Cerebral Haemodynamic Aspects of Severe Carotid Stenosis: Asymptomatic vs Symptomatic

G. Lucertini*, D. Ermirio and P. Belardi

Vascular Surgery, Università degli Studi di Genova, Genova, Italy

Objectives: to compare cerebral haemodynamics in patients with asymptomatic and symptomatic severe (>70%) internal carotid artery (ICA) stenosis.

Methods: we assessed 195 consecutive patients, 116 with asymptomatic carotid stenosis (ACS) and 79 with symptomatic carotid stenosis (SCS). Using transcranial Doppler we assessed cerebral vasoreactivity (CVR) following acetazolamide test, the middle cerebral artery flow velocity ratio after/before carotid clamping (mv-MCA ratio), and the carotid back pressure (CBP) during crossclamping.

Results: no significant differences between the two groups were demonstrated regarding CVR (47 vs 39%), mv-MCA ratio (50 vs 52%), or CBP (36 vs 44 mmHg). However, in patients with contralateral ICA occlusion all three variables were significantly lower as compared to patients with patent contralateral ICA. Also patients who needed a shunt during surgery had significantly lower values of mv-MCA ratio and CBP. Patients who suffered peri-operative neurologic deficits (n = 6; 3%) did not differ from patients who had an uneventful course.

Conclusions: clinical state of ICA stenosis is independent of cerebral haemodynamics. Occluded contralateral ICA is more important for predicting cerebral ischaemia caused by carotid clamping. Finally, none of the haemodynamic parameters showed predictive value for peri-operative neurologic morbidity.

Key Words: Carotid stenosis; Carotid endarterectomy; Cerebral vasoreactivity; Transcranial Doppler; Back pressure.

Introduction

It is generally believed that in both symptomatic and asymptomatic patients with carotid artery disease the risk of stroke is most closely related to the degree of stenosis.1–6 However, other factors such as cerebral haemodynamics may be important in determining whether a particular pattern of extracranial arterial disease lead to symptoms.

We investigated patients with severe internal carotid artery (ICA) disease in order to compare asymptomatic and symptomatic stenoses with regards to cerebral haemodynamics.

Patients

We studied a consecutive series of 195 patients (144 males, median age [range] 69 [49–81]) with >70% carotid stenosis on duplex scanning between October 1998 and December 2001.

* Please address all correspondence to: G. Lucertini, Cattedra di Chirurgia Vascolare, Università degli Studi di Genova, Largo Rosanna Benzi, 8, 16132 Genova, Italy.

Based on examination by a neurologist, patients were separated in two groups:

- 116 patients, 85 males and 31 females, with 119 (59%) asymptomatic carotid stenoses (ACS), and
- 79 patients, 70 males and 9 females, with 81 (41%) symptomatic carotid stenoses (SCS), consisting of 61 cases with previous transient ischaemic attacks, 13 with previous amaurosis fugax, 7 with minor stroke.

Methods

By transcranial Doppler (TCD) middle cerebral artery mean flow velocity (mv-MCA) was monitored continuously during carotid surgery in patients with an acoustic temporal window (189 cases, 94%), using a 2 MHz probe of the TCD (EME TC2-64, Germany). In order to calculate mv-MCA ratio, we related the flow velocity before to the value after clamping. Using the same TCD machine we also assessed the ability of the cerebral vascular system to increase the blood flow after applying vasodilating stimuli, achieved by
i.v. administration of the carbonic anhydrase inhibitor, acetazolamide (Diamox). Acetazolamide was not administered to patients who were allergic to sulfonamides (among which acetazolamide) or who suffered from severe heart disease, severe liver disease, chronic renal insufficiency, or electrolyte or acid-base disturbances. The cerebral reactivity (CVR) was expressed as the percentage mv-MCA increase 20 min after intravenous administration of 1 g of acetazolamide in 178 (89%) cases.

The surgical procedure was carried out under regional/local anaesthesia. Shunting was used when a neurological event (unconsciousness or focal neurological deficit) was observed. Based on these criteria, carotid shunt (Pruitt-Inahara shunt model 400-40-8F, produced by Ideas for Medicine, U.S.A) was employed in 18/200 (9%) cases, of whom 9/119 (8%) were asymptomatic and 9/81 (11%) were symptomatic. ICA back pressure (CBP) during carotid crossclamping was determined in all cases.

Statistics

Asymptomatic and symptomatic patients were compared to evaluate differences related to gender, age, heart disease, hypertension, diabetes, and occlusion of the contralateral internal carotid artery. There was no statistical difference (using Chi-squared test for comparison of percentages, and using Mann–Whitney $t$-test for comparing the two groups) among the parameters (Table 1).

Groups were compared with regards to, CVR, mv-MCA ratio%, and CBP using Mann–Whitney $t$-test, and statistical significance was accepted at the 1% level.

Results

As shown in Table 2, no significant differences were found between the ACS and SCS groups with regards to CVR, mv-MCA ratio, or CBP.

<table>
<thead>
<tr>
<th>Table 1. Data regarding the asymptomatic carotid stenosis and the symptomatic carotid stenosis groups.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asymptomatic patients</td>
</tr>
<tr>
<td>n = 116</td>
</tr>
<tr>
<td>Cases</td>
</tr>
<tr>
<td>Gender – males : females</td>
</tr>
<tr>
<td>Age – median (range)</td>
</tr>
<tr>
<td>Heart disease</td>
</tr>
<tr>
<td>Hypertension</td>
</tr>
<tr>
<td>Diabetes</td>
</tr>
<tr>
<td>Contralateral internal carotid artery occlusion</td>
</tr>
</tbody>
</table>

There were significant differences between the subgroup with contralateral patent ICA and the one with contralateral occluded ICA with regards to CVR (16–100%, median 36, vs 10–100%, median 52, $p < 0.01$), mv-MCA ratio (0–81%, median 35, vs 0–100%, median 64, $p < 0.01$), and CBP (10–62 mmHg, median 33, vs 0–140 mmHg, median 65, $p < 0.01$).

When we compared the shunted subgroup to the non-shunted one, we found a significant difference with regards to mv-MCA ratio (0–62%, median 8, vs 0–100%, median 67, $p < 0.01$) and CBP (0–60 mmHg, median 35, vs 0–140 mmHg, median 64, $p < 0.01$), but not to CVR (20–65%, median 36, vs 3–160%, median 51, $p > 0.02$).

Peri-operative neurologic complications occurred in 6/200 (3%) cases: three patients presented transient ischaemic attacks and the other three had minor strokes with almost complete recovery. There were no significant differences between the complicated subgroup (6 cases) and the uncomplicated one (194 cases) with regards to CVR (25–78%, median 38, vs 10–100%, median 45, $p = 0.63$), mv-MCA% (0–72%, median 42, vs 0–100%, median 50, $p = 0.38$), and CBP (0–68 mmHg, median 44, vs 0–140, median 44, $p = 0.91$).

Discussion

Yonas et al.8 and Webster et al.9 showed an increased risk of stroke in symptomatic patients with compromised CVR. Gur et al.10 pointed out that ACS patients with impaired CVR (less than 40%) were also more subject to ischaemic cerebral events.11

Several parameters can be employed to evaluate the cerebral haemodynamic characteristics of carotid stenosis12–19.

We used CVR, mv-MCA ratio, and CBP because of their pathophysiologic significance, value, and reliability.

Our observations agree with those of Nighoghossian et al.20 who evaluated three small groups

G. Lucertini et al.
Based on findings of the acetazolamide test alone, they concluded that there is no statistical difference between asymptomatic and symptomatic carotid stenosis. Taking into consideration three haemodynamic parameters in two large series, we were not able to find any significant differences between asymptomatic and symptomatic severe carotid stenosis. Our study is different from the two previous ones in that it includes all consecutive cases of asymptomatic and symptomatic stenosis.

We observed wide ranges of values for the haemodynamic parameters in both groups. This means that the haemodynamic conditions of the severe carotid stenosis might vary a great deal, and this variability does not depend on the clinical state (asymptomatic and symptomatic).

Based on this observation, we would like to stress that carotid stenosis shows exactly the same problems regarding cerebral tolerance during temporary carotid occlusion regardless of the clinical state, whether asymptomatic or symptomatic. Therefore, the risk of cerebral ischaemia during carotid endarterectomy (CEA) is the same for both asymptomatic and symptomatic stenosis patients.

We would like to emphasise that the haemodynamic parameters showed significant differences between the subgroup with patent contralateral ICA and the one with occluded contralateral ICA. Therefore, we must take occlusion of the contralateral ICA into account as a risk factor for cerebral ischaemia caused by carotid clamping during CEA according to previous observations by other authors. Taking into consideration three haemodynamic parameters, we were not able to find any significant differences between asymptomatic and symptomatic carotid stenosis.

Finally, none of the evaluated haemodynamic parameters showed predictive value for peri-operative neurologic complications.

References


Accepted 5 March 2002