Carotid-cavernous fistula: a controlled embolus technique for occlusion of fistula with preservation of carotid blood flow

Technical note

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A case is described in which a carotid-cavernous fistula was eliminated successfully with preservation of the carotid circulation by a small ball-shaped muscle embolus introduced via an arteriotomy in the cervical carotid. The intent is to lodge the embolus in the fistula without occluding the carotid siphon. A long thread is attached to the embolus to permit its withdrawal if its position in the siphon proves unsatisfactory. Neither the intracranial nor cervical carotid artery is ligated.

KEY WORDS carotid cavernous fistula occlusion by embolization

IN 1931, for the treatment of carotid-cavernous fistula, Brooks introduced the method of embolization via the cervical carotid artery to tamponade the carotid siphon and thereby occlude the fistula. Hamby and Gardner later reported a modification of Brooks' procedure by using a 5-mm ball-shaped embolus intended to lodge in the fistula. In the past 30 years, management has consisted mainly of trapping the fistula, with or without embolization of a large strip of muscle or artificial material. Russian authors have used a large muscle embolus bearing a silver-clip marker and controlled by its attachment to a long Nylon thread that extends through the opening in the cervical carotid artery; the thread permits withdrawal of the embolus if its position in the siphon is unsatisfactory as judged from radiographic localization of the silver clip. The cervical carotid artery is then ligated. Krayenbühl has described a similar method modified by packing the muscle strip into the fistulous segment by means of the balloon of a Fogarty embolectomy catheter. Stern, et al. have noted that carotid occlusive operations are generally successful in obliterating the fistula but that the critical problem has become one of predicting and avoiding the complication of cerebral ischemia. To avoid these hazards, it would be necessary to preserve carotid blood flow.

We are reporting an embolization tech-
Fig. 1. Preoperative left carotid arteriogram. Anteroposterior (left) and lateral (right) projections showing characteristic pattern of carotid-cavernous fistula (arrows).

Technique to eliminate a carotid-cavernous fistula while maintaining the carotid circulation intact.

Case Report

This 43-year-old patient had had a post-traumatic pulsatile bruit over the left eye for 3 months, associated with moderate left proptosis, conjunctival injection, and palpebral edema. The bruit could be abolished during digital compression of the left carotid in the neck, which also caused transient loss of vision in the left eye, persisting for several seconds after release of compression. Left carotid arteriography revealed a left carotid-cavernous fistula (Fig. 1). Right carotid arteriography showed that the left hemisphere was being supplied from the right carotid. To determine the size of the muscle embolus to be used, routine films taken at the rate of 3 per sec did not visualize the orifice of the fistula, but cine-arteriography of the left carotid circulation at 30 frames per sec showed rough outlines of the defect. This helped in the decision to make the muscle embolus 4 mm in diameter.

Operation. Under local anesthesia, the left carotid bifurcation was exposed in the neck. A muscle embolus was prepared from a thin strip of muscle taken from the sternocleidomastoid. Figure 2 illustrates schematically the major steps in the procedure. A silver clip was attached at one end of the muscle strip which was then folded on itself in the shape of a ball, trimmed to a diameter of 4 mm. A figure “8” through-and-through suture of Tevdek* 4-0 was placed in the muscle-ball embolus 4 mm in diameter. The muscle-ball embolus projected beyond the opening of the catheter at one end.

* Teflon-impregnated Dacron.
The purpose of the catheter was to facilitate control of the embolus by means of its attached thread.

Having prepared the catheter-embolus assembly, all three carotid segments were clamped, and an incision was placed in the internal carotid artery at its junction with the external carotid. The catheter-embolus assembly was inserted in the lumen of the artery and the arteriotomy was sutured around the catheter. The clamps on the common and internal carotid arteries were removed, permitting the embolus to be propelled upward by the bloodstream. The extravascular portion of the catheter and the long extension of thread projecting from the catheter were secured by clamps to prevent their being drawn into the carotid by the forceful arterial stream.

The patient reported immediate cessation of the intracranial noise and, simultaneously by auscultation, the bruit also abruptly ceased. There were no subjective or objective neurological changes. A radiograph localized the silver clip in the left parasellar region beneath the anterior clinoid process. An intraoperative arteriogram showed patency of the carotid siphon with marked spasm of the carotid distally; the carotid-cavernous fistula was no longer seen.

Clamps were again applied to the common and internal carotid arteries, and the catheter was withdrawn. The Tevdek thread, however, was left in the lumen of the artery. The remaining portion of the arteriotomy incision was closed and the thread extending through the arterial incision was sutured to fascia adjacent to the vessel. The latter step was intended to prevent the embolus from embolizing beyond the carotid siphon. A silver-clip marker was attached to the thread at its point of fascial attachment in the neck for later identification radiographically or for operative reexploration if necessary.

Postoperative Course. The patient's convalescence was benign. He remained neurologically intact and the intracranial noise and bruit did not reappear. The chemosis and
proptosis of the left eye began to clear rapidly. On follow-up examination 6 months later, he remained asymptomatic. Plain skull films showed that the silver clip in the left parasellar region had not moved (Fig. 3). A left common carotid arteriogram revealed complete patency of the carotid system and no evidence of filling of the fistula (Fig. 4). When last seen, 19 months after operation, the patient continued to be well.

Discussion

While the cine study was useful, it was probably not essential, since measurements of the carotid diameter on the regular serial arteriogram would have sufficed in arriving at a decision regarding embolus size. At surgery, we were prepared to try an embolus 1 or 2 mm larger or smaller than the 4 mm embolus which did prove satisfactory.

In selecting the mode of treatment for this patient, consideration was given to the fact that his dominant left hemisphere was nourished largely via the circle of Willis from the contralateral carotid system. Digital compression of the left carotid artery produced ipsilateral ischemic symptoms (visual loss), probably precipitated by the shunting or "steal" of blood from the left hemisphere into the fistula; it seemed likely that cervical carotid occlusion alone would embarrass perfusion of the left hemisphere. This hazard would be reduced by simultaneous intracranial occlusion of the supraclinoid carotid. We could not be sure, however, that adequate perfusion of the left hemisphere would be maintained after elimination of left carotid blood flow. Since the problem focused more on preserving cerebral perfusion than on obliteration of the fistula, we elected to use the embolization technique alone in an attempt to selectively occlude the fistulous defect in the carotid wall.

Isamat, et al., have reported a case similar to ours with the critical exception that a thread was not attached to the muscle embolus. They state that simple embolization, without special precautions to prevent distal embolization into the cerebral circulation, is appropriate if it can be shown angiographically that the major blood flow of the carotid artery pours into the fistula. The hazard exists, nonetheless, of distal arterial embolization, or of flushing of the embolus into the
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venous system via the cavernous sinus. Some precautions such as the attachment of a thread to the embolus to prevent these complications seem essential to make the technique predictably safe.

Another innovation has been described by Hosobuchi whereby the fistula is obliterated by thrombosis induced in the cavernous sinus by the introduction of copper wire. This technique, like the embolization method presented here, offers the advantage of preserving blood flow in the carotid artery. Although the thrombotic technique represents a valuable alternative to the currently available occlusive procedures, a craniotomy and cerebral retraction are generally required, which could be avoided by the controlled-embolization method.

Like the standard carotid occlusive methods, the controlled-embolus method would fail in cases in which the fistula is fed by an anastomotic branch of the carotid within the cavernous sinus. Elimination of the fistula in such cases would require use of either Hosobuchi's thrombotic technique, or Parkinson's direct transcavernous approach, or Riechert's method of anchoring a tantalum plate on the floor of the middle fossa to compress the cavernous sinus.

A theoretical hazard of the controlled-embolus method concerns the permanent presence of a long thread in the carotid lumen. This involves the possibility of thrombus formation on the thread, with fragments breaking loose to flow into the cerebral circulation, or perhaps thrombotic occlusion of the carotid itself. In selecting the intra-arterial suture material, consideration may be given to catgut which would be reabsorbed. An objection to the use of this material lies in the hazard that fragments of the reabsorbing catgut might embolize the cerebral circula-

Fig. 4. Six-month postoperative left carotid arteriogram. Anteroposterior (left) and lateral (right) projections showing patency of the carotid system and no evidence of filling of the carotid-cavernous fistula. Improved circulation is illustrated by filling of the left anterior cerebral artery which had filled only transiently before operation (compare with Fig. 1).
tion. In future trials, a monofilament material (e.g., Nylon) would be preferable to a braided suture, in order to eliminate the potential for thrombus formation in the "dead space" within the braid. Alternatively, a relatively nonthrombogenic metal suture, such as beryllium copper, or stainless steel, might be used.

Conclusions

The controlled-embolus method described is such that it can be tried in a given patient without limiting the subsequent possibility of other standard procedures. Should the method fail to obliterate the fistula, the surgeon retains the option of withdrawing the embolus and doing nothing further, or proceeding immediately with any of the occlusive procedures, or with one of the recent techniques of inducing thrombosis in the cavernous sinus.

References

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