Internal carotid artery stump angioplasty for the treatment of cerebrovascular occlusive disease

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Nineteen patients underwent a total of 21 stump angioplasty procedures for an occluded internal carotid artery. Indications for surgery included the preparation of the donor vessel for a subsequent extracranial-intracranial bypass procedure, the occurrence of emboli to the intracranial vasculature from the external carotid artery circulation, and the association with symptomatic occlusive disease of the external carotid artery accompanying occlusion of the ipsilateral internal carotid artery.

The technique utilized and the results obtained in these 19 patients are presented. In select patients, the removal of an occluded internal carotid artery stump via a stump angioplasty is beneficial in preventing the catastrophic sequela of embolic cerebrovascular disease.

KEY WORDS: stump angioplasty □ bypass procedure □ carotid artery □ carotid endarterectomy □ transient ischemic attack

THE external carotid artery (ECA) is an infrequent source of emboli entering the cerebrovascular system. It is not usually thought of as such a source, and hence is not often implicated in cerebrovascular disease. We are presenting a series of 19 patients who underwent stump angioplasty of an occluded internal carotid artery (ICA); these cases demonstrate the usefulness of the operation, the techniques employed, and the results obtained.

Clinical Material and Methods

Patient Population

This series of patients were selected for surgery because they had cerebrovascular disease combined with: 1) symptoms suggestive of embolic phenomena ipsilateral to an occluded ICA with at least a 5-mm arterial stump (four patients); 2) symptoms suggestive of hypoperfusion phenomena in preparation for an extracranial-intracranial (EC-IC) bypass procedure in the presence of an occluded ICA with at least a 5-mm stump (nine patients); 3) a stenotic ECA and an occluded ICA with at least a 5-mm stump in patients who were exhibiting either hypoperfusion or embolic phenomena ipsilateral to the diseased vessels (five patients); or 4) an occluded ICA and common carotid artery (CCA) with at least a 5-mm stump on the ICA in preparation for a reversed saphenous vein interposition graft from the subclavian artery to the ECA (one patient).

Operative Technique

In all cases stump angioplasty was performed through a diagonal incision along the anterior border of the sternocleidomastoid muscle. The CCA, ICA, and ECA were isolated, and 7500 U heparin was infused intravenously. A temporary ligature was placed around the superior thyroid artery, and vascular clamps were positioned on the ECA above all palpable atherosclerotic disease and on the CCA approximately 4 cm below the bifurcation. Precautions for maintaining intraoperative cerebral protection were followed in a similar manner to those used in ICA endarterectomy procedures, since some patients derive substantial intracranial flow from the ECA.

An arteriotomy was then made at the base of the ICA and carried circumferentially around the entire artery in such a way as to allow for the preservation of enough back wall of the vessel to supply a flap for the ventral aspect of the arteriotomy. The specifics of the operation are illustrated and described in Fig. 1.

Thickened atherosclerotic plaque was usually involved at the bifurcation of the CCA. If the plaque does
Fig. 1. Illustration of the internal carotid artery (ICA) stump angioplasty surgical procedure described here. ECA = external carotid artery; CCA = common carotid artery; STA = superior thyroid artery. A: The occluded ICA is noted, with its stump. B: In order to remove the stump from the circulation, an incision is made on the front wall of the ICA at the bifurcation point. C: If a simultaneous external carotid endarterectomy is indicated, an extension of the incision at its superior apex is made up the ECA. This extension is made over the anterior surface of the vessel in order to facilitate ease of closure. D: Next, an incision through the posterior wall of the ICA (dotted line) is made in a manner that will ensure that there is sufficient vessel for closure without constricting the lumen. This requires a moderate flap, which may have to be cut to fit after the ICA has been removed from the immediate field. The location of the posterior wall incision (dotted line) is exposed by retraction of the anterior wall of the ICA at its base. E: The ICA is then separated from the CCA-ECA complex. F: Both the arteriotomy at the CCA-ECA junction and the stump of the ICA are then sutured with 5-0 or 6-0 Prolene. G: If a simultaneous ECA endarterectomy is performed, the arteriotomy is closed in one section.

Operative Results

All patients in this series underwent stump angioplasty of an occluded ICA with angiographic postoperative patency and minimal or no luminal encroachment (Fig. 2). Four patients underwent surgery for symptoms suggestive of embolic phenomena ipsilateral to an occluded ICA with at least a 5-mm stump. All patients in this group underwent stump angioplasty without endarterectomy. One of these patients had previously undergone placement of an EC-IC bypass and it was thought that emboli from the stump of his occluded ICA were entering the intracranial circulation via the bypass graft. Another of these patients underwent stump angioplasty for the treatment of embolic symptoms 1 year after an EC-IC bypass procedure which was performed for hypoperfusion transient ischemic attacks (TIA's). The embolic TIA's were clearly different from those noted prior to placement of the EC-IC bypass and did not occur until 1 year after the initial procedure. The two remaining patients in this group who experienced TIA's of embolic nature had an ICA stump and a contribution of intracranial flow from the ECA circulation. One of these two patients was noted to have an angiographic filling defect in the ICA stump (Fig. 2 upper left). This filling defect was confirmed on a real-time ultrasonic sector scan (Fig. 2 lower) and at surgery. Preoperative ischemic symptoms were eliminated in all patients in this group.

Nine patients underwent a total of 10 stump angioplasties for symptoms suggestive of hypoperfusion phenomena; this procedure was performed in preparation for placement of an EC-IC bypass in the presence of an occluded ICA with at least a 5-mm stump. Five stump angioplasties were performed without an accompanying ECA endarterectomy and five were combined with an endarterectomy. Preoperative symptoms were eliminated or substantially reduced in eight of the nine patients. The TIA's in one patient were not altered by the EC-IC bypass procedure.

There were five patients who underwent stump angioplasty for a stenotic ECA and an occluded ICA with at least a 5-mm stump, in whom either hypoperfusion or embolic phenomena ipsilateral to the diseased vessel was suspected. In each patient an ECA endarterectomy was performed at the same operation as the stump angioplasty. A single patient in this group underwent surgery for a high-grade ICA stenosis. On the basis of coexisting medical problems it was decided to delay surgery (a planned ICA endarterectomy) for 1 month. At the time of surgery, the ICA was noted to be occluded and modest attempts at reestablishing flow with a Fogarty catheter were unsuccessful. A stump angioplasty...
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plasty was, therefore, performed with an ECA endarterectomy. All patients in this group noted resolution of their preoperative symptoms.

Finally, one patient underwent bilateral stump angioplasties for an occluded ICA and CCA on both sides; these procedures were undertaken in preparation for reversed saphenous vein interposition grafts from the subclavian artery to the ECA. Surgery on the right and left sides was separated by 1 week. Preoperatively, the patient experienced TIA’s due to hypoperfusion in the posterior circulation. Complete resolution of these symptoms and an improved sense of well-being was noted after the two operations.

No neurological sequelae were observed in this series except for the case in which new TIA’s occurred 1 year postoperatively and in the case where the TIA’s failed to resolve following a stump angioplasty and an EC-IC bypass placement. The TIA’s recurring in the first of these two patients were, most likely, not of the same origin as those noted preoperatively. Other complications were minimal and local in nature.

**Discussion**

External carotid artery endarterectomy has been shown to be effective in treating select cases of occlusive cerebrovascular disease. Mirfakhraee, et al., demonstrated the efficacy of transluminal angioplasty of the ECA in cases of cerebrovascular insufficiency. Few authors have discussed the stump of the occluded ICA as a pathological entity. Although Barnett, et al., considered that the size of the stump was an important factor in determining the need for an angioplasty, we noted no correlation with the size of the stump and our patients’ symptoms; however, we did not encounter any symptomatic patients with an ICA stump of less than 5 mm in length. We therefore used this minimum dimension as one of our criteria for surgery.

Schuler, et al., suggested that an EC-IC bypass following an ECA endarterectomy is seldom required in patients with ipsilateral ICA occlusion and ECA stenosis. This is not inconsistent with the results presented here, nor with the findings of the EC/IC Bypass Study Group. Much of the advantage attributed to the EC-IC bypass in patients who had previously undergone an ipsilateral ECA endarterectomy and ICA stump angioplasty as well as an EC-IC bypass procedure may be due to the former procedure alone.

Zarins, et al., noted an augmentation of cerebral blood flow following ECA endarterectomy. This evidence also explains the efficacy of an ECA endarterectomy as a treatment modality for cerebrovascular insufficiency in select cases. Much of the benefit attributed to ECA surgery may be secondary to augmentation of cerebral blood flow in cases where an ECA endarterectomy was performed. The four cases presented here, in whom a simple stump angioplasty was performed, illustrate the benefits of eliminating an embolic source (the ICA stump) from the ECA circulation. This is in agreement with Barnett, et al.,. The case presented in Fig. 2 further illustrates this concept.

When an unsuspected occlusion of an ICA is found at surgery, a modest attempt at reestablishing flow should be made using a Fogarty catheter. This was performed in one patient in this series. Should this prove unsuccessful, a stump angioplasty should be performed in order to prevent subsequent embolic phenomena. An ECA endarterectomy should also be performed, when indicated, in order to maximize the contribution to intracranial flow from the ECA.
Symptoms that occur ipsilateral to an occluded ICA may be secondary to one or more of several factors. They may be due to hypoperfusion without a surgically correctable lesion. On the other hand, a stenotic ECA may be endarterectomized, resulting in the augmentation of cerebral blood flow. Finally, emboli may be arising from the stump of the occluded ICA, thus passing into the intracranial circulation via the ECA. We believe that an ICA stump angioplasty, with or without an accompanying ECA endarterectomy, is preferable to nonsurgical management in select patients with an occluded ICA and ipsilateral hemispheric symptoms.

References


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