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Original article

Urolithiasis Management in Resource-Limited Settings: A Multicentric Retrospective Study in the Democratic Republic of Congo

Pablo Kuntima Diasiama Diangienda [1], Dieudonné Molamba Moningo [1], Alain Ngoma [2], Mathieu Nkumu Loposso [1], Michel Daudon [3]

[1]Department of Urology, Faculty of Medicine, University of Kinshasa, Kinshasa, Democratic Republic of Congo.
[2]Department of Clinical Biology, Faculty of Medicine, University of Kinshasa, Kinshasa, Democratic Republic of Congo.
[3]Functional Explorations Department, Faculty of Medicine, University of Pierre and Marie Curie, Paris, France.

*Corresponding Author: Pablo Diangienda Kuntima Diasiama, MD, PhD; *pablodiang@gmail.com, diangkdd@yahoo.fr*

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Abstract

Introduction: Despite the increasing use of minimally invasive surgery techniques in the management of urolithiasis worldwide, resource-limited countries are still experiencing various challenges. This study aims to analyze different therapeutic modalities used in the treatment of urolithiasis in the Democratic Republic of Congo. ***Methods:*** After Institutional Review Board approval, records of 194 patients who presented with documented urolithiasis in 13 hospitals across 4 provinces from January 2010 through September 2019 were retrospectively analyzed. The different layers of stones were analyzed by infrared spectrophotometry. ***Results:*** Urolithiasis was symptomatic in 52.6% (n=194) of patients. Overall, 86.1% (i.e. 167 out of 194) of stones were removed by surgery, 9.8% spontaneously resolved; 3.1% were extracted after ureteroscopy and 1% of patients had undergone extracorporeal shock wave lithotripsy. Lumbotomy was the most used route (45.2% of cases) in conventional surgery. ***Conclusion:*** Most patients in this study were treated by conventional surgery. These results suggest the need to increase the use of minimally invasive surgery.

Keywords: ***urolithiasis, clinic, treatment, chemical composition.***

Introduction

Urolithiasis is a common health problem and a source of morbidity and mortality around the world. Over time, the prevalence of lifetime risk for urolithiasis has been increasing [1-3]. In recent years, treatment options of this condition have evolved, mostly the surgical aspect. This treatment is currently well standardized, both in emergency situations and in long-term treatment which requires a more complete assessment [4]. Various treatment modalities have evolved over the years. Recently, there have been important advancements in minimally invasive techniques. Treatment modalities include extracorporeal shock wave lithotripsy (ESWL), percutaneous nephrolithotomy (PCNL), retrograde intrarenal surgery (RIRS) and laparoscopic ureterolithotomy. However, discrepancies exist regarding these treatment options around the world. In industrialized countries, conventional surgery only accounts for one percent of treatments, micro-invasive surgery becoming the most widespread therapeutic modalities [4,5]. In a resource-limited setting such as the Democratic Republic of Congo (DRC), conventional surgery is still widespread. However, data on the various treatments options in this setting are lacking. Therefore, this study aimed to analyze the different therapeutic modalities used in the treatment of urolithiasis in the DRC.

Patients and Methods

Design, setting, period and population of the study

This was a cross-sectional study including patients treated for urolithiasis in various public and private hospitals in the DRC from January 2010 through September 2019. Only patients treated during this study period and whose stones were analyzed at the Functional Explorations Department of TENON Hospital (APHP, Paris, France) were included. The setting included public and private hospitals in the 4 provinces of the DRC: the city of Kinshasa, Kongo Central Province, South Ubangi Province and the province of South Kivu. The sampling approach was carried out by reasoned or strategic choice; thus, 194 patients took part in this study. Only patients followed during this study period whose stones were analyzed at Tenon Hospital were included in this study.

Infrared analysis of stones and parameters of interest

The different layers of stones were analyzed by Fourier transform infrared spectrophotometry (Vector 22 FT-IR spectrophotometer, Bruker Optics, Champs-sur-Marne, France) in absorbance mode by accumulation of 32 spectra between 4000 and 400 cm-1, with a resolution of 4 cm-1. The stones were classified according to their main component (chemical or crystalline body representing the large proportion in a given stone).

Data relating to demographic characteristics, clinical features, modalities of diagnosis and treatment were extracted from the clinical records and included: age, sex, body mass index (BMI), site of the stones, their obstructive or not nature, the state of the ipsilateral kidney (for stones of the upper apparatus), the circumstances of discovery, the annual frequency, the profession of the patients, the large diameter of the stones, their mode of elimination, the approach used in conventional surgery, as well as the main components of the stones analyzed.

In addition we investigated the possible link between the mode of elimination, the site of the stones, their average diameter and the main types of each stone analyzed. BMI was categorized into four groups following the World Health Organization (WHO) guidelines; underweight (BMI <18.5), normal/healthy weight (BMI 18.5 to <25), overweight/pre-obesity (BMI 25 to <30), and obesity (BMI >=30). The profession was categorized as civil servant, liberal, student / pupil and unemployed. Any employee of the state public service was considered a civil servant, while any unemployed individual with or without professional qualification was considered unemployed. The stones were classified into two categories depending on whether or not their size was greater than 20mm.

Statistical analysis

Data encoding was performed on Excel 2013 software and then transferred to SPSS 22.0 Statistics software version 22.0 (IBM, Armonk, USA). Continuous variables were expressed as means and medians. Categorical variables were summarized into proportions. Differences in categorical variables between groups were assessed using Chi square test or the chi-square likelihood-ratio as appropriate. Differences in means were assessed by the student's t test. P values less or equal to 0.05 were interpreted as statistically significant. Statistical analysis was performed using SPSS Statistics software version 22 (IBM, Armonk, USA)

Results

Among the 194 patients included in this study, 69% (n=133) were males, with a M / F sex ratio of 2.2. The ages ranged from 4 to 87 Years with a median of 50 years and a mean (SD) of 48.1 years (17.3). BMI was available for 99 patients, among which 40.4% had normal BMI, 39.4% were overweight, 16.2% were obese, and 4% were undernourished. Compared to males, females had a higher BMI (27.4 ± 4.7 vs. 24.9 ± 4.2, p = 0.002). Of The upper tract was the commonest sites of lodgment accounting for 61.3% (n=119) across ages and gender. The ureters (26.3%) and the bassinet (12.9%) were the anatomical sites most commonly involved. Pyelo-caliceal, caliceal, and pyélo-ureteral junction stones accounted for 9.8%, 9.3%, and 3.1%, respectively. Among stones lodged at the upper urinary tract, 94 (79%) were obstructive. In 13 patients (11%) the ipsilateral kidney was destroyed (**Figure 1**). At the level of the lower urinary tract, bladder and urethra stones accounted for 37.6% and 1% respectively.

Lithiasis was symptomatic in 72.3% of patients (n=194) and its discovery was incidental on medical imaging (ultrasound or standard radiography) in 22.7% of patients or intraoperatively (during surgical treatment of lower obstructive uropathy) in 5% of cases. The most frequent clinical features were flank pain (29.7%), low back pain (24.1%), dysuria (12.8%), hematuria (6.4%), and urinary tract infection (1.4%) (**Table 1**).

Regarding professional status, 28.9% of patients were unemployed, 16.5% were civil servants, 10.8% were self-employed, and 9.3% were students. Data were available only for 127 patients (**Table 2**). Obstructive uropathies were 6.5 times more frequent in patients with lower tract stones compared to those with upper tract stones (p < 0.001) (**Table 2**).

The vast majority of the patients with urolithiasis (85.6%) were managed with conventional surgery (the case of figure 2). Nineteen stones (9.8%) resolved spontaneously, 6 (3.1%) were extracted after ureteroscopy (URS) and 2 stones (1%) were treated by ESWL (**Table 2**).

Upper tract stones were 2.4 times more often cleared spontaneously than lower tract stones (12.6% upper urinary tract vs. 5.3% lower urinary tract, p < 0.001) (**Table 2**).

In conventional surgery, lumbotomy (45.2%) was the most used approach. Cystolithotomy was performed on 69 patients (41.6% of all conventional surgical procedures) (**Table 2**).

Stones containing calcium oxalate (whewellite) predominated (65.5%, n=127), followed by anhydrous uric acid (11.3%, n=22), and carbapatite (7.2%, n=14). Struvite and anhydrous uric acid were the predominant types in the lower tract (p < 0.001) (**Table 3**).

The mean size of the extracted stones was 23.4 ± 17.0 mm (a median of 19.5 mm). Forty-five stones from the lower urinary tract (60%) had a diameter of 20 mm or larger (figure 3). The mean size of lower tract stones was twice as large as that of upper tract stones (34.1 ± 21.0 mm vs. 16.6 ± 8.6mm, p<0.001). Stones that resolved spontaneously had a mean size 2.9 times smaller than that of stones removed by conventional surgery (8.4 ± 3.9 mm vs 24.8 ± 17.1mm, p = 0.005) (**Table 3**).

Table 1: Demographic and clinical characteristics

Characteristics	n=194 (%)
Age, median (years)	50
Male, n (%)	133(68.6)
Female, n (%)	61(31/4)
Presentation of clinical features, n (%)	
Flank pain	107(55.1)
Dysuria	23(11.9)
Nausea/vomiting	51(26.3)
Hematuria	11(5.7)
Urinary tract infection	2(1.0)
Number of seats of stones, n (%)	
One site	174(89.7)
Two sites	20(10.3)
Anatomic stone sites (1), n (%)	
Upper urinary tract	119(61.3)
Lower urinary tract	75(38.7)
Anatomic stone sites (2), n (%)	
Ureter	51(26.3)
Pyeloureteral junction	6(3.1)
Pyelocaliciel	19(9.8)

Other	118(60.8)
Therapeutic modalities, n (%)	
Conventional surgery	166(85.6)
Ureteroscopy	7(3.6)
Extracorporeal lithotripsy	2(1.0)
Spontaneous elimination	19(9.8)

Table 2: Patient characteristics, stone size according to their site and techniques of conventional stone surgery according to their site

	Sites of stones			
Variables	Upper tract n=119(%)	Lower tract n=75(%)	All n=194(%)	p
Profession				0.113
Unemployed	35(29.4)	21(28.0)	56(28.9)	
Official	15(12.6)	17(22.7)	32(16.5)	
Liberal	17(14.3)	4(5.3)	21(10.8)	
Student / pupil	9(7.6)	9(12.0)	18(9.3)	
Unspecified	43(36.1)	24(32.0)	67(34.5)	
Obstructive uropathy				<0.001
Yes	6(5.0)	39(52.0)	45(23.2)	
No	113(95.0)	36(48.0)	149(76.8)	
Treatment modalities				<0.001*
Surgical	95(79.8)	71(94.7)	166(85.6)	
Spontaneous	15(12.6)	4(5.3)	19(9.8)	
Ureteroscopy	7(5.9)	0(0.0)	7(3.6)	
LEC	2(1.7)	0(0.0)	2(1.0)	
Stones diameter				
Average (mm)	16.6±8.6	34.1±21.0	23.4 ± 17.0	<0.001
≤20	80(67.2)	26(34.7)	106(54.6)	
> 20	26(21,8)	45(60.0)	71(36.6)	
Fragments	13(10.9)	4(5.3)	17(8.8)	
Pathways / Acts	Sites of stones		All n=166(%)	
	Upper tract n=95(%)	Lower tract n=71(%)		
Lumbotomy				
Total nephrectomy	13(13.7)	0(0.0)	13(7.8)	
Nephrolithotomy	12(12.6)	0(0.0)	12(7.2)	
Pyelolithotomy	41(43.2)	0(0.0)	41(24.7)	
High ureterolithotomy	9(9.5)	0(0.0)	9(5.4)	
Para rectal				
Middle and low ureterolithotomy	20(21.0)	0(0.0)	20(12.0)	
Suprapubic median				
Cystolithotomy	0(0.0)	69(97.2)	69(41.6)	
Perineal				
Urethrolithotomy	0(0.0)	2(2.7)	2(1.2)	

**Likelihood-ratio chi-square*

Table 3: Size and types of stones by management modalities

	Management modalities					
Variables	**Surgical N=166**	**Spontaneous N=19**	**Ureteroscopie N=7**	**ESL N=2**	**All n=194**	**P**
Large dimension (mm)	24.8±17.1	8.4±3.9	8.3±2.1	13,0±0,0		<0.001*
≤20	85(50.9)	17(89.5)	3(50.0)	1(50.0)	106(54.6)	
>20	71(42.5)	0(0.0)	0(0.0)	0(0.0)	71(36.6)	
Fragments	11(6.6)	2(10.5)	3(50.0)	1(50.0)	17(8.8)	
Majority components						0.628
Whewellite	108(65.1)	14(73.7)	4(57.1)	1(50.0)	127(65.5)	
Anhydrous uric acid	19(11.4)	2(10.5)	0(0.0)	1(50.0)	22(11.3)	
carbapatite	12(7.2)	0(0.0)	2(28.6)	0(0.0)	14(7.2)	
Weddellite	10(6.0)	3(15.8)	1(14.3)	0(0.0)	14(7.2)	
Struvite	10(6.0)	0(0.0)	0(0.0)	0(0.0)	10(5.2)	
Ammonium urate	6(3.6)	0(0.0)	0(0.0)	0(0.0)	6(3.1)	
Cystine	1(0.6)	0(0.0)	0(0.0)	0(0.0)	1(0.5)	

**Likelihood-ratio chi-square*

Left pyonephrosis on pyelic calculus in a 49-year-old female patient who underwent nephrectomy. It was an irregularly shaped stone 19 mm in large diameter, with a heterogeneous, bumpy, rough surface with the presence of confluent deposits in layers of beige color. Heterogeneous section, crystalline, concentric and radial at the periphery and without detectable organization in depth, dark yellow-brown to dark brown. Majority composed of 79% whewellite.

Figure 1: Left pyonephrosis on pyelic calculus

Bilateral radiopaque pyelocalicial stones in a 63-year-old patient removed surgically (lumbotomy). Stones measuring 35X25X18 mm on the left and 31X25X24 mm on the right with a crystalline surface, spiculated and light brown-yellow to dark brown in color and composed essentially of whewellite and weddellite.

Figure 2: Bilateral pyelocalicial radiopaque stones extracted by lombotomy

a. 81X58X37 mm diameter oval calculus, surgically extracted from the bladder of a 47-year-old patient with benign prostatic hyperplasia. Stone predominantly composed of 86% uric acid.

b. Irregular stone of 65X30X26 mm, extracted from the urethra of a 12-year-old patient followed for posterior urethral valves. Stone predominantly composed of ammonium acid urate.

Figure 3: Illustrations of the two stones removed from the lower urinary tract.

Discussion

Our findings revealed that the majority of patients with urolithiasis were male and that the most frequent presenting feature was flank pain. Urolithiasis was symptomatic in 72.3% of patients and its discovery was incidental (on medical imaging or during surgery) in 20.1% of cases. Renal colic was the most common presenting feature. This is consistent with findings from earlier studies conducted elsewhere [6,7]. Indeed, clinical manifestations revealing urolithiasis are often unrelated to the chemical type of stones and lend themselves to a common description. Typical renal colic is the most frequent revealing feature [2,4]. Pain in renal colic results from the sudden and significant increase in intrapyelic pressure above the urethral obstacle [2,4,8-10]. The increase in intrapyelic pressure can be explained by two factors. The first is anatomical due to the formation of a circular edematous ridge in the wall of the ureter around and above the enclosed stone and the second is functional due to an uncontrolled homeostatic reaction with the secretion of prostaglandins E2; hence justifying the use of non-steroidal anti-inflammatory drugs in the symptomatic treatment of renal colic [2,4]. Therefore, patients presenting with renal colic should be carefully evaluated for urolithiasis to mitigate underdiagnosis cases. However, less characteristic pain or other signs (Hematuria in 4.3% of cases and urinary tract infection in 1% of cases in this series) may also be indicative of urolithiasis. It is not uncommon for a kidney stone to be discovered incidentally on an unprepared abdomen x-ray, abdominal ultrasound, or when developing proteinuria, urinary tract leukocyturia, pyuria or macroscopic hematuria. In some cases, urolithiasis is discovered with major complications, including acute pyelonephritis, stone anuria or chronic renal failure [2,4,11]. It should also be noted that typical renal colic is rare in young children and is observed mainly from the age of 15 and that in case of diagnostic doubt, after performing the unprepared abdomen x-ray and ultrasound, the CT scan without injection is now recognized as the benchmark examination [5,11].

From a therapeutic standpoint, our study revealed that most of stones (85.6%) were extracted by conventional surgery, 9.8% of stones were eliminated spontaneously and only 4.1% of stones were

removed by minimally invasive surgery (URS in 3.1% of cases and ESL in 1% of cases).

These results corroborate those of studies conducted in other sub-Saharan African countries. A study conducted in Cameroon reported that conventional surgery accounted for 96% [12]. In Burkina Faso, the authors report 100% use of conventional surgery [13,14]. However, our results contrast with those of studies conducted in other settings. Indeed, Laziri et al. [15] in Morocco use modern urological techniques (LEC, PNLC and URS) in 72.7% of cases. A study in France reported that URS accounted for 76% of treatment, followed by ESWL (21.3%), PNLC (2.6%) and conventional surgery (0.1%) [16]. Another study in France reported 100% use of the URS [17,18]. The difference could be explained, at least partially, by the lack of equipment and limited expertise in most African countries.

Additionally, inaccessibility to health care (28.9% of the unemployed and 10.8% with a liberal activity), Can also be a contributive factor. The large diameter of the stones described in this study and the diagnosis of urolithiasis at a stage of complications (11% of patients in this series had a destroyed kidney on the stone of the upper urinary tract) also represent a challenge for mini-surgery.

Beyond the characteristic limitations described in this study limiting the use of minimally invasive surgery in developing countries, current treatment modalities for urolithiasis are minimally invasive and include LEC, URS and PNLC [4,19] and open and laparoscopic surgical techniques have limited indications. It should also be recalled that LEC has lost its place as a first-line modality for many indications despite its proven efficacy [19]. In the perspective of complying with the current international standards established in the management of urolithiasis, we have witnessed over the past three years the progressive endowment of clinics in Kinshasa with minimally invasive surgery equipment.

In conditions of countries with limited resources, we first suggest medical treatment for any infra centimetric caliceal, ureteral or pyelic non-obstructive stone: effective diuresis (at least 2l / 24 hours and evenly distributed over 24 hours), control of urinary pH (between 6 and 7) and urine density (below 1.010), sterilization of urine, balanced and varied diet (after dietary investigation) and administration of an alpha blocker. Under this treatment, 9.8% of patients in this series spontaneously expelled their stones. Abbassene et al. [20] in Algeria reported that 51.9% of stones cleared spontaneously.

In accordance with the recommendations of the European Association of Urology (EAU) [21], conventional surgery is performed for stones with destruction of the kidney, stones with associated anatomical anomaly, coralliform stones or obstructive ureteral or pyelic stones of large diameter. Caliceal stones, sometimes difficult to access with conventional surgery and often responsible for partial renal obstruction, were medically managed until the conditions for endourological treatment were met. Finally, large-diameter bladder stones were systematically treated by conventional surgery.

Finally, it is well known that conventional surgery is associated with various complications compared to minimally invasive techniques. However, it offers the possibility of obtaining a urinary tree without stone ("stone free"). Minimal invasive techniques, beyond their complications such as lesions of the renal parenchyma (sub capsular, intra and peri-renal hematomas) and arterial hypertension linked to ESL, do not always offer the possibility of obtaining a urinary tree "Stone free": ESWL 30 to 76% of cases, URS 95% of cases for pelvic ureteral stones and 80% for kidney stones less than 10 mm and 72% for those of 10 and 20 mm and PCNL 80 in 85% of cases [4,12].

ESWL remains the gold standard for kidney stones and ureteral stones in children, and open or laparoscopic surgery is still one of the treatment options for urinary stones in children and should be reserved for single cases [11,22]. Medical expulsive therapy with an alpha-blocker may also have a beneficial effect in the treatment of ureteral stones in children. Advances in URS with clearer digital imaging and single-use ureteroscopes have made URS more attractive even in children. With the miniaturization of instruments, percutaneous PCNL, although a more invasive treatment modality, remains a therapeutic choice for large stones in children and adults [22].

The major majority body of stones was calcium oxalate, results consistent with previous studies conducted in various parts of the world [3,12,18].

To the best of our knowledge, this is the first study describing urolithiasis management in the DRC. This study was multi-centric including data from various regions across the country. Furthermore, analysis of the chemical composition of the renal stones was conducted. Information on the composition of renal stones is key in understanding the pathophysiology of urolithiasis. However, some limitations should be considered. First the relatively low sample size and missing data from some variables such as the BMI.

Conclusion

The use of minimally invasive surgery techniques in resource-constrained regions is very limited due to the various reasons such as lack of equipment, limited number of expertise, and socio-economic. Thus, preventive measures including balanced and varied diet, adequate fluid intake (>2.5 L daily), and early diagnosis would help mitigate severe cases and complications.

Key Points

What do we know?

Nowadays, the treatment of urolithiasis is turned towards minimally invasive surgery techniques which bring more advantages for both the patient and the urologist. Calcium oxalate monohydrate is the most common chemical component of urinary stones in the world

What's new?

This study outlines the various reasons limiting the use of minimally invasive surgical techniques in countries with limited resources, the strategy to overcome them and confirms on a non-negligible sample calcium oxalate monohydrate as the preponderant chemical component in a country where related data are scarce.

List of abbreviations

ESWL: Extracorporeal shock wave lithotripsy
PCNL: percutaneous nephrolithotomy
RIRS: Retrograde intrarenal surgery
DRC: Democratic Republic of Congo
BMI: Body mass index
WHO: World Health Organization
URS: Ureteroscopy

Declarations Ethics approval and consent to participate

This study was approved by the ethics committee of the School of Public Health of the University of Kinshasa. Participation of human research subjects conformed to institutional review board guidelines, applicable laws, and the World Medical Association Declaration of Helsinki.

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Conflict of Interest

No conflict of interest has been declared by the authors.

Data availability

The authors confirm that the data supporting the findings of this study are available upon request.

Author's contributions

PD, DM and MD designed, collected, interpreted, wrote and edited the manuscript. AN and ML analyzed the data, read and corrected the article. All authors have read and approved the final version of the article.

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