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Chronic Kidney Disease Secondary to Urolithiasis in Sudan: Clinical Presentation, Risk Factors and Renal Outcome

Awadelkareem Abdelgeyoom Ahmed Elshareef[1], Zohair Mohammed Salih Korena[2], Sufian Khalid Noor[1], Isam A.A. Obeid[3], Dina H. Elbashir[4], Motwakil Imam Awadelkareim Imam[2] , Ahmed Mahjoub Awad Ali[2*]

[1], Nile Valley University , Faculty of Medicine, Sudan
[2] Shendi University , Faculty of Medicine, , Sudan
[3] Ministry of Health, Khartoum State; Haj Al-Mardi Teaching Hospital, Sudan
[4] University of Science and Technology, Faculty of Medicine, Sudan
*Corresponding author: Ahmed Mahjoub Awad Ali (ahmedmahjoub649@ush.edu.sd)

Abstract: ***Background****: Chronic kidney disease (CKD) is a major global health burden. Although urolithiasis contributes to a small proportion of end-stage renal disease (ESRD) worldwide, delayed diagnosis and limited access to urological care may increase its impact in low-resource settings.* ***Objective:*** *To assess the clinical presentation, management, and outcomes of patients with CKD secondary to renal stone disease in Khartoum State, Sudan.* ***Methods:*** *A prospective, multicentre, hospital-based cohort study was conducted between April 2016 and April 2018. Adult patients with symptomatic urolithiasis for more than three months and evidence of renal impairment were enrolled. Estimated glomerular filtration rate (eGFR) was assessed at baseline and six weeks after intervention. Data were analyzed using SPSS.* ***Results:*** *A total of 215 patients were included; 64.7% were male, with the majority aged 40–59 years. Most patients originated from regions lacking specialized urological services. Delayed treatment (>3 months after diagnosis) was observed in 79.5%. Emergency intervention was required in 42.3% of cases. Complete stone clearance was achieved in 80%. At six-week follow-up, 51.6% had normal eGFR, while 8.5% progressed to ESRD. Nephrectomy was performed in 10.7%, and mortality was 1.9%. Emergency intervention and incomplete stone clearance were significantly associated with poor renal outcomes.* ***Conclusion:*** *Renal stone disease is an important and potentially preventable cause of CKD in Sudan. Delayed presentation and emergency intervention are associated with worse outcomes, while complete stone clearance significantly improves renal recovery. Strengthening early referral and urological services may reduce progression to ESRD.*

Keywords: Chronic Kidney Disease, Renal Stone, estimated GFR, Sudan.

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Introduction

Chronic kidney disease (CKD) is a worldwide health problem. The prevalence of end-stage renal disease is increasing in the United States [1]. Certain measurements were used to estimate the prevalence of CKD, such as serum creatinine, estimated glomerular filtration rate (eGFR), and albuminuria. Physiological adaptation is complete with mild renal impairment after relieving obstructive uropathy [2], but when the GFR falls below 20% of normal, progressive renal azotemia may occur [2]. Moreover, when the GFR falls below 50% of normal, a progressive renal impairment will continue even in spite of treating the underlying cause [2]. In 2012 the Kidney Disease Improving Global Outcome (KDIGO) committee adopted a classification system involving the cause of kidney disease, the eGFR, and the level of albuminuria, and they divided CKD into five stages according to the GFR level [3]. The etiologies of CKD include different groups of diseases, which can be divided into tubulo-interstitial, hereditary, primary renal disease, and systemic diseases. Diabetes mellitus and hypertension represent the most common causes of CKD, followed by glomerular diseases, while urological diseases, including urolithiasis, account for only 2% of overall ESRD. [4, 5]

The aim of this study was to assess the presentation and the outcome of patients presented with renal stones and CKD in Khartoum State, Sudan.

Methodology:

Study area:

This study had been conducted in Khartoum State from April 2016 to April 2018 in the urological departments in the governmental hospitals (Omdurman, Khartoum North, and Ibn Sinna Hospital). These centers provide good urological services in the form of open, laparoscopic & endourological services, in addition to nephrology departments.

Study **Design:**

This is a prospective, descriptive, cohort, multicenter, hospital-based study.

Study population:

Two hundred fifteen patients who presented to the referred clinics with symptomatic renal stone disease for more than 3 months were enrolled in this study.

Sample technique:

Total coverage technique.

Inclusion Criteria

Diagnosis of Chronic Kidney Disease (CKD) according to KDIGO criteria: eGFR <60 mL/min/1.73m² for ≥3 months

OR

Evidence of structural kidney damage for ≥3 months

Radiological evidence of urolithiasis (ultrasound, CT scan, or IVU)

Evidence of obstructive uropathy attributable to renal/ureteric stones

Patients managed or followed at our hospital during the defined study period.

Exclusion Criteria

CKD due to other established causes:

Diabetic nephropathy

Hypertensive nephrosclerosis

Chronic glomerulonephritis

Polycystic kidney disease

Acute kidney injury (AKI) without chronicity (<3 months)

Post-renal obstruction due to non-stone causes:

Malignancy

Prostatic enlargement

Urethral stricture

Patients with incomplete medical records

Data collection and analysis:

Data was collected by using a constructed questionnaire and analyzed by using the computer program Statistical Package for Social Sciences (SPSS). The P-value was considered significant if <0.05.

Ethical approval:

The ethical concern was approved by hospital managers, and verbal consent was taken from the patients.

Results:

Two hundred fifteen participants were enrolled in this study; 64.7% were male. The most common age group was between 40 and 59 years old (34.4%). Our patients were coming from different areas of Sudan, with more than one-third coming from western states.

Regarding the type of occupation, 38.6% of jobs were laborers or students, while 31.2% were illiterate Table [1].

The duration of symptoms before seeking medical advice was also analyzed, and we found that in 39% the symptoms lasted for more than 36 months. The time lag between the diagnosis and treatment was found to be > 36 months in 31.2%. The delay in receiving definitive treatment after diagnosis was found in 83.2%, and the cause of it was lack of medical service in 34.4%. Past history (PH) of renal stone disease was found in 54.4%; the commonest treatment modalities used in case of previous stone treatment were ESWL and open surgery Table [2]. Stone analysis and metabolic workup were done only in 1.4% Table [2]. CT KUB was done for all patients; obstructive uropathy was detected in 99.1%, commonly at the renal pelvis with multiple stones. Emergency interventions were needed in 42.3%, while 93.5% needed elective interventions Table [5]. After 6 weeks of follow-up, G1 CKD was detected in 51.6% and G5 CKD in 8.5% of pts. Complete stone clearance was achieved in 80% of patients and 42.3% of them had G1CKD, while residual stone was found in 13% with G1CKD in only 2.3%. Overall Nephrectomy (NPH) was done for 10.7%, while death was reported in 1.9%.

Table 1: Sociodemographic in 215 patients with CKD due to renal stone disease in Khartoum in the period from April 2016 to April 2018

Factors	NUMBER	%
Age groups (years)		
<20	37	17.2
20 < 40	60	27.9
40 < 60	74	34.9
60 < 80	41	19.1
80 < 100	3	1,4
Gender		
Male	139	64.7
Female	76	35.3
Resident		
Khartoum State	15	7
Gazira state	17	7.9
South states (Sinnar, Blue Nile, and White Nile)	29	13.5
Northern states (North & River Nile)	44	20.5
Eastern states (Red Sea, Kassala & Gadarif)	30	14.9
Western states (Darfur, Kordofan)	80	37.7
Occupation		
Non specific work	83	38.6
Employee	36	16.7
Student	42	19.5
Ideal for a retailer or housewife	47	21.9
Preschool	7	3.3

Level of education		
Illiterate	67	31.2
Primary	58	27
Secondary	51	23.7
Tertiary	33	15.3
Preschool	6	2,8

Table 2: Patient characteristics in 215 patients with CKD due to renal stone disease in Khartoum in the period from April 2016 to April 2018

Factors	NUMBER	%
Duration of disease		
< 1 year	73	34
1 < 2 years	40	18.7
2 < 3 years	18	8.3
3 < 4 years	84	39
Home medical services		
None	2	0.9
Medical center or dispensary	90	41.9
Rural hospital	71	33
Teaching hospital	51	23.7
Tertiary hospital	1	0.5
Interval between diagnosis and management		
<3months	43	20
3<12 months	65	30.2
12<24 months	40	18.6
24<36 months	15	7.2
36<48 months	52	24
Causes of delay		
No medical service	74	34.4

patient factors	28	13
Financial problems	64	29.8
Ignorance	13	6
No delay	36	16.8
Treatment modalities in PMH of stone		
ESWL	54	46.2
Open surgery	37	31.6
Medical treatment	4	3.4
Endourological treatment	4	2.6
Spontaneous passage	15	3.4
No treatment	117	12.8
Total (pts)		
Stone analysis results		
Hyperuricosuria (uric acid stone)	1	33.3
Hyperoxaluria (calcium oxalate stone)	1	33.3
hypercalciuria (calcium oxalate stone)	1	33.3
Total (pts)		
CT sites of stones		
Renal pelvis	103	47.9
Ureteric in 27.4% (59 patients)	59	27.4
Urinary bladder in 1.4% (3 patients)	3	1.4
Multisite and/or bilateral	50	23.3
CT number of stone		
Single stone	82	38.1
Two stones	36	16.7
Multiple stones	97	45.1

Table 3: Education levels & outcome in 215 patients with CKD due to renal stone disease in Khartoum in the period from April 2016 to April 2018

Education Level	OUTCOME									Total
	Stone free CKD stage?			Residual stone CKD stage?			Neph	NFK	Dead	
	1	2-4	ESRD	1	2-4	ESRD				
Preschool	1	3	0	1	1	0	0	0	0	6
Illiterate	7	11	6	0	8	12	20	3	0	67
Primary	31	16	0	2	4	1	3	1	0	58
Secondary	31	14	1	1	4	0	0	0	0	51
Tertiary	21	7	0	1	2	1	0	0	1	33
Total	91	51	7	5	19	14	23	4	1	215

P.value = 0.000

Table 4: Patient character and outcome between diagnosis and treatment in 215 patients with CKD due to renal stone disease in Khartoum in the period from April 2016 to April 2018

Patient's character	OUTCOME									Total
	Stone free CKD stage?			Residual stone CKD stage?			Neph	NFK	Dead	
	1	2-4	ESRD	1	2-4	ESRD				
Duration of disease										
< 1 year	40	23	0	4	4	1	1	0	0	0.13
1< 2 years	23	10	1	1	5	0	0	0	0	
2< 3 years	5	6	0	0	5	1	2	2	0	
3< 4 years	23	12	6	0	8	12	20	2	1	
Interval between diagnosis & treatment										
<3 months	29	7	0	4	1	1	0	0	1	0.00
3<12 months	32	23	0	1	4	0	1	0	0	
12<24 months	23	11	0	0	8	2	0	0	0	
24<36 months	2	2	0	0	2	6	3	2	0	
36<48 months	5	8	7	0	5	6	19	2	0	
Causes of treatment delay										
No service	28	16	2	0	8	9	9	2	0	

Patient factors	14	3	2	0	3	2	3	1	0	0.09
Financial	29	16	2	0	6	2	7	1	1	
Ignorance	4	2	1	0	2	1	3	0	0	
No delay	16	14	0	5	0	0	1	0	0	

Table 5: Surgical intervention and outcome in 215 patients with CKD due to renal stone disease in Khartoum in the period from April 2016 to April 2018

Type of Intervention	**Stone-free CKD**	**Residual stone CKD**	**NEP**	**NFK**	**Died**	**P.value**
Emergency						
Not needed	91	11	20	1	1	0.001
PCN	25	1o	2	2	0	
DJ	22	5	1	0	0	
HD	2	1	0	0	0	
combine	9	11	0	1	0	
total	149	38	23	4	1	
Elective						
None	o	9	0	2	1	0.001
PCNL	12	9	0	0	0	
URS	59	11	0	0	0	
ESWL	9	2	0	0	0	
Open surgery	43	5	0	0	0	
Laparoscopic PL	3	0	0	2	0	
Nephrectomy	0	0	23	0	0	
Combine	23	6	0	0	0	
Total	149	38	23	4	1	

Table 6: eGFR and outcome in 215 patients with CKD due to renal stone disease in Khartoum in the period from April 2016 to April 2018

eGFR	**Stone-free CKD stage**	**Residual stone CKD stage**	**Nep**	**Dead**	**NFK**	**P.value**
>90	91	5	13	0	1	0.000
90-15	41	19	10	2	0	
<15	7	14	0	2	0	

Total	149	38	23	4	1	

Discussion:

In this study 64.7% of patients were male, which was consistent with the result of the Pearl study. [6] The most commonly affected age group was between 40 and 60 years old in 34.4% of patients. This age range was also mentioned in a study conducted by Johnson[7.]

Seventy-eight percent of the patients came from areas lacking urological facilities, mainly from Kordofan, Darfur, River Nile State, North State, and the White Nile area, while patients from Khartoum and Gezira states with good urological services represent only 7% and 7.9%, respectively.

About thirty-eight percent of the patients were hospital managers, laborers, or people who work in hot weather, with excessive sweating and improper water intake. This will increase their risks of having urolithiasis, as mentioned by Chen[8]. Moreover, Fakheri and Goldfarb proved the effect of temperature on increasing stone prevalence[9].

The level of education of participants of this study was found to be an important factor, as 31.2% of patients were illiterate, and this was correlated significantly with the outcome. This result contradicts Chris's result about the education level and the risk of CKD [10].

The long interval between diagnosis and treatment in our study had worsened the outcome. The causes of delay in receiving definitive treatment were lack of urological service at home, financial problems, and lack of health insurance or patient factors, and they were found to be statistically significant, and this result was supported by the Necmettin study[11].

In 54.4% of the patients there was a past history of renal stone disease; 34.1% of them were between 40 and 60 years old, which is the commonest age for renal stone disease. Interestingly, Shang and Alexander in their studies concluded that the presence of a previous history of renal stone disease is a risk factor for renal impairment[12, 13, and 14 .]

Regarding treatment modalities used in cases of previous stone history, ESWL and open surgery (13%) were the most commonly used options. This might reflect the lack of endourological treatment. Repeated sessions of ESWL were a routine practice in the past (usually the old version) conducted by untrained personnel. We can assume the possible role of ESWL and open surgery in causing kidney damage as mentioned by the Scott McDougal and Khalaf studies[15, 16] .

Stone analysis was done for only 1.4%, and even the results were not conclusive. This may be due to the non-familiarity of the doctors with it and the lack of standard laboratory services, and this may cause recurrent stone formation with their sequel and complications, including CKD, and this was consistent with studies [17, 18].

The outcome was worse in patients who needed emergency intervention. They had more G5CKD, more death, a lower percentage of G1CKD, and a lower rate of nephrectomy. While elective intervention was associated with better G1CKD and G5CKD in only 5% of patients. This result was inconsistent with the result of Vaughan's study, which states clearly that the recovery of renal function is related to the duration of obstruction, and they put 6 weeks as the upper limit after which the kidney function will not recover completely[19] .

Complete stone clearance was achieved in 80.4% of the patients, and this can be attributed to the great advances in urological services in the last years. Those patients with complete stone clearance had favorable outcomes. Patients, Mercimek in his study found that proper treatment of stones is essential for restoration of renal function[20] .

Normal-level GFR was found in 51.6% of the patients six weeks after treatment, and it was related to the good treatment of the stone and favorable outcome.

Conclusions:

Renal stone disease is a significant contributor to CKD and ESRD in Sudan. Delayed presentation and emergency intervention are associated with poor renal outcomes, while timely and complete stone clearance offers substantial renal recovery. Strengthening early detection, improving access to urological services, and implementing preventive strategies are essential to reduce CKD burden.

Recommendations:

Clinical Practice

Early Detection and Monitoring

○Routine assessment of renal function (serum creatinine and eGFR) should be incorporated into the management of all patients with urolithiasis.

○Patients with obstructive uropathy should undergo reassessment of renal function at ≥3 months to determine chronicity.

Timely Urological Intervention

○Prompt decompression (e.g., ureteric stenting or percutaneous nephrostomy) should be prioritized in obstructive cases to prevent irreversible renal damage.

○Multidisciplinary collaboration between nephrology, internal medicine, and urology services should be strengthened.

Metabolic Evaluation

○Recurrent stone formers should undergo appropriate metabolic workup and receive individualized preventive counseling, including hydration and dietary advice.

Public Health and Policy

Awareness and Prevention Programs

○Community-based health education campaigns should emphasize adequate hydration, early symptom recognition, and timely healthcare seeking behavior.

Strengthening Diagnostic Capacity

○Expansion of ultrasound services at district and rural hospitals is recommended to facilitate early detection of obstructive uropathy.

Integration into Non-Communicable Disease (NCD) Strategies

○CKD secondary to urolithiasis should be incorporated into national NCD control frameworks, in line with broader recommendations from the World Health Organization regarding chronic disease surveillance and prevention.

Research

Prospective multicenter studies are needed to determine the national burden and long-term renal outcomes of stone-related CKD in Sudan.

Studies evaluating stone composition patterns and metabolic risk factors in the Sudanese population are warranted.

Cost-effectiveness analyses comparing early stone intervention versus long-term dialysis care would provide valuable policy guidance.

Limitations

This study is limited by its hospital-based design and relatively short follow-up period. However, it represents one of the first prospective multicentre studies in Sudan addressing renal stones as a cause of CKD.

Author's contribution statement: all the Author are shares in the all the activities

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ABBREVIATIONS

CKD	Chronic kidney disease

G (1-5) CKD	Chronic kidney disease stage (1-5)
ESRD	End-Stage Renal Disease
ESWL	Extracorporeal Shock Wave Lithotripsy
eGFR	Estimated Glomerular Filtration Rate
RRT	Renal Replacement Therapy
DM	Diabetes Mellitus
HTN	Hypertension
SPSS	Statistical Package for Social Sciences
SMSB	Sudanese medical specialization board
MET	Medical Expulsive Treatment
PL	pyelolithotomy
PT(s)	patient(s)
UL	ureterolithotomy
URS	ureterorenoscopy.
NFK	Nonfunctioning kidney
NPH	Nephrectomy
PCNL	Percutaneous Nephrolithotomy

CONFLICT OF INTEREST

The authors declared no conflict of interest

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