Original Research Article

Prevention of Contrast Induced Nephropathy in Patients with Pre Existing Renal Dysfunction by Hydration with Sodium Chloride Versus Sodium Bicarbonate in Patients Undergoing Coronary Angiogram

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Abstract

Background: Contrast induced nephropathy is a recognized complication of angiographic procedures and results from administration of iodinated contrast media. CIN has become the third-leading cause of acute renal failure (ARF) affecting 12% of individuals. The study is being performed to evaluate the potential effects of sodium bicarbonate administration compared to normal saline hydration in patients with pre-existing renal disease for coronary angiography.

Materials and methods: A total of 80 patients with pre-angiographic estimated a creatinine clearance <60 ml/min, were selected and randomly assigned in a 1:1 ratio, where patients received 0.9% Sodium chloride for 6hrs before and after coronary angiogram or patients received sodium bicarbonate group 1 hour before and 6 hours after the coronary angiogram.

Results: Among the Normal Saline group, after contrast the mean creatinine was 1.37 ± 0.18, Mean Creatinine Clearance was 53.4 ± 10.74. Among the Sodium Bicarbonate group, after contrast the mean creatinine was 1.43 ± 0.18, Mean Creatinine Clearance was 50.07 ± 10.77. In both groups,

creatinine significantly increased after contrast medium (baseline vs. peak p 0.05). In the present study, among the normal saline group 10% had contrast induced nephropathy and among the bicarbonate group, 17.5% had contrast induced nephropathy, overall incidence of Contrast Induced Nephropathy is 13.75%. No significant difference was observed between the 2 groups

Conclusion: Present study demonstrated that the incidence of contrast induced nephropathy (CIN) in patients with elective procedures is similar when using nephroprotection with normal saline solution or bicarbonate solution without differences in the frequency of important adverse events.

Key words

Contrast induced nephropathy, CIN, Sodium bicarbonate, Normal saline.

Introduction

Contrast induced nephropathy is a recognized complication of angiographic procedures and results from administration of iodinated contrast media [1, 2, 3]. Rising usage of radiological procedures has resulted in an increasing incidence of the procedure-related contrast-induced nephropathy (CIN). The reported incidence of contrast-induced nephropathy ranges from 2% in low risk populations to 50% in high-risk populations. In hospitalized patients, CIN has become the third-leading cause of acute renal failure (ARF) affecting 12% of individuals [4]. Sodium bicarbonate is often used as a means of preventing CIN based on sodium bicarbonate's antioxidant properties and alkalinizing abilities in the renal tubule [5]. The medical literature varies in the effects of sodium bicarbonate in preventing CIN [6]. The study was being performed to evaluate the potential effects of sodium bicarbonate administration compared to normal saline hydration in patients with pre-existing renal disease for coronary angiography.

Materials and methods

All patients referred to the Department of Cardiology at Gandhi Medical College and Hospital, patients underwent planned coronary angiographic procedures at our institution. A total of 80 patients with pre-angiographic estimated creatinine clearance <60 ml/min, were selected and screened to determine if they met the study criteria and the eligible candidates were divided into 2 groups, those receiving normal saline and those receiving sodium bicarbonate.

Inclusion criteria

Estimated glomerular filtration rate (GFR) of < 60 mL/min per 1.73 m^2. The estimated GFR was calculated using serum creatinine levels and the Modification of Diet in Renal Disease study equation (186.3 X serum creatinine level-1.154 X age-0.203 [X 0.742 if female]).

Exclusion criteria

- Inability to obtain consent,
- Age <18 years,
- Allergy to radiographic contrast media,
- Emergency cardiac catheterization,
- Patients on pre-existing dialysis,
- Those who receive sodium bicarbonate infusion prior to randomization,
- Pregnancy
- Cardiogenic shock
- Acutely decompensated congestive heart failure,
- Severe valvular abnormality (e.g., severe aortic stenosis or mitral regurgitation),
- Single functioning kidney,
- Exposure to radiographic contrast media within the preceding 2 days
- History of kidney or heart transplantation, and
- Change in estimated GFR of 7.5% or more per day or a cumulative change of 15% or more over the prior 2 or more days

Procedure

Eligible patients were randomly assigned in a 1:1 ratio to receive an infusion of either sodium chloride or sodium bicarbonate.

I. Patients assigned to isotonic saline received 1 ml/kg/h 0.9% Sodium chloride for 6 hours before and after the procedure.

II. Patients in the sodium bicarbonate group (154 mEq/l in dextrose and water) received 3 ml/kg for 1hr before contrast medium, followed by an infusion of 1 ml/kg/h for 6 hours after the procedure.

Echocardiographic evaluation of left ventricular function was performed in all patients on admission. Coronary angiography through the femoral artery was performed by the standard techniques.

All Coronary angiography procedures were done with non-ionic low-osmolar Omnipaque 300. Serum creatinine concentration was assessed at the time of hospital admission and on 48 hours after the procedure. Contrast induced nephropathy (CIN) was defined as an increase of $\geq 25\%$ or 0.5 mg/dl in pre-procedure Serum creatinine at 48 hours after the procedure.

Statistical analysis

Data entry was done using MS Excel. SPSS (ver10) software was used for statistical analysis. Data were expressed using descriptive statistics such as mean and standard deviation (SD) for continuous variables and frequency, percentages for categorical variables. Patients were divided into two groups according to the development of contrast induced nephropathy (CIN) after the coronary procedure. Comparison of groups was performed by independent samples t test or Mann Whitney U test for continuous variables. Categorical variables were compared by the Chi-square test $\chi 2$ or Fisher's exact test. Using Medcalc software, relative risk (RR) was calculated for CIN. In this study, all tests are 2-tailed, with differences reported as significant if $P < 0.05$ were considered as significant.

Results

Distribution of comorbities and diagnosis which were taken as baseline characteristics as mentioned in **Table - 1** and **Table – 2**.

Table - 1: Baseline distribution of comorbidities and drugs in both the groups.

Co - morbidities	Normal saline group		NaHCO3 group	
	No. Of patients	Percent (%)	No. Of patients	Percent (%)
DM	24	60	26	65
HTN	23	57.5	21	52.5
Smoking	21	52.5	27	67.5
Alcohol	19	47.5	26	65
ACE inhibitors	27	67.5	33	82.5
Diuretics	24	60	31	77.5

Creatinine and creatinine clearance in both the groups, before and following i.v. contrast, however, this elevation in creatinine clearance comparing both groups has not attained statistical significant (**Table – 3**). CIN incidence in Normal saline vs NaHCO$_3$ group was as per **Table – 4**.

Table - 5 depicting statistical analysis comparing the significance of comorbidities and drugs with

contrast induced nephropathy CIN in both the normal saline and the bicarbonate groups. Statistically no significant difference was observed between CIN present and absent groups in terms of creatinine after contrast and Creatinine clearance after contrast as the p >0.05.

Table - 2: Baseline diagnosis requiring coronary angiography in both the groups.

Diagnosis	Normal saline group		NaHCO3 group	
	Frequency	Percent	Frequency	Percent
AWMI	12	30	18	45
IWMI	8	20	5	12.5
IPWMI	6	15	2	5
NSTEMI	3	7.5	8	20
USA	7	17.5	4	10
HEART FAILURE	4	10	3	7.5
TOTAL	40	100	40	100

Table - 3: Creatinine and creatinine clearance in both the groups, before and following i.v. contrast.

	Normal saline group	NaHCO3 group	p value
Serum creatinine before contrast	1.39 ± 0.16	1.36 ± 0.13	>0.05
Serum creatinine after contrast	1.37 ± 0.18	1.43 ± 0.18	>0.05
Creatinine clearance before contrast	51.4 ± 7.30	52.3 ± 8.11	>0.05
Creatinine clearance after contrast	53.4 ± 10.74	50.7 ± 10.77	>0.05

Discussion

Present study demonstrates that the incidence of contrast induced nephropathy (CIN) in patients with elective procedures is similar when using nephroprotection with normal saline solution or bicarbonate solution without differences in the frequency of important adverse events. These results, added to those reported in previous studies, would allow to suggest that hydration

with either solution would be appropriate to diminish the incidence of contrast induced nephropathy (CIN) in patients with moderate renal dysfunction.

Table - 4: CIN incidence in Normal saline vs NaHCO$_3$ group.

Contrast induced nephropathy	Normal saline group		NaHCO3 group		Relative risk	p value
	Frequency (n)	%	Frequency (n)	%		
Present	4	10	7	17.5	0.58	>0.05
Absent	36	90	33	82.5		
Total	40	100	40	100		

Table – 5: depicting statistical analysis comparing the significance of comorbidities and drugs with contrast induced nephropathy.

Parameters	CIN patients in Normal saline group (n = 4)	CIN patients in NAHCO3 group(n = 7)	p value
DM	2	6	>0.05
HTN	3	7	>0.05
Smoking	3	6	>0.05
Alcoholism	3	5	>0.05
EF%	30.50 ± 10.90	41.71 ±18.70	>0.05
ACE inhibitors	2	7	>0.05
Diuretics	2	7	>0.05
BMI	19.9 ± 2.26	23.3 ± 4.27	>0.05
Creatinine before	1.23 ± 0.15	1.29 ± 0.12	>0.05
creatinine clearance before	54.25 ± 4.85	54.85 ± 4.41	>0.05
Creatinine after	1.57 ± 0.13	1.63 ± 0.19	>0.05
creatinine clearance after	41.25 ± 3.77	42.0 ± 5.06	>0.05

In the present study, among the normal saline group 10% had contrast induced nephropathy and among the bicarbonate group, 17.5% had contrast induced nephropathy with mean of 13.7%. These results are consistent with the study done by Mccullough, et al. [1], where CIN incidence was 13.7%. Similarly, a study done by Nough, et al. [7] had an incidence of CIN as 12.8 %.No significant difference was observed between the 2 groups, even when CIN (10% saline vs. 17.5% sodium bicarbonate; p>0.05).

Among the Normal Saline group, before contrast the mean creatinine was 1.39 ± 0.16, Mean Creatinine Clearance was 51.4 ± 7.30, among the Sodium Bicarbonate group, before contrast the mean creatinine was 1.36 ± 0.13, Mean Creatinine Clearance was 52.3 ± 8.11. There was no significant difference between two groups (p value > 0.05).In both groups, creatinine increased after contrast medium.

The primary end point of contrast-induced nephropathy occurred in 4 patients (10%) infused with sodium chloride but in only 7 (17.5%) of those receiving sodium bicarbonate, in contrast to a recent study [9] in which contrast-induced nephropathy occurred in (13.6%) with sodium chloride but only 1 (1.7%) of those receiving sodium bicarbonate chloride (mean difference, 11.9%; 95% confidence interval [CI], 2.6%-21.2%; P = .02).This difference could be explained as patients in the latter study had a stable creatinine with better eGFR than our study population and our study group was comparatively smaller in size.

Sub group and retrospective analysis done by Maoli, et al. [8] (10% vs 12%, p>0.05) 96, concluded no significant difference between sodium bicarbonate vs sodium chloride groups, which was consistent with our data.

Sodium bicarbonate-based hydration was found to be superior to normal saline in prevention of contrast-induced nephropathy in a meta-analysis of 17 studies [10]. It is difficult to comment on the difference in the results between the previous studies and the present study. Possible explanations include the population size, the extension of creatinine monitoring up to 2 days, and the planned nature of the procedure. However, no definitive explanation can be found.

Also, in the subgroup of patients who had CIN , which was defined as 25% relative increase in baseline, serum creatinine were not significantly associated with comorbidities such as hypertension, diabetes, these results are consistent with results in a previous study [11], which compared subgroup of CIN with risk factors.

However, there are a few limitations: enrolled patients with eGFR <60 ml/min per 1.73 m^2 and may not be generalizable to other populations with more preserved kidney function. Present study patients were monitored only during hospitalization and we were not able to determine the presence of further complications. No additional measures of renal function, such as cystatin C, or renal injury were studied.

Conclusion
Present study demonstrated that the incidence of contrast induced nephropathy (CIN) in patients with elective procedures is similar when using nephroprotection with normal saline solution or bicarbonate solution without differences in the frequency of important adverse events.

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