Diagnostic and therapeutic alternatives in patients with symptomatic "carotid occlusion" referred for extracranial-intracranial bypass surgery

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An increasing number of patients with symptomatic carotid artery occlusion are being referred for extracranial to intracranial bypass grafts. After careful clinical and angiographic assessment, a number of these patients have been treated with a direct approach to the carotid arteries in the neck or with anticoagulation rather than with a bypass graft. These patients may be categorized diagnostically under the following headings: 1) complete occlusion of the internal carotid artery (ICA) with intracranial patency; 2) spontaneous dissection of the ICA; 3) atheromatous pseudo-occlusion; 4) carotid artery occlusion with stenosis of the contralateral ICA; 5) occlusion of the ICA and stenosis of the external carotid artery; and 6) thrombus in the intracranial segment of an occluded ICA. Each of these categories is discussed briefly, and illustrative cases are presented.

KEY WORDS • carotid artery occlusion • spontaneous carotid dissection • extracranial-intracranial surgery • anastomosis • transient ischemic attack • cerebral ischemia • internal carotid artery • endarterectomy

EXTRACRANIAL to intracranial (EC-IC) bypass operations are being performed with increasing frequency. The precise indications and the long-term value of these procedures, however, remain under study. For this reason, more established therapeutic alternatives may be preferable in many patients referred for EC-IC bypass grafts.

We describe and categorize a number of patients referred for bypass surgery with an initial diagnosis of symptomatic occlusion of the internal carotid artery (ICA). The patients presented with the following disorders: 1) complete occlusion of the ICA with intracranial patency; 2) spontaneous dissection of the ICA; 3) atheromatous pseudo-occlusion; 4) carotid artery occlusion with stenosis of the contralateral ICA; 5) occlusion of the ICA with stenosis of the external carotid artery (ECA); and 6) thrombus in the intracranial segment of an occluded ICA. A representative case from each category is described. After detailed preoperative studies, these patients were managed by endarterectomy or anticoagulation.

Complete Occlusion of the ICA with Intracranial Patency

Case 1

This 70-year-old man had an episode of left hemiparesis which resolved partially, leaving only mild residual weakness of the left side of the face and the left hand. Over the next 3 months, he had multiple episodes of amaurosis fugax in the right eye. An arteriogram performed at another hospital showed complete occlusion of the right ICA, and he was referred to our service for an EC-IC bypass.

Subtraction of the original films showed that patency of the intracranial portion of the ICA was maintained through external carotid collateral vessels (Fig. 1). The patient underwent a carotid endarterectomy with Fogarty catheter embolectomy and has been free of transient ischemic attacks (TIA's) since the operation 3 years ago. Postoperative noninvasive studies have indicated patency of the operated vessel.
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FIG. 2. Case 2. Right common carotid arteriograms. Left: The right ICA is occluded. Note the relatively normal bifurcation with gradual tapering of the internal carotid artery (ICA, arrow). This is the typical "post sinus occlusion" seen in some cases of spontaneous dissection. Right: Six weeks after the initial study shown left, there is complete resolution of the dissection with restitution of the normal caliber of the lumen of the ICA.

FIG. 1. Case 1. Preoperative right common carotid arteriogram showing complete occlusion of the right internal carotid artery (ICA, large arrow). The intracranial portion of the right ICA is patent down to the petrosal canal (small arrows).

Comment

There is a high probability of reestablishing flow by endarterectomy in a "chronically" occluded ICA when there is angiographic demonstration of patency of the intracranial portion of the ICA at least down to the petrous canal. In these cases, it appears that small branches of the ICA, such as the carotico-tympanic and pterygoid arteries, develop sufficient anastomotic connections with branches of the ECA to keep the intracranial portion of the ICA patent. In many of these cases, the ICA distal to the plaque is found at operation to be collapsed or to contain a fibrous clot that extends only to the base of the skull, and can be extracted easily by suction or by careful use of a Fogarty catheter. This technique carries a small risk of producing a carotid-cavernous fistula or dislodging distal thrombus with resulting embolism, but with some experience the rate of complications is low.

We have managed four other patients in this manner. In three, we were successful in reestablishing flow. One of these three patients had a severe, acute, completed stroke, which worsened significantly after surgery as a result of cerebral edema. The other two patients had mild to moderately severe acute neurological deficits preoperatively. One patient improved markedly and the other was unchanged by surgery.

Spontaneous Dissection of the ICA

Case 2

This 42-year-old man presented to another hospital complaining of a severe right-sided headache which developed while he was driving. He was able to drive to work, but as soon as he tried to walk, he found himself staggering. A co-worker pointed out that his right eye was "droopy." He then had a spell of numbness of the left hand, which resolved on his way to the hospital. During the next week, he had several spells of numbness of the left upper extremity and several spells of amaurosis fugax of the right eye at different times. An arteriogram showed a complete occlusion of the right ICA, and he was referred as a candidate for EC-IC bypass.

On examination, we found that he had a Horner’s syndrome on the right side and tenderness on the right side of the neck. There was no bruit. These findings and a review of the arteriogram (Fig. 2 left) suggested
that he had suffered a spontaneous carotid dissection. He was given a course of anticoagulant drugs for 6 weeks, at which time a second arteriogram showed complete resolution of the dissection (Fig. 2 right). The anticoagulants were stopped, and he has been free of symptoms for the last 2½ years.

Comment

The first report of spontaneous carotid dissection was probably by Anderson and Schechter in 1959. In 1972, Ojemann and co-workers presented a case treated successfully by surgical intervention. Later, Ehrenfeld and Wylie described 10 patients treated surgically, but they also observed seven other patients who did well without surgery. In six of these, a subsequent arteriogram showed improvement in the caliber of the artery. Subsequently, others have also described the frequent improvement in the arteriographic appearance of dissections with time, and have emphasized the relatively benign natural history of this condition in those patients who do not present with a massive stroke. It has been suggested that recurrent transient symptoms or small strokes in these patients are frequently due to embolization. Some patients have been managed successfully by anticoagulation, but, as stated earlier, other patients have done well with no treatment at all.

The typical angiographic features of spontaneous carotid dissection range from the classical "string sign" to a small "telltale" pouch just distal to the bifurcation in an otherwise normal-appearing artery. Other typical angiographic appearances include long irregular narrowing with scalloped edges, a distal aneurysmal pouch usually at about the level of C-1 and a "post sinus" tapering occlusion such as was found in our patient. Common to all the "typical" angiographic appearances of dissection is the fact that the origin of the ICA is spared. The dissection usually starts about 1 to 3 cm distal to the bifurcation and ends at the base of the skull, with an abrupt return to normal caliber and appearance at the entrance of the petrous canal.

Two other patients with spontaneous dissection of the carotid artery have been treated recently in our service. Their initial arteriograms showed a typical "string sign." Both presented with TIA's, and one had, in addition, a mild fixed neurological deficit. Both patients were treated with anticoagulant agents and had repeat arteriography about 6 weeks after the initial study. In one patient, the ICA has progressed to complete occlusion; in the other patient, the artery's caliber had returned to almost normal. The anticoagulants were stopped after the second arteriogram, and both patients have been symptom-free for at least a year.

Atheromatous Pseudo-Occlusion

Case 3

This 62-year-old man presented after two prolonged but reversible spells of left-sided numbness and weakness. He was referred to us after an arteriogram revealed a "complete occlusion" of the right ICA. A review of the late films of the lateral skull series showed a slowly advancing column of dye flowing in an anterograde fashion in the ICA to finally reach the supraclinoid portion of the ICA that had already filled in a retrograde fashion from ophthalmic collateral vessels (Fig. 3). The patient underwent a routine carotid endarterectomy and has been symptom-free during a short follow-up period.

Comment

Recently we reported three other patients who were thought to have a complete occlusion at the origin of the ICA on their initial arteriograms. After reviewing the late films of the initial or of a repeated angiographic study, it was noted that there was a trickle of blood going through the bifurcation in anterograde fashion and, therefore, the occlusion was incomplete. These patients were relieved of their TIA's by endarterectomy of the involved ICA. Flow was reestablished in each case. The term "atheromatous pseudo-occlusion" was suggested to distinguish this entity from other forms of "pseudo-occlusion." Countee and Vijayanathan reported on a similar group of patients. Both of these reports emphasized specialized angiographic techniques that allow better recognition of the phenomenon of "incomplete" or "almost complete" occlusion of the ICA.

Carotid Occlusion with Stenosis of the Contralateral ICA

Case 4

This 57-year-old man presented after several episodes of transient worsening of a speech deficit. He had had a stroke 3 years before admission that had left him with a moderately severe right-sided hemiparesis and dysphasia. Angiography showed complete occlusion of the left ICA and severe stenosis of the right ICA at its origin. The right ICA provided most of the flow to the left middle cerebral artery (MCA) through a large anterior communicating artery. He was referred for an EC-IC bypass. A right carotid endarterectomy was carried out, and he has remained free of his intermittent symptoms for about 2 years.

Comment

There is some evidence that suggests an increased risk in performing an endarterectomy when the opposite ICA is occluded. The data from the Joint Study of Extracranial Arterial Occlusion indicates that about 43% of the patients in this category either died or had a severe stroke. A number of these patients, however, were operated on after a recent severe stroke, and several underwent surgery to reopen the occluded artery. In this study, only 10 patients had
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Fig. 3. Case 3. Preoperative right common carotid arteriograms. Left: Late film. A column of dye can be seen in the usual position of the internal carotid artery (ICA, black arrows). There is retrograde opacification of the supraclinoid portion of the right ICA (open arrow). Right: Two seconds later, the column of dye seen (left) has joined the previously opacified portion of the ICA (arrow), thus demonstrating patency of the entire right ICA.

TIA's alone, and had an endarterectomy of the stenotic artery with no attempt made to reopen the occluded artery. In this group, there was no death or serious neurological morbidity. Recently, Patterson reported 23 patients with a completely occluded carotid artery who underwent endarterectomy of the opposite, stenotic carotid artery. There was no operative morbidity or mortality. Other authors also report an acceptably low rate of complications under these circumstances.

In a thoughtful editorial summarizing surgical indications in stroke patients, Fields recommended endarterectomy on the stenotic side in patients with contralateral carotid occlusion and transient symptoms. We agree with this recommendation, provided that there is angiographic evidence that the cerebral hemisphere or the eye responsible for the symptoms is primarily supplied by the stenotic vessel. If symptoms recur in spite of a technically successful endarterectomy, EC-IC bypass could be considered.

Occlusion of the ICA with Stenosis of the ECA

Case 5

Seven months prior to admission to another hospital, this 66-year-old man had a 4-hour episode of right hemiparesis and aphasia. After this episode, he had multiple attacks of amaurosis fugax on the left. An arteriogram showed complete occlusion of the left ICA with severe stenosis of the left ECA (Fig. 4 left). There was retrograde filling of the left ophthalmic...
artery by external carotid collateral vessels. He was referred as a candidate for EC-IC bypass. A left external carotid endarterectomy was performed, and he has been asymptomatic for 1 1/2 years. Postoperative arteriography showed a normal ECA lumen (Fig. 4 right).

Comment

Several series of ECA endarterectomy performed in patients with ICA occlusion are reported, mostly in the general surgical literature. In most of these articles, the clinical and angiographic indications for surgery are not described clearly. A recent paper by Countee and Vijayanathan describes 23 carefully studied patients with ICA occlusion. Eleven of these patients underwent ECA endarterectomy. These authors emphasize the importance of careful angiographic techniques to ascertain the pattern of collateral supply to the brain and eye. They recommend ECA endarterectomy only when there is angiographic demonstration of supply to the symptomatic region by external carotid branches. Our indications for ECA endarterectomy are similar to those listed by these authors.

Various operative techniques for ECA endarterectomy have been described. We believe that complete removal of the plaque from the ICA as well as from the ECA is essential to insure a smooth closure of the origin of the ICA flush with the common carotid.

Thrombus in the Intracranial Segment of an Occluded ICA

Case 6

This 59-year-old man underwent a left carotid endarterectomy because of left hemispheric TIA's. Three months later, he suddenly developed severe expressive aphasia and weakness of the face and arm on the right side. At the time of admission, 4 hours later, he was improving rapidly. Arteriography showed complete occlusion of the left ICA at the site of the previous endarterectomy. The right carotid injection showed excellent filling of all of the left MCA territory through a large anterior communicating artery. A small amount of reflux into the distal portion of the left ICA outlined an intraluminal thrombus (Fig. 5). The patient was considered for an EC-IC bypass but, in view of the angiographic findings, we decided to treat him with anticoagulant drugs and contemplate the operation only if his symptoms recurred. His deficit cleared over the next few days. Anticoagulants were discontinued after 6 months, and he has remained asymptomatic.

Comment

We have not found a similar case in the literature. In discussing hemorrhagic complications of EC-IC procedures, we described another case of a patient with symptomatic occlusion of the ICA who underwent an EC-IC bypass and developed a hemorrhagic infarct 2 days after the procedure. Retrospectively, a thrombus was identified in the intracranial portion of the occluded ICA, and it was postulated that the postoperative stroke was possibly due to embolism from that source.

Discussion

In addition to the specific situations illustrated above, there is another group of patients, recently described by Barnett and his associates, with symptoms referable to a redundant or ulcerated "stump" of the ICA. These patients have ischemic symptoms in the area of supply of the occluded ICA. Arteriography demonstrates a large stump, which sometimes is irregular or ulcerated. When there is an obvious route of embolization via the ECA to the symptomatic eye or hemisphere, obliteration or resection of the stump is recommended. Seven of Barnett's nine patients were treated successfully by ligation of the stump and by common and external endarterectomy when indicated.

The patients we have described in this report have had symptoms in the ICA territory sometime after occlusion of the ICA was known or was presumed to have occurred. In general, we have not considered surgery in patients who have a completed stroke or a single reversible ischemic event and are found to have an occluded ICA unless their symptoms recur. An ex-
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dition that patients who tolerate carotid occlusion initially without a major deficit have a relatively low incidence of recurrent symptoms related to that hemisphere.18,28 When recurrent ischemia does occur distal to an occluded ICA, the available arteriograms should be studied carefully to try to identify cases of incomplete carotid occlusion which, in our opinion, should be treated by endarterectomy. In other cases, the arteriograms may suggest that the apparent occlusion is due to spontaneous dissection, in which case anticoagulant therapy may be considered.

When a lesion, such as contralateral carotid stenosis, external carotid stenosis, or a redundant stump of the ICA, is seen, a direct surgical approach should be considered if there is angiographic demonstration of blood supply from the area of the lesion to the symptomatic eye or hemisphere. When there is angiographic demonstration of a thrombus or ulcerated plaque in the intracranial portion of the occluded ICA, anticoagulation should be considered if the symptoms appear to be due to embolism.29 When the available arteriograms are incomplete or of suboptimal quality, it may be preferable to repeat them. In addition, the arteriograms should be repeated if the available study is not recent. There are many reports in which "recanalized" occlusions and changes in collateral supply seen on repeat arteriograms can make a contemplated form of treatment no longer rational.1,12,16,25,26,29,31,41,44,46 Cerebral blood flow determinations, noninvasive directional Doppler studies, and dynamic palpation of facial pulses are additional studies that can supplement the arteriograms and help to delineate the patterns of collateral circulation.

The effectiveness of the EC-IC procedure is still under study. There is suggestive evidence of its value in reducing the frequency of TIA’s, but there is as yet no conclusive proof of this operation’s ability to reduce the incidence of stroke or death from cerebrovascular disease.30,31 Reichman32 has discussed in detail the complications of EC-IC procedures, and Samson and Boone33 have recently reviewed several large series by experienced microsurgeons. This latter review indicated that EC-IC bypass procedures carry an average mortality rate of 4.3%, and a 2.4% risk of serious neurological complications. The total morbidity of the operation was approximately 20%, of which about one-half were serious complications and the rest were minor wound problems or transient neurological deficits. Unless further experience indicates a significant reduction in morbidity, EC-IC bypass procedures should be considered only when more conventional therapeutic alternatives are not available. Even then, we prefer to recommend this operation only within the framework of a randomized multicenter study until its value is well established.

References


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