Risk factors and incidence of contrast-induced acute kidney injury associated with diagnostic or interventional coronary angiography

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Abstract

Background and Aims: Coronary angiography/ interventions depend on iodinated contrast media (CM) and consequently pose risk of contrast-induced acute kidney injury (CI-AKI). This is an important complication that accounts for a significant number of cases of hospital-acquired kidney injury, with adverse effects on prognosis and health care. This study aimed to assess incidence and evaluate risk factor CI-AKI associated with diagnostic or interventional coronary angiography.

Methods: A prospective cross sectional observational hospital based study was conducted. All patients undergoing percutaneous coronary angiography in Manipal Teaching Hospital from May 1, 2019 to April 31, 2020 were included in this study. Appropriate statistical tests were used to analyse results and P <0.05 was considered statistically significant.

Results: We evaluated a total of 155 patients. Among them, 90 (58%) were male and 65 (42%) female. The mean age of patients was 62.74 ± 13.9 years. Overall incidence of contrast induced acute kidney injury was 15.48%. CI-AKI was observed to be more common in patient with advance age and diabetes. Apart from advance age and diabetes, none of the other conventional risk factors such as hypertension, anaemia, volume of contrast, baseline chronic kidney disease found to have a significant association with incidence of CI-AKI. None of the patients in our study required renal replacement therapy, and there was no mortality.

Conclusion: The overall incidence of CI-AKI after coronary intervention in this study is high. Patients with advance age and diabetes were at high risk of CI-AKI.

Introduction

Contrast-induced acute kidney injury (CI-AKI) is a transient impairment of renal function which occurs after intravascular administration of iodinated contrast media. In the past, CI-AKI was considered to be a mild state with asymptomatic and transient elevations in serum creatinine values. However, recent studies have demonstrated that both short term and long-term mortality rates have been found to be significantly higher in patients with CI-AKI compared to patients without CI-AKI.[1] CI-AKI is multifactorial, being dependent on patient-related and contrast-related risk factors. Among the patient-related factors, the most important is the baseline renal function: the incidence of CI-AKI ranges from 2% in patients with normal renal function to 30-40% in patients with creatinine >2 mg/dl.[2-4] Other important risk factors of CI-AKI are diabetes mellitus and advanced age. Anemia due to periprocedural bleeding may also contribute the risk for CI-AKI development, according to the decrease in hemoglobin levels.[5] Moreover, heart failure and hemodynamic instability such as periprocedural hypotension and use of intra-aortic balloon pump have shown to be associated with an increased risk of CI-AKI.[6] Very few studies have been conducted in our country so far.

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Therefore, we conducted prospective cross sectional observational study to assess incidence and evaluate risk factors of CI-AKI associated with diagnostic or interventional coronary angiography.

METHODS

This is prospective cross sectional observational hospital based study conducted in Manipal Teaching Hospital, Pokhara, Nepal. All patients undergoing percutaneous coronary angiography from May 1, 2019 to April 31, 2020 were included in this study. The absolute amount of contrast media was recorded after each procedure. Laboratory data including pre- and post-procedural serum creatinine, glucose, serum sodium, serum potassium, and baseline hemoglobin were collected. Serum creatinine values were measured before the procedure for the baseline value and at 48 hours and 5days. All patients were hydrated adequately as per the standard protocol, and no nephrotoxic drugs were used in them post contrast exposure.[7]

Clinical Definitions:

CI-AKI was defined as an increase of >25% or >0.5 mg/dl in pre-percutaneous coronary intervention (PCI) serum creatinine at or after 48 h after PCI.[8] Data were entered on MS XP sheet and then converted to SPSS 20 version for statistical analysis. Continuous variables were expressed as mean, standard deviation (SD), and categorical data were presented as absolute values and percentages.

data derived from the absolute total score for each parameters. Degree of freedom was also reported with Chi-square, Effect size was reported with Cramer's V. P-value of <0.05 was concluded as being statistically significant. For the absolute total score of the parameters, mean ranks were calculated and analysis was done with Mann-Whitney U test.

Results:

We evaluated a total of 155 patients. Among them, 90 (58%) were male and 65 (42%) female. The mean age of patients was 62.74 ± 13.9 years. Baseline characteristics of the patients are depicted in Table -1.

Table-2 showed twenty-four (15.48%) patients developed CI-AKI in the entire study population. Table-3 provides the detailed features of patient with CI- AKI. Briefly, CI-AKI was observed to be more common in advance age group of more than 70 years than age group less than 70 year (P = 0.045). Similarly, CI- AKI was found to occur more common in diabetics than in those without diabetes (P = 0.027). Hypertension, anaemia, baseline creatinine clearance was not observed to have an increased incidence of CI-AKI compared to rest of the population.

Descriptive analysis of the volume of contrast was also done to determine the role of volume of CM in the occurrence of CI-AKI. The mean volume of contrast given to patient in our study was 96.8 ± 28.8 ml. Patient who underwent intervention was given higher volume (120 ± 23.2) ml of CM compared to those who underwent diagnostic angiography (70 ±12.6 ml). However, the difference in volume of contrast administered to CI-AKI group (104 ±25 ml) was not statistically significant as compared to that of non CI-AKI (95±16 ml) group (P =0.33). None of the patient in our study required renal replacement therapy and there was no mortality.

Table 1. Characteristics of patients of study population

	Male	Female	Total
	31.02 ± 13.31	27.81 ± 7.87	0.06
Number	90	65	155
	23.91 ± 5.87	23.67 ± 4.9	0.43
Age (yrs)	63.06±13.7	62.32±14.18	62.74±13.92
	2.8	5.5	0.168
HTN	42(46.6%)	21(32.30%)	63(40.65%)
DM	17(18.8%)	14(21.54%)	31(20%)
Anemia	63(70%)	44(67.69%)	107(69.03%)
eGFR< 60 ml	11(12.2%)	12(18.46%)	23(14.84%)
CIAKI	12(13.33%)	12(18.46%)	24(15.45%)

Table 2. Frequency of CI- AKI in study population

	Number (%)	Creatinine at Admission (before Procedure)	Creatinine at 48hrs
Patients with CI-AKI	24(15.48)	0.9042 ± 0.49	1.7250 ± 1.44
Patients without CI-AKI	131(84.52)	0.9388 ± 0.48	0.9840 ± 0.64

Table- 3: Risk factors for contrast induced- Acute kidney injury

		CI-AKI	P value
Age	≥70yrs	13 (23.21)	0.045
	<70yrs	11 (11.11)	
Gender	Male	12 (13.33)	0.384
	Female	12 (18.46)	
DM	Present	9 (29)	0.027
	Absent	15 (12.09)	
HTN	Present	12 (19.05)	0.310
	Absent	12 (13.04)	
Anemia	Present	15 (14.02)	0.452
	Absent	9 (18.7)	
eGFR	<60	5 (21.73)	0.319
	≥60	19 (14.39)	

Discussion:

Our study showed 15.48 % incidence of CI-AKI in patient undergoing coronary angiography. Some studies showed lower incidence[9-12] of CI-AKI than our study and some studies were similar.[13-16] But there is wide variation in reported incidence of AKI in the world [17]. This is assumed to be caused by lack of standardization, timing of creatinine measured, baseline characteristics and type of contrast used. Cho et al found overall incidence of 14.5 % in their study among 510 patients who underwent cardiac catheterization.[14] Similarly, study done by Chong E et al found to have high incidence of 11.5% despite the prophylactic measures were taken.[15] Marenzi et al showed very

high incidence of 19% CI-AKI in patient undergoing coronary intervention.[16] Contrast to our study, Jeon et al, Sharma et al and Rihal et al, showed low incidence of CI–AKI in their study.[9,10,12]

Another significant observation of our study is the self-limiting course of the CI-AKI in all patients without the requirement of renal replacement therapy. The main reason for this observation could be that none of our patients had moderate to severe renal insufficiency and also the severity of CI-AKI was mild. A similar observation was made by Lautin et al[18] but this is in contrast to previous studies of CI-AKI.[19,20] Multiple factors could explain this observation including careful patient selection, minimal use of CM, avoidance of nephrotoxic drugs, and ensuring proper hydration in the post-procedure period.

Advanced age has been demonstrated to be a risk factor for the occurrence of CI-AKI.[21] In this study, the incidence of CI-AKI in patient's ≥ 70 years was 23.21% vs 11.11 % in age less than 70 years (P= 0.045). The result was consistent with the finding of Palli E et al.[22] Study by Marenzi et al. and Mehran et al. showed ≥ 70 years of age appeared to be an independent predictor of CI-AKI.[16,17] The reasons for this higher risk of CI-AKI in advance age group are probably multifactorial, including aging kidney, atherosclerosis, presence of multi-vessel disease, and more difficult vascular access due to tortuosity and calcification of the vessels requiring relatively larger amounts of contrast.

Besides advance age, diabetes mellitus is another well-recognized independent risk factor for CI-AKI.23 This study showed 29% of diabetic patients developed CI-AKI. Our study is also consistent with that of many studies, who found the presence of diabetes to be a significant risk factor for the occurrence of CI-AKI.[24-26] Rahman et al showed 36% of diabetic patient developed CI –AKI.[27] In contrast to our study, Parfrey et al. in a prospective trial of patients with diabetes, showed that none of 85 patients with diabetes and normal renal function developed clinically significant renal impairment.[28] Importantly, in diabetic patients with preserved renal function and the absence of other risk factors, the rates of CI-AKI are usually comparable to those of a non-diabetic population, while clinically important CI-AKI usually occurs in a subset of diabetics with underlying renal insufficiency.[29,30]

In this study, apart from advance age and diabetes, none of the other conventional risk factors such as hypertension, anaemia, volume of contrast, baseline chronic kidney disease were found to have a significant association with incidence of CI-AKI. This could be due to the small number of patient in our study. Iakovou et al reported female gender is an independent predictor of CIN development after coronary intervention.[31] Wen-hua et al showed anaemia is associated with higher incidence of CI-AKI with moderate renal insufficiency.[32] Patients with PCI did not have a higher incidence of CI-AKI despite receiving a higher CM dose due to the smaller volume of CM used than in other studies. This observation emphasizes that pre-existing renal compromise and comorbid ailments play an important role in the development of CI-AKI other than the type and quantity of CM.[33]

Our study has few limitations including small sample size, single study center, and limited study period. Less patients with compromised baseline renal function were exposed to contrast. This might act as selection bias during the study.

In conclusion, CI-AKI is a potential risk factor for all patients undergoing diagnostic or interventional coronary angiography. Our study showed overall incidence of CI-AKI is high. Patient with advance age and diabetes significantly increase the incidence of CI-AKI.

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