The use of an intraluminal shunt for bypass grafts of the cavernous internal carotid artery

Technical note

TOMOKATSU HORI, M.D., EISHI IKAWA, M.D., ATSUMI TAKENOBU, M.D., YUICHI ANNO, M.D., SEIJRO TANIURA, M.D., TAKASHI WATANABE, M.D., AND YOSHIYUKI UEDA, PH.D.

Division of Neurosurgery, Institute of Neurological Sciences, Tottori University School of Medicine, Tottori, Japan

The authors describe an indwelling intraluminal shunt for use during graft bypass procedures of the cavernous internal carotid artery. The clinical use of this shunt in a patient with meningioma invading the right cavernous sinus is described. This shunt has also been found applicable during carotid endarterectomy, and should prove to be a useful addition to the neurosurgical armamentarium for skull-base surgery.

KEY WORDS • intraluminal shunt • graft • bypass • cavernous sinus • anastomosis, vascular • internal carotid artery

Graft bypass of the cavernous portion of the internal carotid artery (ICA) is useful in the treatment of various neoplastic and vascular lesions of the cavernous sinus.1-5 The need for this procedure is increasing as the direct surgical treatment of cavernous sinus lesions becomes more widespread. A major disadvantage of the graft bypass procedure is the long period of ICA occlusion required, especially in petrous-to-supraclinoid ICA graft bypass procedures. Use of an intraluminal shunt is presently the procedure of choice to overcome the risk of ischemic complications during temporary ICA occlusion. However, in our experience, currently available shunt tubes have not proved satisfactory for use during cavernous ICA bypass procedures.2 We have therefore designed a new shunt tube for use in these situations.

This report describes the newly designed shunt tube and its successful use in a petrous-to-supraclinoid ICA graft bypass procedure for meningioma invading the right cavernous sinus and causing severe stenosis of the cavernous ICA. This shunt tube has also performed well during carotid endarterectomy, and may be useful for other lesions involving the intracranial vasculature. Experimental use of the shunt tube in a canine model for carotid artery bypass by means of an end-to-side jugular vein anastomosis was satisfactory in terms of the ease of use and shunt stump pressure.

Description of the Device

The shunt is constructed of flexible soft elastic silicone.* The middle section is dilated to an outer diameter of 5 mm; the ends are smaller and available in various sizes from 2 to 4 mm in outer diameter, depending on the size of the vessels needed for the bypass. Another tube with a Y-shaped end is connected by a T junction to the central part of the shunt tube (Fig. 1). One arm of the Y is for measuring the arterial pressure of the stump, and the other is for irrigation of the whole system with heparinized saline. The proximal and distal ends of the main tube are inserted into the vessels to be used for anastomosis and are secured in place with 3-0 silk suture. When an important perforating vessel is present at the site of shunt tube insertion, a side hole may be made in order to prevent ischemia, as shown in Fig. 1 right.

Case Report

This 72-year-old woman with symptoms of right-sided loss of vision, headache, and transient ischemic attacks was admitted to our hospital.

Examination. An enhanced computerized tomography (CT) scan demonstrated a medial sphenoid wing...
meningioma compressing the optic chiasm and invading the right cavernous sinus (Fig. 2 left). Right carotid angiography revealed severe stenosis of the cavernous ICA, most likely due to tumor invasion (Fig. 3 left). The angiogram also demonstrated poor collateral circulation to the right middle cerebral artery territory. It was decided to extirpate as much as possible of the intradural part of the tumor in order to decompress the chiasm. The possibility of removing the intracavernous portion of the tumor was rejected because of the patient’s age. Bypass of the cavernous ICA using a saphenous vein graft was undertaken in order to prevent further ischemic complications.

Operation. The operation was performed on March 26, 1990. Although the tumor was quite hemorrhagic, it was not difficult to remove. The supraclinoid and

FIG. 1. Photograph with scale (left) and schematic drawing (right) of the intraluminal shunt. Note the dilated middle portion of the shunt tube, with another tube connected by a T junction. The second tube has two ports, one connected to a transducer to monitor stump pressure and the other to irrigate the shunt tube with heparinized saline. When a side hole is required to perfuse perforating branches of the internal carotid artery, it can be made with microscissors as shown (right).

FIG. 2. Left: Preoperative contrast-enhanced computerized tomography (CT) scan demonstrating the extent of tumor invasion. Right: Postoperative contrast-enhanced CT scan demonstrating the extent of intradural tumor removal. The saphenous vein graft (arrow) is also enhanced.

FIG. 3. Left: Preoperative right carotid angiogram showing stenosis of the intracavernous internal carotid artery. Right: Right carotid angiogram 3 months after the operation demonstrating patency of the saphenous vein graft.

FIG. 4. Schematic drawing showing anastomosis of the petrous carotid-to-intradural carotid saphenous vein graft with the indwelling shunt tube. The two aneurysm clips are placed close to the ophthalmic artery and proximal anastomotic sites. There are three sutures untied at the proximal anastomotic site and two sutures untied at the intradural part.
Intraluminal shunt for bypass grafts

Sundt\textsuperscript{4} advocates the use of a shunt tube during carotid endarterectomy when the intraoperative EEG recording deteriorates. This approach seems to be the most reasonable, and is the one that we follow. Our own experience and the reports by others\textsuperscript{4} of ischemic problems during cavernous ICA bypass surgery indicate that a shunt tube is also needed during many of these procedures. The particularly long period of ICA occlusion required to complete the petrous-to-supraclinoid ICA bypass graft suggests that a shunt tube would be especially useful during this operation. Due to problems with cerebral blood flow or EEG monitoring during the cavernous ICA graft bypass procedure, the routine use of a shunt in these cases may prove beneficial in reducing the incidence of ischemic complications. Preoperative angiography with balloon occlusion testing of the ICA as well as cerebral blood flow or EEG monitoring should help to further delineate patients with insufficient collateral circulation who would benefit from use of a shunt during the cavernous ICA graft bypass procedure.

In the patient described here, preoperative balloon testing was not revealing, but the use of this shunt tube may be indicated in almost all patients for whom a petrous carotid-to-intradural carotid saphenous vein graft is planned, as recently reported by Spetzler, et al.\textsuperscript{5} This shunt tube may also be useful for sinus or carotid artery reconstruction. This is the first report of the clinically successful use of an intracranial indwelling shunt during a cavernous ICA graft bypass procedure. Further clinical trials will be needed to assess the safety and usefulness of this technique.\textsuperscript{6}

Acknowledgment

The authors wish to thank Dr. William Kuhn for his valuable suggestions and for review of this manuscript.

References


\textsuperscript{†} ALF 21 flowmeter manufactured by Advance Co. Ltd., Tokyo, Japan.