Effect of Acute Myocardial Infarction on Cholesterol Ratios*

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Objective: In patients with acute myocardial infarctions (MIs), cholesterol levels are no longer valid after 24 h from presentation because acute MI causes a rapid decline in serum levels of total cholesterol, low-density lipoprotein (LDL) cholesterol, and high-density lipoprotein (HDL) cholesterol. The objective of this study was to evaluate the effect of acute MI on the total cholesterol/HDL cholesterol ratio and the LDL cholesterol/HDL cholesterol ratio.

Methods: The study consisted of 45 patients who were admitted to the hospital with acute MIs. Serum levels of total cholesterol, HDL cholesterol, LDL cholesterol, and triglycerides were determined on day 1 post-MI and day 4 post-MI. The total cholesterol/HDL cholesterol ratio and the LDL cholesterol/HDL cholesterol ratio were calculated. Serum lipid levels and cholesterol ratios were compared between day 1 post-MI and day 4 post-MI.

Results: From day 1 post-MI to day 4 post-MI, the mean (± SD) serum levels of total cholesterol (188.4 ± 52.5 vs 170.5 ± 57.2 mg/dL, respectively; p = 0.01), LDL cholesterol (120.3 ± 48.9 vs 105.9 ± 43.0 mg/dL, respectively; p = 0.009), and HDL cholesterol (45.0 ± 18.5 vs 39.3 ± 16.1 mg/dL, respectively; p < 0.001) decreased, but the mean serum level of triglycerides (119.2 ± 81.2 vs 149.3 ± 68.3 mg/dL, respectively; p = 0.006) increased. The cholesterol ratios, however, remained unchanged between day 1 post-MI and day 4 post-MI. The total cholesterol/HDL cholesterol ratio was 4.59 ± 1.84 on day 1 post-MI and 4.67 ± 1.77 on day 4 post-MI (change not significant). The LDL cholesterol/HDL cholesterol ratio was 2.96 ± 1.58 on day 1 post-MI and 2.99 ± 1.44 on day 4 post-MI (change not significant).

Conclusion: Acute MI does not affect the cholesterol ratios. Therefore, when the absolute levels of serum cholesterol are no longer valid (beyond 24 h after an MI), the cholesterol ratios still could be useful for cholesterol risk assessment in patients with acute MIs.

Key words: acute myocardial infarction; cholesterol; cholesterol ratios; coronary artery disease; coronary risk factor; high-density lipoprotein cholesterol; low-density lipoprotein cholesterol; low-density lipoprotein cholesterol/high-density lipoprotein cholesterol ratio; total cholesterol/high-density lipoprotein cholesterol ratio; triglycerides

Abbreviations: HDL = high-density lipoprotein; LDL = low-density lipoprotein; MI = myocardial infarction

Coronary artery disease remains the most common cause of death despite significant advancements in its prevention and treatment. Aggressive management of the risk factors is one of the crucial elements in the treatment of patients with coronary artery disease. Serum markers that are used for cholesterol risk assessment and management are total cholesterol, low-density lipoprotein (LDL) cholesterol level, and high-density lipoprotein (HDL) cholesterol level.1–4 Patients with acute myocardial infarctions (MIs) should have plasma lipid levels determined within 24 h of the onset of the symptoms of acute MI.1,4 The validity of the plasma lipid levels measured beyond 24 h from the onset of MI has been questioned because many studies5–10 have demonstrated that acute MI results in a transient decline in the serum cholesterol levels, which becomes apparent after 24 h of onset of MI and may last for 2 to 3 months. Therefore, in situations in which plasma lipid levels are not determined within 24 h of the onset of MI symptoms, the cholesterol measurements are usually deferred until the effect of the acute MI is fully resolved, which may result in an inappropriate delay in the management of hypercholesterolemia.6,11

Several epidemiologic studies have shown that the
Tables of total cholesterol to HDL cholesterol and of 
LDL cholesterol to HDL cholesterol also can be 
used as predictors of acute coronary events.4,12 
However, no data exist evaluating the effect of acute MIs 
on these cholesterol ratios. The purpose of the 
present study was to determine whether the acute MI 
 affects the values of the serum cholesterol ratios as it does with absolute serum cholesterol levels.

**Materials and Methods**

**Study Protocol**

The study was approved by the Institutional Review Board for Human Subjects Research of the Long Island College Hospital, and informed consent was obtained from all patients. Forty-five consecutive patients who were admitted to the Long Island College Hospital with a confirmed diagnosis of acute MI were enrolled in the study. The diagnosis of acute MI was made if patients had ischemic-type chest pain for ≥30 min with evidence of ST-segment elevation of ≥1 mm in two anatomically contiguous leads on the ECG or the appearance of a new left bundle-branch block. Patients who had symptoms suggestive of acute MI but did not meet ECG diagnostic criteria, needed to have serum creatinine kinase-MB levels that were more than twice the upper limit of normal. Exclusion criteria were the following: (1) symptoms suggestive of acute MI for ≥12 h; (2) hospital stay of <4 days; (3) already receiving lipid-lowering medications; and (4) coronary artery bypass surgery within 4 days after MI.

**Lipid Measurements**

The serum lipid profile was measured within the first 24 h of the onset of symptoms of MI and again at day 4 post-MI. The serum total cholesterol, HDL cholesterol, and triglyceride levels were measured by an enzymatic colorimetric test using reagents (Boehringer Manheim; Indianapolis, IN) on automated clinical chemistry analyzers. The LDL cholesterol value was calculated by using the Friedewald formula: LDL cholesterol = total cholesterol − HDL cholesterol − (triglyceride/5).13 The cholesterol ratios then were calculated by using the total cholesterol/HDL cholesterol and LDL cholesterol/HDL cholesterol ratios. All the blood samples were 6-h fasting samples.

**Statistical Analysis**

Continuous variables were expressed as the mean ± SD, and the categoric variables were expressed as a percentage. The Student’s t test was used to compare lipid values and ratios between day 1 post-MI (ie, within 24 h) and day 4 post-MI. A two-tailed p value of <0.05 was considered to be significant. All the statistical analyses were performed using computer software (SPSS, version 7.0; SPSS, Chicago, IL).

**Results**

The clinical characteristics of the study patients are summarized in Table 1. Twenty-one patients (44%) were men. The mean age was 70 ± 14 years. Hypertension was present in 27 patients (60%), and diabetes mellitus was present in 11 patients (24%).

<table>
<thead>
<tr>
<th>Table 1—Clinical Characteristics of the Study Population</th>
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<tr>
<td>Clinical Characteristics</td>
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<tr>
<td>Hypertension</td>
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<tr>
<td>Diabetes mellitus</td>
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<tr>
<td>Smoking</td>
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<tr>
<td>Family history of coronary artery disease</td>
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<tr>
<td>Q-wave myocardial infarction</td>
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<tr>
<td>Non-Q-wave myocardial infarction</td>
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</table>

Nineteen patients (42%) were smokers, and 17 patients (38%) had family histories of coronary artery disease. Q-wave MI was diagnosed in 18 patients (40%), and non-Q-wave MI was diagnosed in 27 patients (60%). The peak serum creatinine kinase-MB level was 96 ± 144 ng/mL, with a median value of 30 ng/mL (interquartile range, 13 to 118 ng/mL).

All serum lipid levels changed significantly between day 1 post-MI (ie, within 24 h) and day 4 post-MI. From day 1 post-MI to day 4 post-MI, serum total cholesterol levels (188.4 ± 52.5 vs 170.5 ± 57.2 mg/dL, respectively; p = 0.01), LDL cholesterol levels (120.3 ± 48.9 vs 105.9 ± 43.0 mg/dL, respectively; p = 0.009), and HDL cholesterol levels (45.0 ± 18.5 mg/dL vs 39.3 ± 16.1 mg/dL, respectively; p < 0.001) decreased significantly. On the contrary, the serum triglyceride levels increased significantly from 119.2 ± 81.2 mg/dL on day 1 post-MI to 149.3 ± 68.3 mg/dL on day 4 post-MI (p = 0.006). Regardless of these significant changes in the absolute lipid levels, however, the cholesterol ratios remained unchanged between day 1 post-MI and day 4 post-MI. The ratio of total cholesterol to HDL cholesterol was 4.59 ± 1.84 on day 1 post-MI and 4.67 ± 1.77 on day 4 post-MI (change was not significant), and the ratio of LDL cholesterol to HDL cholesterol was 2.96 ± 1.58 on day 1 post-MI and 2.99 ± 1.44 on day 4 post-MI (change not significant) [Table 2].

**Discussion**

Many studies8–11,14–16 in the past few decades have shown that acute MI results in a significant decrease in the serum levels of total cholesterol, LDL cholesterol, and HDL cholesterol. The acceptable time for the measurement of plasma lipids after an acute MI is within 24 h after the onset of symptoms, and the plasma lipid levels measured beyond 24 h are mostly considered to be invalid.11,17,18 The post-MI decline in serum cholesterol occurs because of the acute-phase response and
Acute MI, like any other tissue injury, initiates various local and systemic reactions. The local response includes vasodilation, leukocyte infiltration and chemotaxis, monocyte and macrophage activation, and cytokine release. The cytokines act on the systemic targets, including the liver, to generate changes in the concentration of various heterogeneous plasma proteins that are known collectively as acute-phase reactants, including lipoproteins and C-reactive protein. By day 4 to 5 post-MI, there is a significant decrease in the serum concentrations of apoprotein A-I and apoprotein B, reflecting the maximum decrease in the serum cholesterol level by this time. While the serum cholesterol level decreases after an acute MI, the serum triglyceride level increases. This paradoxical rise in serum triglycerides is due to an increase in serum C-reactive protein level, which may increase to levels that are several hundred-fold higher than baseline 4 days after an MI. The C-reactive protein binds selectively with very LDL and interferes with its catabolism, thereby increasing the serum triglyceride concentration. The magnitude of the decrease in serum cholesterol level after an MI is positively correlated with the infarct size and is not dependent on the patient’s age or sex, the development of arrhythmias, the medications being received, or the development of heart failure.

The present study has shown that in certain situations in which the plasma cholesterol levels are not measured within the first 24 h after the onset of acute MIs, cholesterol ratios determined from the serum cholesterol measurements taken after 24 h of the onset of acute MIs could be used reliably for cholesterol risk assessment, because at day 4 post-MI when the absolute values of serum total cholesterol, HDL cholesterol, and LDL cholesterol were all significantly decreased from the baseline value of day one (within 24 h) post-MI, the ratios of total cholesterol to HDL cholesterol and LDL cholesterol to HDL cholesterol remained unchanged. The lack of change in these ratios suggests that the post-MI decreases in serum levels of total, LDL, and HDL cholesterol were in equal proportion.

The ratios of total cholesterol to HDL cholesterol and LDL cholesterol to HDL cholesterol that have been reported to correlate with the development of acute coronary events are > 4.5 and > 2.5, respectively. In the present study, the mean (SD) total cholesterol to HDL cholesterol ratio was 4.59 ± 1.84 at day 1 post-MI and did not change significantly at day 4 post-MI, whereas the mean LDL cholesterol level significantly decreased from an unacceptably high level of 120.3 ± 48.9 mg/dL on day 1 post-MI to 105.9 ± 43.0 mg/dL on day 4 post-MI, which is near the desirable level based on the current recommendation by National Cholesterol Education Program, Adult Treatment Panel II.

Table 2—Comparison of the Serum Lipid Values and Ratios Between Within 24 h of MI and Day 4 Post-MI*

<table>
<thead>
<tr>
<th>Serum Lipids</th>
<th>Within 24 h of MI</th>
<th>Day 4 Post-MI</th>
<th>p Value</th>
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</thead>
<tbody>
<tr>
<td>Total cholesterol, mg/dL</td>
<td>188.4 ± 25.2</td>
<td>170.5 ± 57.2</td>
<td>0.011</td>
</tr>
<tr>
<td>LDL cholesterol, mg/dL</td>
<td>120.3 ± 48.9</td>
<td>105.9 ± 43.0</td>
<td>0.009</td>
</tr>
<tr>
<td>HDL cholesterol, mg/dL</td>
<td>45.0 ± 18.5</td>
<td>39.3 ± 16.1</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Triglycerides, mg/dL</td>
<td>119.2 ± 91.2</td>
<td>149.3 ± 68.3</td>
<td>0.006</td>
</tr>
<tr>
<td>Total cholesterol/HDL cholesterol ratio</td>
<td>4.59 ± 1.84</td>
<td>4.67 ± 1.77</td>
<td>0.348</td>
</tr>
<tr>
<td>LDL cholesterol/HDL cholesterol ratio</td>
<td>2.96 ± 1.58</td>
<td>2.99 ± 1.44</td>
<td>0.759</td>
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</tbody>
</table>

*Values given as mean ± SD, unless otherwise indicated.
These findings suggest that the cholesterol ratios could be used to determine cholesterol risk in patients who experienced acute MIs and may have an advantage in situations in which the absolute total and fractionated cholesterol levels are no longer applicable because of the effect of the acute MI (beyond 24 h after the onset of acute MI).

Conclusion

This study demonstrates that acute MI does not affect the cholesterol ratios. Therefore, when the absolute levels of serum cholesterol are no longer valid (ie, beyond 24 h after the onset of MI symptoms), the cholesterol ratios still could be useful for cholesterol risk assessment in patients with acute MIs. Further studies are required to formulate recommendations for treating hypercholesterolemia on the basis of these cholesterol ratios in situations in which the absolute levels of serum cholesterol are not valid.

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