Atherosclerotic Aortic Plaque Detected by Transesophageal Echocardiography*

Its Significance and Limitation as a Marker for Coronary Artery Disease in the Elderly

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Objectives: To elucidate whether atherosclerotic aortic plaque detected by transesophageal echocardiography can be a clinically useful marker for coronary artery disease in the elderly. Background: Atherosclerotic aortic plaque detected by transesophageal echocardiography has been reported to be a marker for coronary artery disease. Its significance may be important particularly in the elderly population, although to our knowledge, there are no data yet available. Methods: We performed transesophageal echocardiography on 84 patients who had previously undergone coronary arteriography. The criteria used to diagnose atherosclerotic plaque on transesophageal echocardiography were the presence of focally or linearly increased echodensity of the aortic intima with lumen irregularity and thickening or ulceration. Results: Significant coronary artery disease (≥50% stenosis) was detected in at least one major coronary artery in 27 of the 84 patients. Aortic plaques were detected by transesophageal echocardiography in 25 of the 27 patients (93%) with coronary artery disease and in 30 of 57 patients (53%) without coronary disease (p<0.001). Among 24 patients 70 years or older, aortic plaques were present in 13 of 14 (93%) patients with coronary artery disease and 9 of 10 patients (90%) without coronary disease. Among 60 patients younger than 70 years, aortic plaques were present in 12 of 13 patients (92%) with coronary artery disease and 21 of 47 patients (45%) without coronary disease (p<0.01). The independent association between coronary artery disease and the presence of aortic plaque, age, gender, and other coronary risk factors was examined by multiple logistic regression analysis. In patients 70 years or older, the presence of aortic plaque failed to be a predictor of significant coronary artery disease, although it was indeed a strong predictor of coronary artery disease in patients younger than 70 years (p<0.05). Conclusions: In elderly patients, atherosclerotic aortic plaque detected by transesophageal echocardiography is not useful in predicting significant coronary artery disease. It is useful only in a relatively younger population. (CHEST 1997; 112:81-86)

Key words: atherosclerotic aortic plaque; coronary artery disease; elderly; transesophageal echocardiography

Atherosclerosis is a generalized process that may involve the entire vasculature.1,2 The relation between the presence of atherosclerotic plaque in the thoracic aorta and the development of cardiovascular disease has been called into attention recently.3 The presence of thoracic aortic calcified plaque, as detected on chest radiographs, has been reported to be associated with an increased risk of cardiovascular death only in men and women younger than 65 years.4 The predictive value of aortic calcified plaque generally diminishes with age. Previous transesophageal echocardiographic studies have also suggested that the detection of atherosclerotic plaque in the thoracic aorta may be a marker for the identification of coronary artery disease,5,6 although it has not been clear whether the same applies to the elderly patients. It is of particular importance in our rapidly aging society to determine whether noninvasively detected atherosclerotic aortic plaque can be a marker for the identification of significant coronary artery disease.

The purpose of this study is to examine whether
Atherosclerotic aortic plaque detected by transesophageal echocardiography can be a clinically useful marker for coronary artery disease in elderly patients.

**Materials and Methods**

*Study Population*

The study population consisted of patients who underwent transesophageal echocardiography for clinical indications at this institution between October 1990 and August 1994. A total of 84 patients (44 men and 40 women; age range, 27 to 80 years [mean±SD, 61±11 years]) were included in this study if coronary arteriography had been performed within 1 week of transesophageal echocardiography. The reason for performing a cardiac catheterization with coronary arteriography was suspected coronary artery disease in 27, valvular heart disease in 39, idiopathic cardiomyopathy in 9, and congenital heart disease in 9 patients.

Medical records of each patient were reviewed for age, gender, and coronary risk factors, including hypertension, diabetes mellitus, hypercholesterolemia, and history of smoking. Hypertension was defined as either systolic BP ≥160 mm Hg or diastolic BP ≥90 mm Hg. Diabetes was defined as hyperglycemia requiring ongoing pharmacologic therapy. Hypercholesterolemia was defined as a total cholesterol level >220 mg/dL on two or more fasting blood samples. History of and current cigarette smoking were considered significant.

*Transesophageal Echocardiographic Examination and Analysis*

Transesophageal two-dimensional echocardiography was performed using ultrasound equipment (Toshiba SSH160A; Tokyo, Japan; and Aloka SSD-570; Tokyo, Japan) with commercially available 5-MHz biplane (n=69) or monoplane (n=15) transducers. All studies were recorded on super VHS videotape for subsequent review and analysis.

Aortic intimal changes were graded on a scale of 1 to 4 proposed by Fazio et al. Atherosclerotic aortic plaque was defined as a lesion with grade 3 or 4 changes (Fig 1). All 84 studies on the recorded tapes were graded by two independent

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**Figure 1.** Grading of aortic intimal changes on transesophageal echocardiography. Top left (A): grade 1: smooth and continuous intimal surface without lumen irregularities or increased echodensity. Top right (B): grade 2: increased echodensity of smooth intima without lumen irregularity or thickening. Bottom left (C): grade 3: focally or linearly increased echodensity of the intima with lumen irregularity and thickening or ulceration. Bottom right (D): grade 4: intimal thickening and lumen irregularity associated with protruding thrombus or highly echodense material that induced shadow artifact consistent with calcification.
cardiologists with extensive experience in transesophageal echocardiography who had no knowledge of clinical and angiographic results. Any discrepancy was resolved by consensus.

Coronary Angiography

Cardiac catheterization and coronary arteriography were performed by the Judkins technique. Angiographic films were interpreted by the angiographers, who had no knowledge of the echocardiographic results.

Coronary artery disease was defined as \( \geq 50\%\) reduction of the luminal diameter (75\% reduction in luminal area) in the left anterior descending, left circumflex, or right coronary arteries. The number of vessels with significant stenosis was recorded. Left main coronary artery disease with \( \geq 50\%\) reduction of the luminal diameter was considered to be two-vessel disease involving left anterior descending and circumflex coronary arteries.

Statistical Analysis

Angiographic and corresponding echocardiographic data were compiled on a \(2 \times 2\) contingency table to allow calculation of sensitivity and specificity as well as positive and negative predictive values. A \(X^2\) test was used to compare categorical variables, and a two-tailed \(t\) test was used to compare continuous variables. Multiple logistic regression analysis was used to determine whether aortic plaque was a statistically significant predictor of significant coronary artery disease independent of age, gender, and coronary risk factors. A \(p\) value \(<0.05\) was considered statistically significant.

RESULTS

Distribution of Aortic Plaques on Transesophageal Echocardiography

Fifty-five of our of 84 patients (65\%) had aortic plaques in the thoracic aorta. Aortic plaques were most frequently found in the aortic arch (52\%) and the descending aorta (51\%). They were least common in the ascending aorta (11\%).

Angiographic Findings

Twenty-seven of 84 patients (32\%) were found to have significant coronary artery disease. Of this group, 11 patients had one-vessel disease, 7 had two-vessel disease, and 9 had three-vessel disease. There was no patient with significant left main coronary artery disease.

Aortic Plaque vs Coronary Artery Disease

Atherosclerotic aortic plaque was detected in the thoracic aorta in 25 of the 27 patients (93\%) with coronary artery disease, and in 30 of the 57 patients (53\%) without coronary disease (\(p<0.001\)) (Table 1). Thus, it was not present in 29 patients. Twenty-seven of these 29 patients (93\%) did not have coronary disease and the remaining two patients had single-vessel disease.

Table 1—Characteristics of Patients With and Without CAD

<table>
<thead>
<tr>
<th></th>
<th>CAD (n=27)</th>
<th>No CAD (n=57)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, yr</td>
<td>67±9</td>
<td>59±11</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Male gender</td>
<td>16 (59)</td>
<td>28 (49)</td>
<td>NS</td>
</tr>
<tr>
<td>Aortic plaque</td>
<td>25 (93)</td>
<td>30 (53)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Hypertension</td>
<td>13 (48)</td>
<td>15 (26)</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Diabetes</td>
<td>11 (41)</td>
<td>9 (16)</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Hypercholesterolemia</td>
<td>12 (44)</td>
<td>9 (16)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>History of smoking</td>
<td>13 (48)</td>
<td>17 (30)</td>
<td>NS</td>
</tr>
</tbody>
</table>

*Data presented are mean value±SD or number (%) of patients in group. CAD=coronary artery disease; NS=not statistically significant (\(p>0.05\)).

The discovery of atherosclerotic plaque in the thoracic aorta on transesophageal echocardiography had a 93\% sensitivity for coronary artery disease. However, the specificity was only 47\%. Although the positive predictive value of aortic plaque for coronary artery disease was 45\%, the negative predictive value was 93\%. The accuracy of transesophageal echocardiography as a test to predict coronary artery disease was 62\%.

Of the 11 patients with single-vessel disease, 9 (82\%) had aortic plaque as did all of the 7 patients with two-vessel disease and all of the 9 patients with three-vessel disease. The severity of coronary artery disease (number of obstructed vessels) was not related to thoracic aortic plaque (Table 2).

Risk Factors and Aortic Plaque vs Coronary Artery Disease

Aortic plaque was associated with significant coronary artery disease (\(p<0.001\)). We also compared the age, gender, and four previously discussed risk factors for coronary artery disease. Of 27 patients with coronary artery disease, 16 were male and 11 were female; their mean age was 67±9 years. Of 57 patients without coronary disease, 28 were male and 29 were female; their mean age was 59±11 years.

Of the 27 patients with coronary disease, hypertension was present in 13, diabetes in 11, hypercho-

Table 2—Relation Between Aortic Plaque and Severity of CAD

<table>
<thead>
<tr>
<th></th>
<th>Present</th>
<th>Absent</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of Diseased Vessels</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>30</td>
<td>27</td>
<td>57</td>
</tr>
<tr>
<td>1</td>
<td>9</td>
<td>2</td>
<td>11</td>
</tr>
<tr>
<td>2</td>
<td>7</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>3</td>
<td>9</td>
<td>0</td>
<td>9</td>
</tr>
</tbody>
</table>

*See Table 1 footnote.
lesterolemia in 12, and a history of smoking in 13. Of the 57 patients without coronary disease, hypertension was present in 15, diabetes in 9, hypercholesterolemia in 9, and a history of smoking in 17 patients (Table 1).

Aortic plaque (p<0.001), age (p<0.001), hypertension (p<0.05), diabetes (p<0.05), and hypercholesterolemia (p<0.01) were significantly associated with coronary artery disease. By multiple logistic regression analysis, however, only age (p<0.05) remained a statistically significant predictor of coronary artery disease; aortic plaque was not associated with coronary artery disease at a statistically significant level (p=0.08).

Risk Factors and Coronary Artery Disease vs Thoracic Aortic Plaque

Coronary artery disease was significantly associated with aortic plaque (p<0.001). We also compared the age, gender, and four risk factors for aortic plaque. Of 55 patients with aortic plaque, 26 were male and 29 were female; their mean age was 66±8 years. Of 29 patients without aortic plaque, 18 were male and 11 were female; their mean age was 53±10 years.

Of the 55 patients with aortic plaque, hypertension was present in 21, diabetes in 15, hypercholesterolemia in 19, and a history of smoking in 18. Of the 29 patients without aortic plaque, hypertension was present in 7, diabetes in 5, hypercholesterolemia in 2, and a history of smoking in 12 (Table 3).

Age (p<0.0001) and hypercholesterolemia (p<0.05) were significantly associated with aortic plaque. By multiple logistic regression analysis, age (p<0.001) and coronary artery disease (p<0.05) remained statistically significant predictors of thoracic aortic plaque, independent of other risk factors.

Risk Factors and Aortic Plaque vs Coronary Artery Disease in Elderly Patients

Among 24 patients 70 years or older, aortic plaque was present in 13 of 14 patients (93%) with coronary artery disease and 9 of 10 patients (90%) without coronary disease. Among 60 patients younger than 70 years, aortic plaque was present in 12 of 13 patients (92%) with coronary artery disease and 21 of 47 patients (45%) without coronary disease (p<0.01) (Table 4). The independent association between coronary artery disease and the presence of aortic plaque, gender, and four risk factors was again examined by multiple logistic regression analysis. In patients 70 years or older, the presence of aortic plaque failed to be a predictor of coronary artery disease, although it was indeed a strong predictor of coronary artery disease in patients younger than 70 years (p<0.05).

Discussion

Atherosclerotic aortic plaque was found not to be a sensitive predictor of significant coronary artery disease in our study patients 70 years or older, although it was indeed useful in predicting coronary artery disease in those younger than 70 years. In elderly patients, care should be taken when atherosclerotic aortic plaque on transesophageal echocardiography is used in the prediction of significant coronary artery disease. Additional noninvasive modalities such as stress echocardiography and thallium myocardial imaging should be considered to further define the high-risk elderly patients who may need coronary angiography.

Atherosclerotic Aortic Plaque in the Elderly

Recent echocardiographic studies have indicated that the transesophageal approach offers high-resolution imaging of the thoracic aorta and is particularly useful in the detailed evaluation of atherosclerotic plaques.5-12 Fazio and coworkers5 have reported that the detection of atherosclerotic plaque in the thoracic aorta by transesophageal echocardiography is a marker for the identification of obstructive coronary artery disease. In their study, the presence of aortic plaque on transesophageal study showed a sensitivity of 90% and a specificity of 90% for obstructive coronary artery disease. The positive predictive value of aortic plaque for obstructive coronary artery disease was 95% and the negative predictive value was 82%. Although the age of their study patients ranged from 22 to 83 years, the significance of aortic plaque in elderly patients in the prediction of coronary artery disease was unfortunately not reported in detail. Since the presence of calcified plaques in the aorta is more closely related to age than any other arteries, we sought the clinical significance of atherosclerotic aortic plaque on transesophageal echocardiography in the identification of
significant coronary artery disease. The atherosclerotic plaque was indeed a good marker for the identification of obstructive coronary artery disease, as reported by Fazio et al. and Tribouilloy et al., but it was not useful in the elderly patients 70 years or older in our study. This result should be taken into account when we stratify risk in elderly patients with suspected coronary artery disease. Other modalities such as stress echocardiography and pharmacologic thallium myocardial imaging may be good alternatives when significant coronary artery disease is strongly suspected in patients 70 years or older.\textsuperscript{13-15}

**Absence of Atherosclerotic Plaque**

Our study was in agreement with that of Fazio and coworkers\textsuperscript{5} that the absence of aortic plaque was highly specific for patent coronary arteries, with a high negative predictive value. This result is particularly important to cardiologists when deciding whether to recommend coronary angiography for elderly patients with valvular heart disease who may need surgical intervention. It may be useful particularly in the presence of other criteria, such as lack of coronary risk factors, in deciding not to perform coronary angiography. There were two patients with significant coronary artery disease who did not have atherosclerotic aortic plaques in the present study. These two patients had single-vessel disease and therefore the absence of aortic plaque was, at times, suggestive of a milder form of coronary artery disease.

**Significance of Coronary Risk Factors**

Associations of thoracic aortic plaques with coronary risk factors were found to be generally weak. Only hypercholesterolemia was significantly correlated with aortic plaque. This is probably because age is so tightly related to the development of aortic plaque.

In the present study, diabetes was an only predictor of significant coronary artery disease in patients younger than 70 years. Multiple logistic regression analysis revealed that coronary risk factors were not statistically significant determinants of coronary artery disease. Large-scale studies may be required to further elucidate the significance of coronary risk factors, particularly in patients 70 years or older.

**Limitations of the Study**

First, the number of our study subjects was relatively small and they were taken from a group of patients who were referred for transesophageal echocardiography to assess a variety of cardiovascular conditions. It is possible that our results might have been biased by this retrospective nature. Secondly, a monoplane transducer was applied to the initial 15 patients, which would make entire visualization of the thoracic aorta difficult, particularly the upper ascending aorta. For this reason and because of the difficulties in imaging this region due to attenuation of ultrasound by the trachea,\textsuperscript{10} it is possible that the incidence of atherosclerotic plaques in the ascending aorta may be underestimated, although care was taken to obtain good images of the ascending aorta except the small portion of distal ascending aorta. With the use of a biplane transducer, the detection of atherosclerotic lesions at this level may have much improved.

Our study must be considered a preliminary one, especially because of the retrospective nature of the study and the small number of study patients; a prospective randomized study with a larger group of patients is needed to confirm our observations.

**Conclusions**

The detection of atherosclerotic aortic plaque by transesophageal echocardiography may be a clinically useful marker for the identification of significant coronary artery disease only in patients younger

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**Table 4—Characteristics of Patients With and Without CAD in Two Age Groups\textsuperscript{*}**

<table>
<thead>
<tr>
<th>Age 70 yr or Older</th>
<th>Age Younger Than 70 yr</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>CAD</td>
<td>No CAD</td>
</tr>
<tr>
<td>(n=14)</td>
<td>(n=10)</td>
</tr>
<tr>
<td>Age, yr</td>
<td>74±3</td>
</tr>
<tr>
<td>Male gender</td>
<td>5 (57)</td>
</tr>
<tr>
<td>Aortic plaque</td>
<td>13 (93)</td>
</tr>
<tr>
<td>Hypertension</td>
<td>8 (57)</td>
</tr>
<tr>
<td>Diabetes</td>
<td>4 (29)</td>
</tr>
<tr>
<td>Hypercholesterolemia</td>
<td>7 (50)</td>
</tr>
<tr>
<td>History of smoking</td>
<td>6 (43)</td>
</tr>
</tbody>
</table>

*See Table 1 footnote.
than 70 years. Its clinical usefulness is limited in elderly patients. This should be taken into account at present in the risk stratification and the decision making, although further detailed analysis of atherosclerotic aortic plaque might bring more useful information in the future. The absence of thoracic aortic plaque seems to be specific for patent coronary arteries and this information may be used in noninvasive risk stratification in elderly patients.

REFERENCES

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