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Prevention of Contrast Induced Nephropathy in Patients Undergoing Coronary Angioplasty by Pretreatment with High Dose Atorvastatin

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Abstract

One potential side effect of coronary angioplasty for the development of acute kidney injury (AKI) is contrast-induced nephropathy (CIN). New data show that atorvastatin, decreases the risk of CIN by its anti-inflammatory and endothelium-stabilizing properties. This paper sought to assess high dose atorvastatin pretreatment in the prevention of CIN in patients who are candidates for coronary angioplasty. This prospective descriptive comparative study was carried out in the department of Cardiology, PAEC Hospital, Islamabad, from 1st August 2024 till 31st December 2024. A total of 214 patients, were equally assigned to two groups: the Atorvastatin Group, comprised of 107 participants and the Control Group comprised of 107 participants. In atorvastatin group, patients took 80mg of orally before 24 hours of angioplasty procedure was done. Routine preoperative IV saline 1 mL/kg/h was given 12 h before and after the procedure. No statin pretreatment was given to patients in control group but they were offered the same level of hydration. Mean age in study group versus control group was (63.2 ± 10.4 years vs. 62.8 ± 11.2, p = 0.685) respectively. The majority of patients (67.3% in the atorvastatin group and 65.4% in the control group) were male.


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The mean contrast volume employed during the procedure was 180.2 ± 25.0 mL in the atorvastatin group and 185.1 ± 30.2 mL in the control group; p = 0.34. High dose atorvastatin administration before coronary angioplasty decreases the incidence of CIN, suggesting that this is a secure and efficient way to maintain renal function.

Keywords: Coronary Angioplasty, CIN, Atorvastatin.

INTRODUCTION

Contrast-Induced Nephropathy is a severe adverse effect of patients receiving coronary angioplasty, defined as AKI occurring within 48 hours of exposure to iodinated contrast agents [1]. CIN is generally considered as a rise in serum creatinine by 25% from the baseline or by≥ 0.5mg/dl within 48 to 72 hours of contrast administration [2, 3]. It is said to be linked with increased morbidity, mortality, more days in the hospital and extra cost in healthcare [4, 5]. There are certain risk factors that contribute to the occurrence of CIN, they include; (CKD), Diabetes mellitus, Heart failure, and Dehydration [6, 7].

Despite the significant advances seen in the interventional cardiology, the prevention of CIN remains an important clinical concern [8]. Procedures like using adequate fluid intake, limiting the volume of contrast, and using low-osmolar or iso-osmolar agents are suggested; these techniques do not eliminate CIN [9]. Over the last few years, efforts have been made in an attempt to prevent the occurrence of CIN through medication [10]. Another emergent strategy is high-intensity statin therapy particularly atorvastatin attributed by their multiple functions [11].

Atorvastatin is a lipid regulating drug in the statin family and identified to possess anti-inflammatory, anti-oxidant, and endothelial preserving properties [12,13]. Such effects are useful in cardiovascular disease prevention and are believed to help offset renal dysfunction by enhancing endothelial function, reducing oxidative stress and preventing contrast-induced inflammation [14].

Therefore, the intention of this study is to investigate how well large doses of atorvastatin can prevent CIN in patients who are at risk for coronary angioplasty. In this study, atorvastatin pretreatment will be compared with standard care without statin therapy to establish the capacity of atorvastatin in decreasing the prevalence of CIN and enhancing clinical outcomes.

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Methodology

This was a prospective descriptive comparative study was carried out in department of Cardiology, from 1st August 2024 till 31st December 2024. Among the 214 patients who were equally allocated into two groups through lottery method, the Atorvastatin Group, comprised of 107 participants and the Control Group comprised of 107 participants. The following were among the patient characteristics used in the study: The baseline blood creatinine levels of patients over the age of 18 receiving elective coronary angioplasty were less than 2.0 mg/dl. The implementation of informed consent was approved by the patient. Patients who had a history of statin allergy or intolerance, pre-operation AKI, patients with end-stage renal disease requiring dialysis, use of high doses of statin therapy within a week before the intervention, significant liver dysfunction, or myopathy were not allowed to participate in the trial. In atorvastatin group, patients took 80mg of orally before 24 hours of angioplasty procedure was done. Routine preoperative IV saline 1 mL/kg/h was given 12 h before and after the procedure. No statin pretreatment was given to patients in control group but they were offered the same level of hydration. Both groups received coronary angioplasty combined with the employment of low osmolar contrast media to avoid the patients' exposure to nephrotoxic substances. The primary end point was CIN, defined as a rise in serum creatinine of $\geq$ 0.5 mg/dL or an average of 25% increase from baseline within the 48- to 72-hour post-surgical period. Serum creatinine level was measured at baseline and at 48 and 72 hours after the procedure using blood samples.

Statistical Analysis

SPSS version 25.0 was utilized for the analysis of the data. Comparison of the two groups for the occurrence of CIN was made using the Chi square test at $p<0.05$. Quantitative data was presented using mean ± standard deviation, while qualitative data was presented as percentage. To control potential confounding factors we used logistic regression analysis and the results were adjusted according to baseline renal function and diabetes.

Results

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This study included 214 patients, with the mean age (63.2 ± 10.4 years vs. 62.8 ± 11.2, p = 0.685). The majority of patients (67.3% in the atorvastatin group and 65.4% in the control group) were male. Diabetes mellitus and hypertension were also comparably matched with 44.9% and 43.9% of patients having diabetes and 55.1% and 57.9% with hypertension respectively (p = 0.70). Utilization of emergency measures was observed in Atorvastatin group in 28.9% and in the control group in 27.1%.

Table 1: Patients' baseline clinical and demographic characteristics

Characteristic	Atorvastatin group (n = 107)	control group (n = 107)	P - value
Age (years, mean ± SD)	63.2 ± 10.4	62.8 ± 11.2	0.68
18–40 years	12 (11.2%)	15 (14.0%)	
41–50 years	22 (20.6%)	20 (18.7%)	
51–60 years	35 (32.7%)	33 (30.8%)	
61–70 years	28 (26.2%)	30 (28.0%)	
>70 years	10 (9.3%)	9 (8.4%)	
Male Gender n (%)	72 (67.3%)	70 (65.4%)	0.76
Diabetes Mellitus, n (%)	48 (44.9%)	47 (43.9%)	0.89
Hypertension, n (%)	59 (55.1%)	62 (57.9%)	0.70
Baseline Creatinine (mg/dL)	1.12 ± 0.35	1.15 ± 0.37	0.57
History of CKD, n (%)	19 (17.8%)	21 (19.6%)	0.75
Emergency Procedure, n (%)	31 (28.9%)	29 (27.1%)	0.74

The average BMI of the patients in both the atorvastatin and control population where considered overweight (42.1% vs. 43.0%, p = 0.81). The atorvastatin group (65.4%) patients living in urban areas while (64.5%) resident of urban areas. Education levels were similar and patients with secondary education were 43% each in the study and control group (p = 0.78).

Table 2: Distribution of Patients by BMI

Characteristic	Atorvastatin group (n =	control group (n =	Total (n = 214)	P - value

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	107)	107)		
BMI (kg/m²)				
< 18.5 (Underweight)	5 (4.7%)	6 (5.6%)	11 (5.1%)	0.75
18.5 – 24.9 (Normal)	38 (35.5%)	36 (33.6%)	74 (34.6%)	0.74
25.0 – 29.9 (Overweight)	45 (42.1%)	46 (43.0%)	91 (42.5%)	0.81
≥ 30.0 (Obese)	19 (17.8%)	19 (17.8%)	38 (17.8%)	1.00
Socioeconomic Status				
Low	21 (19.6%)	23 (21.5%)	44 (20.6%)	0.72
Middle	59 (55.1%)	60 (56.1%)	119 (55.6%)	0.82
High	27 (25.2%)	24 (22.4%)	51 (23.8%)	0.61
Residence				
Urban	70 (65.4%)	69 (64.5%)	139 (65.0%)	0.88
Rural	37 (34.6%)	38 (35.5%)	75 (35.0%)	0.76
Education Level				
No Formal Education	15 (14.0%)	18 (16.8%)	33 (15.4%)	0.55
Primary Education	25 (23.4%)	23 (21.5%)	48 (22.4%)	0.73
Secondary Education	47 (43.9%)	45 (42.1%)	92 (43.0%)	0.78
Higher Education	20 (18.7%)	21 (19.6%)	41 (19.2%)	0.85

The mean contrast volume used during the procedure was 180.2 ± 25.0 ml in atorvastatin while 185.1 ± 30.2 in control; p value 0.34. The procedure time was comparable as well (65.1 ± 15.4 minutes vs. 67.3 ± 16.5 minutes; p = 0.43). Low osmolar contrast media were used in all patients, and the number of patients who underwent multivessel angioplasty was also comparable (33.6% vs. 31.8%; p = 0.78).

Table 3: Procedural Details and Contrast Volume Used

Parameter	Atorvastatin group (n = 107)	control group (n = 107)	P - value
Contrast Volume, (mL)	180.2 ± 25.0	185.1 ± 30.2	0.34
Procedure Duration, (minutes)	65.1 ± 15.4	67.3 ± 16.5	0.43
Use of Low-Osmolar Contrast	107 (100%)	107 (100%)	—
Multivessel Angioplasty, n	36 (33.6%)	34 (31.8%)	0.78

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(%)			
Radial Access, n (%)	58 (54.2%)	60 (56.1%)	0.77

The mean contrast volume used during the procedure was 180.2 ± 25.0 ml in atorvastatin while 185.1 ± 30.2 in control; p value 0.34. Similarly, the control group (15.9%) saw a spike in creatinine of ≥25% considerably more frequently than the atorvastatin group (6.5%; p = 0.03). In comparison to the control group, which stayed in the hospital for 3.1 ± 1.4 days, patients in the atorvastatin group spent an average of 2.4 ± 1.0 days (p = 0.01).

Table 4: Prevalence of Contrast Induced Nephropathy (CIN)

Outcome	Atorvastatin group (n = 107)	control group (n = 107)	P - value
CIN Incidence, n (%)	7 (6.5%)	17 (15.9%)	0.03*
Absolute Creatinine Increase ≥0.5 mg/dL, n (%)	6 (5.6%)	13 (12.1%)	0.08
Increase in Creatinine ≥25%, n (%)	7 (6.5%)	17 (15.9%)	0.03*
Length of Hospital Stay (days mean ± SD)	2.4 ± 1.0	3.1 ± 1.4	0.01*

There was only one case of myopathy in the atorvastatin group (0.9%) whereas there were none in the control group (p = 0.31). 1.9% of the atorvastatin group and 0.9% of the control group had abnormal liver function, specifically an ALT that was more than twice the upper limit of normal. The control group experienced one all-cause mortality (0.9%), while the atorvastatin group experienced none (p = 0.32).

Table 5: Adverse Events and Safety Monitoring

Adverse Event	Atorvastatin group (n = 107)	control group (n = 107)	P - value
Myopathy, n (%)	1 (0.9%)	0 (0%)	0.31
Liver Dysfunction (ALT > 2x ULN)	2 (1.9%)	1 (0.9%)	0.56
AKI Requiring Dialysis, n (%)	0 (0%)	2 (1.9%)	0.16
All-Cause Mortality, n (%)	0 (0%)	1 (0.9%)	0.32

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Discussion

The study reveals that the use of atorvastatin before the procedure reduced the incidence of CIN by having 6.5 % as compared to the 15.9 %. This reduction is in agreement with previous studies revealing an association of statins with lower risk of developing CIN in different populations undergoing similar procedures [15].

For example, Tada et al., (2014), reported in their study that atorvastatin decreased the CIN rate from 15% in a control group to 8% in an atorvastatin group of patients undergoing cardiac interventions, thus resembling our study [16]. Closely, Zhang et al. (2016) have revealed that statin pretreatment can decrease CIN risk by approximately 35%; This figure is quite similar to our 58 % reduction in CIN incidence on comparing atorvastatin group with control group [17].

Also, the results of the present study that revealed a significantly higher magnitude of at least 0.5 mg/dL of serum creatinine in only 5.6% of the atorvastatin patients as oppose to 12.1% in the control group argues for the beneficial effects of atorvastatin. This finding is in line with Mehran et al., (2004) study showing that the absolute rise of creatinine was 0.5 mg/dL in 7% of the patients who received statins compared to 15% of patients who did not receive the drug [18].

It is also important to note that, similar to previous studies, we observed a decrease in the hospital stay in the atorvastatin group patients (2.4 ± 0.94 days) as compared to the control group patients (3.1 ± 1.21 days; $p = 0.01$); the use of atorvastatin decreases CIN and improves clinical outcomes, which may thereby decrease hospital stay (Rao et al., 2015) [19].

On the subject of side effects, we did not find that the atorvastatin group was at any higher risk for adverse effects than the control group. The frequency of myopathy (0.9%) and liver dysfunction (1.9%) in the present study were low and had been reported in other studies such as the study by Collet et al. (2013) that observed myopathy rate at 0.5% to1% in patients on statin therapy [20]. There were no cases of the development of acute kidney injury to the extent that dialysis was needed in the atorvastatin group, thus strengthening the safety argument for high-dose atorvastatin use in the current context.

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Conclusion

This study has established substantial evidence that high-dose atorvastatin before treatment can effectively lessen the occurrence of (CIN) in patients that undergo coronary angioplasty. In support of this view, this study had a relatively mean decrease of CIN rates from 15.9% in the control group to 6.5% in the atorvastatin group demonstrating the usefulness of atorvastatin as a prophylactic measure against CIN.

The implication of these results is that high-dose atorvastatin can be viewed as a preventive measure in CIN for high-risk patients in cardiac procedures. A higher level of research is needed in order to identify the renal outcome of atorvastatin in long-term and for creating the standard protocols for the application of the drug. The use of atorvastatin as part of the pre-procedural management of patients may improve patient outcomes and clinical care in relation to coronary angioplasty.

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