

RISK OF CONTRAST INDUCED NEPHROPATHY IN PATIENTS UNDERGOING PRIMARY CORONARY ANGIOPLASTY

Vinay Kumar¹, Nirmitha Dev M^{*2}, Vasudha KC³

¹Under graduate Student, Final MBBS, M S Ramaiah Medical College, Bangalore 560054, India

^{*2}Assistant Professor, Department of Biochemistry, M S Ramaiah Medical College, Bangalore 560054, India.

³Professor & Head, Department of Biochemistry, M S Ramaiah Medical College, Bangalore 560054, India

E-mail of Corresponding Author: nirmitha2dev@yahoo.co.in

Abstract

Background: Contrast induced nephropathy (CIN) is one of the common cause for hospital acquired renal failure in patients undergoing coronary angioplasty for acute myocardial infarction. The aim of this study was to assess the renal function in patients after primary coronary angioplasty by estimating the levels of serum creatinine (Sr. Cr)

Materials & Methods: Sample sizes of 51 subjects were included for the study. Serum creatinine levels were measured before and after the procedure. The difference in Serum creatinine levels was calculated. CIN was defined as increase in Sr Cr >0.5 or $>25\%$ compared to the baseline value.

Results: Out of the 51 cases, CIN occurred in 7.8% (4 cases). In addition, 19.6 % (10 cases) had pre-existing renal insufficiency out of which 3 subjects developed CIN. According to recently proposed definition of contrast nephropathy 5.9 % (3 cases) and 7.8% (4 cases) were in grade 1 and 2 respectively. Incidence of CIN in patients with diabetes mellitus was found to be statistically significant ($p < 0.05$) as compared to patients without diabetes mellitus.

Conclusion: CIN is a common complication of primary coronary angioplasty. Its incidence is more in patients with pre existing renal insufficiency and diabetes mellitus compared to patients with normal renal function and without any underlying risk factors.

Keywords: Contrast induced nephropathy, primary coronary angioplasty and renal insufficiency serum creatinine

1. Introduction

Contrast induced nephropathy (CIN) is a common complication in patients undergoing percutaneous coronary interventions, with a mortality rate of 30%¹. It is one of the leading causes of hospital acquired renal failure². In the present era of modern interventional cardiology; many patients require such procedures during their lifetime. Hence it is necessary to assess risk of development of nephropathy in such patients. Contrast nephropathy is defined as a rise in the serum creatinine levels of at least 0.5 mg/dL or increase in serum creatinine levels of more than 25% of the baseline level within 48 hours of contrast medium administration³.

A recent definition of contrast nephropathy in patients undergoing percutaneous coronary intervention was proposed by Harjai, *et al*⁴. This tripartite definition classifies contrast nephropathy as grade 0 (serum creatinine increase $<25\%$ above baseline and <0.5 mg/dL above baseline), grade 1 (serum creatinine

increase $\geq 25\%$ above baseline and <0.5 mg/dL above baseline), or grade 2 (serum creatinine increase ≥ 0.5 mg/dL above baseline). This classification is prognostic of long-term outcomes of patients after percutaneous coronary intervention. Patients with grade 2 nephropathy had the worst outcome while those with grade 0 nephropathy had the best outcome on long-term follow-up⁴.

The development of CIN in patients undergoing percutaneous coronary intervention depends on various risk factors like diabetes mellitus, dehydration, patients on nephrotoxic drugs and the amount of contrast dye used^{5,6}. These subjects may have varying degrees of renal dysfunction such as renal vascular disease & mild renal insufficiency which happen to predict the presence of coronary artery disease⁷.

Since only a few studies have been carried out in this aspect there is a need to assess impairment of renal function in the group of patients undergoing coronary angioplasty in different

populations. The present study proposes to investigate the impairment in renal function after the procedure and to determine the incidence of CIN amongst these subjects.

2. Materials & methods

Study was conducted on patients undergoing coronary angioplasty in the Department of Cardiology, of MSRMH, located in the city of Bangalore. The ethical clearance for the study was taken from our institutional Ethical review board, and informed consent was obtained from all patients. Approval number is MSRMC/EC/2010.A total of 51 consecutive cases undergoing coronary angioplasty were recruited in the study. All the patients were undergoing such procedure for the first time. Patients of both sex and aged between 20-70yrs were included. Patients with end stage renal disease on dialysis, on nephrotoxic drugs and patients with previous history of contrast administration were excluded from the study.

Type of contrast agents and dose, angioplasty technique, and supportive pharmacologic therapies were left to the discretion of the interventional cardiologist.

Random blood samples were collected from patients before the procedure as well as 48 hours after the procedure during their stay in the hospital. Serum creatinine levels were estimated by modified Jaffe's method (the reference range is 0.7-1.2 mg/dL)⁸. Weight to the nearest kilograms, height in meters in light cloth and blood pressure in mm of Hg. were recorded. Further, BMI was calculated⁹. Information on related co morbidities such as diabetes mellitus and hypertension were also elicited and was verified with the records.

As per the definition of CIN, difference in the creatinine levels before & 48 hours after the procedure was calculated. Percentage increase in the creatinine levels was calculated based on difference in the creatinine levels/ creatinine levels before the procedure x100.

Statistical analysis: All the data was tabulated and frequency distribution tables were prepared according to various factors. Statistical analysis was done by employing chi-square test of significance. Proportion of the patients developing contrast induced nephropathy was calculated with 95% confidence limits.

3. Results

A total of 51 patients who underwent coronary angioplasty were included for the study in which 45 were males and 6 were females. Of these 51

cases, 41 cases (80.4%) had normal creatinine levels while 10 cases (19.6%) had ≥ 1.2 mg/dL. After the procedure 4 cases (7.8%) developed CIN, (i.e. a difference of >0.5 mg/dL in the creatinine level). An association was found between the differences in the creatinine level with the development of nephropathy, which was found to be statistically significant ($P=0.04$). The mean creatinine levels of those cases that developed CIN were 1.83 ± 0.62 mg/dL while it became 3.05 ± 1.17 mg/dL after the procedure (Table 1). Out of the total subjects 10 cases (19.6 %) had pre-existing renal insufficiency. Of these 7 cases (70.0%) did not develop CIN as compared to 3 cases (30%) who developed CIN. One patient without prior renal insufficiency but a known case of diabetes and hypertension also developed CIN (the creatinine levels increased from 1.12mg/dL to 2.6mg/dL).

When the study population was divided further based on new definition of contrast nephropathy recently proposed by Harjai, et al 43 cases (84.3%) were in grade 0, [36 cases had Sr. Cr <1.2 & 7 cases had Sr. Cr >1.2]. 3 cases (5.88%) were in grade 1, all had Sr. Cr <1.2 and 4 cases (7.8%) were in grade 2 [3 cases had Sr. Cr >1.2 & 1 case had Sr. Cr <1.2]. The differences in the proportion of subjects with different grades was found to be statistically significant when analyzed according to presence or absence of nephropathy ($P=0.011$) (Table 2).

In this study population 26 cases (50.98 %) were diabetic out of which 6 cases (23.07%) developed CIN and was statistically significant ($P<0.05$).

4. Discussion

This study shows CIN is a common complication in patients undergoing percutaneous coronary interventions. It is responsible for increase in hospital morbidity & mortality and prolonged hospitalization¹⁰. The incidence of CIN is variable ranging from 5% to 50% depending on the various factors and is more in patients who have pre-existing renal insufficiency¹¹. In the present study also the incidence is more in patients with serum creatinine level >1.2 mg/dL and is statistically significant ($P=0.004$) when compared within the groups. The study also shows that few of the population with no H/O previous renal insufficiency had developed CIN.

According to new definition of contrast nephropathy in patients undergoing percutaneous coronary intervention 3 cases (5.88 %) developed Grade I nephropathy but had

normal baseline renal function. 4 cases (7.8%) were in Grade II out of which one subject normal baseline renal function had and others were previously nephropathic. Hence this classification helps to identify the subjects at risk, showing that the subjects with normal renal function can also develop CIN. There is need for follow up of these patients for long term prognosis as it has been found that the patients in Grade II nephropathy can have worst outcome⁴.

Studies have shown subjects with diabetes mellitus undergoing percutaneous coronary intervention are at more risk of developing CIN¹². In the present study also the incidence of CIN is more in these subjects and is statistically significant ($p < 0.05$). It is also shown that diabetes mellitus is an independent risk factor for CIN, incidence varying from 5.7% to 29.4%¹³. There is a synergistic effect in patients having diabetes mellitus with pre-existing renal insufficiency.^{14,15}

The cause for development of CIN in patients undergoing percutaneous coronary intervention is variable. It can be due to the direct toxic effect of the contrast dye on kidney, Contrast agents will lead to an increase in osmolality, thus resulting in vasoconstriction of the afferent arterioles and subsequently medullary ischemia. The ischemia is likely to cause damage to the kidney, which is mediated by oxygen free radicals. Also, an atheroembolus may be dislodged into the renal arteries during invasive angiographic procedures, leading to renal dysfunction.¹⁶ Hence its association is not by chance but due to various risk factors that were previously mentioned. Thus effect of the contrast agents can increase proportionally in these patients and in patients having impaired renal function. Many preventive strategies like maintenance of hydration, administration of drugs such as mannitol, furosemide and Acetylcysteine have been developed. But their effectiveness in preventing CIN is still unknown¹⁷.

This study shows that the incidence of CIN is more in subjects with abnormal basal renal function compared to subjects with normal basal renal function. Its incidence is also more in subjects with various underlying risk factors like diabetes mellitus.

It is necessary therefore to detect the early impairment of kidney and to assess risk/benefit ratio in patients undergoing coronary interventions. Further long term and large group studies are required to minimize the risk of

developing nephropathy and to implement preventive measures in patients undergoing such procedures. This study also indicates the need for follow up of such group of patients to check for development of nephropathy in future.

The limitation of this study is that the sample size is too small and is confined to a single study centre. Other factors, contributing to the development of renal impairment such as hemodynamic instability, dose of contrast agent, type of the angioplasty procedure and the supportive treatments is not considered in our study, which would have perhaps influenced the clinical outcome of our patients.

We can conclude from this study that CIN is one of the most common causes for hospital acquired renal failure in patients undergoing coronary interventions. In the modern era, there is increase in population undergoing such procedures. Therefore, this complication challenges the cardiologists and the other concerned clinicians to develop some preventive strategies especially in patients with compromised renal function.

Acknowledgment

We greatly thank Prof. Murthy N.S, Department of community medicine, M S Ramaiah Medical College for his help, support and co-operation during this research work. We are grateful for M S Ramaiah medical college student research committee for funding this project.

References

1. Rezkalla S H. Contrast Nephropathy. *Clin Med Res* 2003; 4:301-304
2. McCullough P A, Soman S S. Contrast-induced nephropathy. *Crit Care Clin* 2005; 21:261-280
3. Barrett B J, Parfrey P S. Clinical practice. Preventing nephropathy induced by contrast medium. *N Engl J Med* 2006; 354 (4): 379–86
4. Harjai K J, et al. A comparison of contemporary definitions of contrast nephropathy in patients undergoing percutaneous coronary intervention and a proposal for a novel nephropathy grading system. *Am J Cardiol* 2008; 101(6):812-9
5. McCullough P A, Wolyn R, Rocher L L, Levin R N, and O'Neill W W. Acute renal failure after coronary intervention: incidence, risk factors, and relationship to mortality. *Am J Med* 1997; 103:368–375.
6. Davidson C J, Hlatky M, Morris K G, et al, Cardiovascular and renal toxicity of a

- nonionic radiographic contrast agent after cardiac catheterization. A prospective trial. *Ann Intern Med* 1989; 110:119–124.
7. Conlon P J, Little M A, Pieper K, Mark D B. Severity of renal vascular disease predicts mortality in patients undergoing coronary angiography. *Kidney Int* 2001; 60:1490–1497.
 8. Fabiny D L, Ertinghausen G. Automated reaction-rate method for determination of serum creatinine with the CentrifChem. *Clin Chem* 1971; 17:696–700.
 9. WHO expert consultation. Appropriate body mass index for Asians population and its implications for policy and interventions strategies. *Lancet* 2004; 363(9403):157–63
 10. Rihal, C S, Textor S C, Grill D E, et al. Incidence and prognostic importance of acute renal failure after percutaneous coronary intervention. *Circulation* 2002; 105:2259–64.
 11. Parfrey P. The clinical epidemiology of contrast-induced nephropathy. *Cardiovasc Intervent Radiol* 2005; 28:3–11.
 12. Nikolsky E, Aymong E D, Dangas G and Mehran R. Radiocontrast nephropathy: identifying the high-risk patient and the implications of exacerbating renal function. *Rev Cardiovasc Med* 2003;4: 7–14
 13. Rudnick M R, Berns J S, Cohen R M, Goldfarb S. Nephrotoxic risks of renal angiography: contrast media-associated nephrotoxicity and atheroembolism-a critical review. *Am J Kidney Dis* 1994;24:713–727
 14. Toprak O, Cirit M, Yesil M. Impact of diabetic and pre-diabetic state on development of contrast-induced nephropathy in patients with chronic kidney disease. *Nephrol Dial Transplant* 2007; 22(3):819–826.
 15. Berns A S. Nephrotoxicity of contrast media. *Kidney Int* 1989; 36: 730–740.
 16. Katholi R E, Woods W T, Taylor G J, et al. Oxygen free radicals and contrast nephropathy. *Am J Kidney Dis* 1998 , 32:64–71
 17. Solomon R, Werner C, Mann D, D'Elia J, Silva P. Effects of saline, mannitol, and furosemide to prevent acute decreases in renal function induced by radiocontrast agents". *N. Engl. J. Med* 1994. 331 (21): 1416–20.

TableNo: 1 Incidence of CIN in patients with/without preexisting renal insufficiency

	Serum creatinine <1.2	Serum creatinine >1.2	Total
NO CIN	40(97.6)	7(70.0)	47
CIN	1(2.4)	3(30.0)	4
Total	41 (100)	10 (100)	51

(P=0.004)

TableNo: 2 Incidence of CIN based on Harjai, et al, Classification

Grade	Serum creatinine <1.2	Serum creatinine >1.2	Total
0	36	7	43(84.3)
1	3	0	3(5.88)
2	1	3	4(7.8)
Total	41	10	51(100.0)

(P=0.011)

Figures in parenthesis indicate percentages