Cerebral Microembolism Detected by Transcranial Doppler During Cardiac Procedures

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Background and Purpose—Cerebral embolism with clinical sequelae may rarely complicate cardioversion and cardiac catheterization. Transcranial Doppler sonography has recently been introduced to monitor microemboli entering the middle cerebral artery in cardiac and carotid surgery. We therefore used this technique to evaluate the risk of asymptomatic embolism during common cardiac procedures.

Methods—Patients were monitored by transcranial Doppler while undergoing direct current cardioversion (n=15) and cardiac catheterization (n=17).

Results—Microemboli were detected in all patients having cardiac catheterization but in only 1 patient after cardioversion.

Conclusions—Microembolism occurred frequently during cardiac catheterization and rarely during cardioversion. It is not yet known whether this has clinical relevance. (Stroke. 2000;31:2508-2510.)

Key Words: cardiac catheterization ■ cardioversion ■ embolism ■ ultrasonography, Doppler, transcranial

Some common cardiac interventional procedures carry a risk of clinically obvious cerebral embolism. The risk may be high, as at the time of direct current cardioversion in the absence of anticoagulation, or low, as during cardiac catheterization or left ventricular angiography. The advent of transcranial Doppler sonography (TCD) has provided the means to record microemboli entering the middle cerebral artery, for example, during cardiac surgery, carotid endarterectomy, or angioplasty. In the case of coronary artery bypass surgery, there is evidence that such microembolism is related to evidence of cerebral impairment, as judged by the results of neuropsychological testing.

Current methodology does not permit ready distinction between gaseous and particulate microemboli, which may have a major bearing on the likelihood of clinical significance. We sought to assess the incidence of such embolism during cardiac catheterization and cardioversion to determine whether such procedures may carry a risk of subclinical cerebral complications.

Subjects and Methods

Patients about to undergo cardioversion (n=15) or cardiac catheterization (n=19) gave consent for TCD recordings from the middle cerebral artery through the temporal bone window. Recordings were made on an EME 4040 Pioneer system, recorded on video, and studied off-line as previously described. Microembolic events (MEE) were defined as high-intensity signals at least 3 dB above baseline.

Catheterization

TCD recordings were made throughout the procedure. Major physical events, such as insertion of a guidewire or its manipulation, were noted and timed by the observer supervising the TCD recording.

Direct Current Cardioversion

All subjects were anticoagulated with warfarin during the preceding 4 weeks, and all had therapeutic levels of anticoagulation at the time of attempted cardioversion. Patients were monitored for microembolic signals for 30 minutes before rhythm conversion, during the attempted change, and for the following 30 minutes. An additional 30-minute recording was performed 2 hours later.

Results

Cardiac Catheterization

Of the 19 patients recruited, the TCD recordings were unusable in 2 patients because of an inability to insonate the middle cerebral artery. Angiography was performed in all patients with injections into the aorta in 3, into the left ventricle in 12, and into coronary arteries or grafts in 16. Percutaneous transluminal coronary angioplasty (PTCA) was performed in 4 patients.

MEE were detected in all but 1 instance (Table). Angiography was accompanied by such signals in every case in which left ventricular injections were made, in 2 of 3 aortic injections, and in 14 of 16 coronary injections. PTCA was accompanied by MEE in all but 1 case, during inflation of the balloon in 2 cases, and during both inflation and deflation in 1 case. Microembolic signals were commonly recorded dur-
ing insertion or change of catheters (11/17), manipulation of the catheter tip in the aorta or left ventricle (7/12), any other manipulation of the catheter (6/17), and change of manifold or syringe (5/17). The number of signals recorded varied from zero to too numerous to count. The cases and number of signals recorded are shown in the Table. No patient suffered a neurological complication.

Direct Current Cardioversion

No microemboli were recorded before cardioversion. One patient’s recordings revealed 2 MEE: 1 at 4 minutes and 1 at 18 minutes after the onset of sinus rhythm. No others had any evidence of microembolization. Four patients remained in atrial fibrillation.

Discussion

This small study confirms previous research (eg, References 2 and 6) that cardiac catheterization, coronary angiography, and angioplasty are all accompanied by the presence of microembolic signals on TCD recordings. Whether these events have any detectable influence on cerebral function remains to be seen. In the case of coronary artery bypass graft with cardiopulmonary bypass, there is evidence that such emboli are causally linked to neuropsychological impairment after surgery that persists for up to 5 years.7,8 Although less data on the subject exist, carotid endarterectomy and angioplasty are both accompanied by similar microembolism, but there is little evidence of comparable cognitive impairment.9 Studies of neuropsychological function after catheterization appear warranted.

It is likely that most of the signals recorded during angiography consist of gaseous material, and Markus et al10 have shown that the rate of injection affects their numbers, in accord with that interpretation. The embolic signals caused by manipulation of the catheter or guidewire and during balloon-inflation of vessels are more likely to be solid and theoretically more likely to have pathological sequelae.

Cardioversion, by contrast, was only accompanied by microembolic signals in 1 case. This contrasts with the accepted risk of cerebral macroembolism in this clinical context. However, the entire period of clinical risk was not covered by continuous recordings. There was no instrumentation to cause trauma to the endothelium, nor were injections made. The conversion of atrial rhythm, however, was associated with rapid changes in the left atrium with the development of echo contrast, and this is when preformed atrial thrombus may dislodge and embolize. It seems possible that full anticoagulation, which all our patients received, successfully prevented the formation of atrial thrombus. This speculation may be verified by performing recordings during emergency procedures in which a number of patients may not be receiving anticoagulation treatment. The absence of MEE supports the success of this policy, although the conclusions are insecure because of the small sample size.

### Number of Presumed Microemboli Detected by TCD

<table>
<thead>
<tr>
<th>Patient</th>
<th>Diagnostic Procedure</th>
<th>Total No. of Emboli During Coronary Injections</th>
<th>Catheter and Guidewire Manipulation</th>
<th>Balloon Inflation/Deflation</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>LV, CA, PTCA</td>
<td>LV, 8</td>
<td>25</td>
<td>9</td>
</tr>
<tr>
<td>2</td>
<td>LV, CA</td>
<td>LV, multiple</td>
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<td>21</td>
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<tr>
<td>3</td>
<td>LV, CA</td>
<td>LV, 41</td>
<td>2</td>
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<tr>
<td>4</td>
<td>LV, CA</td>
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<td>12</td>
<td>17</td>
</tr>
<tr>
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<td>LV, CA</td>
<td>LV, 13</td>
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<td>19</td>
</tr>
<tr>
<td>6</td>
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<td>6</td>
<td>3</td>
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<td>8</td>
<td>5</td>
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<td>8</td>
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<td>...</td>
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<tr>
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<tr>
<td>17</td>
<td>LV, CA</td>
<td>LV, 13</td>
<td>0</td>
<td>19</td>
</tr>
</tbody>
</table>

Angiogram includes test dose. LV indicates left ventricle; CA, coronary artery.
If neuropsychological testing were to demonstrate subtle but definite impairments after cardiac catheterization and PTCA, the question of antithrombotic prophylaxis in these common procedures would be raised. However, Fischer et al\textsuperscript{2} were unable to demonstrate significant differences in the number of emboli detected during left heart catheterization when heparin and aspirin were used. The situation might prove a good test for newer antiplatelet agents.

References
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