritis	1 (5.55)	0 (0)	1 (4)
Fever + Acute orchitis	1 (5.55)	0 (0)	1 (4)
Median duration of surgery (minutes)	142.5 [115–185]	130 [125–142.5]	135 [120–165]
Mean duration of hospitalization (days)	3.06 ± 1.00	2.43 ± 0.54	2.88 ± 0.93

The imaging technique used to locate the stones in all 62 patients was the anterioposterior abdominopelvic CT scan. The sizes of the stones ranged from 16–40 mm, with a median stone size of 23.5 [20.25–27.75] mm. Urinalysis was performed in all patients with 3 (12%) patients having positive results, *Escherichia coli* being the culprit pathogen in 2 (8%) cases and *Proteus mirabilis* in 1 (4%) case. The results of the surgery and the paraclinical workup are presented in Table 3.

Table 3: Paraclinical parameters of the patients

Variables	Males (%)	Females (%)	Total (%)
Stone size			
< 20	2 (11.11)	1 (14.29)	3 (12)
20–29	11 (61.11)	5 (71.43)	16 (64)
≥30	5 (27.78)	1 (14.29)	6 (24)
Median size of stone (mm)	24.5 [21–32]	23 [20.5–25]	23.5 [20.25–27.75]
Culprit pathogen			
None	15 (83.33)	7 (100)	22 (88)
Escherichia coli	2 (11.11)	0 (0.0)	2 (8)
Proteus mirabilis	1 (5.56)	0 (0.0)	1 (4)

Of the 25 patients treated with PCNL, 17 (68%) were stone-free after the intervention. All 3 (100%) patients with stones measuring <20 mm was stone-free after surgery. Of the 16 patients with stones measuring 20–29 mm, 12 (75%) became stone-free while of the 6 patients with stones ³30 mm, 2 (24%) were stone free. 100% of the females were stone-free after surgery irrespective of stone size.

Table 4: Stone-free rate following PCNL.

Stone size (mm)	Male (%)	Female (%)	Total (%)
All sizes	10/18 (55.55)	7/7(100)	17/25 (68)
< 20	2/2 (100)	1/1 (100)	3/3 (100)
20–29	7/11 (63.64)	5/5 (100)	12/16 (75)
≥30	1/5 (20)	1/1(100)	2/6 (24)

Discussion

LPL and PCNL are the recommended procedures in the management of large (≥ 20 mm) renal calculi, with PCNL being the gold standard [3]. The current study highlights our experience in the management of 25 patients with kidney stones using standard percutaneous nephrolithotomy. The patients in this study had stones with a median size of 24.5 [range: 16–40] mm and met the criteria for PCNL. A pooled analysis assessing the efficacy and safety of minimally invasive percutaneous nephrolithotomy compared to the standard percutaneous nephrolithotomy revealed that the minimally invasive approach is associated with significantly higher stone-free rate, shorter operative time, shorter duration of hospital stay, and lesser occurrence of postoperative fever [11]. Carrion et al. argued that the prone approach to PCNL is superior to the supine approach as it offers the surgeon key advantages, such as the possibility of puncturing anatomically abnormal urinary tracts, performing multiple percutaneous tracts in the same kidney, experiencing the vacuum cleaner effect, ease of exploring the upper calyx through the inferior calyx, and the possibility to perform endoscopic combined intrarenal surgery and bilateral simultaneous surgery [7]. However, the prone position has been reported to be associated with a higher occurrence of visceral injuries and post-operative infections [12]. The modified supine position gives greater comfort to the patient and has a low impact on a patient's blood circulation and respiratory system [13]. In our study, patients were treated in the prone position in most cases and in the modified supine position (in which patients were placed in a supine position with a water bag under the flank) in a few cases when the use of a ureteroscope was imperative. After localization of the calculi, several methods exist for fragmentation prior to extraction. Lithotripsy in the literature has been achieved through ultrasonic, hydraulic, mechanic, ballistic, and laser methods either independently or in combination [14]. Radfar et al. in a randomized controlled trial did not find any significant difference between ultrasonic and ballistic lithotripsy in PCNL in terms of stone-free rate and complications but reported that significantly shorter stone clearance time was observed when using ballistic lithotripsy for harder stones and ultrasonic lithotripsy for soft stones [15]. In the present study, lithotripsy was performed using the Swiss lithoclast (the first available percutaneous ballistic lithotripsy device) among 23 patients and laser in 2 others.

A systematic review and meta-analysis conducted by Zeid et al. showed that the stone-free rate following PCNL can range from

81.2 – 98.7% [16]. We obtained in the present study, a stone-free rate of 68%. We noticed that the stone-free rate decreased with increasing stone size. Güler et al. reported in a randomized prospective study where 51 patients were treated with PCNL, that the stone-free rate was 71.7%, which is close to the rate obtained in our study [17]. The slightly lower stone-free rate gotten in our study could be explained by the fact that 12% of our patients had Staghorn stones which are more difficult to remove through standard PCNL alone and usually require auxiliary procedures like shockwave lithotripsy or flexible nephroscopy in addition to PCNL [18].

In our study, the mean operative time was 130 [range: 80-250] minutes, which was higher than the 74.9 minutes reported by Güler et al. and the 60.49 minutes reported by El Sheemy et al. [17,19]. The mean duration of hospital stay in the present study was 3.06 days, which was shorter than the 4.29 days reported by El Sheemy et al. [19]. This difference could be explained by the relatively lower complication rate (16%) in the current study compared to the complication rate of 20.5% reported by El Sheemy et al. Two patients (8%) had a fever alone, 1 (4%) had a fever associated with acute nephritic colic, and 1 (4%) other had a fever associated with acute orchitis. Kandemir et al. in a randomized prospective study involving 72 patients treated with standard PCNL reported a complication rate due to post-operative fever of 2.8% [20].

There is a divergence in the literature as to whether a drain should be placed following PCNL or not. Tubeless PCNL, in which no drain is placed is an available and safe option in carefully evaluated and selected patients. It is significantly associated with a shorter hospital stay, shorter time to return to normal activity, lower postoperative pain scores, less analgesia requirement, and reduced urine leakage [21]. Despite the advantages of tubeless PCNL, the insertion of a nephrostomy tube after PCNL as drainage is still considered a standard procedure as in addition to acting as drainage, it also serves as a medium to tamponade bleeding along the PCNL tract and can also provide access to perform a second exploration and percutaneous chemolitholysis if necessary [22]. In the current study, all 25 patients, had a percutaneous nephrostomy drain placed postoperatively and left in place for 24 hours.

Conclusion

PCNL is a gold standard for managing voluminous renal stones (≥ 20 mm) as it provides an innovative and efficient alternative to open surgery and to laparoscopic pyelolithotomy in resource-limited settings. It is reliable, reproducible and has fewer complications and, therefore, proves to be an excellent choice of treatment in Sub-Saharan Africa.

Acknowledgments

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Availability of Data and Materials

The data analyzed in this study are available from the corresponding author upon reasonable request.

Ethics statement

Ethical approval was obtained from the institutional review board of the Faculty of Medicine and Pharmaceutical Sciences and the ethics committee of the *Centre medico-chirugicale d'urologie* in Douala, Cameroon. The requirement for informed consent was waived due to the retrospective nature of the study.

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