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The Effect of STA-MCA Bypass on Regional Cerebral Blood Flow In Ischemic Foci

Wendy M. Robertson, PAC,*, K.M.A. Welch, MD,*, James R. Ewing, MS, James I. Ausman, MD, PhD,† and Fernando G. Diaz, MD, PhD†

The effect of STA-MCA bypass on regional cerebral blood flow (rCBF) is unclear. Since asymmetries of rCBF have previously been shown to identify the focus of maximal cerebral ischemia, a study was performed to assess the effects of surgical revascularization on rCBF in this focus. Sixteen candidates for STA-MCA bypass were studied preoperatively and postoperatively. The rCBF was measured by the 133Xenon inhalation technique with eight contralateral probe pairs. The probe pair with the maximal percentage difference in initial slope index (ISI) was identified and corresponded to the clinically involved hemisphere in 14 patients. Following surgery, the ISI increased in the region of maximal ischemia (from 36.0 ± 8.0 to 42.0 ± 9.0, p < 0.05), and the asymmetry of flow was reduced (from 16.8 ± 8.0 to 8.6 ± 9.8, p < 0.001). Hemispheric ISI and hemispheric asymmetry of ISI remained unchanged after surgery. The results suggest that STA-MCA bypass may effectively increase flow in a focus of ischemia/oligemia. The clinical significance of this improvement in rCBF must await further study. (Henry Ford Hosp Med J 1986;34:48-50)

In recent years, the extracranial to intracranial arterial bypass procedure has been widely performed in an attempt to improve cerebral perfusion in clinically selected cases of brain ischemia. The effect of the procedure on regional cerebral blood flow (rCBF) is, however, far from clear (1-3). Such studies are effectively performed using the Xenon inhalation technique (4), not only because it is noninvasive but also because it circumvents the problem, inherent with intraarterial injection techniques, of isotope delivery to brain in patients with carotid occlusion. We have shown this technique to be sensitive to clinically evident focal ischemia on the basis of a probe by probe analysis of regional probe pair asymmetries (5).

The purpose of this study was to assess the efficacy of the superficial temporal artery-middle cerebral artery (STA-MCA) bypass procedure in reversing focal areas of ischemia as measured by asymmetry of regional cerebral blood flow.

Methods and Clinical Material

Sixteen candidates for STA-MCA bypass, the majority of whom had a residual ischemic neurological deficit or history of transient ischemic attacks, were studied. Eight males and eight females, age 45 to 80 years (mean 64.3 years) were included. Nine patients had arteriographically demonstrated internal carotid artery occlusion, two patients had middle cerebral artery occlusion, and five had middle cerebral artery stenosis.

The rCBF was measured by the 133Xenon inhalation technique (4) with eight hemispheric probe pairs arranged around the patient’s head as shown in the Figure. CBF measures were obtained an average of six weeks before surgery and 12 weeks postoperatively. The initial slope index (ISI) (6) was used as an index of perfusion. The mean ISI in each of the 16 probes was calculated, as well as the mean hemispheric ISI in the operated and nonoperated hemispheres. The percentage difference in hemispheric blood flow and in each probe pair was calculated, and the probe pair with the maximal percent ISI difference was identified.

Postoperative arteriography results were available in 14 patients and demonstrated patency of the bypass in 13 patients and nonpatency in one patient.

Results

The probe of lowest ISI preoperatively was found in the hemisphere ipsilateral to the arteriographic lesion in 14 of the 16 patients studied. In these 14 patients, the mean hemispheric ISI in both the operated and nonoperated hemispheres did not change significantly postoperatively. Likewise, the percent difference in hemispheric blood flow was unchanged after surgery (Table 1). However, the probe of maximal asymmetry of regional blood flow was affected by surgery. The percentage difference in ISI in the maximally ischemic probe was reduced from 16.8 ± 8.0 to 8.6 ± 9.4 (p < 0.001, paired t-test). The regional flow (ISI) was significantly increased from 36.0 ± 8.0 to 42.0 ± 9.0 (p < 0.05) postoperatively (Table 2). The one patient with a nonpatent bypass also had an increase of CBF with a decrease in the asymmetry of the maximally ischemic probe.

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Table 1
Mean and Percentage Difference in Hemispheric ISI in Operated and Nonoperated Hemispheres

<table>
<thead>
<tr>
<th>Hemispheric ISI*</th>
<th>Preoperative</th>
<th>Postoperative</th>
<th>p†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operated hemisphere</td>
<td>41.0 ± 8.0</td>
<td>43.1 ± 9.0</td>
<td>ns</td>
</tr>
<tr>
<td>Nonoperated hemisphere</td>
<td>42.6 ± 8.0</td>
<td>44.8 ± 9.0</td>
<td>ns</td>
</tr>
<tr>
<td>Percent hemispheric difference</td>
<td>6.5 ± 5.1</td>
<td>6.6 ± 6.2</td>
<td>ns</td>
</tr>
</tbody>
</table>

*mean ± standard deviation
†paired t-test

Table 2
Mean and Percentage Difference in ISI in the Maximally Ischemic Regional Probe

<table>
<thead>
<tr>
<th>Maximum Ischemic Probe*</th>
<th>Preoperative</th>
<th>Postoperative</th>
<th>p†</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISI</td>
<td>36.4 ± 8.0</td>
<td>42.0 ± 9.0</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Percent difference in ISI</td>
<td>16.8 ± 8.0</td>
<td>8.6 ± 9.4</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

*mean ± standard deviation
†paired t-test

Discussion

The 133Xenon intraarterial injection technique of measuring rCBF has limitations in the delivery of isotope to an area of brain supplied by an occluded artery. Schmiedek et al (7) demonstrated an improvement in rCBF after STA-MCA bypass by this method, using selective injection of the external carotid artery or the contralateral internal carotid artery. The 133Xenon inhalation technique employed in the present study is more effective in assessing the full effect of all sources of collateral supply to the clinically involved hemisphere. Previous studies using this technique (1,3) have demonstrated bilateral increases in CBF following STA-MCA anastomosis. De Weerd et al (8) noted an increase in hemispheric blood flow in five of ten patients undergoing surgery with a decrease in hemispheric asymmetry in eight patients.

No effect was found on overall hemispheric CBF in either the operated or nonoperated hemispheres. Mean flow values may be less sensitive to focal ischemic cerebrovascular disease (CVD) since decreases have been observed with aging and with elapsed time postoperatively in surgical patients (3). We contend that asymmetries of flow are more sensitive to the presence of occlusive disease (9) and, as this study demonstrates, also to the reestablishment of flow through surgical revascularization.

The results of this study suggest that STA-MCA bypass surgery is effective in increasing CBF in a focal area of maximal ischemia. However, the one patient with a nonpatent bypass also showed improvement in flow, introducing the reservation that CBF may increase with time-elapsed poststroke (1). Although the clinical correlation of post-surgical blood flow changes is not considered in this study, it has not shown a relationship to focal changes in other studies (10). The multicenter controlled trial of STA-MCA bypass, confined to clinically selected patients, failed to demonstrate a significant benefit (11). Positron emission tomography studies have revealed changes in the oxygen extraction fraction in a subgroup of surgical candidates (12,13). Further study of surgical candidates with demonstrated focal asymmetries of rCBF, in combination with perturbations of glucose metabolism and oxygen utilization and/or high-energy phosphate metabolism measured by PET scanning or NMR spectroscopy, respectively, may aid in defining a group of patients who will benefit clinically from surgical intervention.

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References


