Prevalence of Extracranial Carotid and Vertebral Artery Disease in Chinese Patients With Coronary Artery Disease

Wai Hong Chen, MBBS; David Sai Wah Ho, MBBS, PhD; Shu Leong Ho, MD; Raymond Tak Fai Cheung, MBBS, PhD; Stephen Wing Keung Cheng, MS

Background and Purpose—Chinese have been reported to have an extremely low prevalence rate of carotid and vertebral artery disease in comparison with whites. Previous studies, however, have been limited to general hospital stroke admission or postmortem series and were prone to selection bias. Extracranial cerebrovascular disease (ECCVD) is associated with coronary artery disease (CAD) in whites. Data associating ECCVD with CAD in Chinese patients are not available.

Methods—We studied 153 consecutive Chinese patients with angiographically documented CAD. Duplex ultrasonography was performed to identify any underlying extracranial carotid and vertebral artery disease. Patient demographics; vascular risk factors; history of myocardial infarction, transient ischemic attack (TIA) or stroke; concomitant peripheral vascular disease (PVD); degree of left ventricular dysfunction; and extent and severity of CAD were also noted and analyzed.

Results—Significant (≥50%) stenosis of one or more of the extracranial cerebral arteries was found in 32 patients (21%). The internal and external carotid arteries were involved in 17 of 153 patients (11%) and 19 of 153 patients (12%), respectively. The vertebral artery was involved in 9 of 153 patients (6%) and the common carotid artery in 3 of 153 (2%). Diabetes mellitus, hypertension, a history of TIA or stroke, and PVD were significantly associated with the presence of ECCVD.

Conclusions—Significant ECCVD is not uncommon in Chinese patients with CAD, and the prevalence is comparable with that reported in white populations. Patients with a history of diabetes, hypertension, TIA, stroke, and PVD are more likely to have concomitant ECCVD. (Stroke. 1998;29:631-634.)

Key Words: carotid artery diseases ■ cerebral arteries ■ Chinese ■ coronary artery disease ■ vertebral artery

Atherothrombosis of the large cerebral arteries is an important cause of cerebrovascular disease and accounts for 30% to 60% of all ischemic strokes.1,2 The distribution and severity of atherosclerotic cerebrovascular disease has been reported to vary among patients of different ethnic origins.3,4 Previous studies reported that Chinese stroke patients had more intracranial small-vessel disease than did white stroke patients, whereas extracranial disease was extremely rare. However, these reports were limited by relatively small study sample size4,10 or lack of detailed clinical and laboratory (eg, duplex ultrasonography or cerebral arteriography) evaluation for extracranial disease.9 Another major limitation of any general hospital stroke presentation or autopsy series in developing countries is selection bias. This includes factors relating to the popularity of alternative therapy, difference in economic power and threshold of hospital presentation between males and females,11,12 and difference in rates of presentation to and admission by a private versus public hospital. Thus, in Hong Kong, patients with hemorrhagic strokes are more likely to present to and be admitted by a hospital, whereas those with minor strokes or TIsAs are more likely to seek treatment from Chinese herbalists or acupuncturists or are refused admission by an overcrowded public hospital. In fact, patients with TIsAs have often been excluded from previous series.8,9,11,12 These patients may have significant extracranial cerebrovascular disease with large artery to small artery embolization as a cause of the TIA or minor stroke.

CAD has been associated with ECCVD in white population series. In patients with CAD, significant ECCVD has been reported to be present in 12% to 28%.13-15 There have been no similar studies in Chinese patients with CAD. The objectives of this study are therefore to (1) determine the prevalence, distribution, and severity of ECCVD in Chinese patients with CAD and (2) identify the clinical variables associated with ECCVD.

Subjects and Methods
We included in this study 153 consecutive patients presenting to our center for diagnostic cardiac catheterization who had angiographically proved CAD. A detailed history was taken and physical examination performed by one of two physicians (W.H.C. and D.S.W.H.). Data collected included age, sex, history of cigarette smoking, and presence of diabetes mellitus, hypertension, hypercholesterolemia (defined as pretreatment fasting total cholesterol level ≥5.4 mmol/L), TIA, stroke, and PVD. The overall patient characteristics are summarized in Table 1.
TABLE 1. Patient Characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Overall (n=153)</th>
<th>Without ECCVD (n=121)</th>
<th>With ECCVD (n=32)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age, 66±8 y</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>88 (58)</td>
<td>70 (58)</td>
<td>18 (56)</td>
<td>NS</td>
</tr>
<tr>
<td>Female</td>
<td>65 (42)</td>
<td>51 (42)</td>
<td>14 (44)</td>
<td></td>
</tr>
<tr>
<td>Smoking history</td>
<td>82 (54)</td>
<td>63 (52)</td>
<td>19 (59)</td>
<td>NS</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>42 (27)</td>
<td>26 (21)</td>
<td>16 (50)</td>
<td>.001</td>
</tr>
<tr>
<td>Hypertension</td>
<td>99 (65)</td>
<td>73 (60)</td>
<td>26 (81)</td>
<td>.03</td>
</tr>
<tr>
<td>Hypercholesterolemia</td>
<td>113 (74)</td>
<td>91 (75)</td>
<td>22 (69)</td>
<td>NS</td>
</tr>
<tr>
<td>History of MI</td>
<td>41 (27)</td>
<td>33 (27)</td>
<td>8 (25)</td>
<td>NS</td>
</tr>
<tr>
<td>Extent of CAD</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>One-vessel</td>
<td>50 (33)</td>
<td>42 (35)</td>
<td>7 (22)</td>
<td>NS</td>
</tr>
<tr>
<td>Two-vessel</td>
<td>51 (33)</td>
<td>38 (31)</td>
<td>13 (41)</td>
<td>NS</td>
</tr>
<tr>
<td>Three-vessel</td>
<td>52 (34)</td>
<td>39 (33)</td>
<td>12 (37)</td>
<td></td>
</tr>
<tr>
<td>Normal LV function</td>
<td>112 (73)</td>
<td>90 (74)</td>
<td>22 (69)</td>
<td>NS</td>
</tr>
<tr>
<td>TIA or stroke</td>
<td>13 (8)</td>
<td>6 (5)</td>
<td>7 (22)</td>
<td>.02</td>
</tr>
<tr>
<td>PVD</td>
<td>10 (7)</td>
<td>3 (2)</td>
<td>7 (22)</td>
<td>&lt;.0001</td>
</tr>
</tbody>
</table>

MI indicates myocardial infarction; LV, left ventricle; and NS, not significant.

TABLE 2. Distribution of Extracranial Cerebrovascular Disease

<table>
<thead>
<tr>
<th>Artery Involved</th>
<th>No. of Patients</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertebral artery</td>
<td>9</td>
<td>6</td>
</tr>
<tr>
<td>Common carotid artery</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>External carotid artery</td>
<td>19</td>
<td>12</td>
</tr>
<tr>
<td>Internal carotid artery</td>
<td>17*</td>
<td>11</td>
</tr>
<tr>
<td>Degree of internal carotid artery stenosis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>50–79%</td>
<td>8†</td>
<td>5</td>
</tr>
<tr>
<td>80–99%</td>
<td>5‡</td>
<td>3</td>
</tr>
<tr>
<td>100%</td>
<td>48</td>
<td>3</td>
</tr>
</tbody>
</table>

*Bilateral disease in 3 patients; †1 patient had bilateral disease; ‡1 patient had contralateral carotid occlusion; §1 patient had bilateral carotid occlusion.

Selected Abbreviations and Acronyms

- CAD = coronary artery disease
- ECCVCD = extracranial cerebrovascular disease
- ICA = internal carotid artery
- PVD = peripheral vascular disease
- TIA = transient ischemic attack

Results

Significant (≥50%) stenosis of ≥1 extracranial cerebral arteries was found in 32 patients (21%; Table 2). The lesions were located in the common carotid artery in 3 of 153 patients (2%), the ICA in 17 of 153 patients (11%), the external carotid artery in 19 of 153 patients (12%), and the vertebral artery in 9 of 153 patients (6%). Bilateral ICA stenosis was found in 3 patients (2%). Nine (6%) patients had ≥80% stenosis in one or both of the ICAs. The characteristics of patients with and without ECCVCD are shown in Table 1. Diabetes mellitus, hypertension, and a history of TIA, stroke, and PVD were significantly associated with the presence of ECCVCD.

Discussion

Many published series have reported on the differences in ECCVCD between whites and Orientals. An angiographic study in Japanese stroke patients showed that extracranial ICA lesions were less frequent and milder in Japanese than in Americans, whereas intracranial disease was more common in Japanese. Studies in Chinese patients with TIA or ischemic stroke have also reported a 9% to 30% prevalence of extracranial carotid disease, as opposed to 30% to 60% in white patients. An autopsy series in Hong Kong Chinese revealed extracranial carotid artery stenosis of ≥50% in 18% and total occlusion in 2% of the cases. This is much lower than the corresponding figures of 40% and 8% to 11% reported in two white population series. Small sample size and selection bias are major limitations of these studies. In addition, hemorrhagic strokes are often overrepresented in hospital-based series, because patients often present with more severe symptoms, such as headache, vomiting, and loss of consciousness. This is all the more important in developing countries, because patients with milder or transient symptoms tend to be turned away by overcrowded public hospitals or seek alternative treatment from herbalists and acupuncturists.

In our study, instead of performing another stroke or autopsy series we took a different approach to address the impression that ECCVCD is rare among Chinese. It has been well reported that ECCVCD is associated with CAD. In four studies in white patients on the prevalence of carotid artery disease among patients with CAD, significant (defined as ≥50%) ICA stenosis was found in 12% to 28% of the patients. When a definition of ≥80% was used, the prevalence of ICA stenosis was reported to range from 6% to 9%. In our study, we found a prevalence of 11% and 6% when ≥50% and ≥80%, respectively, were used to define significant ICA stenosis. Thus, the prevalence of significant ICA stenosis in our cohort is comparable with those reported in series examining white patients, and significant ECCVCD is definitely not rare among Chinese. This is in accord with two recent studies on patients of Asian origin that suggest a rising prevalence of...
ECCVD in Japanese and Taiwan Chinese stroke victims. Thus, severe extracranial ICA stenosis was found to be five times more prevalent in a recent cohort (1989 to 1993) compared with an earlier cohort (1963 to 1965) of Japanese ischemic stroke patients.\textsuperscript{25} In a recent study on Taiwan patients with cortical infarcts,\textsuperscript{27} ipsilateral ICA stenosis of $\geq 50\%$ was present in $32\%$ of the cases. This compares with the findings of two studies in white patients that $37\%$ of the patients with cortical infarcts\textsuperscript{26} and $41\%$ of those with nonlacunar infarctions\textsuperscript{28} had ipsilateral ICA stenosis of $\geq 50\%$. Increased affluence and westernization of lifestyles in our region could partly explain the rising prevalence of ECCVD in Chinese and Japanese.\textsuperscript{26} Another explanation is increased diagnosis and detection as a result of a lower threshold of presentation to and admission by hospitals in these countries, in turn resulting from improved public education and increased health spending.

Availability and improved treatment for ECCVD in these countries over the last two decades may have also played a part. All these factors could explain the rising prevalence of atherosclerotic disease in the extracranial cerebral arteries in Chinese. Among patients with CAD in our series, diabetes, hypertension, TIA/stroke, and PVD were identified as predictors of concomitant ECCVD. This is also in accord with two other studies that found TIA/stroke and PVD to be significantly associated with severe carotid stenosis.\textsuperscript{17,18}

**Limitations**

Duplex scanning is an accurate, noninvasive method for identifying significant carotid artery disease. A sensitivity of up to $95\%$ and specificity of up to $90\%$ have been reported.\textsuperscript{30–33} In our vascular laboratory, a peak systolic velocity of $\geq 1.25$ m/s as a cut point in identifying carotid artery stenosis of $\geq 50\%$ is associated with a sensitivity of $90\%$ and specificity of $95\%$. A peak systolic velocity of $\geq 1.4$ m/s as a cut point in identifying carotid artery stenosis of $\geq 80\%$ is associated with a sensitivity of $95\%$ and specificity of $95\%$. These figures were based on an analysis of 80 consecutive cases in which each patient had undergone both angiography and duplex scanning in our center.

Although the role of ultrasound in the assessment of vertebral artery disease is less well defined and the accuracy of duplex scanning in identifying vertebral artery disease is lower than that of carotid artery disease, sensitivities of $73\%$ to $76\%$ and specificities of $94\%$ to $97\%$ have been reported in two large series.\textsuperscript{21,24} In any case, the relatively poor sensitivity of duplex scanning in identifying significant vertebral artery disease could only have underestimated the true prevalence of ECCVD, further emphasizing that ECCVD in Chinese is not as rare as previously thought.

This study addressed only the prevalence of ECCVD among Chinese patients with CAD, not the prevalence in the general population or stroke population. Relatively few statistics are available on the prevalence of CAD in Chinese. Although the prevalence of CAD among Hong Kong Chinese has been reported to be lower than that in white populations,\textsuperscript{26} one autopsy series\textsuperscript{26} found the incidence of atherosclerosis among Hong Kong Chinese to be comparable with that in Western populations. Local cardiologists have also noted an increasing demand for coronary care units, coronary angiography, angioplasty, and surgery. For example, the demand for coronary angioplasty in Hong Kong (500 procedures per million population per year) is comparable with that in many European countries.\textsuperscript{17} Nevertheless, many patients who suffer stroke or TIA do not have concomitant CAD. Significant racial difference in the prevalence of ECCVD among stroke patients may still exist. Thus, caution should be exercised in generalizing these results to the general population.

In conclusion, in contrast to previous reports, we find that significant extracranial atherosclerotic cerebral arterial disease is not uncommon in Chinese patients with CAD. The prevalence of $21\%$ is comparable with those reported for white populations. This is in accordance with two recent studies\textsuperscript{26,27} in patients of Asian origin that suggest a rising prevalence of ECCVD in Japanese and Taiwan Chinese stroke victims. Among patients with CAD, clinical variables such as diabetes, hypertension, TIA, stroke, and PVD were predictive of concomitant extracranial cerebrovascular disease. These findings are also in accord with those reported in studies in white patients.

**References**


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