Transcavernous Repair of Carotid Cavernous Fistula*

Case Report

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When we were confronted with our first case of carotid cavernous fistula which required repair by transcavernous approach we doubted that another case would appear during our lifetime. However, when the current case failed to respond to all standard methods of obliteration, we found we had a second such case.

To review briefly the anatomy and pathology of the region, the normal cavernous carotid hangs freely within the cavernous sinus away from contact with the bony dura except in its most anterior-inferior portion. It normally has three main branches, the meningo-hypophyseal artery, the artery to the inferior cavernous sinus, and McConnell's capsular artery, all of which come in intimate contact with the bony dura within the cavernous sinus.

There are two types of traumatic arterial fistulae within the cavernous sinus. In type 1, the carotid itself is torn. Trapping alone may or may not succeed depending on the size of the collaterals mentioned above. Embolization may or may not succeed depending on the size of the opening. In Type 2, a branch of the carotid is torn within the cavernous sinus. No amount of trapping and embolization can obliterate the distal source, which is fed from the opposite internal carotid or from the external system, as in Hayes' case, or both.

Previous work has demonstrated a triangular space in the lateral wall of the cavernous sinus bounded by the third and fourth nerves above, and the fifth and sixth nerves below. An incision placed within this triangular space avoids the cranial nerves and provides exposure of the cavernous carotid and its primary branches.

Case Report

Examination. O. H., a 38-year-old man, was admitted to the Winnipeg General Hos-

pital on October 19, 1964, profoundly comatose with a complete right hemiplegia and severe respiratory difficulty after a fall from a ladder. An emergency tracheostomy was performed. The left pupil was noted to be dilated and fixed. Skull films revealed no fracture, but there was an unusually large sella turcica, presumably the result of a large asymptomatic pituitary tumor (Fig. 1). A left carotid angiogram, performed in anticipation of an acute extra- or subdural hematoma, revealed a left carotid cavernous shunt (Fig. 2). A bruit was then noted. A right brachial angiogram revealed that the right carotid irrigated both hemispheres and also cross-filled into the left carotid cavernous fistula.

Within 24 hours, the left eye was propossed and pulsating with marked engorge ment of the conjunctival vessels (Fig. 3). By the 14th day, it was evident that the patient was going to survive; the tracheostomy was no longer necessary. He remained hemiplegic, completely aphasic, and had a total ophthalmoplegia on the left.

First Operation. A left transfrontal craniotomy was performed and the left internal carotid clipped above the clinoid. The ophthalmic artery was coagulated and divided over a hook. The bulging blue mass was noted within and above the sella, but not touched. The left carotid bifurcation was exposed in the neck. Clamping the internal carotid in the neck did not abolish the bruit. Therefore, muscle and tagged cottonoid emboli were introduced via the severed stump of the external carotid, after the method of Jaeger. The bruit diminished transiently with each embolism. Finally, a lengthy muscle strip was stuffed into the internal carotid; the opening in the external carotid was sutured and the clamp removed from the common carotid. It was hoped that this muscle strip would eventually wash up into the fistula or initiate a thrombus which would propagate up into the fistula.

Postoperative Course. Four days later, a
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left carotid angiogram demonstrated that the carotid and the fistula were both entirely open. The opacification in the cavernous sinus had enlarged upward, and one of the tagged cottonoids was visible in the angiogram and in the plane films lodged at the very apex of the ballooned vascular channels (Fig. 4). The other tagged cottonoid emboli could be seen lying in a column conforming to the curve of the carotid siphon within the cavernous sinus.

Second Operation. On December 16 the left carotid was re-exposed in the neck, and additional muscle and cottonoid emboli were forced up the internal carotid through a catheter. Assuming the emboli were lodging within the cavernous carotid, we hoped that successive emboli might pack the lumen further back until the region of the fistula or the principal feeder was occluded. After the insertion of 15 more emboli, the bruit ceased. The internal carotid was then ligated and sectioned in the neck.

Postoperative Course. Thirty-six hours later, the bruit and pulsations were back as forcefully as ever. On more careful inspection of the x-rays, it was now evident that the tagged cottonoids, although in a curved

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Fig. 1. Skull film showing marked enlargement of the sella turcica with posterior displacement of the posterior clinoids.

Fig. 2. Left carotid angiogram showing dense opacification of the left cavernous sinus and feeble opacification of the vessels distal in the carotid system.

Fig. 3. Patient 24 hours after the accident. Note the exophthalmus on the left with obliteration of the superior palpebral crease.
column parallel to the cavernous carotid, were beneath and outside it, free in the cavernous sinus. We now realized that we were dealing with a very severe Type 1 carotid cavernous fistula with an opening sufficiently large to accommodate any embolism capable of traversing the carotid.

A right carotid angiogram again showed filling of the left cavernous fistula and fair visualization of both intracranial carotid systems. The patient still had a complete right hemiplegia and aphasia, and a total left ophthalmoplegia. There was no direct pupillary response on the left, but a normal right consensual response from the left, and a normal appearing disc on the left. The proptosis, pulsations, and bruit were steadily increasing (Fig. 5). There was no known remaining method of approach other than a direct transcavernous attack.

Third Operation. A transcavernous operation was performed on March 31 1965, under profound hypothermia and cardiac arrest. The craniotomy, surface-cooling, and femoral vessel cannulization were all started simultaneously. The greatest problem with our previous similar case had been the uncontrollable surface-oozing which we had attributed to the anatomical changes secondary to the shunt plus the heparinized blood and hypothermia and the prolonged exposure of the blood to the pump mechanism. This severe oozing had persisted even after the fistula was closed. For this reason all surfaces were covered with Surgicel as soon as they were exposed. This included the undersurface of the scalp flap, the outer and inner surfaces of the dural

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† Surgicel is manufactured by Johnson and Johnson, New Brunswick, N. J.

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**Fig. 4.** Lateral and anteroposterior views showing the single Olivecrona clip on the supraclinoid carotid. Arrows point to multiple short linear opacifications in the cavernous sinus, representing the opaque threads on the cottonoid emboli. The small linear opacification just posterior to the supraclinoid clip in the lateral view and just medial to the clip in the anteroposterior view represents one of the cottonoid emboli which escaped upward into the dome of the cavernous sinus.
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flap, and all other dural surfaces and all cortical surfaces.

Excellent exposure of the cavernous sinus was obtained using Urevert, lumbar puncture drainage, and, finally, aspiration of an additional liter of venous blood into the pump after the pump was stopped. Because of the large pituitary tumor with backward displacement of the dorsum sellae and posterior clinoids, the landmarks were distorted. The triangular space was eventually localized and an incision made within it, exposing

![Fig. 5. Close-up 5 months after the accident. Note the severe conjunctival vessel engorgement and the extensive exophthalmus. Compare with Fig. 3.](image)

![Fig. 6. Postoperative view showing complete recession of the exophthalmus and of the vessel engorgement.](image)

![Fig. 7. Postoperative right lateral and anteroposterior carotid angiograms showing obliteration of the fistula with complete filling of both carotid systems. Compare with Fig. 2. Note the two additional Olivecrona clips which are in the cavernous sinus beneath the original clip, which is on the supraclinoid carotid. Compare with Fig. 4.](image)
the cavernous carotid, which was elevated with a right-angle hook after coagulating and sectioning the meningo-hypophyseal trunk. Clips were placed as far proximally and distally as possible on the cavernous carotid, and the intervening fistulous segment of the carotid was sectioned and removed. Two torn arterial segments, presumably the capsular artery of McConnell and the artery to the inferior cavernous sinus, were coagulated. The lateral wall of the cavernous sinus was resutured and the pump started. There was no bruit audible.

The total time of circulatory arrest was 35 minutes at an esophageal temperature of 12.4°C. Defibrillation was achieved with a shock of 330 watt seconds on the fourth attempt with an esophageal temperature of 33°C. The absence of surface-oozing was a most pleasant feature when the Surgery was floated off with warm saline. The wound was closed routinely without a drain.

Postoperative Course. The patient awakened promptly to his previous level of consciousness, without any change in his neurological picture. His eye rapidly returned to its normal color and position, and remains so to date (Fig. 6). Postoperative right-carotid angiograms revealed excellent filling of both carotid systems, with no residual fistulae present (Fig. 7). The cottonoid previously located high above the sella was now below the level of the clinoids. There was improved circulation in both carotid beds as a result of obliteration of the shunting feature of the fistula.

Over 2 years postoperatively, the patient is still free of any pulsations, conjunctival congestion, bruit, or any other evidence of recurrence of his fistula. His neurological state has remained virtually unchanged from that which existed before surgery. He is able to say an occasional word and usually makes his wants known. He walks with a typical hemiplegic gait. The vision is intact in the left eye, as it was from the very beginning. The only improvement in the pre-operative ophthalmoplegia was a minute upward and outward movement of the left eye.

Summary

There are two types of traumatic arteriovenous fistula within the cavernous sinus, either one of which may on occasion fail to respond to trapping and embolization. We have again demonstrated that the normal anatomy of the triangular space provides an adequate exposure to the cavernous carotid, and that with the help of profound hypothermia and cardiac by-pass, sufficient time is available to enter and leave the cavernous sinus and to do the necessary surgery without jeopardizing brain function.

References