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ORIGINAL RESEARCH

Role of surgery for upper urinary tract stones in low-income countries: semi-rigid ureteroscopy and percutaneous nephrolithotomy in Benin

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Background: Percutaneous nephrolithotomy (PCNL) and semi-rigid ureteroscopy (SR-URS) are adequate therapeutic means of treating upper urinary tract stones. This study aimed to evaluate the effectiveness of this approach in managing urinary lithiasis at the National University Hospital Centre of Cotonou (CNHU-Cotonou).

Patients and methods: This was a retrospective, descriptive study conducted at the Urology Department of the CNHU-Cotonou from 28 November 2018 to 31 December 2022. The records of patients with upper urinary tract lithiasis treated with PCNL and SR-URS were reviewed and included.

Result: A total of 121 patients were included. The average age was 46 years. The average stone size was 32 mm at the renal level and 6 mm at the ureteral level. PCNL was performed in 69 cases and SR-URS in 57 cases, with complete lithotripsy rates of 73.9% and 91.2%, respectively. In 53.6% (*n* = 37) of cases during PCNL, postoperative drainage was made by nephrostomy. During the SR-URS, a JJ-stent was placed in 92.9% (*n* = 53). The postoperative course was simple in 78.5%. A postoperative urinary tract infection was observed in 61.5% of cases. The average hospital stay was two days.

Conclusion: Endoscopic surgery is now used to treat upper urinary tract stones at CNHU-Cotonou. The combination of PCNL and SR-URS gives satisfactory results in our environment with limited equipment.

Keywords: urolithiasis, lithotripsy, percutaneous nephrolithotomy, ureteroscopy, nephrostomy

Introduction

The surgical management of urolithiasis has seen many advances in recent decades, making it less and less invasive. Three main techniques practically supplant open surgery for urolithiasis.[1] These are ureteroscopy ([URS] rigid and flexible), percutaneous nephrolithotomy (PCNL), extracorporeal lithotripsy, and, in some cases, laparoscopic surgery. Various scientific committees formulate recommendations to make an optimal surgery choice according to the characteristics of urolithiasis.[2,3]

Implementing these recommendations is often difficult due to equipment availability, especially in low-income settings. Given this context, we had to adapt the available means to different cases of lithiasis while being as minimally invasive as possible. The two techniques available in Benin are PCNL and semi-rigid ureteroscopy (SR-URS). Through this work, we aim to evaluate the outcomes and the effectiveness of these two techniques in managing urolithiasis in the Republic of Benin.

Patients and methods

This retrospective, descriptive study was conducted at the Urology Department of National University Hospital Centre of Cotonou (CNHU-Cotonou) from 28 November 2018 to 31 December 2022 (50 months). The studied population included those who suffered from urolithiasis at any level of the upper urinary tract and had surgical management during the study period. This study did not account for the patients suffering from urolithiasis whose treatment was strictly medicinal or who were not eligible for surgical treatment.

The evaluated variables included the clinical evaluation of the patients, the characteristics of the lithiasis (topography, dimensions, density), the nature of the surgical treatment, and its results. The therapeutic means studied in this work are PCNL and SR-URS. All the cases used general anaesthesia.

PCNLs were performed in the standard way (dilation to 24 Fr), systematically in the supine position, with a nephoscope size of 20 Fr. URS was performed with a semi-rigid 7.5 Fr ureteroscope. The energy used in both techniques for the lithotripsy was cordless pneumatic LithoClast®.

A urine examination ensures the sterility of the urine. When the latter is positive, directed antibiotic therapy is implemented 48 hours before the surgical procedure and empirically continued five days postoperatively. The antibiotic prophylaxis consisted of third-generation cephalosporins in case the urine culture is not sterile. We used the Medi Tech Trust irrigation tank (25 litres) to ensure good irrigation continuity during surgery.

The patients were considered “stone-free” either intraoperatively under double control (endoscopic and fluoroscopic) or on control imaging (renal ultrasound or computed tomography [CT] scan), showing no stones larger than 4 mm.

Data was collected based on a form drawn up and completed according to information from patients' medical records, the anaesthesia register, and the operative notes. Data were analysed with EpiData version 4.6.0.2 software. The quantitative variables are expressed as an average with their standard deviation, and the qualitative variables as a proportion. A probability $p < 0.05$ for these values was considered statistically significant.

Results

During the study period, 121 patients were operated on for urolithiasis.

Patient characteristics

The patients' ages ranged from 3 to 86 years, with a mean of 46 years. Some comorbidities were found among the patients, namely hypertension (22.3%), diabetes (7.4%), and thromboembolic disease (pulmonary embolism, 0.8%). According to gender, males were represented in 76.03% (*n* = 92), whereas the female rate was 23.97% (*n* = 29), i.e. a 3.17 sex ratio.

Diagnostic characteristics

The presenting symptoms were renal colic in 85.9% (*n* = 104) of cases, followed by obstructive renal failure in 9.3% (*n* = 11). Table I presents a breakdown of the patients according to their reason for admission.

Table I: Distribution according to reasons for admission

	Frequency	%
Renal colic	104	85.9
Obstructive kidney failure	11	9.3
A chance discovery on scanner	3	2.4
Haematuria	2	1.6
Sepsis	1	0.8
Total	121	100.0

Laboratory and imaging results

Imaging

All patients underwent a CT scan before surgical treatment. Ultrasound and plain abdominal X-ray were done in 96.7% (*n* = 117) and 6.6% (*n* = 8), respectively.

Chemistry and microbiology

The kidney function assessment was average in 82.7% (*n* = 100) and altered in 17.3%. Urine culture was positive in 19.3% (*n* = 24), and the most found organisms were *Escherichia coli* (45.8%) and *Klebsiella pneumoniae* (12.5%). The distribution of organisms found in the urine culture is presented in Table II.

On CT scan, the position of the stones was in the renal pelvis in 50% (*n* = 37) and the calyxes in 62.1% (*n* = 46). The average renal stone size was 32 mm, with extremes of 8 mm and 48 mm. Staghorn calculi was found in 47.8%. The density varied from 394 HU to 1 885 HU, averaging 854.5 HU.

Table II: Organisms found in the urine culture

Organisms	*n*	%
Escherichia coli	11	44.7
Klebsiella pneumoniae	3	12.5
Enterobacter sp.	2	8.3
Pseudomonas aeruginosa	2	8.3
Enterobacter cloacae	2	8.3
Staphylococcus aureus	2	8.3
Burkholderia cepacia	1	4.8
Acinetobacter sp.	1	4.8
Total	24	100.0

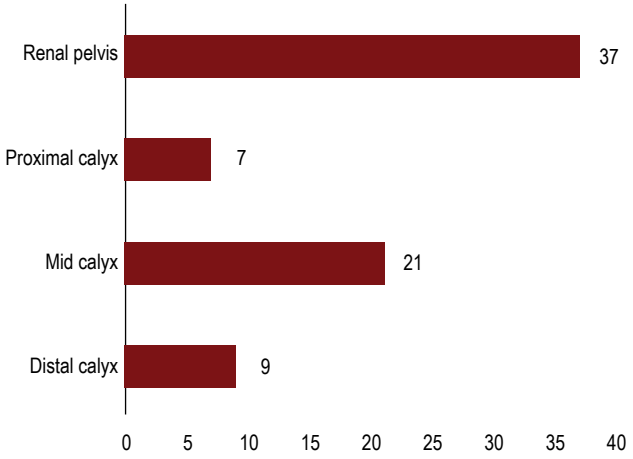

Figure 1: Stone position in the kidney

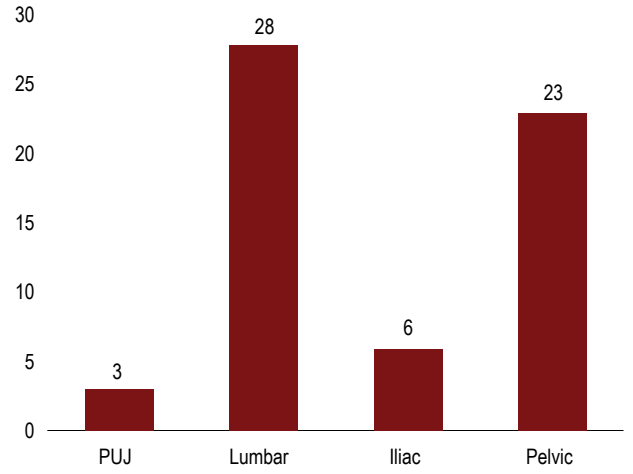

Figure 2: Stone position in the ureter
PUJ – pelviureteric junction

At the ureter, stones were primarily located in the lumbar ureter, with a rate of 46.8%. An average of 6 mm was measured, with 13 mm and 53 mm extremes. The density ranged from 798.5 HU to 1 406 HU, with an average of 387 HU. Figures 1 and 2 show the stone location distributions in the kidney and ureter. Figure 3 shows multiple bilateral renal pelvic lithiasis complicated by bilateral hydronephrosis with laminated renal parenchyma.

Previous treatment

Emergency procedures are occasionally performed while awaiting treatment for known urolithiasis. These procedures are shown in

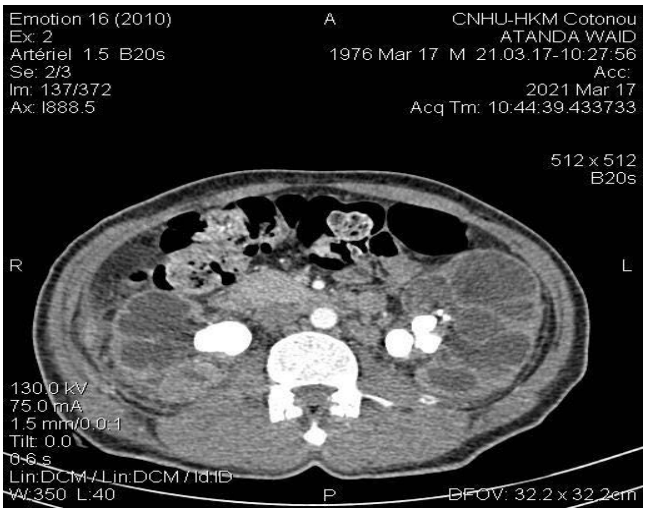

Figure 3: CT image of bilateral renal pelvis stone; on the right are multiple bilateral renal calculi, and on the left are five stones, the largest measuring 4.8 mm and 1 273 UH in density

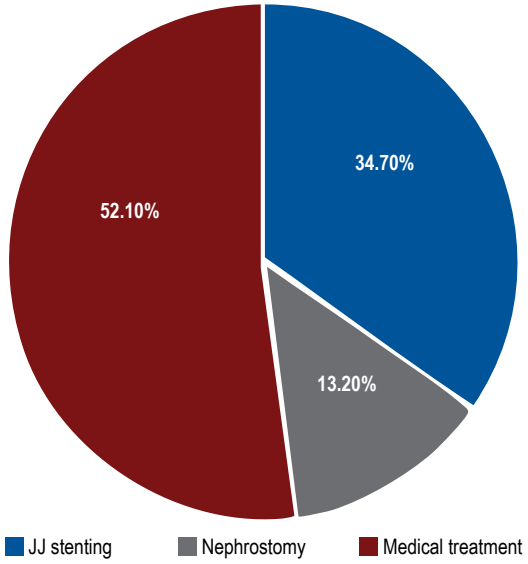

Figure 4: Procedure rates before lithotripsy

Figure 4. The medical treatment consisted of analgesics, anti-inflammatories, and antibiotics.

Breakdown by type of surgery performed

Percutaneous nephrolithotomy (PCNL)

We performed 69 PCNL procedures with a stone-free rate of 73.9% (*n* = 51) versus 10.8% (*n* = 6) incomplete clearance. Post-PCNL drainage was done in 53.6% (*n* = 37) of nephrostomy, with JJ-stent placement in 20 patients (29%), and double drainage by nephrostomy and JJ-stent placement in 17.4% (*n* = 12).

The average baseline haemoglobin level of the patients was 14.8 g/dl. During surgery, 13 patients were transfused. Transfused patients had an intermediate haemoglobin level of 12.9 g/dl, with extremes of 09.5 g/dl and 15.2g/dl.

Ureteroscopy (URS)

We performed 57 URSs, with a 91.3% (*n* = 51) stone-free rate. URS was preceded by JJ-stent placement in 12 patients. Preoperatively, drainage was performed by a JJ-stent at the end of the procedure in 53 patients (92.9%). The stone-free status correlated well with preoperative drainage ($p = 0.03$).

The average procedure duration was 72 minutes (1 hour and 12 minutes) per URS, ranging from 138 minutes (2 hours and 18 minutes) to 185 minutes (3 hours and 3 minutes). URS combined with NLPC was performed in five patients, i.e. in 4.1% of cases where the ureteral lithiasis at the start is retropropulsed into the renal pelvis (two cases) and in patients with both ureteric and renal lithiasis (three cases).

Evolution

The postoperative follow-up was simple in 78.5% (*n* = 95) of cases. Postoperative complications were classified according to Clavien–Dindo and are presented in Table III.

Table III: Distribution of complication grades according to Clavien–Dindo classification

Clavien–Dindo classification	*n*	%
I	3	11.5
II	16	61.5
III	5	19.2
IV	1	3.9
V	1	3.9
Total	26	100.0

The rate of urinary complications was 21.5%, the most frequent of which was sepsis, followed by moderate haematuria spontaneously resolving (61.5%) or self-limited by haemostatics (30.8%). There was a statistically significant difference between positive urine culture and sepsis ($p = 0.01$). One death was related to these procedures. There was no significant link between renal colic and the type of surgery ($p = 0.17$).

Reoperations were observed in 18 patients. The causes of reoperation were peritoneal irritation (requiring JJ-stent placement), partial lithotripsy, and material defects occurring during the first operation.

The median duration of ureteral drainage (JJ-stent) was 13–139 days, with an average of 56 days. The average nephrostomy time was three days, with extremes of six and two days. The hospital stay time was 5–11 days, with an average of two days.

Postoperative imaging was performed to confirm that the patients were stone-free. Ultrasound was used for 27 patients, and CT for 44 patients. There was radiological confirmation of 62 patients as stone-free (51.2%).

Discussion

Dealing with stones in the upper urinary system is an essential part of a urology department's activities. Therapeutic indications have undergone profound changes in recent years. These developments leave virtually no room for open surgery. Developing countries are still struggling to align themselves with these recommendations.[2,3]

The advantages of minimally invasive endoscopic surgery are widely recognised, even if they pose numerous problems with the availability of necessary and fragile equipment. The longer lifespan and more accessible maintenance make rigid and semi-rigid endoscopes the most accessible to offer endoscopic stone treatment, particularly in developing countries like ours where the need is growing.[1]

PCNL, URS (rigid and flexible), and extracorporeal lithotripsy are essential treatment methods for upper urinary tract stones with concrete indications.[2,3] PCNL is the technique of choice for large stones (L20 mm) located in the pylon-calyceal system.[5] SR-URS is a well-established surgical technique indicated for the treatment of ureter stones. This consists of operating retrogradely in the ureter under visual and fluoroscopic control.[4]

Urolithiasis remains a pathology of the subject of quarantine. Painful crises are mainly found in our study, confirming the typical clinical expression of lithiasis of the upper urinary tract.[2] The lithiasis is confirmed by imaging; a CT scan was used for all our patients since it is the imaging of choice for urolithiasis. Another aspect is that the CT scan is independent of the patient's and the physician's opinions.[2] A CT scan has become mandatory before any urological procedure for stone treatment to better understand the urinary tract's morphology and the stone's characteristics (size, shape, topography, and density).[9] The availability of CT has improved, even though the cost and accessibility remain a challenge in our countries.

In emergencies, such as renal colic, JJ-stent placement or a nephrostomy was performed while awaiting lithotripsy in 52.1% and 13.2% of cases, respectively. The emergency procedures performed were indicated in cases of hyperalgesic renal colic or obstructive pyelonephritis or to prepare the ureter for lithotripsy.[10] Treating complicated renal colic due to urolithiasis is surgical and consists of draining the urine from the upper urinary tract.[2] Other authors recommend first-line extracorporeal lithotripsy before resorting to PCNL or SR-URS.[11] This process is still not easily accessible in developing countries.

The average age of our patients was 46 years. Laziri et al.[6] noted an average age of 39 years in their series. Niang et al.[7] and Perez Castro et al.[8] reported an average age of 44.7 years, with 48.8 and 49 years, respectively.

Stones were more extensive and dense in the PCNL group than in the URS group. These results are identical to those in the literature.[9] The diameter of the renal pelvis is greater than that of the ureters, favouring the formation of macro lithiasis. In addition, PCNL is indicated for kidney stones with a diameter greater than 2 mm because these stones take the longest to fragment, and the probability of complete treatment in a single URS stage is low.[10,11] Miniaturised forms of PCNL are increasingly being developed, which can treat stones with diameters less than 2 mm.[12-13]

Furthermore, the absence of other alternatives for endoscopic treatment of upper tract stones led us to extend our indications to stones of smaller diameters. The smallest diameter observed in our series was 8 mm. The other types, namely extracorporeal lithotripsy and flexible URS, have high costs and are difficult to maintain for the means available to our health systems.[14-15]

Our study's stone-free rate for the two groups is lower than that of several other studies.[16-20] Three main reasons can explain this difference. First, the size of the stone included in our series is greater than that of other series, comparing PCNL and URS. In our centre, PCNL and URS are used for stones greater than one centimetre in diameter because these are the two means of available endoscopic treatment. Secondly, our study included all patients for whom surgery was attempted or failed, including those for whom stone fragmentation was partially performed or stopped for defective material or purulent urine. The third reason for this difference is the recent introduction of PCNL and SR-URS to our therapeutic tools according to the period of this study. The learning curve of PCNL is sometimes known to be long and difficult.

Postoperative drainage by JJ catheter was used in 29% of cases in the PCNL group and 92.9% in the URS group cases. Several authors approve ureteral drainage for the initial treatment of ureteral trauma induced by URS; its interest is discussed when URS has been simple.[19] Ureteral drainage would prevent postoperative complications, such as lumbar pain secondary to ureteral oedema and the development of ureteral stenosis, also facilitating the evacuation of stone fragments after lithotripsy. Nevertheless, ureteral drainage seems to be questioned by several authors.[9,10] Several disadvantages of JJ-stent ureteral drainage are listed in the literature. Chi et al.[20] found signs of bladder irritation in 83% of patients drained by JJ ureteral catheter. They recommended not using the JJ ureteral catheter, given the intensity of the discomfort felt by 44% of patients.[20]

Since the first use of PCNL, nephrostomy has been indicated to quantify bleeding, allow tamponade of the access trajectory, create a urinary diversion, and provide access to a secondary procedure if necessary.[21,22] Despite this drainage, up to 17% of residual kidney stones remain.[23] The importance of the residual fragments has been discussed by authors, although currently, there is a consensus to define them as smaller than 4 mm.[4-6,21,22] In 1997, Bellman et al.[24] described tubeless PCNL, which consists of leaving an internal catheter in place for possible revision; they used a JJ-stent as an internal bypass. This procedure has reduced the need for analgesia postoperatively, shown shorter hospital stays, and a faster return to normal activities. This modality has undergone numerous modifications.

In our study, the average postoperative upper urinary tract drainage duration in URS was significantly longer than PCNL. The nephrostomy tube has a risk of reno-cutaneous fistula if its stay is prolonged. The surgical time was longer for PCNL because this procedure requires two stages: a first stage via the urethra (a retrograde endoscopic approach for placing the ureteral catheter) and a percutaneous stage. The time for the approach is longer due to the need for ultrasound identification and the dilation of the puncture route, which is not the case in the URS process.[11] The literature explains the difference because ureteroscope operators

have set themselves a maximum working time within the renal cavities to limit the associated risk of hyper pressure.[22] It is accepted that the PCNL process should not exceed two hours.[10] In this study, the average duration exceeds two hours. This was due to many factors, such as the financial challenge of facing multiple surgeries, the study period, and the training time.

Postoperative complications in both procedures were dominated by sepsis. Grisard et al.[11] found haematuria and pain as complications. Our result can be explained by the long operating time and lithotripsy, which leads to the spread of germs and pyuria during the operation.

Postoperative imaging confirmed only 62 patients as stone-free. This is lower than the intraoperative confirmation during the PCNL and URS processes. We primarily relied on perioperative checking to evaluate the patients as stone-free.

Conclusion

Progress in the surgical management of urinary lithiasis is considerable. The gold standard remains minimally invasive surgery. In this context, rigid endoscopy offered satisfactory results in low-income countries based on PCNL and SR-URS. These two techniques have considerably supplanted open surgery to treat our centre's lithiasis.

Conflict of interest

The authors declare no conflict of interest

Ethical approval

The data was collected and processed while preserving the patients' anonymity and the confidentiality of the information collected.

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