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**Original Research Article**

# Co-relation between total cholesterol, high density lipid, low density lipid and glycosylated haemoglobin in diabetic patients with severity of acute coronary syndrome

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## ABSTRACT

**Background:** Cardiovascular disease is a leading cause of illness and death worldwide. Diabetic patients with dyslipidaemia are at increased risk for coronary artery disease, often manifesting as acute coronary syndrome (ACS), which can be life-threatening. This study aims to correlate lipid profiles (total cholesterol, low-density lipoprotein (LDL), high-density lipoprotein (HDL)) and glycosylated haemoglobin (HbA1c) levels with ACS severity (single versus multi-vessel disease) and examine how the duration of diabetes influences ACS severity.
**Methods:** This cross-sectional study involved diabetic patients aged 30 and above who presented with their first ACS episode in the Emergency Department and underwent coronary angiography. Blood samples were collected for HbA1c and lipid profile assessments. Exclusion criteria included known coronary artery disease, current use of hypolipidemic drugs, and conditions that could confound lipid results.
**Results:** Patients with multi-vessel disease (MVD) had higher mean HbA1c (9.06±1.34) compared to those with single-vessel disease (SVD) (7.86±0.87). The MVD group also had higher total cholesterol (213.17±30.78 mg/dl) and LDL (143.60±27.79 mg/dl) levels compared to the SVD group (183.96±34.33 mg/dl, 107.66±27.23 mg/dl). HDL levels were lower in the MVD group (31.29±9.92 mg/dl) compared to the SVD group (45.16±14.46 mg/dl). Diabetes lasting more than 10 years was associated with a higher incidence of MVD (44%).
**Conclusions:** Early detection and effective management of diabetes, including glycemic control and lipid regulation, can reduce the severity and incidence of ACS in diabetic patients.

**Keywords:** ACS, LDL, HDL, Multi-vessel disease, Single vessel disease

## INTRODUCTION

The phrase acute coronary syndrome (ACS) encompasses a range of clinical manifestation associated with acute myocardial ischemia. It includes various conditions such as 'ST-segment elevation myocardial infarction (STEMI), 'non-ST-segment elevation myocardial infarction (NSTEMI) and unstable angina (UA).[1]

Atherosclerosis is a progressive condition marked by plaque build-up in the arteries, beginning early in life and potentially leading to acute ischemic events. Key risk factors include dyslipidaemia, hypertension, diabetes, smoking, obesity, psychological stress, physical inactivity, and poor diet. These factors damage the endothelium, resulting in endothelial dysfunction, which is critical for plaque formation.[2]

Hyperglycemia can promote atherosclerosis through several mechanisms: it causes endothelial vasomotor dysfunction, promotes advanced glycation end products, increases circulating free fatty acids, heightens systemic

inflammation, and creates a prothrombotic state. Endothelial vasomotor dysfunction, common in diabetic vascular disease, is associated with higher hypertension and worse cardiovascular outcomes.[3]

Glycosylated haemoglobin (HbA1c) is a key biomarker that reflects average plasma glucose levels, both fasting and postprandial, over the past 2 to 3 months, making it essential for effective diabetes management. This form of glycated hemoglobin is formed through non-enzymatic glycation and its levels depend on red blood cell lifespan and blood glucose. HbA1c is crucial for monitoring diabetes and assessing the risk of microvascular complications, with a diagnosis of diabetes made if HbA1c exceeds 6.5%.[4,5]

Dyslipidemia is a major risk factor for atherosclerosis in individuals with type 2 diabetes mellitus (T2DM). Certain lipid profile characteristics associated with diabetes increase the risk of atherogenesis. Research has shown that elevated total cholesterol (TC) levels contribute to the constriction of coronary vessels, raising the risk of coronary artery disease (CAD). High levels of low-density lipoprotein cholesterol (LDL-C) can lead to arteriosclerosis by accumulating in the artery walls, potentially promoting thrombosis. Additionally, low levels of high-density lipoprotein cholesterol (HDL-C) are considered one of the strongest individual risk factors for CAD.[6,7]

This study aimed to evaluate the relationship between total cholesterol, HDL, LDL, and HbA1c levels in diabetic patients with varying severity of ACS, classified by single or multi-vessel disease via coronary angiography. The results could help predict the type of coronary artery disease in these patients, as multi-vessel disease is associated with higher mortality risk.

HDL, LDL, total cholesterol, and HbA1c can serve as valuable indicators for determining the need for angiography in ACS patients, as not all patients require this procedure. By assessing these markers, healthcare providers can inform diabetic patients about the potential severity of ACS before angiography. These four simple metrics can effectively convey the urgency of angiography in patients with ACS, supporting evidence-based medical practice.

### *Aims and objectives*

Aims and objectives were: to determine the level of total cholesterol, LDL, HDL and HbA1c in type 2 diabetes mellitus patients presented with first episode of ACS undergoing angiography; to study co-relation between total cholesterol, LDL, HDL and HbA1c (glycaemic control) in diabetic patients with severity of acute coronary syndrome by angiography as measured single vessel vs multi vessel disease; and also to assess the relationship between the length of time an individual has had diabetes and the severity of acute coronary syndrome in patients diagnosed with diabetes.

## METHODS

This study employs an observational cross-sectional design to examine the relationship between serum lipid profile and HbA1c levels in diabetic patients with varying severity of ACS. The study spans 18 months, from February 2023 to July 2024, with participants recruited from the outpatient department (OPD) and inpatient department (IPD) at LLR Hospital and LPS Cardiology Institute in Kanpur.

### *Inclusion criteria*

Participants must be willing to provide consent for the study, aged 30 or older, and of either sex. The inclusion criteria specifically target known diabetes mellitus patients who are presenting with their first episode of ACS in the emergency setting and have undergone coronary angiography.

### *Exclusion criteria*

Exclusion criteria include known cases of coronary artery disease, patients already taking hypolipidemic medications, and individuals with conditions that may affect lipid profile measurements, such as hypothyroidism, obstructive liver disease, chronic kidney disease, and nephrotic syndrome. Additionally, patients on medications like estrogen, progestins, anabolic steroids, corticosteroids, retinoids, cyclosporine, and antiretroviral drugs are also excluded from the study.

### *Sample size*

250 diabetic patients with acute coronary syndrome.

### *Methodology of data collection*

The research took place in the General Medicine Department of G.S.V.M. Medical College in Kanpur, Uttar Pradesh, India, over an 18-month period from February 2023 to July 2024. Patients were recruited from both the OPD and IPD at LLR Hospital and LPS Cardiology Institute. A detailed history of the current illness, along with past medical, personal, and family histories, was collected, and a thorough general and systemic examination was performed.

After obtaining written consent, patients underwent further investigations, including electrocardiography (ECG), cardiac troponins, glycosylated hemoglobin, fasting lipid profile, liver function tests, kidney function tests, and complete blood count. The diagnosis of acute coronary syndrome was confirmed based on the electrocardiogram findings, cardiac troponin levels, and clinical presentation.

All patients underwent coronary angiography using the Siemens Artis Zee floor-mounted cardiac catheterization lab system to assess for single-vessel or multi-vessel coronary artery disease.

HbA1c levels were measured using an enzymatic assay method on an automated analyzer. Total cholesterol was assessed with a liquid cholesterol reagent set based on an enzymatic method, while triglycerides were measured using the glycerokinase-peroxidase method on the same analyzer. HDL cholesterol was determined by the phosphotungstic acid method, and LDL was calculated using the formula: total cholesterol - (VLDL + HDL), with very low-density lipoprotein (VLDL) estimated as triglycerides divided by 5. The analyzer used was from Shenzhen Mindray Bio-Medical Electronics.

### *Statistical analysis*

The data was entered into Microsoft excel 2010, and statistical analysis was conducted using IBM statistical package for the social sciences (SPSS) Statistics V 20.00. Categorical variables were analyzed using proportions and percentages. Continuous variables were summarized by means and standard deviations, and associations were tested using parametric statistical methods. correlation between two continuous variables using Pearson correlation coefficient.

## RESULTS

The study included 250 patients, with a majority of 75.2% males (188) and 24.8% females (62). Among the participants, 38.8% had single vessel disease, while 61.2% had multiple vessel disease. Regarding the type of acute coronary syndrome (ACS), 10.4% had unstable angina, 27.2% had NSTEMI, and 62.4% had STEMI. Hypertension was present in 40.4% of patients, and 28.8% were smokers while 24.8% had a history of alcoholism. Biochemical parameters revealed an average HbA1C of 8.47%, total serum cholesterol of 196 mg/dl, LDL of 126 mg/dl, and HDL of 38.9 mg/dl. Demographic data of the study population (Table 1).

The mean HbA1c level was 7.86% (SD=0.87) for those with single vessel involvement and 9.06% (SD=1.34) for those with multiple vessel involvement, further confirming the statistically significant relationship between poorer glycemic control and increased severity of ACS (Table 2).

The mean serum HDL values is 45.16 mg/dl (SD=14.46) in the single vessel disease compared to 31.29 mg/dl (SD=9.92) in the multiple vessel disease. These findings highlight a significant inverse association between HDL levels and the severity of coronary vessel involvement (Table 3).

The mean serum LDL levels is 107.66 mg/dl (SD=27.23) in the single vessel disease group compared to 143.60 mg/dl (SD=27.79) in the multiple vessel disease group. These findings highlight a significant co-relation was also found between LDL and ACS severity (Table 4).

**Table 1: Demographic data of the study population.**

| Parameters | Number of cases | Percentage |
|---|---|---|
| **Gender** | | |
| Male | 188 | 75.2 |
| Female | 62 | 24.8 |
| **Vessel involvement** | | |
| Single vessel disease | 97 | 38.8 |
| Multiple vessel disease | 153 | 61.2 |
| **Type of ACS** | | |
| Unstable angina | 26 | 10.4 |
| NSTEMI | 68 | 27.2 |
| STEMI | 156 | 62.4 |
| **Hypertension** | | |
| Present | 101 | 40.4 |
| Absent | 149 | 59.6 |
| **Substance abuse** | | |
| Smoking | 72 | 28.8 |
| Alcoholism | 62 | 24.8 |
| **Study parameters (mg/dl)** | | **Range** |
| HbA1C (mean±SD) | 8.47±1.23 | 6.6–12.5 |
| Total serum cholesterol (mean±SD) | 196±35.6 | 124–286 |
| LDL (mean±SD) | 126±32.9 | 52.2–232 |
| HDL (mean±SD) | 38.9±14.9 | 19.6–86.2 |

**Table 2: Distribution of cases according to HbA1c with type of vessel involvement (n=250).**

| HbA1c (%) | Single vessel involvement (%) | Multiple vessel involvement (%) | P value |
|---|---|---|---|
| **6.5-8.4** | 66 (68.04) | 56 (36.6) | <0.001 |
| **≥8.5** | 31 (31.95) | 97 (63.39) | |
| **Mean HbA1c (SD)** | 7.86 (0.87) | 9.06 (1.34) | <0.001 |

**Table 3: Distribution of cases according to serum HDL with type of vessel involvement (n=250).**

| Serum HDL (mg/dl) | Single vessel involvement (%) | Multiple vessel involvement (%) | P value |
|---|---|---|---|
| **<40** | 38 (39.17) | 130 (84.96) | <0.001 |
| **≥40** | 59 (60.82) | 23 (15.03) | |
| **Mean serum HDL (SD)** | 45.16 (14.46) | 31.29 (9.92) | <0.001 |

Our study found a significant correlation between serum cholesterol levels and coronary vessel involvement.

Participants with cholesterol <200 mg/dl had mostly single vessel disease (69.07%), while those with levels between 200-239 mg/dl had a mix of single (19.58%) and multiple vessel involvement (49.01%). Cholesterol ≥240 mg/dl showed less single vessel (11.34%) and more multiple vessel involvement (15.03%) (Table 5).

**Table 4: Distribution of cases according to serum LDL with type of vessel involvement (n=250).**

| Serum LDL (mg/dl) | Single vessel involvement (%) | Multiple vessel involvement (%) | P value |
|---|---|---|---|
| **<100** | 36 (37.11) | 14 (9.15) | <0.001 |
| **≥100** | 61 (62.88) | 139 (90.84) | |
| **Mean serum LDL (SD)** | 107.66 (27.23) | 143.60 (27.79) | <0.001 |

**Table 5: Distribution of cases according to serum cholesterol with type of vessel involvement (n=250).**

| Serum cholesterol (mg/dl) | Single vessel involvement (%) | Multiple vessel involvement (%) | P value |
|---|---|---|---|
| **<200** | 67 (69.07) | 55 (35.94) | <0.001 |
| **200–239** | 19 (19.58) | 75 (49.01) | |
| **≥240** | 11 (11.34) | 23 (15.03) | |
| **Mean serum cholesterol (SD)** | 183.96 (34.33) | 213.17 (30.78) | <0.001 |

The mean duration of diabetes was 5.27 years (SD=3.89) for those with single vessel involvement and 11.22 years (SD=7.03) for those with multiple vessel involvement, further supporting that duration of diabetes was significantly associated with type of vessel involvement.

**Table 6: Distribution of cases according to duration of diabetes with type of vessel involvement (n=250).**

| Duration of diabetes (years) | Single vessel involve-ment (%) | Multiple vessel involve-ment (%) | P value |
|---|---|---|---|
| **Less than 5** | 45 (46.39) | 28 (18.3) | <0.001 |
| **5–10** | 47 (48.45) | 57 (37.25) | |
| **More than 10** | 5 (5.15) | 68 (44.44) | |
| **Mean duration (SD)** | 5.27 (3.89) | 11.22 (7.03) | <0.001 |

## DISCUSSION

Cardiovascular disease (CVD) is a leading cause of morbidity and mortality globally, yet it is largely preventable through the management of modifiable risk factors. In this study, we investigated the relationship between various risk factors including cholesterol levels, HbA1c, and lipid profiles and the severity of ACS, as assessed by coronary angiography for single- or multi-vessel disease. We included 250 diabetic patients diagnosed with ACS, recruited from the OPD and inpatient care at LLR Hospital and LPS Cardiology Institute, Kanpur.

The mean age of the patients was 56.57±13.16 years, with a male predominance (75.2%) compared to females (24.8%). Among the 250 patients, 26 (10.4%) had unstable angina, 68 (27.2%) had NSTEMI, and 156 (62.4%) had STEMI. These proportions align with findings from previous studies, such as Kumar et al, where the majority had STEMI.[1]

The prevalence of common cardiovascular risk factors was high in our cohort: 40.4% of patients had a history of hypertension, 28.8% were smokers, and 24.4% consumed alcohol. These findings are consistent with other studies, including Baligar et al and the UK prospective diabetes study (UKPDS), which also report elevated rates of hypertension, smoking, and alcohol use among diabetic populations.[8]

Our study examined the severity of coronary artery disease by categorizing patients into those with single-vessel disease (SVD) and multi-vessel disease (MVD) based on coronary angiography. We found that 38.8% had SVD, while 61.2% had MVD. This is similar to Kumar et al, where 32.2% had SVD and 67.8% had MVD.[1] This classification is clinically important as patients with MVD often require more intensive treatment than those with SVD.

Age was found to influence the extent of coronary involvement, with patients aged 51–70 years more likely to have MVD, while those aged 41–50 years had a higher proportion of SVD. This aligns with Baligar et al, where older age groups showed higher proportions of MVD, suggesting a cumulative effect of aging on ACS severity.[8]

A significant relationship was observed between HbA1c levels and the severity of coronary artery disease. Among patients with HbA1c levels between 6.5% and 8.4%, 68.04% had SVD, while 36.6% had MVD. In contrast, patients with HbA1c ≥8.5% had a higher occurrence of MVD (63.39%), with only 31.95% having SVD. The average HbA1c levels were significantly higher in patients with MVD (9.06%) compared to those with SVD (7.86%), confirming a strong association between poor glycemic control and more severe ACS. This is consistent with findings from studies by Baligar et al, Tahir et al, and Ayhan et al.[9,10,15]

Furthermore, our study showed an inverse relationship between HDL cholesterol levels and ACS severity. Patients with HDL <40 mg/dl had a higher incidence of MVD (84.96%) compared to those with HDL ≥40 mg/dl,

where a majority (60.82%) had SVD. These findings are consistent with research by Gonzalez-Pacheco et al and Zhao et al which found that lower HDL levels are associated with greater cardiovascular risk.[11,12]

We also found that LDL cholesterol levels correlated with ACS severity. Among patients with LDL <100 mg/dl, most had SVD (37.11%), while those with LDL ≥100 mg/dl predominantly had MVD (90.84%). This is in line with studies by Pant et al and Kumar et al, which also found a significant association between higher LDL levels and increased severity of coronary artery disease.[1,2]

Finally, our study revealed that patients with longer durations of diabetes had more severe coronary artery disease. Specifically, 44% of patients with diabetes duration >10 years had MVD, compared to a higher proportion of SVD in those with diabetes duration <10 years. These findings are supported by studies from Tahir et al and Syvanne et al which also reported a linear relationship between diabetes duration and coronary artery disease severity.[13,14]

### *Limitations*

Sample size in our study is small. Hence more studies with large sample size on diabetic patients with ACS are needed in future to stabilise the association of risk factor and severity of ACS.

Duration of study is short, hence follow up of patients was not included in the study.

## CONCLUSION

Cardiovascular disease remains a leading cause of morbidity and mortality globally, with DM playing a key role in the progression and severity of ACS. This observational study of 250 diabetic patients with ACS, admitted to LLR Hospital and LPS Cardiology Institute in Kanpur, explored the relationship between glycemic control, lipid profiles, diabetes duration, and ACS severity. The findings revealed that most patients (61.2%) had multi-vessel disease, highlighting the need for intensive treatment strategies. Higher HbA1c levels (≥8.5%) were strongly associated with multi-vessel involvement, emphasizing the importance of glycemic control in reducing ACS progression. Additionally, lower HDL and elevated LDL and serum cholesterol levels correlated with increased ACS severity, reinforcing the predictive value of lipid profiles. The duration of diabetes (≥10 years) also contributed to more severe coronary involvement. Overall, this study underscores the importance of optimizing glycemic and lipid management to improve cardiovascular outcomes in diabetic patients.

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