# The Predictive And Discriminative Values Of Serum Lipids, Lipoproteins And Apolipoproteins In Atherosclerotic Coronary Artery Disease

*ALAETTIN AVSAR*[*1]
*ABDULLAH DOGAN*[2]
*MURAT SARUC*[3]
*SEDAT DEMIR*[4]
*TALAT TAVLI*[5]
*ALI BAYRAM*[**6]

**SUMMARY:**

**The purpose of this study was to assess the predictive and discriminative value of lipids, lipoproteins and clinical risk factors in atherosclerotic coronary artery disease (CAD). In addition, we attempted to find out whether lipid, lipoprotein and apolipoprotein concentrations are related to the extent of disease. We also studied interrelations among the variables (lipids, lipoproteins, apolipoproteins and clinical risk factors). We determined the prevalence of abnormalities of lipids, lipoproteins and apolipoproteins in CAD groups and control group. We studied in 138 patients. The patients were divided into groups on the basis of the angiographic results. The mean values for total cholesterol (TC), LDL cholesterol (LDL-C), apolipoprotein B (Apo B) and the ratio of Apo B to Apo A-I were significantly higher in patients with CAD group than in control subjects. HDL cholesterol (HDL-C), triglyceride (TG) and Apo A-I levels were not significantly different between the control and CAD groups. Stepwise discriminant analysis showed that the ratio of HDL-C/TC was a better discriminator than other lipid and nonlipid factors. TC and LDL-C levels and the ratio of HDL-C/TC were correlated with severity of CAD. In conclusion, plasma apolipoprotein levels may not be considerably better markers for CAD than traditional lipid determinations. The best discriminator in this study is a low ratio of HDL-C/TC.**

**Key Words: Serum lipids, lipoproteins, apolipoproteins, coronary artery disease, coronary angiography.**

## Introduction:

Atherosclerosis is a progressive disease that generally begins in childhood but does not become clinically manifest until middle to late adulthood[1].

There has been intensified interest in the contribution of the measurement of lipid, lipoprotein and apolipoprotein levels to the evolution of atherosclerotic cardiovascular disease[2]. Blood lipids have been established as fundamental to atherogenesis[3]. Serum lipids, lipoproteins and more recently apolipoproteins and lipoprotein (a) have been shown to be independent risk factors for CAD and its prognosis[4].

MD Department of Cardiology, Faculty of Medicine, Celal Bayar University Manisa-Turky.
* MD Department of Internal Medicine, Faculty of Medicine, Celal Bayar University Manisa-Turkey.
** MD Department of Cardiology, Faculty of Medicine, Karadeniz Technique University, Trabzon-Turkey.
1 Assistant Professor of Cardiology
2 Cardiologist
3 Assistant of Internal Medicine
4 Associated Professor of Cardiology
5 Professor of Cardiology

**TABLE-1**
**Demographic Characteristics of Patients with Coronary Artery Disease**

| Coronary Artery Disease Groups | Case Number (n:91) | Men (n:63) | Women (n:28) | Age (year) | Range of Age |
|---|---|---|---|---|---|
| One Vessel | 42 | 32 | 10 | 53.33±9.23 | 32-73 |
| Two Vessels | 29 | 16 | 13 | 57.55±9.69 | 40-71 |
| Three Vessels | 20 | 15 | 5 | 58.1±9.48 | 40-72 |

Although the causal connection between hypercholesterolemia and atherosclerosis is well understood, the potential relation between elevated triglyceride levels or decreased HDL-C levels and atherosclerotic CAD remains controversial[3,5].

LDL-C level has been shown to be a major risk factor for CAD in animal studies, clinical trials and observational epidemiological studies[6,7].

**Methods:**

Between April 1993 and October 1993, 138 patients were admitted to the department of Cardiology, Selcuk University School of Medicine Konya with suspicion of CAD.

The CAD group consisted of 91 cases (63 men and 28 women). The control group consisted of 47 cases (22 men and 25 women).

Patients with valvular heart disease, those on lipid lowering agents, and those who underwent surgery or trauma within 6 weeks were excluded from this study. Neither control nor CAD group patients were using steroid, estrogen, oral contraceptive, anabolic androgen and thyroid hormone preparations which affect the measurements of lipids, lipoproteins and apolipoproteins. Since the ratio of beta blocker drug treatment receivers and inadequate compliance to treatment resembles in control and CAD groups, it has been postulated that the use of medication beta blocker drug would be affecting in same manner measurements of lipids, lipoproteins and apolipoproteins.

**TABLE-2**
**Clinical Characteristics of Patient and Control Groups**

| Variables | Control Group (n:47) | One Vessel (n:42) | Two Vessels (n:29) | Three Vessels (n:20) | P Value p1 | p2 | p3 |
|---|---|---|---|---|---|---|---|
| Age (year) | 53.42±9.39 | 53.42±9.23 | 57.55±9.69 | 58.1±9.48 | >0.05 | >0.05 | >0.05 |
| Sex (M/F) | 22/25 | 32/10 | 16/13 | 15/5 | <0.01 | >0.05 | <0.05 |
| Hypertension | 17(36%) | 23(55%) | 20(69%) | 11(55%) | >0.05 | <0.01 | >0.05 |
| Smoking Score | 1.36±0.57 | 1.78±0.66 | 1.45±0.70 | 1.54±0.56 | <0.01 | >0.05 | >0.05 |
| D. Mellitus | 4(8.5%) | 4(9.5%) | 6(21%) | 4(20%) | >0.05 | >0.05 | >0.05 |
| BMI | 26.7±3.31 | 25.9±3.10 | 27.1±2.98 | 26.7±3.68 | >0.05 | >0.05 | >0.05 |

**BMI: Body mass index**
**Data are expressed as mean±SD.**
**P value is significant at the 0.05 level of significance.**

In recent studies the serum concentrations of the apolipoproteins, have been considered, even better discriminators between patients with CAD and healthy controls than the levels of total cholesterol or lipoproteins[8-11]. In the Framingham Study, newer lipid measures such as apolipoproteins A-I and B have shown little or no additional effect in predicting CAD[12].

Coronary arteriography of all cases were performed at Selcuk University, School of Medicine. Coronary angiography was performed by the Judkins technique via the right femoral artery. All arteriograms were examined by two independent cardiologists who

**TABLE-3**

**Serum Lipid, Lipoprotein, and Apolipoprotein Levels in Control Subjects and Patients with Coronary Artery Disease**

| Variables | Control Group (n:47) | One Vessel (n:42) | Two Vessels (n:29) | Three Vessels (n:20) | All Patients (n:91) | P Value p1 | p2 | p3 | p4 |
|---|---|---|---|---|---|---|---|---|---|
| TC (mg/dl) | 214.85±49.11 | 223.47±49.11 | 250.31±57.10 | 265.7±56.51 | 241.31±55.75 | NS | <.01 | <.001 | <.01 |
| HDL-C (mg/dl) | 45.90±9.87 | 43.54±13.74 | 42.92±10.96 | 42.66±9.33 | 43.15±11.91 | NS | NS | NS | NS |
| LDL-C (mg/dl) | 135.74±40.38 | 146.42±43.22 | 165.96±61.19 | 179.75±50.8 | 159.98±52.38 | NS | <.05 | <.001 | <.01 |
| TG (mg/dl) | 162.13±80.67 | 188.97±99.45 | 201.06±137.6 | 219.25±114 | 199.48±117.4 | NS | NS | NS | NS |
| Apo A-I (mg/dl) | 95.44±42.44 | 94.71±51.91 | 103.3±65.33 | 90.45±35.33 | 95.55±53.22 | NS | NS | NS | NS |
| Apo B (mg/dl) | 87±44.3 | 111.28±51.03 | 118.65±54.05 | 107.74±51.8 | 112.86±51.77 | =.02 | <.01 | NS | <.01 |
| HDL-C/TC | 0.22±0.07 | 0.20±0.06 | 0.18±0.06 | 0.16±0.04 | 0.186±0.06 | NS | NS | <.001 | <.001 |
| Apo B/Apo A-I | 1.04±0.60 | 1.40±0.72 | 1.47±0.85 | 1.35±0.74 | 1.41±0.76 | <.02 | <.05 | NS | <.01 |

**Data are expressed as mean±SD. P value is significant at the 0.05 level of significance. NS: Non Significant.**

were not aware of the cases's clinical history and lipid, lipoprotein and apolipoprotein profile.

The presence of CAD, defined as >50% stenosis of a major coronary artery, was identified on multiple projections. All cases were divided into 4 groups.

1. Control group: Patients with minimal disease (<50% stenosis) or with normal angiograms.

2. One vessel disease group: Defined as >50% stenosis of a major coronary artery.

3. Two vessels disease group: Defined as >50% stenosis of two major coronary arteries.

4. Three vessels disease group: Defined as >50% stenosis of three major coronary arteries.

The following values were obtained from the venous blood sample: total cholesterol (TC), low density lipoprotein cholesterol (LDL-C), high density lipoprotein cholesterol (HDL-C), triglyceride (TG), apo A-I and apo B concentrations (as mg/dl).

Blood samples were drawn from all cases before heparinization and the injection of any radiological

**TABLE-4**

**Prevalence of Lipid, Lipoprotein and Apolipoprotein Abnormalities in Control Subjects and Patients with Coronary Artery Disease**

| Variables | Control Group (n:47) | CAD Group (n:91) | P Value |
|---|---|---|---|
| TC>250 mg/dl | 12 (25.5%) | 34 (37.4%) | NS |
| LDL-C>160 mg/dl | 12 (25.5%) | 41 (45%) | <0.05 |
| HDL-C<35 mg/dl | 4 (8.5%) | 22 (24.2%) | <0.05 |
| HDL-C/TC<0.2 | 19 (40.4%) | 61 (67%) | <0.01 |
| TG>250 mg/dl | 7 (14.9%) | 23 (25.3%) | NS |
| Apo A-I<47.3 mg/dl (<10th percentile | 3 (6.4%) | 9 (9.9%) | NS |
| Apo B> 133.1 mg/dl (>90th percentile) | 5 (11%) | 25 (27.5%) | <0.05 |

**P value is significant at the 0.05 level of significance.**

contrast medium (before catheterization) and after 12 hours fasting. All lipids, lipoproteins and apolipoproteins determinations were performed at the Biochemical Department of Selcuk Univesity. Samples were analyzed immediately for lipids and lipoproteins. Apolipoprotein measurements were performed after collection of samples (samples were refrigerated for up to 7 days before analysis) TC, LDL-C, TG and HDL-C levels were determined enzymatically. Apo A-I and Apo B levels were measured by an immunoturbidometric method.

**TABLE-5**
**Stepwise Discriminant Analysis**

| Variables | F value | P value |
|---|---|---|
| HDL-C/TC | 10.31 | 0.0016 |
| Apo B/Apo A-I | 9.034 | 0.0032 |
| Apolipoprotein B | 8.497 | 0.0042 |
| LDL-Cholesterol | 7.686 | 0.0060 |
| Total Cholesterol | 7.552 | 0.0068 |
| Hypertension | 6.898 | 0.0096 |
| Sex | 6.817 | 0.010 |
| Smoking | 5.887 | 0.016 |
| Triglyceride | 3.818 | 0.052 |

The abnormal values of biochemical variables are defined as:

TC>250 mg/dl, LDL-C>160 mg/dl, HDL-C<35 mg/dl, TG>250 mg/dl, the ratio of HDL-C/TC<0.20. The 90th percentile for apo B was>133.1 mg/dl and 10th percentile for apo A-I<47.3 mg/dl in our study.

Hypertension (≥150/95 mm Hg), diabetes mellitus (DM), cigarette smoking, body mass index (BMI), sudden death or/and CAD before the age of 55 in the first degree relatives were investigated in control and CAD groups.

Blood pressure was measured after a 15 minutes rest. Height and weight were measured during the physical examination. BMI was calculated as weight (kg) divided by the square of the height ($m^2$). Smoking score was established as followed: newer smoked: 1; former smoker: 1.4, smoker (1 to 24 cigarettes/day): 2.2, smoker (≥ 25 cigarettes/day):2.9.

**Statistics:**

The data from the four groups of patients were compared by an analysis of variance, two-tailed t-test and $X^2$ test. To analyze the frequency of patients, $X^2$ test was used. Stepwise discriminant analysis was used to assess the clinical risk factor and biochemical variables as discriminators of CAD. Product moment correlation coefficients (r) were computed to find correlation between variables. Regression analysis was used to study the associations between lipoprotein and apolipoprotein concentrations and CAD.

Data were expressed as mean±standard deviation of the mean. Probability (p) values <0.05 were considered significant.

**Results:**

The mean age and sex distribution of the CAD groups were presented in Table 1. Males were predominate in patients with one and three vessels disease.

Clinical characteristics of CAD and control groups are shown in Table 2. The prevalence of hypertension was higher in two vessels disease group ($p<0.01$).

Smoking score was significantly elevated in one vessel disease group ($p<0.01$). Women in CAD and control groups were not generally are smoker. No differences in the prevalence of family history of CAD and DM and for BMI were noted between the CAD cases and the control subjects.

Lipid, lipoprotein and apolipoprotein levels in control subjects and patients with CAD were given in Table 3. TC, LDL-C, apo B and the ratio of apo B to apo A-I were significantly higher in patients with CAD group than in control subjects. The ratio of HDL-C to TC was significantly lower in patients with CAD group. HDL-C, TG and apo A-I levels were not significantly different in patients with CAD group ($p>0.05$).

Prevalence of lipid, lipoprotein and apolipoprotein abnormalities were presented in Table 4. The prevalence of elevated LDL-C ($p<0.05$) and apo B levels ($p<0.05$) and decrease HDL-C ($p<0.05$) and low

**TABLE-6**

**The Correlations between the Serum Lipids, Lipoproteins and Apolipoproteins in Patients with Coronary Artery Disease**

| Variables | TC | HDL-C | LDL-C | TG | APO A-I | APO B | HDL-C/ TC | APO B/ APO A-I |
|---|---|---|---|---|---|---|---|---|
| TC | | | | | | | | |
| HDL-C | r:0.10 p>0.05 | | | | | | | |
| LDL-C | r:0.88 p<0.001 | r:-0.007 p>0.05 | | | | | | |
| TG | r:0.42 p<0.001 | r:-0.32 p<0.01 | r:0.21 p<0.05 | | | | | |
| APO A-I | r:0.13 p>0.05 | r:-0.09 p>0.05 | r:0.02 p>0.05 | r:0.41 p>0.001 | | | | |
| APO B | r:0.32 p<0.01 | r:-0.25 p<0.02 | r:0.31 p<0.01 | r:0.37 p<0.001 | r:-0.35 p<0.001 | | | |
| HDL-C/ TC | r:0.55 p<0.001 | r:0.74 p<0.001 | r:0.55 p<0.001 | r:-054 p<0.001 | r:0.18 p>0.05 | r:-0.44 p<0.001 | | |
| APO B/ APO A-I | r:014 p>0.05 | r:-0.22 p<0.05 | r:0.22 p<0.05 | r:-0.01 p>0.05 | r:0.56 p<0.001 | r:0.37 p<0.01 | r:-0.27 p<0.01 | |

**r value for correlation is 0.20 (at the 0.05 level of significance)**

ratio of HDL-C/TC (p<0.01) were significantly higher in patients with CAD than in control subjects.

Results of multivariate analysis of biochemical and clinical variables are shown in Table 5. Stepwise discriminant analysis showed that the ratio of HDL-C/TC was a better discriminator than other lipid and nonlipid factors (p=0.0016).

Correlation coefficients between lipid, lipoprotein and apolipoprotein concentrations among patients with CAD were given in Table 6. These interrelations were found frequently in patients with CAD. These relationships were generally weak and positive.

Correlations between the severity of CAD and lipid, lipoprotein and apolipoprotein variables were shown in Table 7. TC and LDL-C levels and the ratio of HDL-C/TC were correlated with severity of CAD (respectively p values, <0.01,<0.02, <0.05).

Correlations between lipid, lipoprotein, apolipoprotein variables and clinical characteristics are shown in Table 8. Apo A-I and the ratio of apo B to apo A-I showed a weak relation with the family history of CAD (r:-0.23, p<0.05 for apo A-I, r:0.29, p<0.01 for the ratio of apo B/apo A-I).

Multiple regression analysis was carried out with the thirteen pairs of variables (Table 9).

**Discussion:**

The importance of lipids, lipoproteins and apolipoproteins have recently been known better in prediction CAD and in promoting regression and

**TABLE-7**

**The Correlations of the Various Biochemical Parameters with the Severity of Coronary Artery Disease**

| Variables | TC | HDL-C | LDL-C | TG | APO A-I | APO B | HDL-C/ TC | APO B/ APO AI |
|---|---|---|---|---|---|---|---|---|
| Severity of CAD | r:0.31 p<0.01 | r:0.03 p>0.05 | r:026 p<0.02 | r:-0.10 p>0.05 | r:-0.01 p>0.05 | r:-0.009 p>0.05 | r:-0.23 p>0.05 | r:-0.01 p>0.05 |

**r value for correlation is 0.20 (at the 0.05 level of significance)**

preventing progression of the present atherosclerosis[13].

The male sex that is major, classic and unchanged risk factor has also been found risk factor in our study[14-16]. Hypertension that is major risk factor for CAD has displayed significant frequeny in two vessels disease[15-19]. Smoking which affects lipid profile was significantly greater in one vessel disease group than in the control group[20,21]. A positive family history is considered independent major risk factor for CAD[14]. In our study, groups did no differ significantly according to frequency of positive family history of CAD. Some authors, like us, have also not observed presence of family history as a risk factor for CAD[22-26]. DM is an other major risk factor in the development of CAD. Although the incidence of DM was markedly elevated in two and three vessels groups, this was not statistically significant. Some investigators could not found DM as a risk factor for CAD[22-25,27]. BMI which increases CAD risk[22,23,28-30], has not been determined as a risk factor in present study.

It is established that hypercholestrolemia is a major risk factor for CAD[5]. In the study of Bolibar, all of the lipid measures showed strong relations with the presence of CAD[4]. In our study, hypercholestrolemia

**TABLE-8**

**The Correlations between the Serum Lipids, Lipoproteins and Apolipoproteins and the Clinical Characteristics of Patients with Coronary Artery Disease**

| Variables | Hypertension | Diabetes | Smoking Score | Family History | BMI | Age | Sex |
|---|---|---|---|---|---|---|---|
| TC | r:-0.8 p>0.05 | r:0.04 p>0.05 | r:-0.13 p>0.05 | r:0.10 p>0.05 | r:0.04 p>0.05 | r:0.06 p>0.05 | r:-0.20 p>0.05 |
| HDL-C | r:0.16 p>0.05 | r:0.07 p>0.05 | r:->-0.12 p>0.05 | r:0.04 p>0.05 | r:-0.18 p>0.05 | r:-0.09 p>0.05 | r:-0.12 p>0.05 |
| LDL-C | r:-0.17 p>0.05 | r:-0.01 p>0.05 | r:-0.15 p>0.05 | r:-0.14 p>0.05 | r:-0.01 p>0.05 | r:0.03 p>0.05 | r:-0.10 p>0.05 |
| TG | r:0.01 p>0.05 | r:0.01 p>0.05 | r:-0.16 p>0.05 | r:-0.10 p>0.05 | r:0.19 p>0.05 | r:-0.03 p>0.05 | r:-0.11 p>0.05 |
| APO A-I | r:0.10 p>0.05 | r:0.07 p>0.05 | r:-0.18 p>0.05 | r:-0.23 p>0.05 | r:0.04 p>0.05 | r:0.09 p>0.05 | r:-0.09 p>0.05 |
| APO B | r:-0.14 p>0.05 | r:0.01 p>0.05 | r:-0.09 p>0.05 | r:0.02 p>0.05 | r:-0.02 p>0.05 | r:0.02 p>0.05 | r:-0.18 p>0.05 |
| HDL-C/ TC | r:0.19 p>0.05 | r:0.05 p>0.05 | r:0.04 p>0.05 | r:-0.02 p>0.05 | r:0.19 p>0.05 | r:0.04 p>0.05 | r:0.01 p>0.05 |
| APO B/ APO A-I | r:-0.19 p>0.05 | r:-0.11 p>0.05 | r:0.10 p>0.05 | r:0.29 p<0.01* | r:-0.05 p>0.05 | r:-0.11 p>0.05 | r:-0.05 p>0.05 |

**r value for correlation is 0.20 (at the 0.05 level of significance)**

was found to be a risk factor for CAD. Discriminant analysis reveal that hypercholestrolemia allows for a good discrimination between patients and control subjects. It showed weak correlation with extent of disease. The correlations between TG, apo B and TC were found. The prevalence of hypercholestrolemia was not different between patients and control subjects, indicating that hypercholestrolemia is not independent discriminator for CAD. Sigurdsson[31] has found that TC is a significant and discriminative risk factor for CAD, and a strong correlation was obtained between apo B and serum cholesterol. In our study, apo B was a stronger discriminative factor than TC concentration. Some investigators showed also the relation of apo B and TC[25,27,30,32,33]. Carlson[34] stated that is the combination of hypercholestrolemia with elevated TG level enhance the CAD risk. The relation between TC and TG was revealed by Pocock[35]. The weak correlation between TC and extent of CAD was found by Naito[23] and Sedlis[32] which were consistent with our study.

**TABLE-9**
**Regression Analysis**

| Variables | r Value | p Value |
|---|---|---|
| LDL C - APO B | 0.31 | <0.01 |
| APO AI - APO B | 0.35 | <0.001 |
| TC - TG | 0.42 | <0.001 |
| HDL - C - TG | -0.32 | <0.01 |
| HDL - C - APO B | -0.25 | <0.05 |
| HDL - C - APO B/APO A-I | -0.22 | <0.05 |
| LDL - C - TG | 0.21 | <0.05 |
| LDL - C - APO B/APO A-I | 0.22 | <0.05 |
| TG - APO B | 0.37 | <0.001 |
| TG - HDL - CTC | -0.54 | <0.001 |
| TC - APO B | 0.32 | <0.01 |
| APO B - HDL - C/TC | -0.43 | <0.001 |
| HDL - C/TC - APO B/APO A-I | -0.27 | <0.01 |

**r value for correlation is 0.20 (at the 0.05 level of significance)**

The role of elevated LDL-C level in the development of CAD is well known[36-39]. In our study, LDL-C was determined as a risk factor and a good discriminator for CAD. It was a significant predictor of the extent of the disease. LDL-C concentrations were correlated with TG and apo A-I levels and the ratio of apo B/apo A-I. The relationship between LDL-C and apo B was also defined by Genest[28], Sedlis[32], and Dhawan[40]. The presence of hypertriglyceridemia and elevated LDL-C level enhance the total risk of CAD. This association could not be showed in our study. Some researchers[41-43], like us, have found relation between extent of CAD and LDL-C level[23,32,44-47]

The decreased HDL-C has been shown to be independent predictor for CAD in prospective and case-control epidemiological studies[5]. In our study, decreased HDL-C was not shown to be a significant risk factor for CAD. HDL-C levels were correlated with TG and apo B levels and the ratio of apo B/apo A-I. Some investigators determined that decreased HDL-C is a risk factor for CAD[2,5,10,22,25,27,29,30,32,48,50]. Some researchers, like us, were not able to define HDL-C as a CAD risk factor[23,24,26,45,51-53]. Moreover, some investigators defined inverse correation between HDL-C and TG[28,35,42,54,55]. Stampfer[27] revealed inverse correlation between HDL-C and apo B. The relationship between HDL-C and apo A-I was also defined by Sedlis[32] and Stampfer[27], but we could not show it. Some investigators have found a relation between the extent of CAD and HDL-C level[32,46,56]. In our study, we could not reveal any correlation between the extent of CAD and HDL-C level. Garfagnini et al. have not found any correlations between them either[57]. In our study, the combination of low HDL-C and hypertriglyceridemia was determined as a risk factor for CAD, which had been also found by Genest[28] and Castelli[58]

The ratio of HDL-CC/TC (or TC/HDL-C) was assessed in various studies. In our study, this ratio was determined as a risk factor for CAD. The best discriminator in this study was a low ratio of HDL-C/TC. Moreover, this ratio was associated with extent of CAD; the ratio was correlated with TG(r:-0.54) and apo B levels and the ratio of apo B/apo A-I. In our study, the most frequent abnormality observed was low ratio of HDL-C/TC. Schmidt showed that the best lipid-related predictor of angiographically documented CAD was the ratio of HDL-C/TC[25]. Some researchers have found that this ratio is a discriminator for CAD[2,23,24,35,54,59,60], others could not have same results[30,61,62].

In our study, raised concentrations of serum TG were not a risk factor and a discriminator for CAD. It was not a significant predictor of the extent of disease. However, TG concentrations were correlated most with other lipids, lipoproteins and apolipoproteins.

TG has been a predictor of CAD in some studies[10,22,25,28,49,50,54,55,58,63-65]. Some studies, as being in our study, showed that TG was not a risk factor for CAD[23,24,26,29,35,62,66,67]. Some investigators found that TG was a weak discriminator in distinguishing patients with CAD from normal control subjects[2,31,61]. The presence of hypertriglyceridemia and elevated apo B was revealed as a risk factor for CAD by Sniderman[43]. In our study, we found a weak correlation between TG and apo B.

The role of apolipoprotein measurement in the detection of CAD has not been clearly defined. Some studies have suggested that the plasma concentrations of apolipoproteins A-I and B are better predictors and discriminators of patients with CAD than traditional lipid measurements[24,28,29,68], but conclusive demonstration will require large prospective and epidemiological studies that include apolipoprotein measurements. In our study, apo A-I was not a risk factor for CAD. Apo A-I was as weak correlated with TG and apo B. The relation between apo A-I and positive family history for CAD was found in our study. Some authors have determined that apo A-I is a risk factor for CAD[10,22,23,27-29,31,46,49,61,62,68,-75]. Others, like us, did not determine apo A-I as a risk facor[24-26,30,47,50,76] Riesen[8] and Garfagnini[57] reported the extent of the disease and apo A-I relation. Koc[30], as being in our study, revealed correlation between apo A-I and apo B. We could not have found the relation of apo A-I and HDL-C, which have been shown by some authors[30-32,61,69]. In our study we found that apo B is a risk factor and a strong discriminative factor for CAD. Apo B concentrations were correlated with TG, LDL-C, TC, apo A-I and with the ratio of HDL-C/TC. Some other investigators also defined apo B as a risk factor for CAD[8,10,23,24,27-29,22,32,44-46,49,50,61,68,69,71-73]. The relationship between LDL-C and apo B was determined by many authors[23,28,32,44-46,61]. Some investigators have found correlation between apo B and TC[30-32,77]. Sedlis[32] and Sniderman[43] reported the correlation between apo B and TG. In our study apo B was not associated with the extent of CAD. Reardon[47] and Riesen[8] have found relation between the extent of CAD and the levels of apo B.

In the present study, we found that the ratio of apo B/apo A-I is a risk factor and a strong discriminator for CAD. The ratio was correlated with LDL-C, HDL-C and the ratio of HDL - C/TC. Some authors previously have determined that the ratio of apo B/apo A-I is a predictive risk factor for CAD[9,23,24,32,45,68,78]. Sedlis[32], Naito[23] and Garfagnini[57] have found a relation between the extent of the CAD and the ratio of apo B/apo A-I. In our study the ratio of apo B/apo A-I was not in association with the extent of CAD.

In conclusion, plasma apolipoprotein levels may not be considerably better markers for CAD than traditional lipid determinations. The best discriminator in this study is a low ratio of HDL-C/TC.

**Correspondence to author:**

Dr. Murat SARUC, 6351. sok 39/12, Atakent, Izmir, Turkey. Tel: +90.542.4115020.

**References:**

1. Clark LT. Atherogenesis and thrombosis: Mechanism, pathogenesis, and therapeutic implications. Am Heart J 1992; 123: 1106-9.

2. Kannel WB, and Wilson PWF. Efficacy of lipid profiles in prediction of coronary disease. Am heart J 1992; 124(3): 768-74.

3. Kannel WB. Range of serum cholesterol values in the population developing coronary artery disease. Am J Cardiol 1995; 76(9): 69-77.

4. Bolibar I, Thompson SG, von-Eckardstein A, Sandkamp M, Assmann G. Dose-response relationship of serum lipid measurements with the extent of coronary stenosis. Strong independent and comprehensive. ECAT Angina Pectoris Study Group. Arterioscler Thromb Vasc Biol 1995; 15(8): 1035-42.

5. Assmann G and Schulte H. Relation of high-density lipoprotein cholesterol and triglycerides to incidence of atherosclerotic coronary artery disease (the PROCAM Experience). Am J Cardiol 1992; 70:733-7.

6. Ross R, Harker L. Hyperlipidemia and atherosclerosis. Science 1976; 193: 1094-100.

7. Lipid Research Clinics Program: The Lipid Research Clinics Coronary Primary Prevention Trial Results. I. Reduction in incidence of coronary heart disease. II. The relationship of reduction in incidence of coronary heart disease to cholesterol lowering. JAMA 1984; 251:351.

8. Riesen WF, Mordasini R, Salzmann C, et al. Apoproteins and lipids as discriminators of severity of coronary heart disease. Atherosclerosis 1980; 37:157-162.

9. De Backer G, Rosseneu M, Deslypere JP. Discriminative value of lipids and apolipoproteins in coronary heart disease. Atherosclerosis 1982; 42:197-203.

10. Genest J, Jenner JL, Mc Namara JR, et al. Prevalence of lipoprotein (a) [Lp (a)] excess in coronary artery disease. Am J Cardiol 1991; 67: 1039-45.

11. Bahl VK, Vaswani M, Thatai D, Wasir HS. Plasma levels of apolipoprotens A-I and B in Indian patients with angiographically defined coronary artery disease. Int J Cardiol 1994; 46 (2): 143.

12. Wilson PW. Established risk factors and coronary artery disease: The Framingham Study. Am J Hypertens 1994; 7(7pt2):7-12.

13. Austin MA, ed Joint lipid risk factors and coronary heart disease. Circulation 1992; 85 (1): 365-7.

14. Report of the National Cholesterol Education Program Expert Panel of Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults. Arch Intern Med 1988; 148:36-69.

15. Braunwald E. Heart disease a text book of cardiovascular medicine: the pathogenesis of atherosclerosis and risk factors for coronary artery disease. 4th ed. Philadelphia: WB Saunders Company, 1992: 1106-60.

16. Kuller LH. Epidemiology of cardiovascular disease: Current perspectives. Am J Epidemiol 1976; 104:425.

17. Report of Inter-Society Commission for Heart Disease Resources. Primary Prevention of the atherosclerotic disease. Circulation 1970;42:55.

18. Stamler J, Stamler R and Liu K. High blood pressure, In: Conner WE, and Bristow JD, eds. Coronary heart disease: Prevention, complications, and treatment. Philadelphia: J.B. Lippincott Company, 1985:85-109.

19. Koren MJ, Devereux RB, Casale PN, et al. Relation of left ventricular mass and geometry to morbidity and mortality in uncomplicated essential hypertension. Ann Intern Med 1991; 114:345.

20. Migas OD. The lipid effects of smoking. Am Heart J 1988; 115:272.

21. Tiwari AK, Gode JD, and Dubey GP. Effect of cigarette smoking on serum total cholesterol and HDL in normal subjects and coronary heart disease patients. Indian Heart J., 1989; 41:92.

22. Buring JE, O'Connor GT, Goldhaber SZ, et al. Decreased $HDL_2$ and $HDL_3$ cholesterol, Apo A-I and apo A-II, and increased risk of myocardial infarction. Circulation 1992; 85: 22-9.

23. Naito HK. The association of serum lipids, lipoproteins, and apolipoproteins with coronary artery disease assessed by coronary arteriography. Ann NY Acad Sci 1985; 454: 230-8.

24. Reinhart RA, Gani K, Arndt MR, et al. Apolipoproteins A-I and B as predictors of angiographically defined coronary artery disease. Arch Intern Med 1990; 150: 1629-33.

25. Schmidt SB, Wasserman AG, Muesing RA, et al. Lipoprotein and apolipoprotein levels in angiographically defined coronary atherosclerosis. Am J Cardiol 1985; 55: 1459-62.

26. Groves P, Rees A, Bishop A, et al. Apolipoprotein (a) concentrations and susceptibility to coronary artery disease in patients with peripheral vascular disease. Br Heart J 1993;69: 26-30.

27. Stampfer MJ, Sacks FM, Salvini S, et al. A prospective study of cholesterol, apolipoproteins, and the risk of myocardial infarction. N Engl J Med 1991; 325: 373-81.

28. Genest J, Judith FR, McNamara MT, Ordovas JM, et al. Lipoprotein cholesterol, apolipoprotein A-I and B and lipoprotein (a) abnormalities in men with premature coronary artery disease. J Am Coll Cardiol 1992; 792-802.

29. Durrington PN, Hunt L, Ishola M, Kane J, Stephens WP. Serum apolipoproteins A-I and B and lipoproteins in middle aged men with and without previous myocardial infarction. Br Heart J 1986; 56:206-12.

30. Koc A, Koker AH, Pasaouglu H, Ustdal M. Angina pektoriste serum lipid, lipoprotein, apolipoprotein degerleri ve risk faktorleri. Turk Kardiyol Dern Ars 1988; 16:81-5.

31. Sigurdsson G, Baldursdottir A, Sigvaldason H, et al. Predictive value of apolipoproteins in a prospective survey of coronary artery disease in men. Am J Cardiol 1992; 69: 1251-4.

32. Sedlis SP, Schechtman KB, Ludbrook PA, et al. Plasma apolipoproteins and coronary artery disease. Mayo Clin Proc 1986;61:313-20.

33. Avogaro P, Bittolo BG, Cazzolato G, Quinci GB. Are apolipoporoteins better discriminators than lipids for atherosclerosis? Lancet 1979; 901-3.

34. Carlson LA, Bottiger LE. Risk factors for ischaemic heart disease in men and women. Results of the 19-year follow up of the Stocholm Prospective Study. Acta Med Scand 1985; 218: 207-11.

35. Pocock SJ, Shaper AG, Phillips AN. Concentrations of high density lipoprotein cholesterol, triglycerides and total cholesterol in ischaemic heart disease. Br Med J 1989; 298: 998-1002.

36. Brown G, Albers JJ, Fisher LD, et al. Regression of coronary artery disease as a result of intensive lipid-lowering therapy in men with high levels of apolipoprotein B. N Engl J Med 1990; 323: 1289-98.

37. Wallace RB, and Anderson RA. Blood lipids, lipid related measures and the risk of atherosclerotic cardiovascular disease. Epidemiol Rev 1987; 9: 95.

38. Stamler J. Population studies. In: Levy RI, Rifkind BM, Dennis BH, et al, eds. Nutrition, lipids, and coronary heart disease. New York; Raven Press 1979; 25-88.

39. Schaefer EJ, Levy RI. Pathogenesis and management of lipoprotein disorders. N Engl J Med 1985; 312: 1300-10.

40. Dhawan J, Bray JL. Relationship between angiographically assessed coronary artery disease, plasma insulin levels and lipids in Asian and Caucasians. Atherosclerosis 1994; 105 (1): 35-41.

41. Huttunen JK, Manninen V, Manttari M, et al. The Helsinki Heart Study: Central findings and clinical implications. Ann Med 1991; 23: 155-9.

42. Mannien V, Tenkanen L, Koskinen P, Huttunen JK, et al. Joint effects of serum triglycerides and LDL cholesterol and HDL cholesterol concentrations on coronary heart disease risk in the Helsinki Heart Study-implications for treatment. Circulation 1992; 85: 37-45.

43. Sniderman AD, Wolfson C, Tengo B, et al. Association of hyperapobetalipoproteinemia with endogenous hypertriglyceridemia and atherosclerosis. Ann Intern Med 1982; 97: 833-9.

44. Sniderman A, Shapiro S, Marpole D, et al. Association of coronary atherosclerosis with hyperapobetalipoproteinemia (increased protein but normal cholesterol levels in human plasma low density [β] lipoproteins). Proc Natl Acad Sci 1980; 77: 604-8.

45. Whayne TF, Alaupovic P, Curry MD, et al. Plasma apolipoprotein B and VLDL, LDL, and HDL cholesterol as risk factors in the development of coronary heart disease in male patients examined by angiography. Atherosclerosis 1981; 39:411-24.

46. De Sager JP, Rausseau M, Riesen WF, Harvengt C. Limitations of the predictive value for coronary vascular disease of plasma lipids and apolipoproteins A-I, A-II, B levels as measured before coronary angiography in 317 patients. In : De Gennes JL, et al, eds. Lantent Dyslipoproteinemias and Atherosclerosis. New York. Raven, 1984; 165-86.

47 Reardon MF, Nestel PJ, Craig IH, Harper RW: Lipoprotein predictors of the severity of coronary artery disease in men and women. Circulation 1985; 71:881-8.

48. Gordon DJ, Probstfield JL, Garrison RJ, et al. High-density-lipoprotein cholesterol and cardiovascular disease. Circulation 1989; 79: 8-15.

49. Hamsten A, Walldius G, Dahlen G, Johansson B, De Faire U. Serum lipoproteins and apolipoproteins in young male survivors of myocardial infarction. Atherosclerosis 1986; 59: 223-35..

50. Barbir M, Wile D, Trayner I, et al. High prevalence of hypertriglyceridemia and apolipoprotein abnormalities in coronary artery disease. Br Heart J 1988; 60: 397-403.

51. Levy RI, Klimov AN. High density lipoprotein cholesterol (HDL-C) and mortality in USSR and US middle age men: collaborative US-USSR Mortality Follow up Study. Circulation 1987; 76 (suppl IV): 167.

52. Wiklund O, Wilhemsen L, Elmfeldt D, et al. Alpha-lipoprotein cholesterol concentration in relation to subsequent myocardial infarction in hypercholestrolemic men. Atherosclerosis 1980; 37: 47-53.

53. Swanson Jo, Pierpont G, Adicoff A. Serum high density lipoprotein cholesterol correlates with presence but not severity of coronary artery disease. Am J Med 1981; 71: 235-9.

54. Nikkila M, Koirula T, Niemela K, Sisto T. High density lipoprotein cholesterol and triglycerides as markers of angiographically assessed coronary artery disease. Br Heart J 1990; 63: 78-81.

55. Al-Muhteseb N, Hayat N, Al-Khafaji M. Lipoproteins and apolipoproteins in young male survivors of myocardial infarction. Atherosclerosis 1989; 77: 131-8.

56. Jenkins PJ, Harper RW, Nestel PJ. Severity of coronary atherosclerosis related to lipoprotein concentration. Br Med J 1978; 2: 388-91.

57. Garfagnini A, Devoto G, Rosselli P, et al. Relationship between HDL-cholesterol and apolipoprotein A-I and the severity of coronary artery disease. Eur Heart J 1995; 16(4): 465-70.

58. Castelli WP. The triglyceride issue: a view from Framingham. Am Heart J 1986; 112: 432-7.

59. Brunner D, Weisbort J, Meshulam N, et al. Relation of serum total cholesterol and high density lipoprotein cholesterol percentage to the incidence of definite coronary events: twenty year follow up of Donolo-Tel Aviv prospective coronary artery disease study. Am J Cardiol 1987; 59: 127-1-6.

60. Castelli WP, Abbott RD, Mc Namara PM. Summary estimates of cholesterol used to predict coronary heart disease. Circulation 1983; 67(4): 730-4.

61. Kottke BA, Zinsmeister AR, Holmes DR, et al. Apoliproteins and coronary artery disease. Mayo Clin Proc 1986; 61:313-20.

62. Maciejko JJ, Holmes DR, Kottke BA, et al. Apolipoprotein A-I as a marker of angiographically assessed coronary artery disease. N Engl J Med 1983; 309: 385-9.

63. Heyden S, Heiss G, Hames CG, Bartel AG. Fasting triglycerides as predictor of total and CHD mortality in Evans County, Georgia. J Chronic Dis 1980; 33: 275-82.

64. Aberg H, Lithell H, Selinus I, Hedstrand H. Serum triglycerides are a risk for myocardial infarction but not for angina pectoris: Results from a 10-year follow up of Uppsala Primary Preventive Study. Atherosclerosis 1985; 54:89-97.

65. Tverdal A, Foss OP, Leren P, et al. Serum triglycerides as an independent risk factor for death from coronary heart disease in middle-aged Norwegian men. Am J Epidemiol 1989; 129: 458-65.

66. Lapidus L, Bengtsson C, Lindquist O, et al. Triglycerides-main lipid risk factor for cardiovascular disease in women? Acta Med Scand 1985;217: 481-9.

67. Hulley SB, Rosenman RH, Bawol RD, Brand RJ. Epidemiology as a guide to clinical decisions: The association between triglyceride and coronary heart disease. N Eng J Med 1980; 302: 1388-9.

68. Avogaro P, Bon BG, Cazzolato G, Rorai E. Relationship between apolipoproteins and chemical components of lipoproteins in survivors of myocardial infarction. Atherosclerosis 1980; 37: 69.

69. Miller NE, Hammett F, Saltissi S, et al. Relation of angiographically defined coronary artery disease to plasma lipoprotein subfractions and apolipoproteins. Br Med J 1981; 282: 1741-4.

70. Noma A, Yokosuka T, Kitamura K. Plasma lipids and apolipoproteins as discriminators for presence and severity of angiographically defined coronary artery disease. Atherosclerosis 1983; 49: 1-7.

71. Brunzell JD, Sniderman AD, Albers JJ, Kwiterovich PO. Apolipoproteins B and coronary artery disease in humans (review). Atherosclerosis 1984; 4: 79-83.

72. Kukita H, Hamada M, Hiwada K, Kokubu T. Clinical significance of measurements of serum apolipoprotein A-I, A-II, and B in hypertriglyceridemic male patients with and without coronary artery disease. Atherosclerosis 1985; 55: 143-9.

73. Kukita H, Hiwada K, Kokubu T. Serum apolipoprotein A-I, A-II and B levels and their discriminative values in relatives of patients with coronary artery disease. Atherosclerosis 1984; 51: 261-7.

74. Sigfusson N, Sigvaldason H, Steingrimsdottir L, et al. Recent decline in ischaemic heart disease in Iceland and change in risk factors. Br Med J 1991; 302: 1371-5.

75. Frazen J, Fex G. Low serum apolipoprotein A-I in acute myocardial infarction survivors with normal HDL cholesterol. Atherosclerosis 1986; 59: 37-42.

76. Van Stiphout WAHJ, Hofman A, Kruijssen HACM, et al. Is the ratio of Apo B/Apo A-I an early predictor of coronary atherosclerosis? Atherosclerosis 1986; 62: 179-82.

77. Cambien F, Warnet JM, Jacqueson A, et al. Relation of parental history of early myocardial infarction to the level of apolipoprotein B in men. Circulation 1987; 76: 266-71.

78. Deslypere JP, De Backer G, Rosseneu M, Vermeulen A. Lipid and apoprotein levels in myocardial infarction survivors: a case control study. Acta Cardiol 1981; 27(suppl): 95-102.