AJNR

Percutaneous embolization of arteriovenous fistulas of the external carotid artery.

A Berenstein, J Scott, I S Choi and M Persky

AJNR Am J Neuroradiol 1986, 7 (5) 937-942
http://www.ajnr.org/content/7/5/937

Percutaneous Embolization of Arteriovenous Fistulas of the External Carotid Artery

Alex Berenstein[1]
John Scott[2]
In Sup Choi[1]
Mark Persky[3]

Nineteen arteriovenous fistulas of the external carotid branches in 17 patients were treated by a variety of percutaneous transvascular techniques. There were nine females and eight males; 11 fistulas were traumatic in origin, five were "spontaneous," and three were thought to be congenital. The most frequent presenting symptoms were a bruit and thrill, followed by pulsatile tinnitus, pulsatile mass, headaches, and ocular problems. The symptoms were related to fistula site and venous drainage. The middle meningeal artery was involved most often, followed by the superficial temporal, occipital, internal maxillary, and ascending pharyngeal arteries. All patients except one were successfully cured, including one recurrence. There were no complications, and the hospital stay averaged 3 days.

Arteriovenous fistulae of the external carotid artery are uncommon lesions usually of traumatic origin. They may occur spontaneously, that is, in some patients, no history of trauma can be elicited. In rare cases, the fistula may be congenital [1].

Excision of the fistula has been the preferred method for surgical management of these lesions; however, this is not always possible because the fistula may be surgically inaccessible [2] or the enlarged feeding vessels and arteriolized veins that drain the high blood flow through the fistula may cause excessive blood loss at surgery [3]. Ligation of the feeding vessels proximal to the fistula may be the only surgical option; however, this results only in temporary control due to the vast collateral network in the head and neck [1, 3–6].

With the advent of transcatheter interventional techniques and new embolic agents, embolization has become the treatment of choice for these lesions [7–9]. Several case reports have appeared in the literature describing embolization of these lesions using a variety of embolic agents [10–12].

Received March 13, 1986; accepted after revision May 19, 1986.

Presented at the annual meeting of the American Society of Neuroradiology, New Orleans, February 1985.

[1] Department of Surgical Neuroangiography, New York University Medical Center and Bellevue Hospital Medical Center, New York, NY 10016. Address reprint requests to A. Berenstein at New York University Medical Center, 550 First Ave., New York, NY 10016.

[2] Department of Neuroradiology, Indiana University Medical Center, Indianapolis, IN 46223.

[3] Department of Head and Neck Surgery, New York University Medical Center, New York, NY 10016.

AJNR 7:937–942, September/October 1986
0195–6108/86/0705–0937

Materials and Methods

Since 1980, we have treated 19 fistulas in 17 patients. One patient had two fistulas of the occipital artery and one of the vertebral artery following penetrating trauma (Table 1). There were nine females and eight males aged 7–57 years (mean, 29 years). Eleven fistulae were traumatic in origin, five were spontaneous, and three were congenital.

The most common presenting sign or symptom was a bruit or thrill, followed by pulsatile tinnitus, headaches, and a pulsatile mass (Table 2). Ocular signs and symptoms were present in three patients and included proptosis, conjunctival injection, blurred vision, diplopia, chemosis, and increased intraocular pressure.

The middle meningeal artery was the most common vessel involved with six intracranial fistulae (Fig. 1) and two extracranial fistulae (Fig. 2), followed by the occipital artery (four fistulae) (Fig. 3), the superficial temporal artery with three fistulae (Fig. 4), and the internal maxillary artery (Fig. 5).

A variety of embolic agents was used to embolize the lesions depending on location and flow characteristics [6, 7]. Isobutyl-2-cyanoacrylate (IBCA) was used to embolize eight primary fistulae and one recurrence, and detachable balloons were used in six. Gianturco coils were

TABLE 1: **Arteriovenous Fistulas of the External Carotid Artery**

Age	Gender	Etiology	External Carotid Branch	Embolic Agent
40	F	Trauma	Internal Maxillary	Detachable balloon
21	M	Trauma	Occipital	Coil*
		Trauma	Occipital	Coil
19	M	Trauma	Superficial temporal	IBCA
31	M	Trauma	Occipital	Liquid silicone[a]
22	F	Spontaneous	Middle meningeal	IBCA
29	F	Spontaneous	Middle meningeal	IBCA
41	F	Trauma	Superficial temporal	IBCA
34	F	Spontaneous	Middle meningeal	IBCA
28	M	Spontaneous	Middle meningeal	PVA, coil, silicone spheres
14	M	Trauma	Middle meningeal	Detachable balloon[b]
		Trauma	Middle meningeal	IBCA
7	M	Congenital	Middle meningeal	Detachable balloon
57	F	Trauma	Superficial temporal	IBCA
19	F	Congenital	Internal maxillary artery	Detachable balloon
38	M	Trauma	Occipital	IBCA
52	M	Spontaneous	Middle meningeal	Detachable balloon
19	F	Congenital	Ascending pharyngeal	Detachable balloon
28	M	Trauma	Superficial temporal	IBCA

* Same patient had a traumatic fistula of the vertebral artery.
[a] Failed embolization.
[b] Recurrence of fistula.

TABLE 2: **Presenting Signs and Symptoms**

Finding	No. of Patients
Bruit or thrill	16
Pulsatile tinnitus	9
Pulsatile mass	9
Headache	5
Ocular problems	3

used in two fistulae, polyvinyl alcohol foam and coils in one, and silicone fluid was used unsuccessfully in one (Table 1).

Results

Eighteen of the 19 fistulae were successfully embolized, with follow-ups from 2 months to 5 years. One recurrence of a middle meningeal artery fistula 2 weeks after embolization was caused by deflation of a detachable balloon. This patient was successfully reembolized with IBCA. No complications occurred in this group of patients. Embolization failed in one patient early in our experience because of proximal occlusion of the major feeding vessel with liquid silicone. The patient refused attempted reembolization because most of his symptoms disappeared.

Discussion

Arteriovenous fistulae represent an abnormal communication between an artery and a vein. Trauma is the most common cause of these lesions. In our series blunt trauma was seen in eight patients and penetrating injuries in three; in one of these, an occipital artery fistula resulted from a hair transplant. In four patients (all with middle meningeal artery single-connection fistulae) (Fig. 1), no history of recent or old trauma could be obtained, and these were considered "spontaneous." In three infants no previous history of trauma was available; their fistulas were either noted by their mothers as a "throbbing mass" or were detected by routine physical examination. These infants had electrocardiographic and chest film evidence of cardiac hypertrophy and/or enlargement. The feeding vessels had maximal hypertrophy, sometimes with a congenital vascular anomaly (Fig. 2) and, therefore, were considered congenital in origin.

Clinical presentation depends on location, anatomy, and venous drainage of the lesion. Lesions that involve scalp vessels (Figs. 3 and 4) usually present with a pulsatile mass, a palpable thrill, and an audible bruit. Lesions located near the base of the skull may present with pulsatile tinnitus (Fig. 5). A fistula involving the middle meningeal artery with venous drainage to the cavernous sinus (Fig. 1) presents similarly in patients with carotid cavernous fistulae. The predominant signs and symptoms include proptosis, chemosis, conjunctival injection, diplopia, and increased intraocular pressure.

New catheter assembly systems and embolic agents [6–8] and techniques have changed the therapy of these lesions and have replaced surgery as the treatment of choice. The choice of embolic agents depends on the location of the fistula and its flow characteristics. In all cases, a permanent agent must be used, since recurrence of the fistula has been reported with the use of Gelfoam [6]. Particulate agents are usually not suitable since they tend to pass through large lesions [7]. The goal of embolization is the occlusion of the fistula itself, rather than occlusion of the feeding pedicles. Because of the vast collateral vascular network in the head

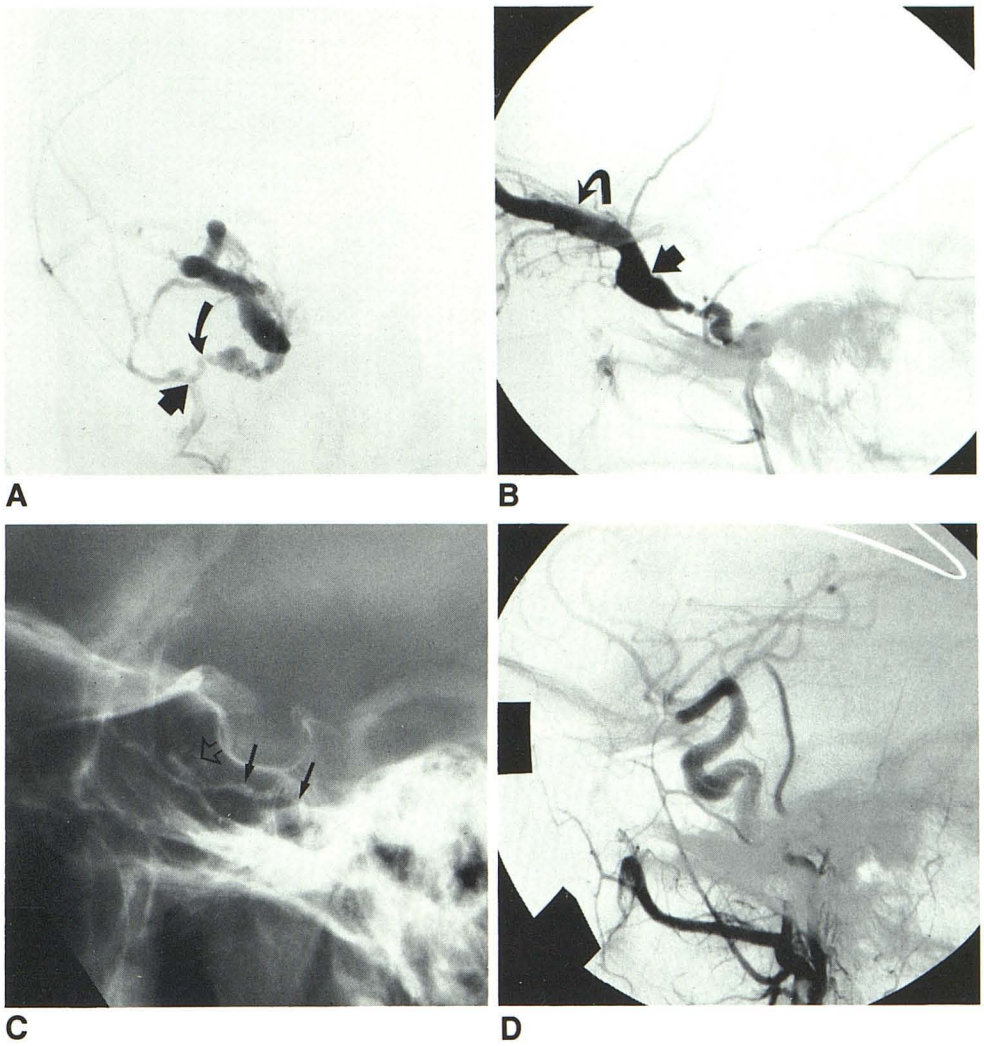


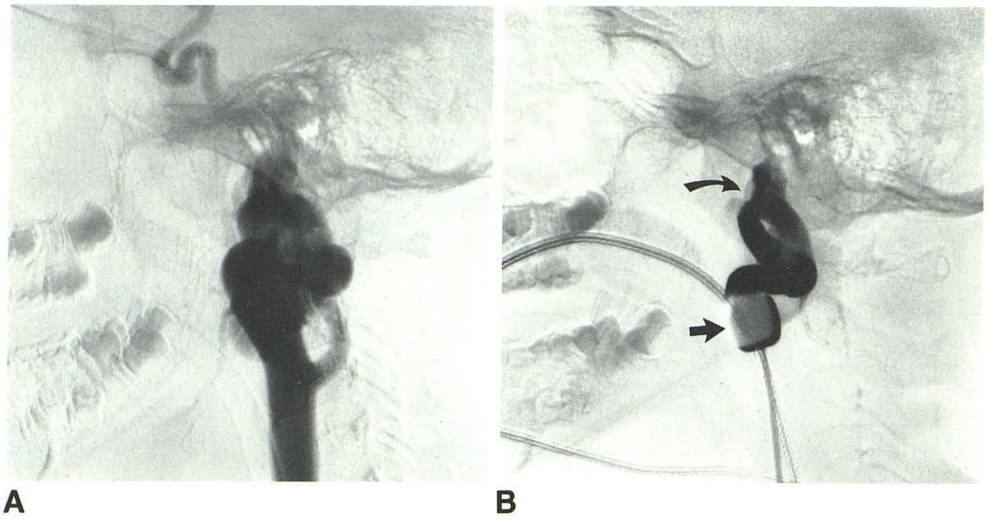
Fig. 1.—Traumatic arteriovenous fistula between middle meningeal artery and cavernous sinus. **A**, Frontal subtraction angiogram of right middle meningeal artery. Catheter tip is at level of foramen spinosum (*straight arrow*). Point of fistulous communication is at acute transition in diameter (*curved arrow*). **B**, Lateral subtraction angiogram later in arterial phase. Venous drainage to cavernous sinus, common ophthalmic vein (*straight arrow*), and superior division of ophthalmic vein (*curved arrow*). **C**, Lateral plain film shows radiopaque cast obtained during embolization (*solid arrows*) with occlusion up to common ophthalmic vein (*open arrow*). **D**, Postembolization control angiogram. Complete disappearance of fistula.

and neck [5, 6], the fistula will recur if only proximal embolization is performed.

We believe that, whenever possible, detachable balloons are the preferred embolic agent and usually are best in the proximal fistulae (Figs. 2 and 5). The high blood flow aids in guiding the balloon to the site of the fistula. Balloons are available in several sizes and can be precisely placed directly at the site of the abnormal arteriovenous communication.

When using detachable balloons in these high-flow conditions, precise placement of the balloon at the fistula site may be difficult as the high flow may push the balloon into the venous side with significant force. Therefore, the balloon should be well attached to the catheter, particularly if using the Serbinenko [13] or Debrun et al. [14] techniques. In our own experience, the arteriovenous fistula is usually at the site of an abruptly changing caliber between the artery and the vein (Figs. 1, 2, 4, and 5) and is easily demonstrated with a double-lumen occlusive angiogram [15] (Fig. 2B). One can see a stenotic area at the acute transition point, which is usually the best place to wedge the balloon and close the fistula. Therefore, to prevent distal migration of the balloon after detachment, we rapidly inflate the balloon several centimeters proximal to the fistula; the fast flow will then push the inflated balloon, which will stop at the stenotic transition between artery and vein. An hourglass appearance of the balloon may be noted (Fig. 2D).

For those fistulas that are more distal in location and are unreachable with detachable balloons (Fig. 4), IBCA, a permanent occlusive agent whose polymerization time can be controlled by the addition of Pantopaque, is a low-viscosity tissue adhesive that can be delivered through a variety of small-size catheters and injectable guidewires [5, 6]. Therefore, it can be injected to occlude a fistula at a distal location (Fig. 4). IBCA can be injected in a single column or with a "push" technique, preceded and followed by a 5% dextrose solution (Fig. 1C). In very high-flow lesions, one can usually use detachable balloons; however, if this is not possible and IBCA is used, one may need some form of flow control or arrest such as double-lumen balloon catheter alone or, preferably, a coaxial assembly [16] to prevent venous and/or



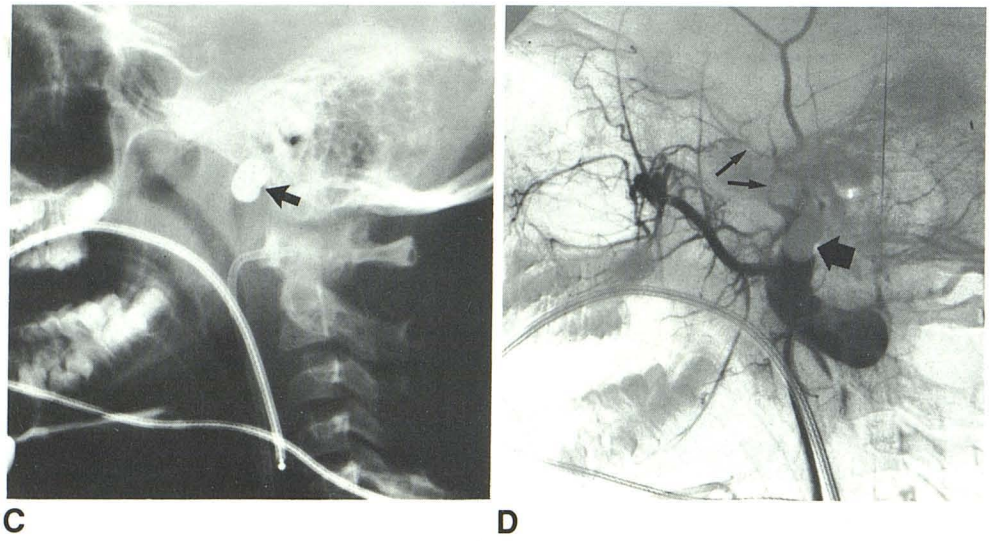


Fig. 2.—Congenital exocranial middle meningeal fistula in child with cardiomegaly. **A**, Lateral right common carotid arteriogram. External carotid artery is markedly hypertrophied. Exact fistula size is not obvious and is difficult to determine. **B**, Lateral subtraction angiogram. Double-lumen occlusive balloon catheter (*straight arrow*) occludes distal external carotid artery. Fistula (*curved arrow*) is at proximal exocranial middle meningeal artery. **C**, Plain film after balloon detachment. Balloon has hourglass appearance at fistula transitional point (*arrow*). **D**, Postembolization angiogram. Balloon occluding fistula is subtracted (*broad arrow*). Preserved distal middle meningeal artery tapers to normal size (*thin arrows*).

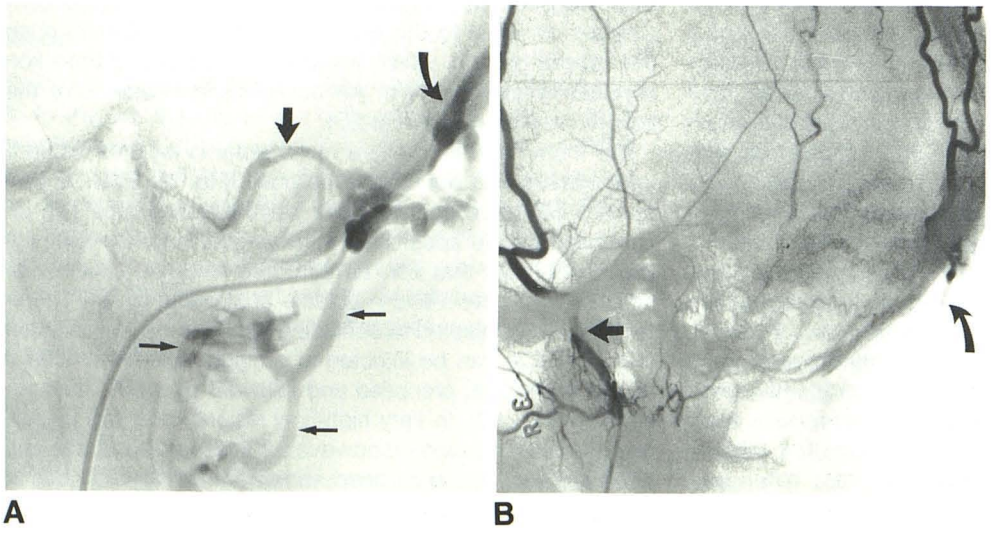


Fig. 3.—Traumatic occipital artery fistula after hair transplant. Lateral subtraction angiogram. **A**, Distal occipital artery. Posttraumatic fistula drains intracranially through transmastoid emissary vein (*thick arrow*) and through superficial scalp (*curved arrow*) and paravertebral (*thin arrows*) veins. **B**, Right superficial temporal artery (*straight arrow*) in late phase after embolization. Reconstitution of right occipital artery up to level of fistula without its filling (*curved arrow*). Good opacification of contralateral (left) occipital artery without filling of fistula.

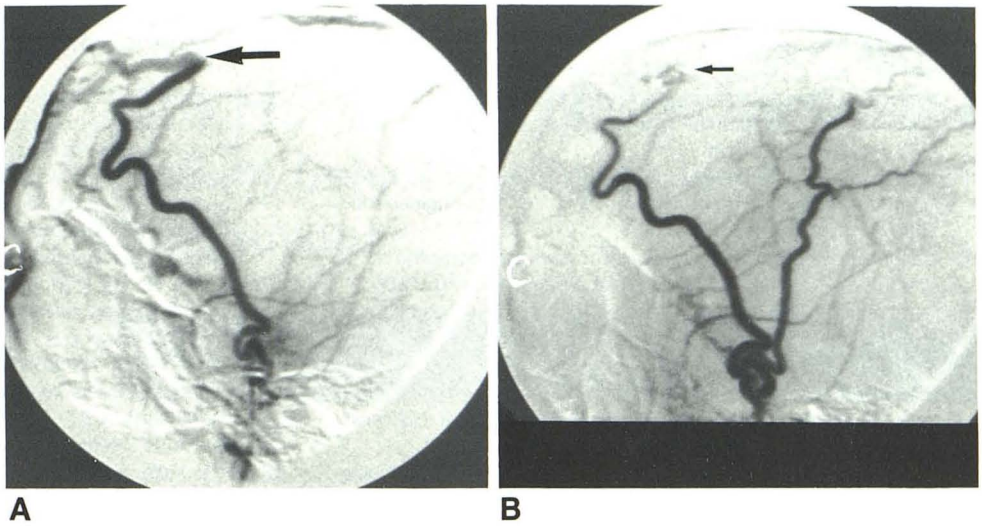


Fig. 4.—Posttraumatic superficial temporal arteriovenous fistula. **A**, Lateral digital subtraction angiogram of left superficial temporal artery. Fistula (*arrow*) with superficial temporal vein. **B**, Control digital subtraction angiogram after IBCA embolization. Note subtracted radiopaque IBCA (*arrow*) and filling of all normal superficial temporal branches.

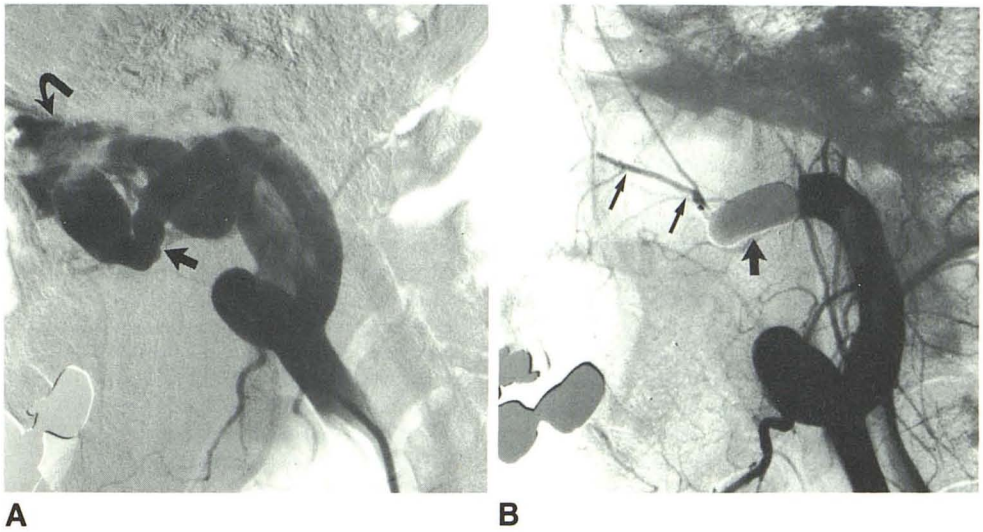


Fig. 5.—"Spontaneous" internal maxillary artery fistula. Lateral subtraction angiograms of left external carotid artery. **A**, External carotid artery is markedly hypertrophied and tortuous (suggesting long-standing high flow). Site of fistula can be determined by irregularities and sudden changes of caliber at arteriovenous connection (*straight arrow*). Fistula drains into pterygomaxillary plexus (*curved arrow*). **B**, After embolization. Subtracted balloon (*thick arrow*) is at fistula site. Opacification of normal internal maxillary artery (*thin arrows*) distal to fistula (and balloon) confirms occlusion of fistula.

pulmonary embolization.

Gianturco coils were used on three occasions where the catheter tip could be placed at the fistula site. These fistulae could have been treated with IBCA or detachable balloons. Coils were used when the lesion involved the arteries of the first or second cervical space, where there are important anastomoses with the vertebrobasilar system [6]. The major disadvantage of coils is the difficulty in placement beyond the catheter tip, the impossibility of retrieval once they have been extruded, and, at times, the necessity to use more than one coil to produce effective occlusion. At present, we believe that other agents such as detachable balloons or IBCA are better. Silicone fluid, a nonadhesive liquid agent [8], was used unsuccessfully on one occasion early in our experience. Had we used IBCA, the patient would have been cured; therefore, we believe silicone fluid is not a good agent for single-communication arteriovenous fistulas.

Embolization has several advantages over surgery in the treatment of these lesions: Embolization is percutaneous, the risks are very low, it can be performed easily even in surgically inaccessible lesions, and it may be repeated if the procedures fail or if the fistula recurs. Recovery is measured in days (3 days), and even when embolization fails, surgery can then be undertaken if necessary.

On the basis of our experience, in which all patients except one were cured by embolization and no complications occurred, we strongly believe that this percutaneous transvascular technique is the treatment of choice for external carotid fistulas, and only when this technique fails should surgery be undertaken.

REFERENCES

1. Stucker FJ. Extracranial arteriovenous fistulas. *Laryngoscope* **1974**;884:970–975
2. Scialfa G, Valsecchi F, Tonon C. Treatment of external carotid

arteriovenous fistula with detachable balloon. *Neuroradiology* **1979**;17:265–267
3. Holt GR, Holt JE, Costez EA, et al. Traumatic facial arteriovenous malformations. *Laryngoscope* **1980**;90:2011–2020
4. Brooks B. The treatment of traumatic arteriovenous fistula. *South Med J* **1930**;23:100–106
5. Lasjaunias P, Berenstein A. *Surgical neuroangiography*, vol 1. *Functional anatomy of craniofacial*. New York: Springer-Verlag, **1986**
6. Lasjaunias P, Berenstein A. *Surgical neuroangiography*, vol 2. *Craniofacial embolization*. New York: Springer-Verlag, **1986**
7. Berenstein A, Kricheff II. Catheter and material selection for transarterial embolization: technical considerations. I. Catheters. *Radiology* **1979**;132:619–631
8. Berenstein A, Kricheff II. Catheter and material selection for transarterial embolization: technical considerations. II. Materials. *Radiology* **1979**;132:631–641
9. Berenstein A. Brachiocephalic vessels: selective and superselective catheterization. *Radiology* **1983**;148:437–441
10. Brismas J, Congvist S. Therapeutic embolization in the external carotid artery region. *Acta Radiol* [*Diagn*] (Stockh) **1978**;19:715–731
11. Djindjian R, Cophignon J, Theron J, et al. Embolization by superselective arteriography from the femoral route in neuroradiology. Review of 60 cases. 1. Technique, indications, complications. *Neuroradiology* **1973**;6:20–26
12. Latchaw RE, Harris RD, Chou SN, et al. Combined embolization and operation in the treatment of cervical arteriovenous malformations. *Neurosurgery* **1980**;6:131–137
13. Serbinenko FA. Balloon catheterization and occlusion of major cerebral vessels. *J Neurosurg* **1974**;41:125–145
14. Debrun G, Lacour P, Caron P, et al. Experimental approach to the treatment of carotid fistulas with an inflatable and isolated balloon. *Neuroradiology* **1975**;9:9–12
15. Berenstein A, Kricheff II. Balloon catheter for investigating carotid cavernous fistulas. *Radiology* **1979**;133:123–129
16. Berenstein A, Kricheff II. A new balloon catheter for coaxial embolization. *Neuroradiology* **1979**;18:239–241