

Comparison of Contrast Induced Nephropathy in Diabetics and Non-Diabetics after Percutaneous Coronary Intervention in Previously Normal Renal Functions

ZAHID HUSSAIN¹, IFTIKHAR AHMED², FAIZA ALAM³, NAVEED AHMED⁴, ATTIYA MUSTAFA⁵, ABDUL MANAF⁶

^{1,2}Residents Cardiology, Armed Forces Institute of Cardiology/National Institute of Heart Diseases, Rawalpindi, Pakistan

³Resident Gynecology & Obstetrics, Bolan Medical Complex Hospital/Bolan University of Medical & Health Sciences, Quetta, Pakistan

⁴MBBS Student, Dera Ghazi Khan Medical College, DG Khan, Pakistan

⁵BDS Student, Bolan University of Medical & Health Sciences, Quetta, Pakistan

⁶House Officer, Bolan Medical Complex Hospital/Bolan University of Medical & Health Sciences, Quetta, Pakistan

Correspondence to Dr. Iftikhar Ahmed, E-mail: driftikharahmed09@gmail.com

ABSTRACT

Aim: To compare the incidence and severity of contrast-induced nephropathy (CIN) in patients who underwent percutaneous coronary intervention at tertiary care hospital of Pakistan.

Study design: Prospective analytic cross-sectional study.

Place and duration of study: Department of Cardiology of a Tertiary Cardiac Care Center of Pakistan from 1st April 2022 to 30th September 2022.

Methodology: Two hundred and fifty patients of coronary artery disease older than 18 years irrespective of gender were enrolled using non-probability consecutive sampling technique. The patients were divided into two groups; diabetic and non-diabetic, who received a contrast medium during the procedure.

Results: Thirty seven (14.66%) patients were diagnosed with CIN after percutaneous coronary intervention. Patients with diabetes 25(69%) were more prone to develop CIN compared with non-diabetic patients 12(31%). Also, patients with diabetes have significantly high levels of post procedure creatinine levels compared with the non-diabetic patients.

Practical Implication: it is cleared from the body by glomerular filtration. The mechanism of CIN is dependent on the medullary ischemia, oxidative stress and tubular cell toxicity.

Conclusion: Contrast-induced nephropathy is a common complication following percutaneous coronary intervention and is more prevalent in diabetic patients. However, none of the patients require hemodialysis.

Keywords: Contrast-induced nephropathy, Diabetic, Non-diabetic, Percutaneous coronary intervention, Renal function

INTRODUCTION

Coronary artery disease (CAD) is a global health burden and is responsible for causing 20 million deaths in 2020. Daily, thousands of people with myocardial ischemia and infarction are admitted to healthcare facilities, and these patients undergo various diagnostic approaches to identify the pathogenesis and severity of the disease^{1,2}. Medical resources, diagnosis, and treatment must improve in developing countries. There are limited resources: access to medical and health resources; knowledge about disease; awareness, trainings, and awareness about health^{20,21,22,23,24,25}.

Percutaneous coronary intervention is considered the widely used therapeutic approach for CAD; it involves using a contrast medium to visualize the coronary arteries better and used to open clogged arteries³. However, in rare cases, the contrast medium is responsible for causing adverse reactions, including reduced renal functions⁴. Referring to the use of contrast medium in diagnostic and therapeutic approaches, the presence of pathological conditions including diabetes, cardiac or renal insufficiency and old age of patients are linked with the pathogenesis of contrast-induced nephropathy (CIN)⁵. CIN is a prevalent complication and is defined as the defacement of renal functions characterized by elevated plasma creatinine levels, i.e., 25% higher than the baseline levels. This complication has an adverse effect on renal physiology and results in its dysfunction. The prevalence of CIN varies and usually ranges from 0 to 50% depending on the patient's health status and the presence or absence of the patient and contrast-related risk factors⁶.

The symptom of CIN appears after the 10 to 24 hours of contrast medium administration; the therapeutic approaches suggested for CIN are limited and require supportive care and dialysis. That is why it is essential to screen patients with high risk for CIN and to use suitable preventive regimens which surely play a vital role in limiting the incidence of CIN⁷. Patients with CAD are

known to have hemodynamic instability, neuroendocrine secretion, and have profound inflammatory responses. Use of contrast agent in these patients can result in the increased secretion of endothelin, adenosine, and angiotensin. Increased levels of nitric oxide and prostacyclin can cause vasoconstriction in renal medulla resulting in ischemia response⁸. This response can damage renal tubules, and can start to produce reactive oxygen species (ROS), and lipid peroxidation of biofilms in kidneys, eventually resulting in the pathogenesis of CIN. Various studies have identified that cardiac insufficiency is responsible for the activation of the renin-angiotensin system and causes variation in endocrine factors resulting in the increased vasoconstriction due to endothelin and reduction in the prostaglandin release. This mechanism causes an imbalance in the renal vasoconstriction and leads to the pathogenesis of CIN^{7,9}.

MATERIALS AND METHODS

The given cross-sectional study was conducted at a Tertiary Cardiac care center Pakistan. A total of 250 patients with coronary artery disease admitted between April 2022 and September 2022 who met the inclusion criteria were included in this study. Sample size was calculated by using CDC Epi Info calculator, as the prevalence of CIN is 0.3%-2.6% in general population¹⁰. All patients older than 18 years regardless of age and patients without a prior history of percutaneous coronary intervention were included. Pregnant women, patients who were allergic to contrast medium, diagnosed with kidney disease and patients who were not willing to fill the consent form were excluded.

Study was conducted after approval of the Institutional Ethical Review Board. A pre-designed questionnaire was used to record the demographic data, medical history, history of drugs patients were receiving previously, vital signs, and hematological analysis. The patients were divided into two groups. Group: A includes diabetic patients with coronary artery disease and Group: B consists of those with coronary artery disease with normal blood glucose levels (non-diabetic). The diagnosis of coronary artery

Received on 10-12-2022

Accepted on 13-05-2023

disease was made by assessing patient's clinical symptoms, including chest pain, change in electrocardiogram, and biochemical analysis of cardiac enzymes.

100-200ml of non-ionic contrast medium (Iohexol) was administered to all patients before the procedure. Serum creatinine levels, body mass index (BMI), hematocrit value, cholesterol and glomerular filtration rate were recorded before and after 48 hours of the procedure. To avoid pre and post-procedure dehydration, dextrose normal saline was given to all patients at the rate of 1ml/kg/hr pre-procedure as well as post procedure. CIN was identified in patients by increased serum creatinine levels, 44.2 µmol/L, after 48 hours of the procedure. Statistical analysis was performed using student t-test by SPSS VR 28. P-value ≤0.05 was considered statistically significant at 95% CI and 5% margin of error.

RESULTS

The mean age of study participants was 54.4±12 years, and the number of male participants 128(51.2%) were more than the female participants 122(48.8%) [Table 1]. A significant raise in serum creatinine levels after the 48h of procedure was observed compared between diabetic and non-diabetic patients via standard t-test where P-value was <0.001 (Table 2). Table 3 suggests that the prevalence of CIN tends to increase with age with the highest percentage of individuals with CIN being in the 61-70 age groups. After the percutaneous coronary intervention, 37(14.66%) of study participants were diagnosed with CIN (Fig. 1). Of these patients, 25 (69%) were diabetic and 12(31%) were non-diabetic, the study data suggested that the incidence of CIN was higher in patients with diabetes (Fig. 2).

Table 1: Baseline characteristics of the study participants

Variables	No. (%)
Age (year)	54.4±12
Male	128 (51.2%)
Female	122 (48.8%)
Systolic Blood Pressure (mm of Hg)	126±3.9
Baseline creatinine (mg/dL)	1.11±0.06
Acute coronary syndrome	85 (34%)

Table 2: Creatinine level of the study participants

	Diabetics	Non-diabetics	p-value
Creatinine pre-PCI (mg/dl)	1.05±0.33	1.03± 0.21	0.001
Creatinine post-PCI (mg/dl)	1.03±0.22	1.10±0.44	0.001

Table 3: Age distribution of study participants (n=14)

Age (years)	Frequency	CIN
20-29	5 (2%)	0%
30-39	25 (10%)	5.5%
40-49	52(21%)	8.5%
50-59	70 (28%)	10.6%
60-69	80 (32%)	10.9%
70	20 (6%)	16.6%

Fig. 1: Incidence of CIN in patients who underwent percutaneous coronary intervention.

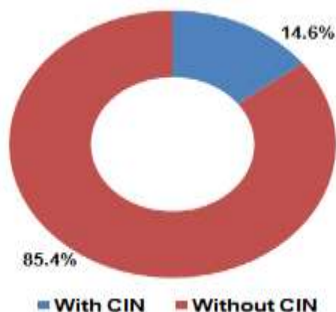
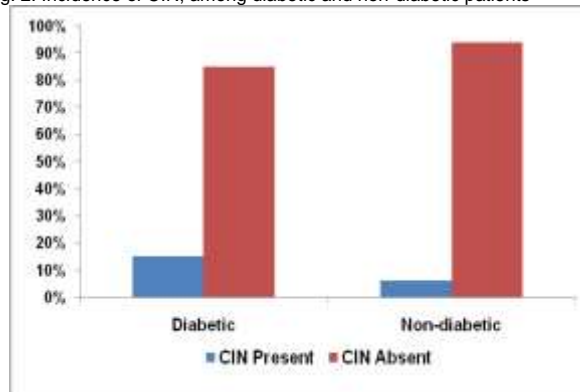


Fig. 2: Incidence of CIN, among diabetic and non-diabetic patients



DISCUSSION

The present study aimed to assess the prevalence of CIN in patients who underwent percutaneous coronary intervention at the Cardiology Department at Armed Forces of Institute of Cardiology and National Institute of Heart Diseases. After the percutaneous coronary intervention, CIN is considered the third prevalent cause of acute kidney injury¹². It is difficult to identify the exact prevalence of CIN, as different studies have considered different definitions and parameters for CIN, the type and dosage of contrast medium, and preventive measures. A study by Ikramullah et al¹³ reported a 10% incidence of CIN in patients undergoing percutaneous coronary intervention at a Tertiary Care Hospital. Similar results were found in a study conducted by Mehran et al¹⁴, which included 8600 patients in the study and identified that 13% had developed CIN. Another study conducted by Weisbord et al¹⁵ identified 13.7% cases with CIN in their research. The present study showed similar results. However, the difference might be due to the use of different contrast mediums or including patients with acute coronary syndrome, which is considered a risk factor for the pathogenesis of CIN.

The study also identified that, patients of advanced age are at higher risk for developing CIN. Patients under 40 years have 5% chance of developing CIN, while patients with age above 60 years have 10 to 15% chance of developing CIN. Similar results were found in a study conducted by Takagi et al¹⁶. Previous studies reported that the female gender is more prone to developing CIN¹⁷; however, in the present study, we did not observe this as the male gender was dominant. Patients of the present study did not need hemodialysis after the pathogenesis of CIN as none of the patients had end-stage kidney disease. The current study also revealed that the incidence of CIN is higher in diabetic patients than in patients having no diabetes. The results of the present study are similar to the results of the Rihal research, reporting the incidence of CIN among diabetic patients as 21.8% and among patients with normal blood glucose levels as 6.8%. A study done by Lautin et al¹⁸ also showed an increased incidence of CIN among diabetic patients. Retrospective study conducted by Mayo Clinic suggested that diabetic patients are more prone to develop CIN¹⁹.

The reason for that is diabetes, which is responsible for damaging renal vessels, making them stiff and reducing kidney function. After the administration of contrast medium, it is separated in the body by intravascular and extracellular fluids. Under physiological conditions it is cleared from the body by glomerular filtration. The mechanism of CIN is dependent on the medullary ischemia, oxidative stress and tubular cell toxicity. However, the pathogenesis of CIN in each patient is still not understood²⁰.

Limitations of study: The present study has some limitations such as; the sample size being small, being a single centered study and the study was conducted for a short period of time, that's why its results cannot be generalized on population.

CONCLUSION

Contrast-induced nephropathy is a prevalent finding after percutaneous coronary intervention, and its incidence is more in patients with advanced age, coronary artery disease and diabetes. Appropriate measures are needed to reduce the risk of this complication.

Acknowledgment: I am deeply grateful to Dr Iftikhar Ahmed for his guidance, patience and support that provided insight and expertise that greatly assisted my research project.

Conflict of interest: Nil

REFERENCES

- Malakar AK, Choudhury D, Halder B, Paul P, Uddin A, Chakraborty S. A review on coronary artery disease, its risk factors, and therapeutics. *J Cellular Physiol* 2019; 234(10):16812-23.
- Shao C, Wang J, Tian J, Tang YD. Coronary artery disease: from mechanism to clinical practice. *coronary artery disease: Therapeutics Drug Discovery* 2020:1-36.
- Capodanno D, Bhatt DL, Gibson CM, James S, Kimura T, Mehran R, et al. Bleeding avoidance strategies in percutaneous coronary intervention. *Nature Rev Cardiol* 2022; 19(2): 117-32.
- Legnazzi M, Agnello F, Capodanno D. Prevention of contrast-induced acute kidney injury in patients undergoing percutaneous coronary intervention. *Kardiologia Polska (Polish Heart Journal)* 2020;78(10):967-73.
- Mehran R, Faggioni M, Chandrasekhar J, Angiolillo DJ, Bertolet B, Jobe RL, et al. Effect of a contrast modulation system on contrast media use and the rate of acute kidney injury after coronary angiography. *JACC* 2018; 11(16): 1601-10.
- Zhang F, Lu Z, Wang F. Advances in the pathogenesis and prevention of contrast-induced nephropathy. *Life Sci* 2020; 259: 118379.
- Sun G, Chen P, Wang K, Li H, Chen S, Liu J, He Y, Song F, Liu Y, Chen JY. Contrast-induced nephropathy and long-term mortality after percutaneous coronary intervention in patients with acute myocardial infarction. *Angiology* 2019;70(7):621-6.
- Azzalini L, Poletti E, Lombardo F, Laricchia A, Beneduce A, Moscardelli S, et al. Risk of contrast-induced nephropathy in patients undergoing complex percutaneous coronary intervention. *Int J Cardiol* 2019;290:59-63.
- Samadian F, Dalili N, Mahmoudieh L, Ziaei S. Contrast-induced nephropathy: essentials and concerns. *Iranian J Kidney Dis* 2018;12(3):135.
- Wang J, Zhang C, Liu Z, Bai Y. Risk factors of contrast-induced nephropathy after percutaneous coronary intervention: a retrospective analysis. *J Int Med Res* 2021; 49(4): 030006052110059.
- Mandal A, Paudel MS, Kafle P, Khalid M, Bhattarai B, Kanth R, et al. Contrast-induced nephropathy following percutaneous coronary intervention at a tertiary cardiac center in Nepal. *Cureus* 2018;10(9).
- Abe M, Morimoto T, Akao M, Furukawa Y, Nakagawa Y, Shizuta S, et al. Relation of contrast-induced nephropathy to long-term mortality after percutaneous coronary intervention. *Am J Cardiol* 2014;114(3):362-8.
- Ikramullah, Israr M, Ali U, Iqbal MA, Ahmad F, Awan ZA. Frequency of contrast induced nephropathy in patients undergoing percutaneous coronary intervention. *Pak Heart J* 2015;48(3).
- Mehran R, Aymong ED, Nikolsky E, Lasic Z, Iakovou I, Fahy M, et al. A simple risk score for prediction of contrast-induced nephropathy after percutaneous coronary intervention: development and initial validation. *J Am Coll Cardiol* 2004;44(7):1393-9.
- Weisbord SD, Mor MK, Resnick AL, Hartwig KC, Palevsky PM, Fine MJ. Incidence and outcomes of contrast-induced AKI following computed tomography. *Clin J Am Soc Nephrol* 2008;3(5):1274-81.
- Takagi T, Stankovic G, Finci L, Toutouzas K, Chieffo A, Spanos V, et al. Results and long-term predictors of adverse clinical events after elective percutaneous interventions on unprotected left main coronary artery. *Circulation* 2002;106(6):698-702.
- Toprak O, Cirit M. Risk factors for contrast-induced nephropathy. *Kidney Blood Pressure Res* 2006;29(2):84-93.
- Lautin EM, Freeman NJ, Schoenfeld AH, Bakal CW, Haramati N, Friedman AC, et al. Radiocontrast-associated renal dysfunction: incidence and risk factors. *AJR* 1991; 157(1): 49-58.
- Victor SM, Gnanaraj A, VijayaKumar S, Deshmukh R, Kandasamy M, Janakiraman E, et al. Risk scoring system to predict contrast induced nephropathy following percutaneous coronary intervention. *Indian Heart J* 2014; 66(5): 517-24.
- Geenen RW, Kingma HJ, van der Molen AJ. Contrast-induced nephropathy: pharmacology, pathophysiology and prevention. *Insights Imaging* 2013;4(6):811-20.
- Shahjahan M, Jabeen M, Farid G. Information Providing in COVID-19 by Health Professionals in Pakistan. *Pakistan Journal of Medical & Health Sciences*. 2022 Dec 12;16(10):641-.
- Farid G, Zaheer S, Khalid A, Arshad A, Kamran M. Evaluating Medical College Lib Guides: A Usability Case Study. *Pakistan Journal of Medical & Health Sciences*. 2022 Aug 26;16(07):461-.
- Farid G, Niazi AK, Muneeb M, Iftikhar S. Attitude towards Utilization of e-Resources of Medical Images among Health Care Professionals. *Pakistan Journal of Medical and Health Science*. 2021 Sep 15 (9);261-263
- Farid G, Iqbal S, Iftikhar S. Accessibility, Usage, and Behavioral Intention of Print Books and eBooks by Medical Students. *Library Philosophy and Practice*. 2021:1-25.
- Farid G, Abiodullah M, Ramzan M. A comparative study of information seeking behaviors of medical faculty working in government and private run medical colleges. *International Journal of Information Management Science*. 2013;2(1):17-24.