

Contrast-Induced Nephropathy: Analysis and Perspective

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Abstract

Original Research Article

Introduction: Contrast-induced nephropathy (CIN) is a common complication of coronary angiography due to the nephrotoxic effects of contrast agents. This study aims to identify the risk factors for acute kidney injury (AKI) in patients undergoing coronary angiography. **Methods:** We conducted a retrospective study over 8 months, from January 2024 to August 2024, in the cardiology department of the Avicenna Military Hospital in Marrakech. All patients received a water-soluble, non-ionic contrast agent. Serum creatinine levels were measured before and 24 to 72 hours after the procedure. Statistical analysis was performed using SPSS software version 21. **Results:** The mean age of the study population was 65.24 ± 8.78 years, with a male predominance (male-to-female ratio: 4.62). Five patients (11.11%) developed CIN. Among them, 33.3% had diabetes and hypertension, 20% had a history of pre-existing cardiac disease, and 27.9% had used nephrotoxic drugs. Two patients (4.4%) received hydration with saline solution, and one patient (2.2%) received hydration with both saline and bicarbonate solutions. Statistical analysis identified a significant association between the development of CIN and two factors: age ($p = 0.014$) and hypertension ($p = 0.036$). **Conclusion:** Larger studies are needed to better identify patients at risk for CIN and implement effective preventive measures for patients undergoing coronary angiography.

Keywords: Contrast-Induced Nephropathy, Coronary Angiography, Risk Factors, Acute Kidney Injury.

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INTRODUCTION

Contrast-induced nephropathy (CIN) is one of the leading causes of acute kidney injury in diagnostic and interventional imaging contexts. This condition is particularly concerning in procedures such as coronary angiography, where the use of contrast agents is prevalent. The pathophysiology of CIN involves complex mechanisms, including altered renal microcirculation, increased oxidative stress, and direct osmotic toxicity. The aim of this study is to identify the risk factors associated with CIN in patients undergoing coronary angiography, to propose preventive strategies, and to optimize clinical management.

METHODOLOGY

This retrospective study was conducted over an eight-month period (January to August 2024) in the cardiology department of the Avicenna military hospital in Marrakech. The objective was to identify risk factors for the development of acute kidney injury following the administration of iodinated contrast agents during coronary angiography. The study included patients who underwent coronary angiography or angioplasty and had serum creatinine measurements available both before

and 24–72 hours after the procedure. Patients undergoing chronic hemodialysis or with incomplete medical records were excluded. Data were collected from medical records and structured data sheets, encompassing anthropometric information, medical history, use of nephrotoxic treatments, procedural details, and biological assessments before and after coronary angiography. Statistical analysis was performed using SPSS software version 21. Fisher's exact test and Student's t-test were applied, with statistical significance set at $p < 0.05$.

RESULTS

Among the 45 patients included in the study, the prevalence of contrast-induced nephropathy (CIN) was 11.1%, with five cases identified. The mean age of participants was 65.24 ± 8.78 years, with the majority (57.8%) aged 60–69. The population was predominantly male, with a male-to-female ratio of 4.62 (82.2% men). Regarding medical history, 33.3% of patients had diabetes or hypertension, 20% had preexisting cardiac conditions, and 2.2% had a history of diabetic nephropathy, renal insufficiency, peripheral vascular disease, or chronic pulmonary disease. The use of nephrotoxic drugs was noted in 27.9% of patients,

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primarily angiotensin-converting enzyme inhibitors (ACEIs) (13.3%), angiotensin receptor blockers (ARBs) (11.1%), and diuretics (8.9%). Additionally, 57.8% of participants were smokers, and only one patient reported alcohol consumption. Overall hydration status was normal, except in one patient (2.2%). The primary indications for coronary angiography were myocardial infarction (28.9%), STEMI (22.2%), and NSTEMI (20%). Procedurally, 55.6% of patients underwent coronary angiography alone, 15.6% underwent percutaneous coronary intervention (PCI), and 28.9% underwent both procedures. The contrast agent used was ULTRAVIST 300, a water-soluble, non-ionic contrast agent, with volumes ranging from 20–30 mL for coronary angiography to 50–100 mL for angioplasty. The radial approach was preferred in 73.8% of cases, while the femoral route was used in 23.8%. Preventive measures were absent in most cases, with only three patients receiving specific hydration protocols. The

coronary findings showed that the majority of patients had mono-vessel (35.6%), bi-vessel (33.3%), or tri-vessel disease (24.4%), while 6.7% had atheromatous arteries without significant lesions. All patients received statins, and most were treated with ACEIs (75.6%), beta-blockers (86.7%), and aspirin (91.1%). Biologically, the median pre-angiography creatinine level was 9.72 mg/L, with a slight increase to 10 mg/L post-procedure. The median glomerular filtration rate (GFR) decreased from 80.59 mL/min/1.73m² to 76.42 mL/min/1.73m². Five patients developed CIN, confirming a prevalence of 11.1%. Further statistical analysis identified significant associations between the development of CIN and factors such as age and hypertension (p-values detailed in the accompanying table). The table N° 1 summarizes the number of patients who developed CIN and their characteristics, along with the statistical significance of each factor.

Table 1: Patients who developed CIN and their characteristics, along with the statistical significance of each factor

parameters		Nephrotoxicity		P-value
		CIN+	CIN-	
Age	years	74.2 ± 7.85	64.12±8.31	P=0,014
sex	Female	1(12,5%)	7(87,5%)	P=0,64
	Male	4(10,8%)	33(89,2%)	
Diabetes mellites	Yes	1(6,7%)	14(93,3%)	P=0,45
	No	4(13,3%)	26(86,7%)	
hypertension	Yes	4(26,7%)	11(73,3%)	P=0,036
	No	1(3,3%)	29(96,7%)	
Pre-existing cardiac disease	Yes	2(22,2%)	7(77,8%)	P=0,26
	No	3(8,3%)	33(91,7%)	
smoking	Yes	2(7,7%)	24(92,3%)	P=0,35
	No	3(15,8%)	16(84,2%)	
Use of nephrotoxic drugs	Yes	3(25%)	9(75%)	P=0,12
	No	2(6,5%)	29(93,5%)	
Previous contrast agent use	Yes	2(33,3%)	4(66,7%)	P=0,13
	No	3(8,1%)	34(91,9%)	
Anemia	Yes	3(25%)	9(75%)	P=0,109
	No	2(6,1%)	31(93,9%)	
Initial serum creatinin > 15mg/L	Yes	2(40%)	3(60%)	P=0,087
	No	3(7,5%)	37(92,5%)	

Table 2: Different prevalence rates reported in the literature

Reference	Study population	Prevalence
Masoomi <i>et al.</i> , [1]	213 patients diagnosed with STEMI undergoing percutaneous coronary interventions (April 2019 – March 2022)	13,1%
La manna <i>et al.</i> , [2]	136 patients undergoing coronary angiography (April 2007 – April 2008)	15,44%
MUHAMMAD <i>et al.</i> , [3]	135 patients undergoing percutaneous coronary intervention	20%
KHAN <i>et al.</i> , [4]	112 patients undergoing percutaneous coronary intervention	22,3%
Tariq <i>et al.</i> , [5]	500 patients diagnosed with acute myocardial infarction planned for percutaneous coronary intervention	5,2%
Batra <i>et al.</i> , [6]	282 patients with STEMI treated by primary percutaneous coronary intervention (October 8, 2016 – April 7, 2017)	12,4%
Israr <i>et al.</i> , [7]	177 patients admitted to the cardiology department for percutaneous coronary intervention	10%
Notre étude	45 patients undergoing coronary angiography or angioplasty	11,1%

DISCUSSION

The results of this study align with international literature, emphasizing the significance of age and hypertension as predisposing factors for contrast-

induced nephropathy (CIN). However, the relatively low prevalence observed in this cohort (11.1%) is slightly below the range reported in similar studies (10–20%). The table 2 summarizes the different prevalence rates

reported in the literature. This difference in prevalence could be explained by the sample size. A population of only 45 patients may limit the statistical power to detect certain secondary risk factors. Additionally, the preventive strategy adopted at the institution, including hydration protocols and limiting the volume of contrast agents used, might have reduced the incidence of CIN. The characteristics of the studied population also played a role, as the majority of the included patients were men, which could influence the outcomes. Clinical studies show an increased prevalence of contrast-induced nephropathy (CIN) in diabetic patients compared to non-diabetics, with significantly higher rates reported in certain contexts such as coronary angiography and angioplasty (40.4% vs. 16%, $p < 0.002$) [25], (29.6% vs. 4.3%, $p = 0.02$) [8]. However, not all studies consider diabetes as an independent risk factor, except in the presence of additional comorbidities [9]. In our analysis, no significant difference was observed for diabetes ($p = 0.45$). Hypertension, on the other hand, is widely identified as an independent risk factor in several studies, with significant results (1.9% vs. 0.4%, $p = 0.016$) [10, 11], although some studies failed to confirm this association ($p = 0.65$) [12]. Our study revealed a significant difference for hypertension (26.7% vs. 3.3%, $p 0.036$). A correlation between cardiovascular diseases and CIN has been reported in the literature, particularly depending on the severity of heart failure [2-13]. However, no significant association was found in our sample ($p = 0.26$). Regarding pre-existing renal insufficiency, studies have shown contradictory results, with some highlighting an increased risk [14, 15], while others do not establish a conclusive link [2]. Biologically, elevated creatinine levels prior to coronary angiography are often associated with an increased risk of CIN, as shown in multiple studies [38-40]. However, our analysis did not find a significant difference ($p = 0.08$). Anemia ($Hb < 11$ g/dL) is also identified as an important risk factor in the literature [16-18], but this association was not confirmed in our study ($p = 0.109$). Hypoalbuminemia is recognized as a risk factor in several studies [19-21], although contradictory results have been reported [2]. Hyperuricemia, in contrast, is consistently associated with an increased risk of CIN [22-25]. Other factors, such as smoking [1] or the use of angiotensin-converting enzyme inhibitors (ACEIs) [26-28], show mixed results across studies. Our analysis did not reveal significant relationships with these parameters ($p = 0.35$ for smoking, $p = 0.12$ for ACEIs). Lastly, alcoholism is not considered a significant risk factor in the literature [29], and this lack of association was also observed in our cohort. To enhance understanding of the mechanisms and preventive strategies, larger-scale prospective studies are indispensable. The integration of predictive biomarkers such as cystatin C or NGAL (Neutrophil Gelatinase-Associated Lipocalin) could provide early diagnostic tools and improve management strategies.

CONCLUSION

CIN is a potentially severe complication of procedures involving contrast agents. The findings of this study highlight the importance of age and hypertension as major risk factors. An appropriate preventive approach, including thorough risk assessment and prophylactic measures, is essential to minimize renal complications. Lastly, larger-scale prospective studies are required to confirm these observations and refine recommendations.

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