Direct puncture of the proximally occluded internal carotid artery for treatment of carotid cavernous fistulas.

V V Halbach, R T Higashida, G B Hieshima and C W Hardin

AJNR Am J Neuroradiol 1989, 10 (1) 151-154
http://www.ajnr.org/content/10/1/151

Direct Puncture of the Proximally Occluded Internal Carotid Artery for Treatment of Carotid Cavernous Fistulas

Van V. Halbach[1]
Randall T. Higashida
Grant B. Hieshima
Carl W. Hardin

Three patients with symptomatic carotid cavernous fistulas (CCFs) characterized by complete occlusion of the proximal internal carotid artery were treated by percutaneous puncture and embolization. Two patients had CCFs associated with traumatic dissections of the internal carotid artery and were treated initially with trapping procedures. Both patients had persistent symptoms related to the CCF and underwent additional surgical procedures (ophthalmic artery ligation and intraoperative embolization) without improvement. The third patient had traumatic occlusion of the internal carotid artery. After direct percutaneous puncture of the carotid artery above the occlusion, a catheter was advanced into the petrous internal carotid artery. Balloons (one case) or coil emboli (two cases) were placed into the cavernous sinus to produce CCF closure. There were no complications from this procedure.

Direct puncture of the carotid artery is an alternative treatment for patients lacking safe access for CCF embolization.

Treatment of symptomatic carotid cavernous fistulas (CCFs) has evolved as greater understanding of the pathophysiology and natural history of the disease has been elucidated. Carotid ligation was used in the early 1800s as the earliest treatment [1]. Fistula closure was a rare outcome because of collateral recruitment through the circle of Willis to supply the supraclinoid carotid artery. To eliminate this supply, trapping procedures were developed [2, 3]. While trapping procedures had a higher incidence of fistula closure, the ophthalmic artery often originated from the "trapped" segment, and severe visual loss frequently ensued [4]. Retrograde flow in the ophthalmic artery from external collaterals as well as hypertrophy of the cavernous dural supply and enlargement of the vasa vasorum could result in persistent fistula supply. Treatment evolved to the placement of embolic material within the fistula site [5, 6], thrombosis of the cavernous sinus [7, 8], or direct surgical repair of the fistula [9]. With the development of detachable balloons by Serbinenko [10] and Debrun et al. [11], a method for CCF closure with preservation of the parent artery emerged. Several studies have shown this to be an effective treatment of symptomatic CCFs [11, 12]. Compression therapy of the feeding artery and draining vein has also been shown effective in selected patients [13]. On rare occasions the carotid artery is occluded proximally by traumatic dissection or by prior surgical ligation and is not available for transarterial balloon embolization. Transvenous embolization has been described [11, 14, 15], but these pathways are not always available.

In the past 10 years we have performed 170 transvascular embolization procedures for symptomatic CCFs. Of these, three patients had direct puncture of the carotid artery above an occlusion for definitive treatment. This technique and its results are the basis of this paper.

Materials and Methods

Three patients with symptomatic CCFs underwent direct puncture of the carotid artery above a proximal occlusion. Two patients (Figs. 1A, 1B and 2A, 2B) had prior surgical trapping

Received February 8, 1988; accepted after revision May 26, 1988.

[1] All authors: Department of Radiology, Neurointerventional Radiology Section, L352, University of California, San Francisco, 505 Parnassus Ave., San Francisco, CA 94143-0628. Address reprint requests to V. V. Halbach.

***AJNR* 10:151–154, January/February 1989**
0195–6108/89/1001–0151

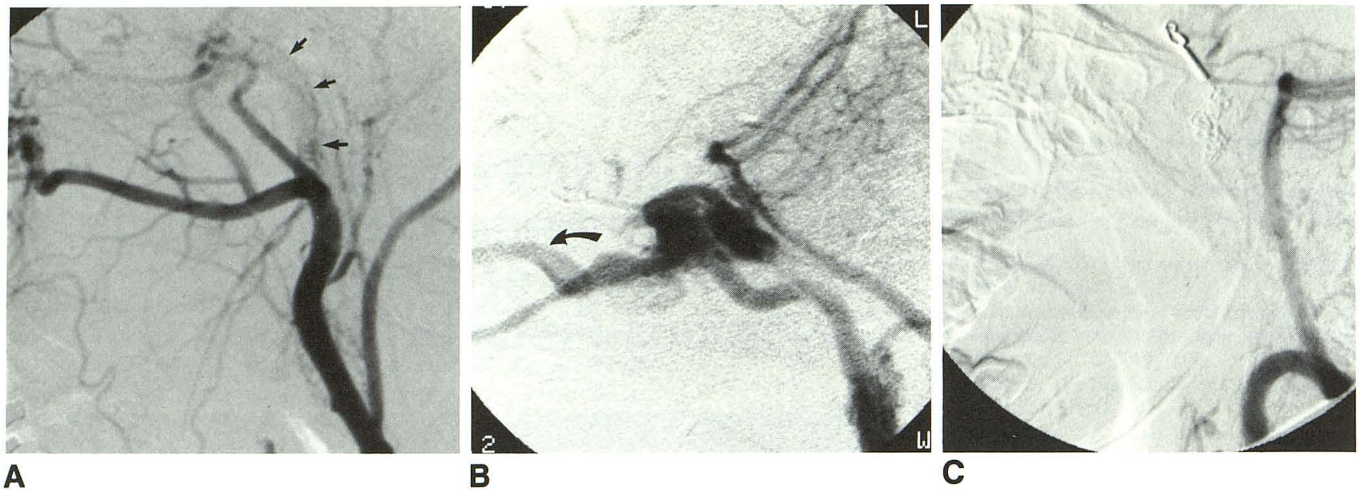


Fig. 1.—*A*, Left common carotid injection, lateral view, shows occluded carotid with trace filling through vasa vasorum (*arrows*).

B, Left vertebral artery injection, lateral view, shows filling of left internal carotid with supply to carotid cavernous fistula and venous drainage to superior ophthalmic vein (*curved arrow*). Vasa vasorum branches supplied from vertebral artery reconstituted the distal carotid.

C, Left vertebral injection, lateral view, after embolization with 0.038-in. Gianturco coils, shows complete closure of fistula.

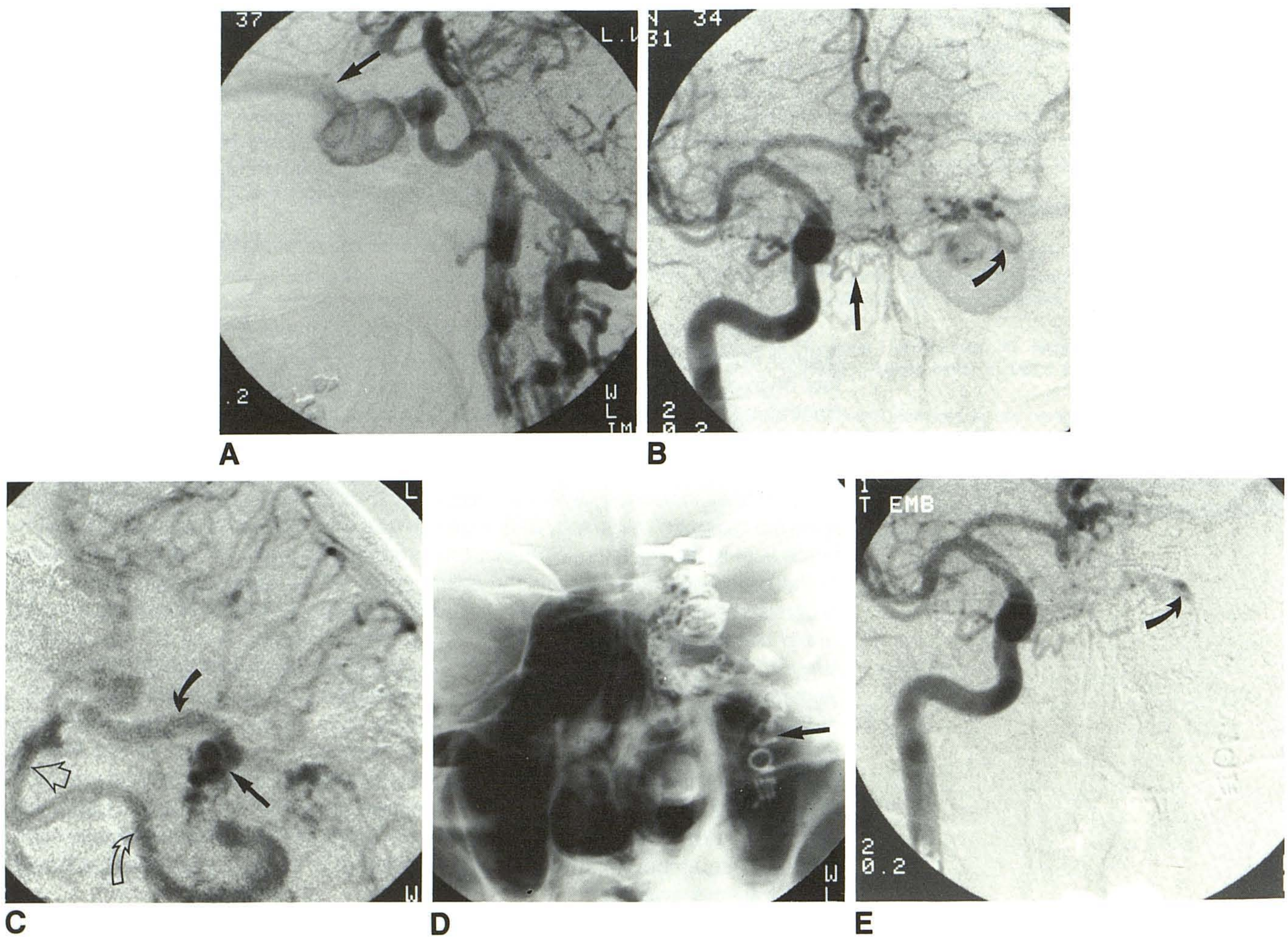


Fig. 2.—*A*, Left vertebral injection, lateral view, demonstrates recanalization of trapped carotid artery with supply to carotid cavernous fistula draining to dilated superior ophthalmic vein (*arrow*).

B, Right internal carotid injection, anteroposterior view, shows supply to left carotid cavernous fistula from meningohypophyseal dural collaterals (*straight arrow*) as well as ophthalmic to ophthalmic artery collaterals (*curved arrow*).

C, Left vertebral injection, base oblique projection (corresponds to line drawing in Fig. 4B), demonstrates reconstituted carotid artery (*solid straight arrow*) and course of petrous carotid artery (*solid curved arrow*). The vertebral and basilar arteries are delineated by *open curved arrow* and *open straight arrow*, respectively.

D, Plain skull X-ray, after embolization, shows coils within cavernous sinus, cavernous carotid, and puncture site (*arrow*).

E, Right internal carotid injection, anteroposterior view, shows obliteration of fistula. Ophthalmic artery (*arrow*) still fills.

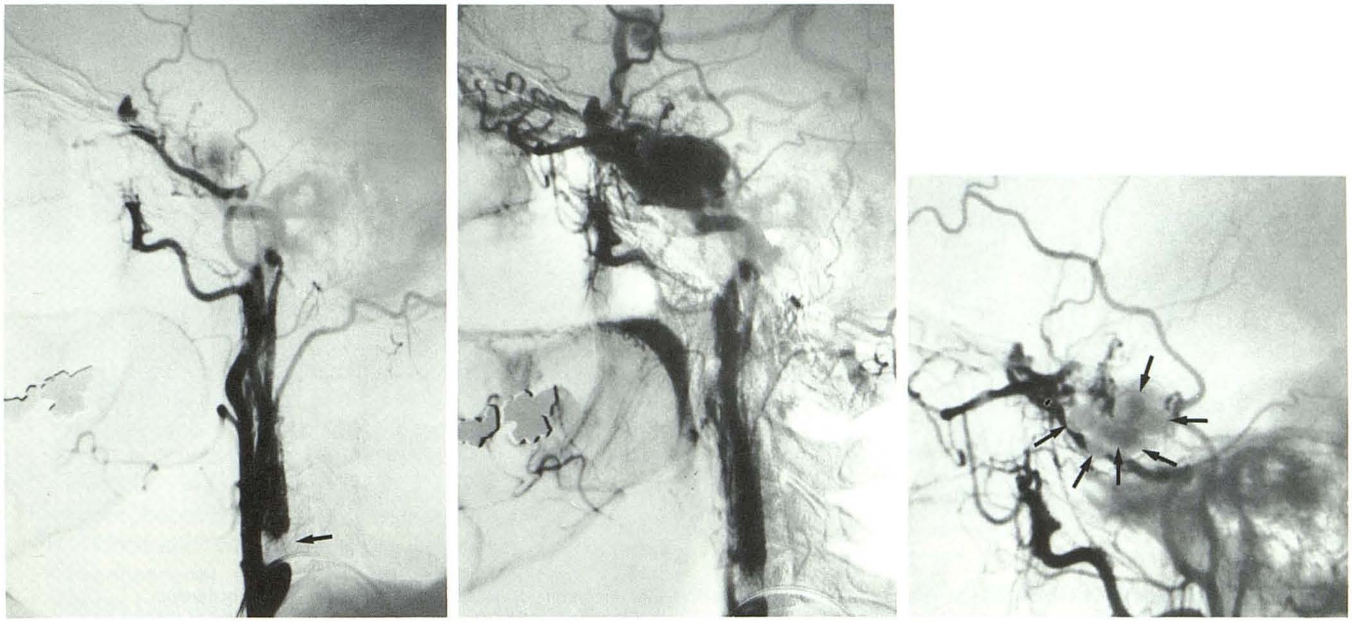


Fig. 3.—*A* and *B*, Common carotid artery injection, mid arterial (*A*) and late arterial (*B*) phases, shows occluded internal carotid artery (*arrow* in *A*). Vasa vasorum reconstitutes internal carotid, which supplies carotid cavernous fistula. Additional supply arose from posterior communicating artery with retrograde flow down the supraclinoid carotid into carotid cavernous fistula.

C, Common carotid angiogram, lateral view, after embolization, shows occlusion of fistula by six balloons (*arrows*).

of the carotid artery for treatment of traumatic dissection associated with the inciting trauma. In both cases, the patients had persistent symptoms related to the fistula. The third patient had traumatic internal carotid occlusion and persistent supply from hypertrophy of the vasa vasorum (Fig. 3). Transfemoral angiography was performed in all cases to delineate the location of the fistula and the supply to the reconstituted carotid. In all three cases the inferior petrosal sinus was occluded, preventing transvenous embolization from this pathway.

The patient was placed in a supine position with a wedge underneath both shoulders. The X-ray tube was then positioned in a submental vertex position with the head rotated 15° away from the side of puncture (Figs. 2C, 4). The neck was prepared with Betadine and draped in a sterile fashion. A point on the neck that projected over the carotid canal was locally infiltrated with 1% lidocaine. An 18-gauge single wall puncture needle was then passed toward the carotid canal. The axis of the needle was parallel to the X-ray beam. In two patients, a roadmap of the reconstituted carotid artery was made by injecting contrasting material in the vertebral collateral and "freezing" the subtracted image (Fig. 2C). The needle could then be positioned upon the subtracted image into the carotid artery. When arterialized pulsatile blood was aspirated from the needle, a Bentson 0.035-in. guidewire was passed into the carotid artery. Sequential Teflon dilators were passed into the carotid artery, followed by a 5.5- or 7.3-French sheath. In one case, balloons were navigated through the carotid artery, across the fistula, into the cavernous sinus and detached. In the remaining two cases, Gianturco coils* were placed into the cavernous sinus to produce fistula obliteration (Figs. 1C, 2D). To prevent hemorrhage from the puncture site in the carotid, multiple coils were placed within the carotid artery as well as at the puncture site (Fig. 2D). The sheath was removed and the puncture site compressed for 30 min. There was no evidence of hematoma. A postembolization angiogram was obtained from all potential pathways (Fig. 2E). The transfemoral arterial catheter was then removed. All patients were discharged 1 day after the procedure.

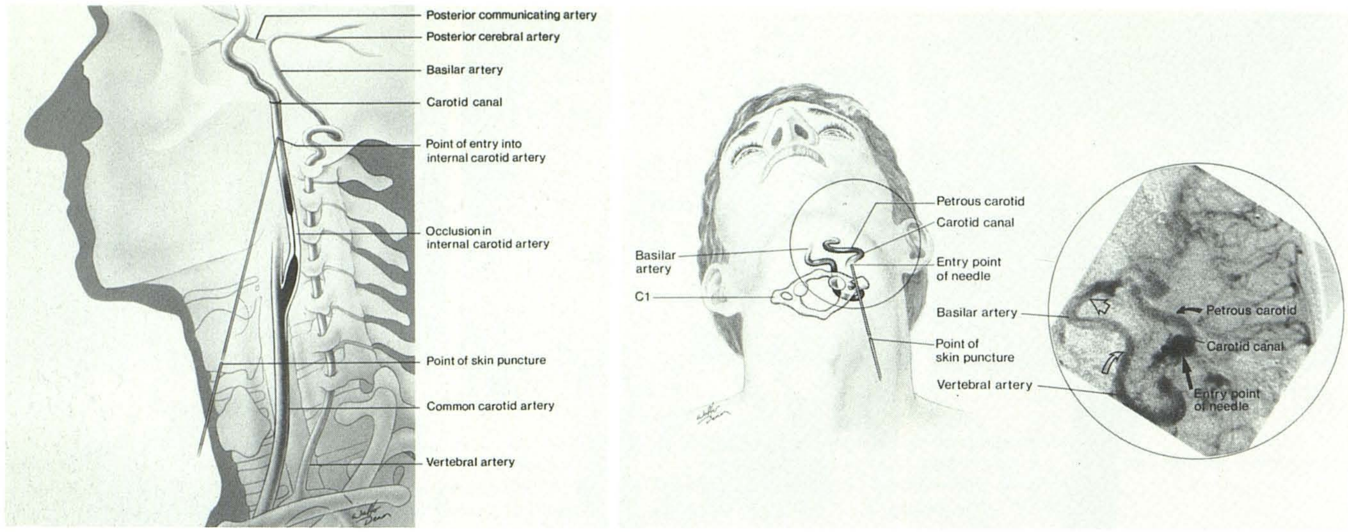
* Cook, Inc., Bloomington, IN.

Results

In all three patients, fistula-related symptoms completely resolved as a result of the procedure. Moreover, there were no complications, and all postembolization angiograms demonstrated complete obliteration of the fistula. The follow-up period ranged from 5 to 60 months (mean, 26 months).

Discussion

Transarterial balloon embolization has emerged as an effective treatment of symptomatic CCFs [11, 13]. When this pathway fails, a transvenous approach can be effective [11, 14, 15]. In rare instances, when neither of these pathways are available, direct puncture may be the best alternative. Patients who have had prior surgical trapping procedures can have persistent fistula-related symptoms, including visual loss and hemorrhage [16, 17]. While surgical exposure of the internal carotid artery above the ligature is possible [16, 17], hemorrhage from surrounding collaterals can complicate surgical exposure. If the site of reconstitution is close to the skull base, surgical access may be difficult.



A B

Fig. 4.—*A*, Line drawing, side view of neck, shows path of needle puncture into ascending cervical carotid artery above the occlusion.
***B*, Line drawing with corresponding angiogram (*inset* and Fig. 2C) shows relationship of vertebral artery to reconstituted internal carotid artery in the submental vertex projection with the head tilted 15° toward opposite side.**

Direct puncture of the carotid artery high in the neck has several potential risks. If hemorrhage at the puncture site is not controlled, then an expanding hematoma could compromise respiration. Manual external compression of a puncture site in the distal ascending cervical carotid artery is difficult because of its deep course and the overlying mandible. We employed several techniques to minimize the risk of hemorrhage. The surgical occlusion or retrograde flow in the distal supraclinoid carotid artery reduces the risk of distal intracerebral embolization, therefore anticoagulation was not used. By placing the skin puncture site low in the neck, the needle pathway paralleled the course of the internal carotid artery, reducing the risk of inadvertent vertebral artery puncture. The use of a single wall puncture technique reduced the risk of bleeding from a back wall puncture. In the last two cases, the use of roadmapping allowed accurate location of the carotid and enabled precise entry. After successful embolization, the reconstituted carotid and the puncture site were occluded with spring coils (Fig. 2D) to prevent hemorrhage after catheter removal.

The short segment of ascending cervical carotid artery distal to the occlusion, limited superiorly by the abrupt angulation of the petrous carotid, may make it difficult to advance guidewires and catheters into this segment. By using a low neck puncture (Fig. 4) the angle between the course of the catheters and carotid artery is narrow. This narrow angle allows any force placed on the catheter, dilator, or guidewire to be close to parallel to the course of the carotid, thus reducing the risk of carotid dissection. Gentle guidewire and catheter manipulations are essential in negotiating the petrous and cavernous carotid segments.

In conclusion, direct puncture and embolization of proximally occluded carotid arteries can be an effective method for treating inaccessible CCFs.

REFERENCES

1. Delens E. De la communication de la carotide interne et du sinus caverneux (aneurysme arterioveineux). Paris: These de Paris, A Parent **1870**
2. Dandy WE. Carotid cavernous aneurysms (pulsating exophthalmos). *Zentralbl Neurochir* **1937**;2:77–113, 165–204
3. Hamby WB. Carotid cavernous fistula. Springfield: Charles C Thomas, **1966**
4. Sanders MD, Hoyt WF. Hypoxic ocular sequelae of carotid cavernous fistulae. *Br J Opthalmol* **1969**;53:82–97
5. Sedzimir CB, Occleshaw JV. Treatment of carotid cavernous fistula by muscle embolization and Jaeger's maneuver. *J Neurosurg* **1967**;22:309–314
6. Ohta T, Nishimura S, Kikuchi II, Toyama M. Closure of carotid cavernous fistula with polyurethane foam embolus. *J Neurosurg* **1973**;38:107–114
7. Hosobuchi Y. Electrothrombosis of carotid cavernous fistula. *J Neurosurg* **1975**;42:76–85
8. Mullan S. Treatment of carotid cavernous fistulas by cavernous sinus occlusion. *J Neurosurg* **1979**;50(2):131–144
9. Parkinson D. Carotid cavernous fistula: direct repair with preservation of the carotid artery. *J Neurosurg* **1973**;38:99–106
10. Serbinenko FA. Balloon occlusion of a cavernous portion of the carotid artery as a method of treating carotid cavitary anastomoses. *Zh Vopr Neirokhir* **1971**;6:3–8
11. Debrun G, Lacour P, Vinuela F, Fox A, Drake CG, Caron JP. Treatment of 54 traumatic carotid cavernous fistulas. *J Neurosurg* **1981**;55:678–692
12. Goto K, Hieshima GB, Higashida RT, et al. Treatment of direct carotid cavernous sinus fistulae: various therapeutic approaches and results in 148 cases. *Acta Radiol [Diagn] (Stockh) [Suppl]* **1986**;369:576–579
13. Higashida RT, Hieshima GB, Halbach W, Bentson JR, Goto K. Closure of carotid cavernous sinus fistulae by external compression of carotid artery and jugular vein. *Acta Radiol [Diagn] (Stockh) [Suppl]* **1986**;369:580–583
14. Berenstein A, Manelfe C. Transjugular approach to carotid cavernous fistulas. *Mt Sinai J Med (NY)* **1981**;48(3):255–258
15. Halbach W, Higashida RT, Hieshima GB, Hardin C, Yang P. Transvenous embolization of direct carotid cavernous fistulas *AJNR* **1988**;9:741–747
16. O'Reilly GV, Shillito J, Haykal HA, Kleefield J, Wang AM, Rumbaugh CL. Balloon occlusion of a recurrent carotid cavernous fistula previously treated by carotid ligations. *Neurosurgery* **1986**;19(4):643–648
17. Kapp JP, Pattisapu JR, Parker JL. Transarterial closure of persistent carotid cavernous fistula after carotid ligation. Case Report. *J Neurosurg* **1984**;61(2):402–404