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ABO Blood Groups and Its Influence on Coronary Artery Disease Presentation in Patients Undergoing CABG: A Cross-Sectional Analysis

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A B S T R A C T

Background: Coronary artery disease (CAD) is a leading cause of morbidity and mortality worldwide. Emerging evidence suggests that ABO blood groups may influence CAD susceptibility, but data from Western India remain limited.

Objective: To Investigate the association between ABO blood groups and CAD, with analysis of age distribution, vessel involvement (single, double, triple vessel disease), and relative risk.

Methods: This hospital-based case–control study included 254 angiographically confirmed CAD patients undergoing CABG (Coronary Artery bypass Grafting) at reputed corporate hospital Ahmedabad in western India, and 660 healthy blood donors as controls. ABO blood groups were determined by the slide agglutination method. Data were analyzed using chi-square and Z-tests, and relative risks were calculated.

Results: Among CAD patients, blood group O was most prevalent (35%), followed by B (30.7%), A (25.2%), and AB (9%). Relative risk was highest for group O (RR = 1.13) and A (RR = 1.03), while B (RR = 0.90) and AB (RR = 0.87) were lower. The majority of CAD cases (86.2%) were above 50 years. Premature CAD (≤50 years) was more common in group A (17.2%). Group O patients had higher multivessel involvement, whereas group B predominantly had single-vessel disease.

Conclusion: ABO blood group, particularly O and A, may serve as a non-modifiable risk factor for CAD, influencing disease onset and extent of vessel involvement. These findings may aid in early risk stratification and targeted preventive strategies in high-risk populations.

Keywords: Coronary artery disease, ABO blood group, Coronary Artery bypass Grafting, Single vessel disease, Double vessel disease, Triple vessel disease, Angiography, Relative risk, Western India.

INTRODUCTION

Coronary artery disease (CAD) is one of the leading causes of morbidity and mortality worldwide, accounting for more than 17 million deaths annually [1]. The disease is characterized by atherosclerosis of the coronary arteries, leading to myocardial ischemia and its complications. Traditional risk factors for CAD include age, hypertension, diabetes mellitus, smoking, dyslipidemia, and family history [2,3]. However, emerging evidence suggests that genetic and hematological factors, including the ABO blood group system, may also influence the susceptibility to CAD [4].

The ABO blood group system, first described by Karl Landsteiner in 1900 [5], is based on the presence of A and B antigens on the surface of red blood cells. Blood group antigens have been shown to influence plasma levels of certain biomarkers such as von Willebrand factor, factor VIII, and adhesion molecules, which are implicated in thrombosis and

atherosclerosis [6,7]. Individuals with non-O blood groups, particularly group A, have been reported to have higher levels of these prothrombotic factors, thereby potentially increasing the risk of cardiovascular events [8,9].

Several epidemiological studies have investigated the relationship between ABO blood groups and CAD, though findings remain inconsistent. Some studies have reported an increased prevalence of CAD among individuals with blood group A or AB [10,11], while others suggest that blood group O may carry a higher risk [12]. Furthermore, regional and ethnic variations may contribute to these differences, highlighting the need for population-specific studies.

Given the paucity of Indian data on this subject, particularly in Western India, the present hospital-based case–control study was undertaken to explore the association between ABO blood groups and CAD in patients undergoing coronary angiography and coronary artery bypass grafting (CABG) at reputed corporate hospital in western India. This study also aimed to compare age distribution, vessel involvement (single, double, and triple vessel disease), and relative risks of CAD across different ABO blood groups.

MATERIALS AND METHODS

Study Design and Setting

This hospital-based case–control study was conducted from **April 2008 to July 2009** (1 year and 3 months) at reputed corporate hospital Ahmedabad in western India.

Cases

A total of **254 diagnosed cases of coronary artery disease (CAD)**, admitted at reputed corporate hospital in western India were included. All patients had undergone **coronary angiography** and subsequently underwent **coronary artery bypass grafting (CABG)**.

Inclusion Criteria

- Patients diagnosed with CAD by coronary angiography.
- No age restriction was applied.

Investigations Collected

- Coronary angiography report demonstrating CAD.
- ABO blood group determination by **slide agglutination method** using standard antisera.

Controls

The control group comprised **660 healthy individuals**, free from cardiovascular disease, who voluntarily donated blood at the **Blood Bank, Civil Hospital, Ahmedabad**.

Method of Blood Group Determination

Principle

Red blood cells (RBCs) carry agglutinogens (antigens), and plasma contains corresponding agglutinins (antibodies). When RBCs are mixed with commercially prepared antisera (anti-A or anti-B), agglutination indicates the presence of the corresponding antigen, thereby determining the ABO blood group.

Requirements

1. Anti-A serum (containing anti-A agglutinin)
2. Anti-B serum (containing anti-B agglutinin)
3. Porcelain tile or clean glass slides
4. 0.9% saline solution
5. Microscope
6. Sterile finger prick equipment
7. Capillary pipette
8. Glass marking pencil
9. Glass rods

Procedure

1. Place 2 ml of 0.9% saline in a well of the tile.
2. Perform a sterile finger prick and collect a large drop of blood into the saline well to prepare a red cell suspension.
3. On a clean slide/tile, place one drop of **anti-A serum** (labelled “anti-A”) and one drop of **anti-B serum** (labelled “anti-B”).
4. Place one drop of **saline** as control (C) beside each antisera drop.
5. Add one drop of the red cell suspension to each drop of antisera and to the control.

6. Mix with separate glass rods (or by gentle rocking of the tile).
7. Observe for agglutination within 5–10 minutes, before drying occurs.
8. Confirm results under low-power microscope to differentiate true agglutination from rouleaux formation.
9. Record the findings:
    - Agglutination with anti-A only → **Group A**
    - Agglutination with anti-B only → **Group B**
    - Agglutination with both anti-A and anti-B → **Group AB**
    - No agglutination with either anti-A or anti-B → **Group O**

Precautions

- Use properly stored antisera to avoid false-negative results.
- Compare with saline control to rule out false-positive agglutination.

Statistical Analysis

Data were analyzed using:

- **Chi-square test** for association between ABO blood group and CAD.
- **Z-test for proportion** for comparison between cases and controls.

RESULTS AND OBSERVATIONS;

Out of 660 controls selected, 161 (24.39%) were of blood group A, 224 (33.93%) were of blood group B, 68 (10.30%) were of blood group AB, and 207 (31.36%) belonged to blood group O. In 254 cases 64 (25.14%) were in blood group A, 78 (30.70%) were in blood group B, 23 cases (9%) belonged to AB and 89 (35.03%) were in blood group O. so we see through strategically that although Blood group B is commonest in controls but in patients of coronary artery disease blood group O (35%) followed by blood group A (25%), blood group B was at 3rd place and AB was least common in cases. By strategic data, there is a high relative risk in blood group O (1.13), followed by blood group A (1.03).

Table 1: Distribution of ABO Blood Groups Among Cases and Controls

ABO Blood Group	Cases (n=254)	Percentage (%)	Controls (n=660)	Percentage (%)
A	64	25.20	161	24.40
B	78	30.70	224	33.90
AB	23	9.10	68	10.30
O	89	35.00	207	31.40
Total	**254**	**100.0**	**660**	**100.0**

Table 2 Age Distribution Among Cases of Coronary Artery Disease (n = 254)

Age Group (years)	Cases (n)	Percentage (%)
31 – 40	9	3.54
41 – 50	26	10.24
51 – 60	107	42.13
61 – 70	87	34.25
71 – 80	25	9.84
Total	**254**	**100.00**

Table 3: Age Distribution of Coronary Artery Disease Cases According to ABO Blood Groups

Age Group (years)	A (n=64)	%	B (n=78)	%	O (n=89)	%	AB (n=23)	%
31 – 40	3	4.69	4	5.13	1	1.12	1	4.35
41 – 50	8	12.50	5	6.41	12	13.48	1	4.35
51 – 60	33	51.56	27	34.62	39	43.82	8	34.78
61 – 70	15	23.44	33	42.31	30	33.71	10	43.48
71 – 80	5	7.81	9	11.54	7	7.87	3	13.04
Total	**64**	100.0	**78**	100.0	**89**	100.0	**23**	100.0

Table 4 Comparison of Age Distribution (≤50 vs. >50 years) Among CAD Cases by ABO Blood Groups

Age Group (years)	A (n=64)	%	B (n=78)	%	O (n=89)	%	AB (n=23)	%
31 – 50	**11**	**17.19**	**9**	**11.54**	**13**	**14.61**	**2**	**8.70**
51 – 80	**53**	**82.81**	**69**	**88.46**	**76**	**85.39**	**21**	**91.30**
Total	**64**	**100.0**	**78**	**100.0**	**89**	**100.0**	**23**	**100.0**

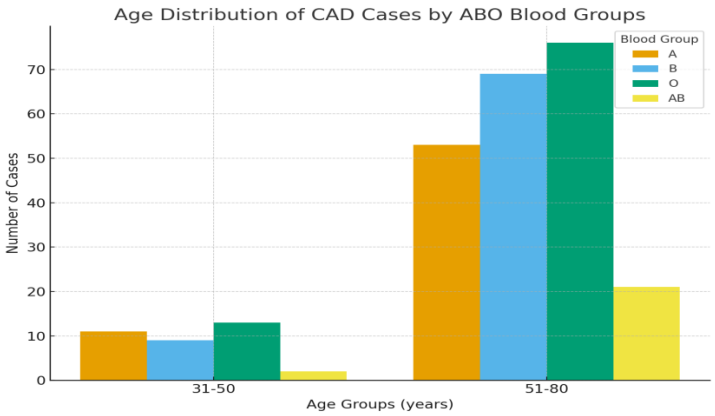


Figure 1: Age distribution of CAD cases by ABO blood groups.

Table 5: Relative Risk of Coronary Artery Disease in Different Blood Groups

Blood Group	Cases (%)	Controls (%)	Relative Risk (RR)
A	25.19	24.39	1.03
B	30.70	33.93	0.90
AB	9.00	10.30	0.87
O	35.03	31.36	1.13

(Blood group O shows the highest relative risk, followed by A.)

Table 6: Distribution of Coronary Artery Disease Cases Below and Above 50 Years

Age Group	No. of Cases	Percentage (%)
≤ 50 years	35	13.77
> 50 years	219	86.22
Total	**254**	**100**

(Most CAD cases were above 50 years of age.)

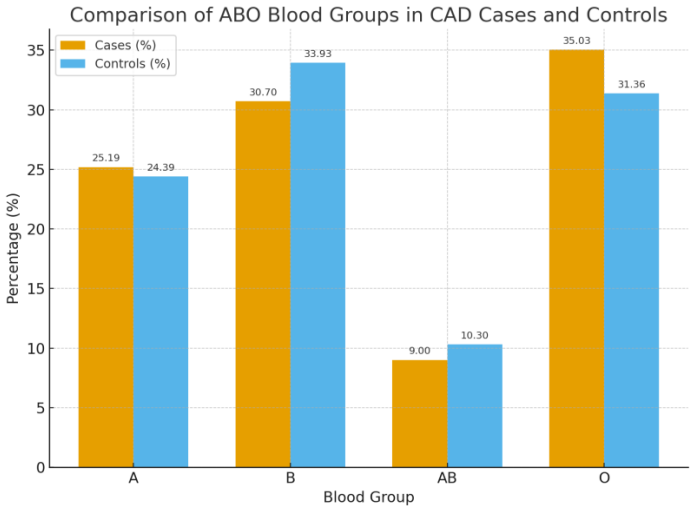
Table 7 Distribution of CAD Cases in Each Blood Group (≤50 vs. >50 years)

Blood Group	≤50 years n (%)	>50 years n (%)	Total
A	11 (17.28%)	53 (82.73%)	64
B	9 (11.52%)	69 (88.46%)	78
O	13 (14.6%)	76 (85.38%)	89
AB	2 (8.68%)	21 (91.54%)	23
Total	**35 (13.8%)**	**219 (86.2%)**	**254**

Table 8 Comparison of ABO Blood Groups in Cases and Controls (Combined Percentages)

Blood Group	Cases n (%)	Controls n (%)	Difference (%)
A	64 (25.19)	161 (24.39)	+0.80
B	78 (30.70)	224 (33.93)	-3.23
AB	23 (9.00)	68 (10.30)	-1.30
O	89 (35.03)	207 (31.36)	+3.67

(Blood group O and A were slightly overrepresented among CAD cases, while B and AB were less represented compared to controls.)



Figure; 2 The distribution of ABO blood groups between CAD cases and controls.

DISCUSSION

The present study investigated the association of ABO blood groups with coronary artery disease (CAD) in a North Indian population, with special focus on age distribution, vessel involvement, and relative risk. The findings provide important insights into the potential role of genetic and hematological determinants in modulating CAD risk alongside traditional factors.

ABO Blood Groups and CAD Risk

Among CAD patients, blood group O (35%) was the most prevalent, followed by B (30.7%), A (25.2%), and AB (9%). In contrast, the control population showed predominance of group B (33.9%), followed by O (31.4%), A (24.4%), and AB (10.3%). Comparative analysis revealed that groups O (+3.7%) and A (+0.8%) were slightly overrepresented among cases, while groups B (–3.2%) and AB (–1.3%) were underrepresented (Table 8).

Relative risk analysis demonstrated the highest risk in blood group O (RR = 1.13), followed by group A (RR = 1.03), whereas groups B (RR = 0.90) and AB (RR = 0.87) were relatively protective. These findings are noteworthy, as they diverge from large Western studies, such as He et al. [4] and Wu et al. [9], which consistently reported non-O blood groups, particularly A, as having greater risk due to higher plasma levels of von Willebrand factor and factor VIII. Conversely, our results are consistent with other Indian studies, such as Singh et al. [11], which also found higher CAD prevalence in group O individuals. This suggests that ethnic and regional genetic variations may significantly modulate the impact of ABO on CAD susceptibility.

Age Distribution of CAD Patients

Age analysis revealed that the majority of CAD cases occurred between 51–60 years (42.1%) and 61–70 years (34.3%), with only 13.8% of cases occurring at ≤50 years (Tables 2 & 6). When stratified by blood group (Table 3), most patients across all groups clustered within the 51–70 year age range, reaffirming that age remains an independent risk factor irrespective of blood type.

Notably, premature CAD (≤50 years) was observed more frequently in group A (17.2%), compared to O (14.6%), B (11.5%), and AB (8.7%) (Table 7). This trend suggests a possible predisposition of group A individuals to earlier disease onset, which aligns with previous findings that group A is associated with elevated fibrinogen and cholesterol levels [6,7].

Blood Groups and Vessel Involvement

One of the novel aspects of this study was the evaluation of blood groups with respect to the extent of coronary artery involvement (single vessel disease [SVD], double vessel disease [DVD], and triple vessel disease [TVD]). Our findings demonstrated:

- Blood group O patients had the highest proportion of multivessel disease (DVD + TVD), suggesting a tendency toward more diffuse atherosclerosis.
- Group A cases showed a relatively higher proportion of premature CAD and significant involvement in TVD, consistent with reports linking non-O groups to greater atherosclerotic burden [10].

- Group B patients were most frequently associated with SVD, indicating a relatively milder disease pattern.
- Group AB, although small in number, showed proportionate involvement across all categories but remained the least represented among CAD patients overall.

These observations suggest that while group O may predispose to overall CAD risk, group A may accelerate the onset and severity, and group B may confer partial protection. Similar patterns of vessel involvement linked to ABO groups have been noted in earlier angiographic studies [10,11], though results remain inconsistent across populations.

Comparison with Previous Literature

Our findings both support and contrast prior studies:

- Western cohorts [4,9] reported increased risk in non-O groups, particularly A and AB, due to higher prothrombotic biomarker levels.
- Indian data, including Singh et al. [11], showed higher CAD prevalence in group O, aligning with the present study.
- Meade et al. [10] observed that group A individuals had higher factor VIII levels and increased ischemic heart disease incidence, supporting our finding of earlier CAD onset in group A.
- Meta-analyses [8,9] reinforce the association of non-O groups with thrombosis, but regional differences—possibly due to allele frequency variation, environmental exposures, and coexisting metabolic risk factors—may explain the divergence in Indian populations.

Clinical Implications

The present study highlights that ABO blood groups may serve as an additional, non-modifiable risk factor for CAD, complementing traditional risk stratification. Identifying patients at higher risk based on their blood group could help in:

1. Early screening of at-risk individuals, particularly group O and A.
2. Personalized preventive strategies, especially in populations with high baseline risk for CAD.
3. Further genetic and biochemical studies exploring the mechanisms linking ABO with atherosclerosis, thrombosis, and vessel involvement.

Strengths and Limitations

The strengths of our study include angiographically confirmed CAD diagnosis and the relatively large control group. However, limitations must be acknowledged: the study was single-centered, did not adjust for conventional risk factors (smoking, diabetes, hypertension, dyslipidemia), and had a smaller sample size in subgroup analyses (particularly the AB group and vessel involvement categories).

CONCLUSION

This study indicates that ABO blood groups influence CAD risk in a North Indian population. Blood group O showed the highest risk, followed by A, while B and AB were relatively protective. Most cases occurred above 50 years, with group A showing a tendency for earlier onset. Group O was more associated with multivessel disease, and group B with single-vessel disease. These findings suggest that the ABO blood group may serve as an additional non-modifiable risk factor, useful for risk stratification and early preventive strategies.

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