

RESEARCH ARTICLE

Role of N-acetylcysteine in prevention of contrast-induced nephropathy among inpatients undergoing coronary angiogram and percutaneous intervention

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ABSTRACT

Background: Nephropathy induced by contrast media used in angiographic procedure is a very common complication and found third most common cause of hospital-acquired acute renal injury. There is no gold standard drug therapy for the management of this condition. **Aims and Objectives:** The present study is designed to evaluate the preventive role of N-acetylcysteine (NAC) in contrast-induced nephropathy (CIN) in susceptible patients receiving intravascular contrast media for coronary angiogram (CAG) and percutaneous transluminal coronary angioplasty (PTCA). **Materials and Methods:** The patients scheduled for elective CAG or PTCA, who were induced with radiocontrast media such as Omnipaque (140–350 ml) and Visipaque (320 mg/ml) were included in the study. The baseline data of serum creatinine (SCR) were measured during 0 h, i.e., prior catheterization referred to as baseline and 24 h, 48 h, and 72 h after contrast administration. The above readings were noted for both the groups where one received NAC plus hydration (1200 mg, orally, twice a day for 48 h) and other group received hydration therapy alone. **Results:** In the study, among the total (326) patients, 149 were treated only with hydration therapy and the mean of SCR levels of these patients before the procedure, that is, at 0 h and after the procedure at 24 h, 48 h, and 72 h is found to be 1.5245, 1.4138, 1.7966, and 0.4899, respectively, and remaining 177 were treated with NAC plus hydration therapy and the mean of the SCR levels of these patients before the procedure, that is, at 0 h and after the procedure at 24 h, 48 h, and 72 h is found to be 1.1616, 1.1546, 0.3586, and 0.01708, respectively. **Conclusion:** Based on the above results, it has been proven that NAC administration through oral route has prevented the CIN after cardiovascular procedures.


KEY WORDS: Serum Creatinine; Renal Injury; Contrast-induced Nephropathy

INTRODUCTION

It is well known that there is a strong relationship between the heart and kidney functions and it is important to know

that any patient have kidney disease who can directly affect the chances of developing heart disease. Similarly, heart disease can directly affect the chances of developing kidney disease. Thus, the preservation of renal function after coronary angiogram (CAG) or percutaneous transluminal coronary angioplasty (PTCA) has become an intense area of research.^[1]

CAG and PTCA have become a common gold standard test for identifying the presence and extent of atherosclerotic coronary artery disease. Unfortunately, the onset of contrast-induced

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renal failure is very common (14.5%) in hospitalized patients undergoing CAG or PTCA.^[2,3] Therefore, it is an immense need in identifying easily administered, well-tolerated, and cost-effective treatment strategies for the prevention of contrast-induced nephropathy (CIN) in interventional cardiology patients. Hence, the present study aims to evaluate the preventive role of N-acetylcysteine (NAC) in CIN among patients undergoing CAG and PTCA.

Objectives

The objectives of the study were to evaluate the preventive role of NAC in CIN in susceptible patients receiving intravascular contrast media for CAG and PTCA.

MATERIALS AND METHODS

It is a prospective observational study, conducted at MNR Medical College and Hospitals, Sangareddy, and Star Hospitals, Banjara Hills, Hyderabad, and for over a period of 6 months with the sample size of 326 patients, in which 177 patients were under NAC and hydration therapy, and other 149 patients were administered with hydration therapy alone. After getting approval from IEC, the written informed consent is obtained from patients who participated in the study.

The patients scheduled for elective CAG or PTCA, who were induced with radiocontrast media such as Omnipaque (140–350 ml) and Visipaque (320 mg/ml) were included in the study. The patients with the following conditions were excluded from the study:

1. Pregnancy and lactation
2. History of allergic reaction to contrast agents
3. Cardiogenic shock
4. Pulmonary edema
5. Multiple myeloma
6. Serum creatinine (SCR) >4 mg/dL and end-stage renal disease
7. Patients using diuretics and nonsteroidal anti-inflammatory drugs.

The baseline data of SCR were measured during 0 h, i.e., prior catheterization referred to as baseline and 24 h, 48 h, and 72 h after the contrast administration. The above readings were noted for both the groups where one received NAC plus hydration (1200 mg, orally, twice a day for 48 h) and the other group received hydration therapy alone. The impairment of renal functions measured as either 25% increase in SCR from baseline or a 0.5 mg/dL increase in absolute SCR level value within 48–72 h after intravenous contrast administration considered as primary end point was the development of CIN. Data were analyzed by independent *t*-test, Chi-square test, and one-way analysis of variance followed by *post hoc* Bonferroni test using the SPSS version 17. $P < 0.05$ was considered as statistically significant.

RESULTS

In the study population, 326 patients were aged in between 41 and 90 years [Table 1]. In total study population, 78% were diagnosed with CAG followed by 19% were diagnosed with PTCA and 3% of both CAG and PTCA. The most commonly used volume of contrast media for CAG and PTCA is 50–100 ml among 232 patients with 71% followed by 100–200 ml among 94 patients with 29%, respectively. Among the patients, 162 (49.6%) patients are found to be with both the comorbidities such as diabetes mellitus and hypertension, followed by 110 (34.0%) patients with hypertension, 41 (12.5%) patients with Type-II diabetes mellitus, and 13 (3.9%) patients with no comorbidities. In the study population of 326 patients, 239 (73.3%) patients were used Omnipaque for diagnostic procedure and 87 (26.6%) patients were used Visipaque as a contrast media.

In the study, of 326 patients, 149 were treated only with hydration therapy and the mean of SCR levels of these patients before the procedure, that is, at 0 h and after the procedure at 24 h, 48 h, and 72 h is found to be 1.5245, 1.4138, 1.7966, and 0.4899, respectively [Table 2], and remaining 177 were treated with the NAC plus hydration therapy and the mean of the SCR levels of these patients before the procedure, that is, at 0 h and after the procedure at 24 h, 48 h, and 72 h is found to be 1.1616, 1.1546, 0.3586, and 0.01708, respectively [Table 2]. At 72 h, NAC plus hydration therapy has shown more significant decrease in SCR levels when compare to hydration therapy alone.

DISCUSSION

The present study is designed to identify the preventive potential of NAC in CIN. Limited data are available for the

Table 1: Age distribution of the study population

Age	Number of cases	Percentage
41–50	46	14.1
51–60	98	30.06
61–70	110	33.74
71–80	62	19.01
81–90	10	3.06

Table 2: Effect of NAC plus hydration therapy and hydration therapy alone on serum creatinine

Hours	Hydration therapy alone Mean±SEM	NAC+Hydration therapy Mean±SEM
0	1.5245±0.06035	1.1616±0.10487
24	1.4138±0.06306*	1.1546±0.10120*
48	0.7966±0.07416*	0.3586±0.10255**
72	0.4899±0.7459*	0.0547±0.01708**

Each value represents Mean±SEM of the number of observations. * $P < 0.01$ compared to the serum creatinine levels before the procedure (at 0 h)
** $P < 0.01$ compared to the hydration therapy. NAC: N-acetylcysteine

role of NAC in CIN in South Indian population. CIN is now recognized as an important cause of renal failure.^[4] Till date, the pathogenesis of CIN is not clear and it has been found that the reduction of renal blood flow, glomerular filtration rate, and direct toxicity of the renal tubules are underlying causes of CIN. Therefore, an adequate hydration before intervention is a key component in maintaining the renal function in patients exposed to contrast agents.^[5] However, 20–50% prevalence of CIN has been observed after standard liquid therapy and it is not suitable for usage in emergency situations.^[6-8]

The production of free radicals in the renal medulla has an additional important factor for the pathogenesis of CIN. Hyperosmolality induced by CIN accelerates the formation of oxygen radicals and consequently leads to toxicity and death of the tubular and glomerular renal cells.

NAC is a potent antioxidant that scavenges a wide variety of free radicals and it may prevent CIN by stopping direct oxidative tissue damage and improve renal hemodynamics.^[9]

The present study results revealed that there was a significant difference in the SCR levels when NAC combined with hydration therapy compare to the hydration therapy alone [Table 2]. Especially at 48 and 72 h after exposure to the contrast agent, the SCR levels significantly decreased in NAC-treated group, which suggests that NAC prevents the oxidative damage of renal tubules, due to its potent antioxidant activity.

The present study results are in corroboration with a study done by Koc *et al.* (2012). In this study, he compared three preventive methods of intravenous injection of NAC plus hydration with a high dose of NaCl ($n = 80$), high dose of NaCl alone ($n = 80$), and standard hydration with NaCl ($n = 80$) and found that NAC plus hydration of high dose of NaCl is more effective than the two other methods. Further, he found that hydration with high dose of NaCl without NAC had no advantage, in comparison with standard hydration.^[10]

CONCLUSION

Based on the above findings, it has been concluded that the oral administration of NAC has a beneficial effect in the prevention of CIN after cardiovascular procedures. Increased morbidity and higher health-care costs associated with CIN can possibly be reduced using NAC prophylactic oral administration at a dose of 1200 mg twice daily on 1 day before and on the day of administration of the contrast agent

along with hydration is useful in preventing renal damage. Further studies are needed to assess the long-term effects of this NAC administration before contrast delivery, particularly in high-risk patients.

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