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Original Research Article

Renal Recovery and Dialysis Dependency after Contrast-Induced Nephropathy: Insights from a Nigerian Cohort

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Abstract: ***Background*:** Contrast-induced nephropathy (CIN) remains a significant cause of hospital-acquired acute kidney injury (AKI) globally, with limited data from sub-Saharan Africa. This study aimed to evaluate short-term renal outcomes, including recovery and dialysis dependency, in patients who developed CIN after contrast-enhanced procedures at a tertiary hospital in Nigeria. ***Methods*:** A prospective study was conducted at the University of Maiduguri Teaching Hospital involving 150 adult patients undergoing radiologic procedures requiring contrast media. Serum creatinine and cystatin C were measured at baseline, 24, 48, and 72-hours post-contrast to identify CIN, defined as an increase in serum creatinine >0.5 mg/dL or >25% from baseline. Renal function was followed up over 3 months to assess outcomes. ***Results*:** CIN was diagnosed in 30% of patients using creatinine and 49.3% using cystatin C. Among the 45 patients diagnosed with CIN, 33 (73.3%) experienced complete renal recovery within two weeks. Eight (17.9%) had persistent renal dysfunction, of which six recovered without dialysis, while two (4.6%) required dialysis. At three months, one patient remained dialysis-dependent, two had not recovered, and four were lost to follow-up. Major predictors of CIN included advanced age, higher contrast volume, elevated baseline serum creatinine, and reduced estimated glomerular filtration rate (eGFR). ***Conclusion*:** CIN is a prevalent complication following contrast administration in this Nigerian cohort. While most patients recover within weeks, a subset remains at risk for persistent dysfunction and dialysis dependency. These findings underscore the importance of risk stratification and close follow-up in resource-limited settings.

Keywords: Contrast-Induced Nephropathy, Acute Kidney Injury, Renal Recovery, Dialysis, Cystatin C, Creatinine.

INTRODUCTION

Contrast-induced nephropathy (CIN) represents a significant iatrogenic cause of acute kidney injury (AKI) and is increasingly recognized as a major contributor to hospital-acquired renal dysfunction worldwide. CIN is clinically defined as a sudden rise in serum creatinine exceeding 0.5 mg/dL or a ≥25% increase from baseline within 48 to 72 hours following the intravascular administration of iodinated contrast media [1]. Despite advances in the safety profile of contrast agents, CIN continues to be a common and serious complication, particularly in high-risk populations such as the elderly, diabetics, and patients with pre-existing renal impairment [2].

Although the global burden of CIN is well documented, data from Sub-Saharan Africa remain limited. In resource-limited settings such as Nigeria, the

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growing availability and utilization of contrast-enhanced imaging modalities including CT scans, angiography, and interventional radiological procedures have led to an increased risk of CIN [3], often compounded by inadequate preventive protocols and delayed recognition of kidney injury. In developed countries, CIN is now the third leading cause of hospital-acquired AKI, accounting for approximately 12% of cases [4, 5]. However, in Nigeria, the true burden remains underexplored, and its clinical consequences may be underestimated [4-13].

Traditionally, serum creatinine has served as the standard biomarker for diagnosing CIN, but its delayed kinetics limits its ability to detect early renal injury [6]. Cystatin C, a cysteine protease inhibitor produced by all nucleated cells, has emerged as a more sensitive and earlier biomarker of kidney dysfunction [7, 8]. It is freely filtered by the glomerulus, not secreted by renal tubules, and less influenced by age, sex, muscle mass, and diet, making it a more stable and potentially superior marker for early detection of CIN. Yet, its utility in African populations remains insufficiently characterized.

The clinical course of CIN is usually benign in most cases, with renal function returning to baseline within a few days to weeks [9]. However, in some patients, particularly those with co-morbidities, CIN can lead to prolonged renal dysfunction, dialysis dependency, and even irreversible kidney failure [10, 12]. These outcomes carry significant prognostic and economic implications, especially in low-resource settings where access to renal replacement therapy is limited and costly.

Previous Nigerian studies, such as the one conducted by Okoye *et al.,* [3]. In Benin, reported a CIN incidence as high as 35.9%, highlighting the pressing need for contextual data and region-specific risk stratification. Despite increasing awareness of CIN, there remains a critical knowledge gap regarding the long-term renal outcomes of affected patients, particularly in terms of the proportion who fully recover, develop persistent dysfunction, or require dialysis.

This study addresses this gap by investigating the renal recovery patterns and dialysis dependency rates among a cohort of patients who developed CIN following contrast-enhanced imaging at a tertiary hospital in north-eastern Nigeria. By combining traditional and novel biomarkers serum creatinine and cystatin C this study aims to provide deeper insights into the trajectory of CIN in a real-world Nigerian setting. Understanding these outcomes is essential for guiding clinical decision-making, optimizing preventive strategies, and informing policy on the use of contrast media in vulnerable populations.

MATERIALS AND METHODS

Study Population and Diagnostic Criteria

The study was conducted in Maiduguri, the capital of Borno State, located in North-Eastern Nigeria (Latitude 11.83110° N, Longitude 13.15100° E). The University of Maiduguri Teaching Hospital (UMTH), where the study took place, is the largest tertiary referral center in the region. It serves not only Borno State but also the surrounding states of Yobe, Adamawa, Gombe, and Bauchi, as well as neighbouring countries including Cameroon, Chad, and the Niger Republic. The Radiology Department at UMTH is equipped with facilities for advanced imaging modalities, including X-ray, magnetic resonance imaging (MRI), and computed tomography (CT), many of which involve the use of iodinated contrast media.

The study population consisted of 150 adult patients (aged 18 years and above) who were referred to the Radiology Department for diagnostic procedures requiring intravenous iodinated contrast administration. Only patients who provided informed written consent were enrolled. Exclusion criteria included patients with known end-stage renal disease (ESRD) on dialysis, recent exposure to contrast media within the past 7 days, hemodynamic instability, known allergy to contrast agents, or active systemic infections.

CIN was diagnosed using standard criteria:

- Serum Creatinine-Based Definition: An absolute increase in serum creatinine of >0.5 mg/dL (44 μmol/L) or a relative increase of >25% from baseline within 48–72 hours after contrast administration.
- Serum Cystatin C-Based Definition: A rise in serum cystatin C of >10% from baseline at 24, 48, or 72-hours post-contrast exposure, based on previous literature supporting its use as an early biomarker for AKI.

All participants underwent baseline renal function assessment using serum creatinine and serum cystatin C. Follow-up samples were collected at 24, 48, and 72 hours after contrast administration. The estimated glomerular filtration rate (eGFR) was calculated using the 2012 CKD-EPI equations for both biomarkers. Renal outcomes were monitored for up to 3 months following contrast exposure.

Inclusion and Exclusion Criteria

Inclusion

All patients undergoing contrast studies in Radiology Department of UMTH who are 18 years and above and have consented.

Exclusion

- Failure to obtain consent from subjects/refusal of subjects to participate in the study

- Subjects with documented end stage renal disease or on maintenance haemodialysis
- Patients in any shock state or severe debilitation
- Subjects who have uncontrolled hyperthyroidism/ thyroid malignancies
- Subjects in heart failure New York Heart Association class III and IV
- Exposure to contrast in the last 24-48hours
- Nursing/pregnant subjects.
- History of hypersensitivity to contrast in the past
- Post renal transplant recipient

Statistical Analysis

Data were analysed using IBM SPSS Version 21.0. Categorical variables were summarized as frequencies and percentages, while continuous variables were expressed as means and standard deviations. The Chi-square test assessed associations between categorical variables and CIN. For continuous variables, normality was tested using Kolmogorov-Smirnov and Shapiro-Wilk tests. Since the data were not normally distributed, the Mann-Whitney U test was used for comparisons. Variables significantly associated with CIN were entered into binary logistic regression to identify independent predictors, followed by multinomial logistic regression to evaluate their predictive value for short-term renal outcomes. A p-value ≤0.05 was considered statistically significant.

RESULTS

Sociodemographic Characteristics

The mean age of the participants was 49.2 ± 15.4 years, with an age range of 23 to 75 years. The largest proportion of subjects (33.3%) fell within the 50–59-year age group (n = 50), followed by those aged 60–69 years, who constituted 20.7% (n = 31). Participants aged 18–29 years were the least represented, with only 6 individuals (4%).

A total of 92 participants (61.3%) were male, while 58 (38.7%) were female, resulting in a male-to-female ratio of approximately 1.6:1.

In terms of educational attainment, the majority of subjects had tertiary education (44.6%, n = 67). Secondary education was reported by 14.7% (n = 22), while 26.7% (n = 40) had no formal education. Additionally, 14.7% (n = 22) had only Islamic education.

With regard to ethnicity, the Kanuri ethnic group constituted the largest proportion of participants, accounting for 32% of the study population. This was followed by the Marghi (18%), Babur (15.3%), and Hausa/Fulani (11.3%) ethnicities. The Shuwa Arabs represented 6% of the sample. Minority ethnic groups, including Yoruba, Igbo (each 6%), and others such as Igala, Tiv, Idoma, Nupe, Jaba, and Egbira, collectively comprised 20% of the study population.

Marital status revealed that the majority of respondents were married (74.7%). Widowed participants accounted for 12%, while 10.7% were single and 2% were separated or divorced.

Table 1: Socio-demographic Characteristics of Study Participants

Variable	Number of subjects (%)	Mean age ± SD (years)
Sex		
Male	92(61.3)	55.5 ± 10.7
Female	58 (38.7)	45.5 ± 13.3
Age Group (years)		
18-29	9(6.0)	
30-39	22 (14.7)	
40-49	27 (18.0)	
50-59	50(33.3)	
60-69	31(20.7)	
70-79	11(7.3)	
Marital Status		
Single	16 (10.7)	
Married	112 (74.7)	
Separated/Divorced	3 (2.0)	
Widowed	19 (12.7)	

Renal Recovery and Dialysis Dependency Following CIN

Out of the 150 patients enrolled in the study, 45 individuals (30%) developed contrast-induced nephropathy (CIN) following exposure to iodinated contrast agents (ICAs). Among these, 33 patients (73.3%) demonstrated complete renal recovery, with serum creatinine levels returning to baseline within two weeks of contrast exposure. Six patients (13.3%) showed persistent renal dysfunction at the two-week mark. Of these six, two individuals (4.4%) progressed to acute kidney injury severe enough to require haemodialysis.

The remaining four patients in this group continued with conservative management.

In addition, four patients (8.8%) were lost to follow-up before their renal recovery status could be fully ascertained (Table 2).

Table 2: Outcome 2 weeks post-CIN

Category of outcome	Number of subjects (%)
Renal recovery	33(73.3)
Non-recovery	6(13.3)
Renal replacement	2(4.6)
Lost to follow-up	4(8.8)
Death	0(0.0)
Total	**45(100)**

Abbreviation: CIN (contrast induced nephropathy)

At the three-month follow-up point, one patient remained on maintenance haemodialysis, receiving treatment twice weekly. Notably, five out of the initial six patients who had persistent renal impairment at two weeks showed subsequent improvement, with their serum creatinine returning to baseline by the end of the third month. However, two patients continued to experience non-recovery of renal function, despite not yet requiring renal replacement therapy (Table 3).

Table 3: Outcome Three Months Post-CIN

Category of outcome	Number of subjects (%)
Renal recovery	38(84.4)
Non-recovery	2(4.4)
Renal replacement	1(2.2)
Lost to follow up	4(8.8)
Death	0(0.0)
Total	**45(100)**

Abbreviation: CIN (contrast induced nephropathy)

DISCUSSION

This study assessed the renal recovery and dialysis dependency following contrast-induced nephropathy (CIN) among patients undergoing contrast-enhanced radiological procedures at the University of Maiduguri Teaching Hospital, North-Eastern Nigeria. The prevalence of CIN in this cohort was 30% using serum creatinine criteria, which aligns with previously reported global estimates ranging from 2% to 50% depending on the population studied and diagnostic criteria employed [17-22].

Of the 150 subjects enrolled, 45 developed CIN post-contrast exposure. A significant proportion of these patients, 73.3% (33/45), achieved full renal recovery within two weeks which corroborate the findings of banda *et al*., [28], in a Malawian hospital, indicating that CIN is often transient and self-limiting in many cases. This finding is encouraging and consistent with earlier studies that suggest spontaneous recovery is common, particularly in patients without underlying chronic kidney disease.

However, a concerning subset of patients experienced persistent renal dysfunction. Six patients (13.3%) had non-recovery of renal function at two weeks post-exposure. Two of these progressed to require haemodialysis, highlighting the potential for CIN to precipitate severe renal impairment necessitating renal replacement therapy similar to a finding in Malawi and Pakistan by banda et and shigidi *et al*., [28, 29]. At the 3-month follow-up, only one of these two patients remained dialysis-dependent, suggesting partial renal recovery in most cases with appropriate supportive care which is in keeping with a study done in Malaysia by Chong *et al*., [30]. Notably, two additional patients with persistent renal dysfunction had not commenced dialysis, indicating a borderline or slowly progressive course.

The findings underscore the clinical importance of early detection, risk stratification, and follow-up monitoring in patients exposed to iodinated contrast agents. Advanced age, elevated baseline creatinine, and reduced eGFR were identified as significant predictors of CIN in this cohort. These variables should guide pre-procedural risk assessment and post-procedural surveillance, particularly in resource-limited settings.

Furthermore, the modest diagnostic performance of serum cystatin C relative to serum creatinine in this study suggests that while cystatin C offers theoretical advantages—such as being less influenced by muscle mass its utility in CIN detection may be limited without standardization and wider availability. This finding aligns with emerging literature questioning the standalone role of cystatin C as a superior biomarker for AKI.

CONCLUSION

Most patients with CIN recover renal function within a short period, but a subset remains at risk for prolonged dysfunction and dialysis dependency. These insights reinforce the need for preventive strategies, such as minimizing contrast volume, ensuring adequate hydration, and individualized risk-based protocols, especially in low-resource environments.

Future research with larger, multicentre cohorts and longer follow-up durations is recommended to better characterize the natural history of CIN and refine strategies for improving renal outcomes in high-risk patients.

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