Distribution of Atherosclerosis and Risk Factors in Atherothrombotic Occlusion

Masahiro Yasaka, MD; Takenori Yamaguchi, MD; and Motoaki Shichiri, MD

Background and Purpose: The present study was performed to determine the relation between distribution of atherosclerosis and risk factors in Japanese patients with atherothrombotic occlusion.

Methods: We studied 154 patients with atherothrombotic occlusion of the extracranial internal carotid artery (n=75, ICA group), the horizontal portion of the middle cerebral artery (n=47, MCA group), and the basilar artery (n=32, BA group), all of which were confirmed by cerebral angiography. We investigated the distribution of atherosclerosis of the three sites and compared the risk factors for atherosclerosis between the three groups. We used 113 subjects without stroke as the control group.

Results: A strong correlation was present between atherosclerosis of the extracranial internal carotid artery and that of the basilar artery. However, only a weak correlation existed between atherosclerosis of the middle cerebral artery and that of the other vessels. Although the prevalence of smoking and hypertension was higher and high density lipoprotein cholesterol levels were lower in the three groups than in the control subjects, no significant differences were found in age, sex, prevalence of smoking and hypertension, serum levels of triglycerides, and high density lipoprotein cholesterol among the three groups. The prevalence of coronary heart disease and diabetes mellitus and the serum levels of hemoglobin A1c, total cholesterol, and low density lipoprotein cholesterol were higher in the ICA and BA groups than in the MCA group. The prevalence of electrocardiographic evidence of left ventricular hypertrophy was higher in the MCA group than in the other groups.

Conclusions: In addition to smoking, hypertension, and low concentration of high density lipoprotein cholesterol, diabetes mellitus and hypercholesterolemia seem to be associated with atherosclerosis of the extracranial internal carotid artery and the basilar artery, and advanced hypertension may play a role in the development of middle cerebral artery occlusion. (Stroke 1993;24:206–211)

KEY WORDS: • angiography • carotid artery diseases • cerebrovascular disorders • risk factors

Angiographic and pathological investigations have indicated racial differences in atherothrombotic occlusive diseases of both the anterior and posterior cerebral circulation.1-9 Specifically, extracranial atherosclerosis is more common in whites, whereas intracranial atherosclerosis is more frequent in blacks and Orientals.

Epidemiological studies have shown that not only genetic factors but also environmental factors are associated with the distribution of atherosclerosis. The Ni-Hon-San study showed that the level of blood pressure did not differ between Japanese men living in Japan and Hawaii, but the incidence of stroke was higher in Japan than in Hawaii, which was inversely associated with dietary animal protein and fat.10,11 The study also reported that serum levels of cholesterol, glucose, uric acid, and triglycerides were lower in Japan than in Hawaii.12 This suggests that appropriate dietary animal protein and fat may exert an inhibitory effect on the incidence of stroke.

High serum levels of cholesterol, however, are related not only to coronary heart disease but also to extracranial carotid artery occlusive disease.13,14 Recently, extracranial carotid occlusive disease has been increasing in Japan in association with dietary changes brought on by the introduction of Western-style foods.

In the present study, to elucidate the relation between the distribution of atherosclerosis and risk factors for atherosclerosis in the Japanese population, we investigated stroke patients with atherothrombotic occlusion of the extracranial internal carotid artery (ICA), the horizontal portion of the middle cerebral artery (MCA), and the basilar artery (BA). We first angiographically examined the distribution of atherosclerosis of the extracranial ICA, MCA trunk, and the BA; we then investigated the relation between risk factors and the distribution of atherosclerosis.

Subjects and Methods

Between January 1, 1985, and June 31, 1991, 2,609 Japanese patients in whom cerebrovascular disease (CVD) was suspected were admitted to the Cerebrovascular Division of the Department of Medicine of the National Cardiovascular Center. According to the clinical findings (including brain computed tomography,
brain magnetic resonance imaging, duplex carotid ultrasonography, transcranial Doppler sonography, and cerebral angiography), the diagnosis of cerebral hemorrhage was made in 275, cardioembolic stroke in 433, atherothrombotic infarction in 345, lacunar infarction in 857, cerebral infarction of undetermined cause in 172, transient ischemic attack in 183, and other neurological disorders in 344 patients.

Of the 2,609 patients, intra-arterial conventional arteriography or digital subtraction arteriography was performed in 1,079 patients in whom a major vessel occlusive lesion or vascular anomaly, such as arteriovenous malformation or angioma, was suspected in the carotid system in 763 patients and in the vertebrobasilar system in 316. Routine examinations included anteroposterior and lateral projections. Of these patients, 154 patients (117 men and 37 women, with a mean age of 64.7 years, ranging from 38 to 78 years) were found to have atherothrombotic infarction or transient ischemic attack resulting from atherothrombotic occlusion of the extracranial ICA (n=47, ICA group), MCA trunk (n=32, MCA group), or BA (n=32, BA group). We entered these 154 patients into the present study.

No patients had a history of or concomitant arterial embolism of the limbs or other parts of the body, or rheumatic heart disease, atrial fibrillation, acute myocardial infarction, prosthetic cardiac valve, nonischemic cardiomyopathy, infective endocarditis, nonbacterial thrombotic endocarditis, congenital septal defect, or cardiac tumor, which were possible sources of cardioembolic stroke.

Angiographic examinations were performed via the transfemoral route in 137 patients and via the brachial route in the remaining 17 patients. After discarding missing, inadequate, or unsatisfactory angiographic studies, we were able to obtain good visualization of the right carotid system in 144 patients (93.5%), of the left carotid system in 133 patients (86.4%), and of the basilar system in 132 patients (85.7%). The proximal part of the extracranial vertebral arteries was not routinely examined. We therefore omitted the investigation of vertebral arteries from the current study.

In the ICA and MCA groups, we measured the degree of stenosis of the contralateral ICA origin, the MCA trunk, and the BA according to the method of Alter et al, relating the diameter of the narrowed lumen to the lumen proximal to the stenosis. In the BA

---

**Table 1. Distribution of Atherosclerosis According to Group**

<table>
<thead>
<tr>
<th></th>
<th>Extracranial ICA</th>
<th>MCA trunk</th>
<th>BA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt;25%</td>
<td>25–75%</td>
<td>≥75%</td>
</tr>
<tr>
<td>ICA group</td>
<td>36</td>
<td>16</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>(56.2)</td>
<td>(25.0)</td>
<td>(18.8)</td>
</tr>
<tr>
<td>MCA group</td>
<td>32</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>(86.5)</td>
<td>(13.5)</td>
<td>(0)</td>
</tr>
<tr>
<td>BA group</td>
<td>12</td>
<td>9</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>(44.5)</td>
<td>(33.3)</td>
<td>(22.2)</td>
</tr>
</tbody>
</table>

ICA, internal carotid artery; MCA, middle cerebral artery; BA, basilar artery. Numbers in parentheses are percentages.
TABLE 2. Concomitants and Risk Factors in Three Cerebrovascular Disease and Control Groups

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>Age (years)</th>
<th>Smoking (%)</th>
<th>Hypertension (%)</th>
<th>Diabetes mellitus (%)</th>
<th>Ischemic heart disease (%)</th>
<th>High voltage on ECG (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ICA group</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>59</td>
<td>65.8±1.2</td>
<td>52 (88%)</td>
<td>42 (71.2%)</td>
<td>31 (52.5%)</td>
<td>20 (33.9%)</td>
<td>12 (20.3%)</td>
</tr>
<tr>
<td>Women</td>
<td>16</td>
<td>65.5±1.8</td>
<td>7 (43.8%)</td>
<td>13 (81.3%)</td>
<td>5 (31.3%)</td>
<td>3 (18.8%)</td>
<td>5 (31.3%)</td>
</tr>
<tr>
<td>Total</td>
<td>75</td>
<td>65.7±1.0</td>
<td>59 (78.7%)</td>
<td>55 (73.3%)</td>
<td>36 (48.0%)</td>
<td>23 (30.7%)</td>
<td>17 (22.7%)</td>
</tr>
<tr>
<td><strong>MCA group</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>35</td>
<td>62.7±2.1</td>
<td>26 (74.3%)</td>
<td>29 (82.9%)</td>
<td>5 (14.3%)</td>
<td>3 (8.6%)</td>
<td>16 (45.7%)</td>
</tr>
<tr>
<td>Women</td>
<td>12</td>
<td>68.2±3.2</td>
<td>10 (83.3%)</td>
<td>10 (83.3%)</td>
<td>3 (25.0%)</td>
<td>4 (33.3%)</td>
<td>4 (33.3%)</td>
</tr>
<tr>
<td>Total</td>
<td>47</td>
<td>64.1±1.8</td>
<td>36 (76.6%)</td>
<td>39 (83.0%)</td>
<td>8 (17.0%)</td>
<td>7 (14.9%)</td>
<td>20 (42.6%)</td>
</tr>
<tr>
<td><strong>BA group</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>23</td>
<td>61.2±2.3</td>
<td>20 (87.0%)</td>
<td>19 (82.6%)</td>
<td>9 (39.1%)</td>
<td>9 (39.1%)</td>
<td>6 (26.1%)</td>
</tr>
<tr>
<td>Women</td>
<td>9</td>
<td>68.8±1.5</td>
<td>6 (66.7%)</td>
<td>7 (77.8%)</td>
<td>3 (33.3%)</td>
<td>2 (22.2%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Total</td>
<td>32</td>
<td>63.3±1.8</td>
<td>24 (75.0%)</td>
<td>26 (81.3%)</td>
<td>12 (37.5%)</td>
<td>11 (34.4%)</td>
<td>6 (18.8%)</td>
</tr>
<tr>
<td><strong>Control group</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>75</td>
<td>60.9±0.9</td>
<td>37 (49.3%)</td>
<td>22 (29.3%)</td>
<td>4 (5.3%)</td>
<td>1 (1.3%)</td>
<td>4 (5.3%)</td>
</tr>
<tr>
<td>Women</td>
<td>38</td>
<td>62.4±1.1</td>
<td>9 (23.7%)</td>
<td>10 (26.3%)</td>
<td>4 (10.5%)</td>
<td>1 (2.6%)</td>
<td>3 (7.9%)</td>
</tr>
<tr>
<td>Total</td>
<td>113</td>
<td>61.4±0.8</td>
<td>46 (40.7%)</td>
<td>32 (28.3%)</td>
<td>8 (7.1%)</td>
<td>2 (1.8%)</td>
<td>7 (6.2%)</td>
</tr>
</tbody>
</table>

ICA, internal carotid artery; MCA, middle cerebral artery; BA, basilar artery; [C], vs. control group; [M], vs. MCA group; [I], vs. ICA group; [B], vs. BA group.

χ² test was used for prevalence of smoking, hypertension, diabetes mellitus, ischemic heart disease, and high voltage on electrocardiogram (ECG). Analysis of variance with Sheffe's multiple comparison test was used for levels of hemoglobin (Hb) Alc, total cholesterol, triglyceride, high density lipoprotein (HDL) cholesterol, and low density lipoprotein (LDL) cholesterol.

For HbA1c, there are two missing values in an ICA group man and an MCA group man; for HDL and LDL cholesterol, there are two missing values in ICA group men.

*p<0.001, †p<0.01, ‡p<0.05.

We compared the degree of stenosis of the extracranial ICA, MCA trunk, and BA in the ICA and MCA groups, and that of the extracranial ICA and MCA trunk in the BA group. In accordance with these data, we analyzed whether any relation existed in the distribution of atherosclerosis.

The following data were carefully collected for each patient from the medical records: 1) age; 2) sex; 3) history of smoking; 4) history of hypertension (defined as past use of antihypertensive agents or blood pressure recordings before stroke onset with systolic ≥160 mm Hg or diastolic ≥95 mm Hg); 5) history of diabetes mellitus (use of insulin or oral hypoglycemic agents, fasting blood glucose ≥140 mg/dl, or random blood glucose ≥200 mg/dl); 6) history of ischemic heart disease (myocardial infarction and/or angina pectoris); 7) left ventricular hypertrophy on electrocardiogram (ECG) (high voltage = SV1 + RV5 ≥3.5 mV); 8) serum level of hemoglobin Alc (HbA1c); 9) fasting serum level of total cholesterol; 10) triglycerides; 11) high density lipoprotein (HDL) cholesterol; and 12) low density lipoprotein (LDL) cholesterol (determined using the formula LDL cholesterol = total cholesterol – HDL cholesterol – triglycerides/5).17 We analyzed the relation between these data and the angiographically evaluated distribution of atherosclerosis. Data collection was complete except for six values: two missing HbA1c values in a group ICA man and a group MCA man, two HDL cholesterol values in a group ICA man, and two LDL cholesterol values in a group ICA man. These six values were omitted in the statistical comparisons of HbA1c, HDL cholesterol, and LDL cholesterol levels.

We routinely performed duplex carotid ultrasonography and transcranial Doppler sonography in patients

![Figure 3](http://stroke.ahajournals.org/)

**Figure 3.** Bar graph shows degree of stenosis of extracranial internal carotid artery (ICA) and middle cerebral artery (MCA) trunk in basilar artery group (mean±SEM).

*p=0.0028, †p=0.033, ‡p=0.027 vs. MCA trunk by unpaired t test.
TABLE 2.  Continued

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>HbA1c (%)</th>
<th>Total cholesterol (mg/dl)</th>
<th>Triglyceride (mg/dl)</th>
<th>HDL cholesterol (mg/dl)</th>
<th>LDL cholesterol (mg/dl)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICA group</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>59</td>
<td>5.4±0.2[C*][M†]</td>
<td>219.7±4.7[C*][M‡]</td>
<td>141.6±8.2</td>
<td>40.6±1.9[C*]</td>
<td>150.8±4.8[C*][M*]</td>
</tr>
<tr>
<td>Women</td>
<td>16</td>
<td>5.9±0.6[C‡]</td>
<td>254.9±9.4[C*][M‡]</td>
<td>131.2±9.6</td>
<td>49.2±3.5</td>
<td>181.1±8.7[C*][M‡]</td>
</tr>
<tr>
<td>Total</td>
<td>75</td>
<td>5.5±0.2[C*][M†]</td>
<td>227.2±4.5[C*][M‡]</td>
<td>139.4±6.8</td>
<td>42.4±1.7[C*]</td>
<td>157.1±4.5[C*][M*]</td>
</tr>
<tr>
<td>MCA group</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>35</td>
<td>4.8±0.1</td>
<td>188.4±7.4</td>
<td>141.2±11.0</td>
<td>39.8±1.7</td>
<td>118.6±7.2</td>
</tr>
<tr>
<td>Women</td>
<td>12</td>
<td>4.9±0.2</td>
<td>206.0±9.4</td>
<td>118.7±13.4</td>
<td>38.9±3.2[C‡]</td>
<td>143.3±12.2</td>
</tr>
<tr>
<td>Total</td>
<td>47</td>
<td>4.8±0.1</td>
<td>192.8±6.3</td>
<td>135.5±9.0</td>
<td>39.6±1.5[C*]</td>
<td>125.3±6.4</td>
</tr>
<tr>
<td>BA group</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>23</td>
<td>5.3±0.2[C‡]</td>
<td>225.5±7.3[C‡][M‡]</td>
<td>164.4±25.4</td>
<td>41.8±3.2[C‡]</td>
<td>151.1±7.8[C‡][M‡]</td>
</tr>
<tr>
<td>Women</td>
<td>9</td>
<td>5.5±0.7</td>
<td>260.3±21.2[C*][M‡]</td>
<td>140.6±24.5</td>
<td>41.1±3.6[C‡]</td>
<td>191.1±7.8[C*][M‡]</td>
</tr>
<tr>
<td>Total</td>
<td>32</td>
<td>5.4±0.2[C‡]</td>
<td>235.6±8.3[C*][M‡]</td>
<td>157.5±19.3</td>
<td>41.6±2.5[C*]</td>
<td>163.1±8.1[C*][M‡]</td>
</tr>
<tr>
<td>Control group</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>75</td>
<td>4.6±0.1</td>
<td>192.7±3.2</td>
<td>123.4±5.9</td>
<td>52.3±1.4</td>
<td>119.3±3.2</td>
</tr>
<tr>
<td>Women</td>
<td>38</td>
<td>4.6±0.4</td>
<td>197.5±5.4</td>
<td>110.6±5.2</td>
<td>54.0±1.8</td>
<td>127.1±4.4</td>
</tr>
<tr>
<td>Total</td>
<td>113</td>
<td>4.6±0.4</td>
<td>194.3±2.6</td>
<td>119.2±4.4</td>
<td>52.8±1.1</td>
<td>121.8±2.6</td>
</tr>
</tbody>
</table>

with suspected CVD as a screening procedure. Of the 344 patients who were finally diagnosed as having neurological disorders other than CVD, we obtained satisfactory and normal B-mode imaging of the bilateral carotid arteries and Doppler sonograms of the common carotid arteries, MCA, ophthalmic artery, and BA in 132 cases. We discarded 19 cases aged <38 years or >79 years to match the ages of the 154 patients with atherothrombotic occlusion. We used 113 subjects (75 men and 38 women, aged 61.4±0.8 years) as a control for statistical comparison. They were composed of patients with epilepsy, cerebral angioma, brain tumor, headache, syncope, peripheral vertigo, or cervical spondylosis.

Continuous data were expressed as mean±SEM. The χ² test was used for analysis of discrete variables. We used the unpaired t test or analysis of variance, coupled with Scheffe’s multiple comparison test, for analysis of continuous variables.

Results

In the ICA group, severe or moderate occlusive lesions of the contralateral extracranial ICA were noted in 28 patients (43.8%) and of the BA in 10 patients (18.6%). There were no patients with severe lesions of the contralateral MCA trunk and only two patients (3.2%) with moderate lesions (Table 1). The degree of stenosis of the contralateral extracranial ICA (41.5±3.8%) was significantly greater than that of the contralateral MCA trunk (13.1±1.8%) and that of the BA (27.2±2.3%) (Figure 1). In addition, the degree of stenosis of the BA was also significantly greater than that of the MCA trunk.

In the MCA group, severe or moderate occlusive lesions of the contralateral MCA horizontal portion were demonstrated in 12 patients (31.6%). Severe lesions of the extracranial ICA or BA were not seen, and there were only a few patients with moderate lesions of the extracranial ICA or BA (Table 1). The degree of stenosis of the contralateral MCA horizontal portion (31.6±4.0%) was significantly greater than that of the contralateral extracranial ICA (21.1±2.5%) and that of the BA (20.6±1.6%) (Figure 2).

In the BA group, severe or moderate occlusive lesions of the extracranial ICA were detected in 15 patients (55.5%), whereas very few patients had moderate stenotic lesions of the MCA trunk (Table 1). The degree of stenosis of the ICA origin (38.8±5.7%) in this group was significantly greater than that of the MCA trunk (20.0±2.0%) (Figure 3).

There were no sexual differences in the distribution of atherosclerosis between the ICA, MCA, and BA groups (Figures 1–3).

Risk factors and concomitants with respect to each group are summarized in Table 2.

The prevalence of smoking, hypertension, ischemic heart disease, and high voltage on ECG was higher and serum levels of HDL cholesterol were lower in the three CVD groups than in the control group. The prevalence of diabetes mellitus and serum levels of HbA1c, total cholesterol, and LDL cholesterol were significantly higher in the ICA and BA groups than in the control group but were not higher in the MCA group. No significant difference was found in the triglyceride level between the three groups and the control group.

In the ICA, MCA, and BA groups, there were no differences in age, prevalence of smoking, hypertension, and serum levels of triglycerides and HDL cholesterol. However, ischemic heart disease and diabetes mellitus were more frequently found in the ICA and BA groups than in the MCA group. The serum levels of HbA1c in the ICA and BA groups were higher (significant in the ICA group men and in the total) than those in the MCA group. The incidence of high voltage on ECG was higher in the MCA group than in the other groups. The total cholesterol and LDL cholesterol concentrations in the ICA and BA groups were higher than those in the MCA group.

Discussion

The ICA origin, MCA trunk, and BA, which were investigated in this study, have been shown to be
frequently involved by atherosclerosis. Baker and Ian-
none19 investigated the location and severity of athero-
sclerosis in 173 consecutive autopsy cases and found
that the most common sites of involvement were the
ICA origin and the distal BA. The MCA and the proximal and mid portions of the BA were the next most
frequently involved.

In patients with extracranial ICA occlusion, occlusive
lesions were also commonly seen in the contralateral
ICA. Likewise, in patients with MCA trunk occlusion,
occlusive lesions on the contralateral side were often
found. These findings suggest that ICAs or MCAs on
both sides were affected very similarly by hemodynamics
and risk factors for atherosclerosis.

In patients with extracranial ICA occlusion, athero-
sclerotic changes were more often seen in the BA than
in the MCA trunk, and in BA occlusion, these changes
were more commonly noted in the extracranial ICA
than in the MCA trunk. However, ICA and BA lesions
were rarely seen in patients with MCA occlusion. These
results suggest that there is a stronger relation between
the distribution of atherosclerosis in the extracranial
ICA and BA than that in the extracranial ICA and
MCA trunk or that in the BA and MCA trunk. Athero-
sclerosis of the extracranial ICA has been reported to
be accompanied rarely by an MCA trunk lesion, and this
finding has been explained mainly by racial differ-
ences.1–8 ICA lesions are more common in whites,
whereas MCA lesions are more frequent in blacks and
Orientals. The same racial differences have also been
reported in the posterior circulation.9 However, there
are few reports on the relation in the distribution of
atherosclerosis between the extracranial ICA and BA or
that between the MCA trunk and BA.

Regarding the concomitants and risk factors for ath-
erosclerosis, our data indicate that smoking, hyperten-
sion, and low levels of HDL cholesterol are basically
related to atherosclerosis of the major brain vessels.
These factors have already been emphasized as risk
factors for atherosclerosis.20,21 Moreover, in our study,
there were curious differences in risk factors and other
concomitants that were associated with the distribution
of atherosclerosis. The prevalence of ischemic heart
disease and diabetes mellitus and serum levels of
HbA1c, total cholesterol, and LDL cholesterol in the
ICA and BA groups were higher than those in the MCA
group. It has already been indicated that the extracra-
nial ICA atherosclerotic lesions tended to coexist in
patients with coronary heart disease and were com-
monly associated with hypercholesterolemia.13,14,21
These reports are consistent with our results. In addi-
tion, our results suggest that ischemic heart disease and
a high level of serum cholesterol are strongly associated
not only with extracranial ICA lesions but also with BA
lesions.

Although the Framingham study indicated that dia-
abetes mellitus was an independent risk factor for cere-
bral infarction,22 it has yet to be fully elucidated whether
diabetes mellitus affects the distribution of athero-
sclerosis in cerebral arteries. Bogousslavsky et al20 reported
that the prevalence of diabetes mellitus was higher in
patients with ICA occlusion than in control subjects.
Gorelick et al9 investigated racial differences in the
distribution of posterior circulation occlusive disease
and found that distal basilar atherosclerotic lesions and
diabetes mellitus were more common in blacks than in
whites. Our results also suggest that diabetes mellitus is
strongly associated with the extracranial ICA and BA.

On the other hand, although the prevalence of hyper-
tension in the MCA group was not significantly higher
than in the ICA and BA groups, high voltage on ECG
was more common in the MCA group than in the other
two groups. This result suggests that advanced hyper-
tension is associated with atherosclerosis of the MCA
trunk. Some reports have already indicated that occlu-
sive lesions of the intracranial cerebral arteries are
associated with severe hypertension.23,24

According to the modified Fisher’s classification of
occlusive CVD presented by Caplan et al, extracranial
ICA and BA lesions belong to the same group, consist-
ing of lesions of large arteries, which are commonly seen
in whites, and they are closely related to serum lipid
levels and coronary heart disease. Our results suggest
that not only in whites but also in the Japanese popu-
lation, atherosclerosis of extracranial ICA and BA is
strongly associated with serum lipid levels and coronary
heart disease.

In conclusion, atherosclerosis of the major cerebral
arteries is basically associated with smoking, hyperten-
sion, and low serum levels of HDL cholesterol. In
addition to these risk factors, diabetes mellitus and high
serum levels of total or LDL cholesterol may play a role
in the development of ICA and BA atherosclerosis, and
advanced hypertension may be related to MCA trunk
atherosclerosis.

Acknowledgments
We thank Dr. Shozo Kobori and Dr. Toromihoko Yano of
the Department of Metabolic Medicine, Kumamoto University
Medical School, for their valuable criticism and excellent
suggestions.

References
1. Heyden S, Heyman A, Goree JA: Nonembolic occlusion of
the middle cerebral and carotid arteries: A comparison of predisposing
2. Heyman A, Fields WS, Keating RD: Joint study of extracranial
arterial occlusion: VI. Racial differences in hospitalized patients
with ischemic stroke. JAMA 1972;222:285–289
and other population groups in Hawaii: An angiographical study.
Stroke 1975;6:539–542
4. Nishimura K, McHenry LC Jr, Toole JF: Cerebral angiographic
and clinical differences in carotid system transient ischemic attacks
between American Caucasian and Japanese patients. Stroke 1984;
15:56–59
5. Gorelick PB, Caplan LR, Hier DB, Parker SL, Patel D: Racial
differences in the distribution of anterior circulation occlusive
6. Caplan L, Babikian V, Helgason C, Hier DB, DeWitt D, Patel D,
Stein R: Occlusive disease of the middle cerebral artery. Neurology
1985;35:975–982
7. Caplan LR, Gorelick PB, Hier DB: Race, sex and occlusive cere-
8. Inzitari D, Hachinski VC, Taylor W, Barnett JM: Racial differ-
ces in the anterior circulation in cerebrovascular disease: How
much can be explained by risk factors? Arch Neurol 1990;47:
1080–1084
MS, Biller J, Kornack D: Racial differences in the distribution of
studies of coronary heart disease and stroke in Japanese men living
in Japan, Hawaii and California: Blood pressure distributions. Am
} Epidemiol 1975;102:502–513
Distribution of atherosclerosis and risk factors in atherothrombotic occlusion.
M Yasaka, T Yamaguchi and M Shichiri

Stroke. 1993;24:206-211
doi: 10.1161/01.STR.24.2.206

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://stroke.ahajournals.org/content/24/2/206