



Contrast Induced Nephropathy- A Single Centre Observational Study

Rohit Rai^{1*}, Rahul Singla¹, Shakil S. Shaikh¹ and Narender O. Bansal¹

¹Department of Cardiology, Grant Government Medical College and Sir JJ Group of Hospitals, Mumbai, India.

Authors' contributions

This work was carried out in collaboration among all authors. Author RR designed the study, performed the analysis and wrote the first draft of the manuscript. Authors RS and SSS supervised the study and analysed the data. All the authors managed the literature search writing of the final manuscript. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/CA/2020/v9i430146

Editor(s):

(1) Prof. Francesco Pelliccia, University La Sapienza, Italy.

Reviewers:

(1) Iure Kalinine Ferraz de Souza, Federal University of Ouro Preto, Brazil.

(2) Daniel Lighezan Timisoara, Victor Babes University of Medicine and Pharmacy, Romania.

Complete Peer review History: <http://www.sdiarticle4.com/review-history/61752>

Original Research Article

Received 25 July 2020
Accepted 01 October 2020
Published 20 October 2020

ABSTRACT

Background: CIN is an important cause of morbidity and mortality post cardiac procedures. Renal derangement and diabetes being the most important risk factors. Multifactorial causation of the disorder led us to study the risk factors associated with CIN.

Methods: All patients who underwent cardiac procedures between March 2019 and March 2020 were screened for CIN and included in the study. Out of the 3192 patients screened 99 patients were diagnosed with CIN. Parameters such as diabetes mellitus, hypertension, CKD, anemia, duration of hospital stay, cardiogenic shock, number of stents, amount and type of contrast, Ejection Fraction, creatinine clearance before and after the procedure, concomitant nephrotoxic drugs were also recorded.

Results: Ninety-nine patients developed CIN amounting to 3% of the total procedures, 11% expired, 18% required dialysis, average creatinine clearance before the procedure was 53.15 ml/min/1.73 m² and post procedure it was 29.16 ml/min/1.73 m², 51.5% of cases had creatinine clearance prior to procedure <60 ml/min/1.73 m², 60.6% were diabetic, 81.8% were hypertensive, 30.3% were anaemic, 15% had heart failure, 33% required ventilatory assistance, average haemoglobin level was 11.83 mg/dl, 33% received iso-osmolar contrast and 45% had EF of 35% or less.

*Corresponding author: E-mail: tummu888@gmail.com;

Conclusions: CIN has a multifactorial causation most common being prior renal derangement and diabetes mellitus. This is one of a kind study in this part of country among cardiac patients. Newer biomarkers of kidney injury could also be studied in future.

Keywords: Contrast Induced Nephropathy (CIN); diabetes mellitus; kidney disease.

1. INTRODUCTION

Contrast induced nephropathy is defined as rise of serum creatinine >0.5 mg/dl from baseline or $>25\%$ rise in absolute value 2-3 days after contrast injection in the absence of other causes of acute kidney injury [1]. It is associated with significant mortality and morbidity after invasive cardiac procedures. Incidence of CIN varies from 1% to 6% in general population depending on certain risk factors the most important being baseline renal function and diabetes mellitus [2]. Other risk factors include advanced age, anaemia, left ventricular dysfunction, volume of contrast agent used, low serum albumin, dehydration, hypotension and concomitant use of nephrotoxins. It has multifactorial pathophysiology including cytotoxicity, disturbances in intrarenal haemodynamics, apoptosis and immune mechanisms. Hydration prior to contrast administration has been shown to reduce CIN incidence by promoting diuresis and avoiding hypotension. N-acetylcysteine has been also recommended but the results are mixed [1]. Iodinated contrast agents are used for diagnosis and in the treatment of coronary artery diseases. With the increasing number of procedures being conducted, increased complexity of lesions and ageing population the incidence of contrast induced nephropathy is rising. Multiple risk factors contribute to development of CIN. We did this study to see the proportion of risk factors associated with CIN and its incidence. There has not been any such study in this part of the country previously and despite all preventive measures being taken patients were developing CIN. Therefore, a multifactorial assessment of association with risk factors needed to be done.

2. MATERIALS AND METHODS

3192 patients undergoing cardiac procedures between March 2019 and March 2020 were screened for change in serum creatinine 48-72 hours after the procedure and 99 patients were diagnosed to have contrast induced nephropathy. It was a retrospective observational study. Bias was in recall which was addressed by electronic records. Parameters such as known case of diabetes mellitus, hypertension, chronic kidney

disease and anaemia were noted. Diabetes was defined as fasting plasma glucose level of ≥ 126 mg/dl [3]. Hypertension was defined as blood pressure $>140/90$ mmHg. Anaemia was defined as haemoglobin level less than 13 g/dl in men and less than 12 g/dl in women [4]. Chronic renal insufficiency was diagnosed as creatinine clearance <60 ml/min/1.73m² by MDRD equation. Duration of hospital stay and associated cardiogenic shock were also taken into consideration. Heart failure was defined using NYHA classification.

Procedural details like number of stents, number of steps, amount and type of dye used were included in the study for analysis. Patient's ejection fraction was recorded on GE Vivid 7 echo machine by eye balling technique. creatinine clearance before and after the procedure were collected. Confounding factors like concomitant use of nephrotoxic drugs or ACE inhibitor use was recorded. All patients underwent pre procedural hydration with intravenous normal saline according to ejection fraction. Statins were used as recommended for the patients. Retrospective analysis of records and data was done. Objective of the study was to observe the association of various risk factors with CIN. Prior deranged creatinine was hypothesized to be an important risk factor.

Statistical analysis was done using Microsoft Excel 365 (Microsoft office 365 edition, Microsoft, Redmond, Washington, U.S.).

3. RESULTS

Out of 3192 patients who underwent cardiac intervention in 12 months from March 2019 to March 2020. Contrast induced nephropathy developed in 99 patients amounting to 3% of the total procedures. Most of them had undergone angiography followed by angioplasty if required.

Females contributed 36.3% of patients who developed contrast induced nephropathy. Mean age of patients was 63.6 \pm 9 years. Of the patients developing CIN 11% expired and 18% required dialysis. Average creatinine clearance before the procedure was 53.15 ml/min/1.73 m² and post procedure it decreased to 29.16 ml/min/1.73 m². Iso-osmolar contrast was used in

33% of the cases. Average creatinine clearance before the procedure in those who expired was 47.85 ml/min/1.73 m² and post procedure it decreased to 25.9 ml/min/1.73 m². Creatinine clearance prior to procedure <60 ml/min/1.73 m² was in 51.5% of cases.

Among the patients who developed CIN 60.6% were diabetic, 81.8% were hypertensive and 30.3% were anaemic, 15% of patients with CIN developed heart failure and 33% required ventilatory assistance. Average time to discharge was 12 days.

Average serum albumin level was 3.34 mg/dl. Average haemoglobin level was 11.83 mg/dl and average mean BP was 91.42 mmHg. ACE inhibitors or concomitant nephrotoxic drugs were used in 6% of the patients.

Among patients who developed CIN 24% underwent procedure in 3 or more steps whereas only 9% patients underwent single procedure, 33% of patients had triple vessel disease, 48% had double vessel disease and 19% had single vessel disease, 33% patients with CIN received iso-osmolar contrast and the rest received low osmolar contrast. Multiple exposures to contrast media within 72 hrs was not there. Average amount of contrast used during the procedure was 180 ml and 45% of patients had EF of 35% or less (Table 1).

4. DISCUSSION

Contrast induced nephropathy is a dreaded complication of radiographic procedures requiring contrast like angiography and angioplasty. 3% of patients who developed CIN in our study required dialysis and on follow up had increased mortality. Deranged preoperative serum creatinine and diabetes were found to be important risk factors for developing CIN. Similarly, in the study by Gruberg et al patients who required dialysis had worse outcomes than those who did not. Increased baseline creatinine and renal failure developing after the procedure requiring dialysis are associated with increased in hospital and long-term mortality [5,6]. Patients developing CIN had longer hospital stay also.

In our study, CIN was found to be more common in elderly, diabetics and hypertensives. McCollough et al also concluded that AKI developed after coronary intervention was associated with increased mortality and patient's risk of CIN can be predicted by patient's creatinine clearance, diabetic status and amount

of contrast used [7,8]. Mehran et al devised a risk score for CIN which included patient related characteristics like age >75 years, diabetes mellitus, chronic congestive heart failure, or admission with acute pulmonary edema, hypotension, anaemia and chronic kidney disease and procedure-related characteristics like the use of elective IABP or increasing volumes of contrast media [9,10]. They assigned a weighted integer to each variable to make up a cumulative score so as to divide patients into low risk with a score of 5 and high risk with a score of 16.

Dangas et al. found that decreased eGFRs, periprocedural hypotension, higher contrast media volumes, lower baseline haematocrit, diabetes, pulmonary edema, intra-aortic balloon pump use and left ventricular ejection fraction <40% were the most significant predictors of CIN in patients with CKD [11]. In our study also patients with shock, higher contrast media use, anaemia, heart failure and low ejection fraction were associated with CIN in patients undergoing cardiac procedures. Evola et al had a statistically insignificant correlation between number of sick vessels and risk of CIN [12]. In our study also majority of patients with CIN had multivessel disease and only 6% underwent primary angioplasty. In the study by Caspi et al also incidence of CIN was similar in those undergoing primary PCI and no PCI [13].

Iakovou Ioannis, et al. studied the impact of gender on the incidence and outcome of contrast-induced nephropathy after percutaneous coronary intervention and found that female gender was an independent predictor of CIN development [14]. In our study 36.3% patients who developed CIN were females. CS Rihal et al. found the overall incidence of AKI after PCI to be low and diabetics to have higher incidence than non-diabetics [15]. Similarly, in our study also 60.6% of patients who developed CIN were diabetics. Toprak et al also supported the fact that diabetics were at higher risk of CIN than pre diabetics [16].

Post renal transplant and use of nephrotoxic drugs was also associated with increased incidence of CIN and intravenous hydration prophylaxis was associated with lower incidence in the study by TS Ahuja et al. [17] We also had increased incidence of CIN in patients on concomitant nephrotoxic drugs and lower incidence due to prophylactic intravenous hydration.

Table 1. Summary of study

| | |
|--|---------------------------------|
| Mean Age | 62.36 years |
| Average Creatinine clearance before procedure | 53.15 ml/min/1.73m ² |
| Average Creatinine clearance after procedure | 29.16 ml/min/1.73m ² |
| underwent procedure in 3 or more steps | 24% |
| underwent single procedure | 9% |
| Average amount of contrast | 180 ml |
| Patients having EF of 35% or less | 45% |
| Patients having diabetes mellitus | 60.6% |
| Patients having Hypertension | 81.8% |
| Patients with prior creatinine clearance <60 ml/min/1.73m ² | 51.5% |

Ours was a retrograde observational study so potential recall and recording bias was there. Being a government hospital, novel renal biomarkers being expensive, could not be tested. The results can be generalised to cardiac patients undergoing cardiac procedures. Our study confirmed the multifactorial risk factors for causation of CIN we also considered number of vessels involved and number of steps during the cardiac procedure.

5. CONCLUSION

Contrast induced nephropathy is a serious complication post cardiac procedures with pre procedure deranged renal status and diabetes being important predictors [18]. Shock, volume and type of contrast used, hypertension, anemia and ejection fraction being other parameters of predicting CIN.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Sudarsky D, Nikolsky E. Contrast-induced nephropathy in interventional cardiology. *International Journal of Nephrology and Renovascular Disease.* 2011;4:85.
2. Parfrey P. The clinical epidemiology of contrast-induced nephropathy.

3. Cardiovascular and Interventional Radiology. 2005;28(2):S3-11.
4. American Diabetes Association. Report of the expert committee on the diagnosis and classification of diabetes mellitus. *Diabetes Care.* 1997;20:1183e1197.
5. World Health Organization. Nutritional anemia: Report of a WHO scientific group. Geneva, Switzerland: World Health Organization; 1968.
6. Gruberg L, Mehran R, Dangas G, Mintz GS, Waksman R, Kent KM, Pichard AD, Satler LF, Wu H, Leon MB. Acute renal failure requiring dialysis after percutaneous coronary interventions. *Catheterization and Cardiovascular Interventions.* 2001;52(4): 409-16.
7. Rudnick MR, Leonberg-Yoo AK, Litt HI, Cohen RM, Hilton S, Reese PP. The controversy of contrast-induced nephropathy with intravenous contrast: What is the risk? *American Journal of Kidney Diseases.* 2020;75(1):105-13.
8. McCullough PA, Wolyn R, Rocher LL, Levin RN, O'Neill WW. Acute renal failure after coronary intervention: Incidence, risk factors, and relationship to mortality. *The American Journal of Medicine.* 1997; 103(5):368-75.
9. Ribitsch W, Horina JH, Quehenberger F, Rosenkranz AR, Schilcher G. Contrast induced acute kidney injury and its impact on mid-term kidney function, cardiovascular events and mortality. *Scientific Reports.* 2019;9(1):1-7.
10. Mehran R, Aymong ED, Nikolsky E, Lasic Z, Iakovou I, Fahy M, Mintz GS, Lansky AJ, Moses JW, Stone GW, Leon MB. A simple risk score for prediction of contrast-induced nephropathy after percutaneous coronary intervention: Development and initial validation. *Journal of the American College of Cardiology.* 2004;44(7):1393-9.

10. Jeon J, Kim S, Yoo H, Kim K, Kim Y, Park S, et al. Risk prediction for contrast-induced nephropathy in cancer patients undergoing computed tomography under preventive measures. *Journal of Oncology*; 2019.
11. Dangas G, Iakovou I, Nikolsky E, Aymong ED, Mintz GS, Kipshidze NN, et al. Contrast-induced nephropathy after percutaneous coronary interventions in relation to chronic kidney disease and hemodynamic variables. *The American Journal of Cardiology*. 2005;95(1):13-9.
12. Evola S, Lunetta M, Macaione F, Fonte G, Milana G, Corrado E, et al. Risk factors for contrast induced nephropathy: A study among Italian patients. *Indian Heart Journal*. 2012;64(5):484-91.
13. Caspi O, Habib M, Cohen Y, Kerner A, Roguin A, Abergel E, et al. Acute kidney injury after primary angioplasty: IS contrast-induced nephropathy the culprit?. *Journal of the American Heart Association*. 2017;6(6):e005715.
14. Iakovou I, Dangas G, Mehran R, Lansky AJ, Ashby DT, Fahy M et al. Impact of gender on the incidence and outcome of contrast-induced nephropathy after percutaneous coronary intervention. *The Journal of Invasive Cardiology*. 2003; 15(1):18-22.
15. Rihal CS, Textor SC, Grill DE, Berger PB, Ting HH, Best PJ, et al. Incidence and prognostic importance of acute renal failure after percutaneous coronary intervention. *Circulation*. 2002;105(19): 2259-64.
16. Toprak O, Cirit M, Yesil M, Bayata S, Tanrisev M, Varol U, et al. Impact of diabetic and pre-diabetic state on development of contrast-induced nephropathy in patients with chronic kidney disease. *Nephrology Dialysis Transplantation*. 2007;22(3):819-26.
17. Ahuja TS, Niaz N, Agraharkar M. Contrast-induced nephrotoxicity in renal allograft recipients. *Clinical Nephrology*. 2000;54(1): 11-4.
18. Davenport MS, Perazella MA, Yee J, Dillman JR, Fine D, McDonald RJ, et al. Use of intravenous iodinated contrast media in patients with kidney disease: Consensus statements from the American College of Radiology and the National Kidney Foundation. *Radiology*. 2020; 294(3):660-8.

© 2020 Rai et al.; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:

The peer review history for this paper can be accessed here:
<http://www.sdiarticle4.com/review-history/61752>