Indirect Carotid-Cavernous Sinus Fistula: Transvenous Embolization from the External Jugular Vein Using a Superior Ophthalmic Vein Approach. A Case Report

Masaki Komiyama, M.D., Kazutoshi Morikawa, M.D., Yoshihiko Fu, M.D., Hisatsugu Yagura, M.D., Toshihiro Yasui, M.D., and Mitsuru Baba, M.D.

Department of Neurosurgery, Baba Memorial Hospital, Sakai, Osaka, Japan

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A case of indirect carotid-cavernous sinus fistula treated by combined transarterial and transvenous embolization is described. A 49-year-old woman with a right indirect carotid-cavernous sinus fistula draining solely to the right superior ophthalmic vein was treated first by transarterial embolization with polyvinyl alcohol particles. Then, by approaching through the superior ophthalmic vein from the right external jugular vein, the cavernous sinus was embolized with platinum wire using a tracker microcatheter, which resulted in marked clinical improvement.

Transvenous embolization by approaching from the external jugular vein through the superior ophthalmic vein represents a promising alternative when shunted blood drains anteriorly to the superior ophthalmic vein.

KEY WORDS: Carotid-cavernous fistula; Embolization; Microcatheter; Platinum wire; Superior ophthalmic vein

Carotid-cavernous sinus fistulas (CCFs) are generally divided into two types: direct and indirect. Direct CCFs are high flow shunts between the cavernous portion of the internal carotid artery and the cavernous sinus. Indirect CCFs are dural shunts between the cavernous sinus and meningeal branches of the internal carotid artery and/or the external carotid artery. Direct CCFs are usually the result of severe head trauma causing a tear in the internal carotid artery or a ruptured intracavernous aneurysm. Indirect CCFs are also called the "dural arteriovenous malformations" of the cavernous sinus. Clinical symptoms of indirect CCFs include chemosis, conjunctival injection, proptosis, diminished visual acuity, ophthalmoplegia, retro-orbital bruit, periorbital swelling, and hyperlacrimation. Due to the high frequency of spontaneous cure, indirect CCFs are often treated conservatively except for cases which necessitate urgent intervention [6,10]. In cases where there is no clinical improvement following conservative therapy, endovascular intervention is the treatment of choice at present [4]. There are currently three methods of treating CCFs: 1) a direct surgical approach to the cavernous sinus [12,13,15,17]; 2) transarterial embolization [2,4,5,10,20,25]; and 3) transvenous embolization. Transvenous embolizations were performed through the inferior petrosal sinus [8,9,14,21] or the superior ophthalmic vein (SOV) [3,4,9,12,18,22–24]. Here we report a case in which the cavernous sinus was successfully embolized through the SOV from an external jugular vein access using a tracker catheter guided by real-time digital subtraction angiography without necessitating cutdown or puncturing of the SOV.

Case Report

A 49-year-old woman experienced right side tinnitus which was synchronous with her heart beat and lasted for a month, then disappeared about 2 months prior to admission. Chemosis, proptosis, and swelling of the eyelids on the right side followed with gradual symptomatic deterioration. On admission the patient was alert but displayed proptosis, chemosis, conjunctival injection, and swelling of the right eyelid. She complained of occasional diplopia at the right gaze, especially in the early morning, and a bruit was audible over her right eyelid.

A skull x-ray showed an enlarged right superior orbital fissure. Enhanced computed tomography revealed

Address reprint requests to: Masaki Komiyama, M.D., Department of Neurosurgery, Baba Memorial Hospital, 244, Higashi 4, Hamadera-Funao-Cho, Sakai, Osaka 592 Japan.

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Figure 1. (A) *The right internal carotid angiogram shows an indirect CCF. The feeding vessels include both the meningohypophyseal and inferolateral trunks. Shunted blood is drained solely to the SOV.* (B) *The right external carotid angiogram discloses the indirect CCF with drainage to the SOV. The feeding vessels are the distal internal maxillary artery (the artery of the foramen rotundum), and the accessory and middle meningeal arteries.*

bulging of the lateral wall of the right cavernous sinus and an engorged right SOV. Conventional angiography visualized an indirect CCF of the right cavernous sinus fed by the branches of both the right external and internal carotid arteries and draining solely to the right SOV (Figure 1*A*). There was no cortical venous drainage nor drainage to the inferior petrosal sinus from the CCF. The posterior part of the cavernous sinus was opacified during the venous phase of the right carotid angiogram. On the external carotid angiogram, the small branches from the distal internal maxillary artery (the artery of the foramen rotundum) and the accessory and middle meningeal arteries were shown to contribute to the CCF (Figure 1*B*). Since the ocular symptoms were progressive, embolization was carried out without first attempting conservative therapy of carotid jugular compression. Polyvinyl alcohol embolization of all the feeding vessels through the external carotid artery was carried out using a real-time digital subtraction technique (Figure 2*A*–*C*). Polyvinyl alcohol particles ranging from 150μ to 250μ were used as the embolic agent with a 3.0-Fr. tracker catheter and a 0.016-in. platinum steerable guidewire (Target Therapeutics, Inc., LA). The postembolization external carotid angiogram showed no opacification of the CCF (Figure 2*D*). Clinically, chemosis and swelling of the eyelids were moderately improved, but the bruit was still audible.

Control digital subtraction angiogram (DSA) carried out 2 weeks after the first embolization showed the dural branches of the right internal carotid artery (the meningohypophyseal and inferolateral trunks) to be slightly more hypertrophied than before, possibly due to complete obliteration of arterial supply from the external carotid artery (Figure 3). Embolization of the dural branches of the internal carotid artery was thought to be technically difficult and presented a risk, so transvenous embolization through the interior petrosal sinus was attempted. After transfemoral catheterization of the right inferior petrosal sinus using a 5.5-Fr. catheter, a tracker catheter was introduced into the posterior part of the cavernous sinus, but could not be advanced to the anterior part. There was no communication between the catheterized cavernous sinus and the distended anterior part of the cavernous sinus, to which the shunted blood drained, so embolization through this route was not feasible (Figure 4*A*).

The right external jugular vein was easily found and a 6.0-Fr. sheath introducer was inserted into it under local anesthesia without difficulty. A short 5.5-Fr. catheter was then introduced into the retromandibular vein through the sheath introducer. Through this catheter, a tracker catheter was coaxially introduced into the superficial temporal vein and then into the periorbital vein. The tracker catheter was further advanced to the SOV, and finally to the anterior part of the cavernous sinus (Figure 4*B* and *C*). Three platinum wires (2–3 cm in length), which were obtained from the distal tips of 0.016-in. steerable guidewires (Target Therapeutics, Inc., LA), were introduced into the cavernous sinus and the distal SOV by loading the platinum wires into a needle introducer and pushing them with another guidewire (Figure 5*A* and *B*). The procedure was carried out under the guidance of real-time digital subtraction.

Venous drainage was markedly reduced by this embolization, and no complications related to the endovascular procedures were observed.

Control DSA carried out 1 month later demonstrated a significant reduction in the size and flow of the fistula, and revealed a small shunted flow from the dural

Figure 2. (A) *Selective injection into the accessory meningeal artery.* (B) *Selective injection into the distal internal maxillary artery.* (C) *Angiogram of the right internal maxillary artery after embolization of the accessory meningeal artery and distal internal maxillary artery with polyvinyl alcohol particles. The CCF is not visualized.* (D) *The right external carotid angiogram after embolization of the middle meningeal artery shows that the CCF has disappeared.*

Figure 3. *A right internal carotid aniogram 2 weeks after particulate embolization of the feeders of the external carotid artery still shows a CCF from the dural branches of the cavernous carotid artery. However, the CCF was not visualized on the external carotid angiogram (not shown).*

branches of the internal carotid artery (Figure 5*C*). Clinical symptoms, such as chemosis and swelling of the eyelids, were markedly improved, and the bruit became inaudible at the final follow-up 3 months after the second embolization.

Discussion

For diagnosis, determination of the prognosis, and planning a course of treatment for CCFs, complete and selective cerebral angiography is essential [16]. These fistulas are generally divided into two types: direct and indirect CCFs. Barrow et al [1] classified CCFs into four types according to the anatomical and angiographical findings. This classification allows the choice of an appropriate treatment for each type of CCF. Type A are direct CCFs with high flow shunts between the internal carotid artery and the cavernous sinus. Types B, C, and D are indirect CCFs. Type B are dural shunts between meningeal branches of the internal carotid artery and the cavernous sinus. Type C are dural shunts between meningeal branches of the external carotid artery and the cavernous sinus. Type D are a combination of Types B and C. According to this classification, our case was Type D.

Indirect CCFs have been found to frequently coexist with venous thrombosis [4,19]. In our case, both the anterior and posterior parts of the cavernous sinus were opacified separately by superselective catheterization of each part of the cavernous sinus. There was no communication between the two parts. Although venous thrombosis was a possible interpretation, congenital or acquired separation of the cavernous sinus was another strong possibility. Since there was no gap between the two opacified parts of the cavernous sinus in this case, venous thrombosis was thought less likely.

In the past, CCFs have been treated by carotid ligation or trapping of the internal carotid artery [11]. Recently, a direct surgical approach to the cavernous sinus was also described [12,13,15,17]. Direct CCFs are treated today with a detachable balloon in an attempt to preserve the patency of the internal carotid artery [2,4,20]. Spontaneous regression of indirect CCFs is not uncommon, with an incidence of from 9.4% to 46% [1,4,10,16]. Because of the normally benign nature of this disease, conservative treatment through carotid jugular compression is initially recommended except in cases with rapidly deteriorating ocular symptoms and/or cortical venous drainage, in which more urgent interventional therapy is necessary [6,10].

There are three methods of embolizing CCFs: 1) direct embolization with surgical exposure of the cavernous sinus; 2) transarterial embolization; and 3) transvenous embolization. These three alternatives can be used alone or together. In the treatment of indirect CCFs, transarterial embolization of the feeding arteries from the external carotid artery is initially carried out [4,5, 10,25]. Recently, direct embolization of the dural branches from the cavernous internal carotid artery has been reported [7]; this is thought useful in selected cases, but catheterization of these branches is very difficult and is always accompanied by a high risk of complications. A transvenous approach to the cavernous sinus (employed as well for the treatment of direct CCFs) is a useful alternative and enables preservation of the carotid flow. The routes to the cavernous sinus are through the inferior petrosal sinus [8,9,14,21] or the SOV [3,4, 9,12,18,22–24]. The preferred route of approach depends on the drainage route from the cavernous sinus, the location of the distended part of the cavernous sinus, and its connection to other parts. The cavernous sinus is most easily accessed through the inferior petrosal sinus by puncturing the internal jugular vein or the femoral vein than through the SOV, because the SOV has an abrupt anatomical angulation.

An SOV approach may be the method of choice when the inferior petrosal sinus is not enlarged, or when a catheter through the inferior petrosal sinus cannot reach the anterior part of the cavernous sinus [22].

A

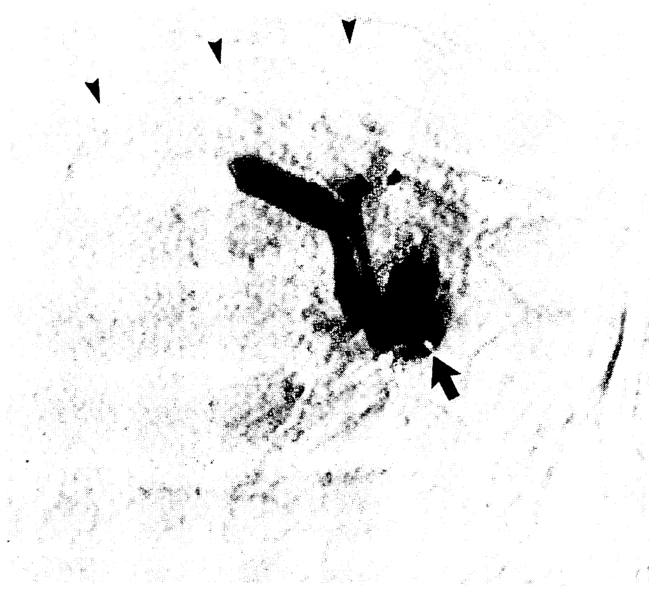

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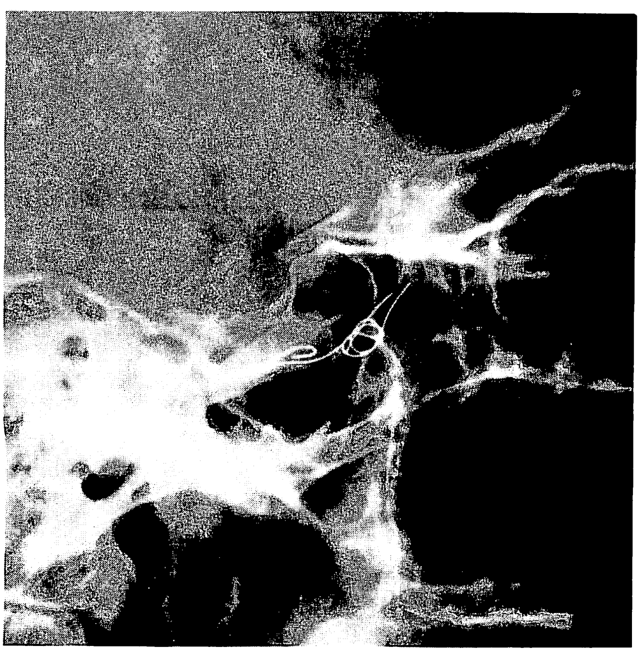
Figure 4. (A) *On the right cavernous sinus venogram, only the posterior part of the cavernous sinus is visualized. The arrow indicates the tip of the tracker catheter in the cavernous sinus and the arrowheads indicate the right inferior petrosal sinus. The anterior part of the cavernous sinus is not visualized.* (B) *The right cavernous sinus venogram (anteroposterior view) shows the tracker catheter (arrowheads) after navigating through the right external jugular vein, the retromandibular vein, the superficial temporal vein, and the SOV. The tip of the catheter (arrow) is located in the anterior part of the cavernous sinus. There is no communication between the two parts of the cavernous sinus.* (C) *The right cavernous sinus venogram (lateral view) shows the tip of the tracker catheter (arrow) in the same position as in B. The arrowheads indicate the tracker catheter in the right superficial temporal vein.*

When the cavernous sinus is approached through the SOV, surgical exposure or direct puncture of this vein or the angular vein is usually carried out [12,22–24]. Teng et al [22] reported that this SOV approach was particularly indicated when the SOV was enlarged and in cases of indirect CCFs fed by small branches of the internal carotid artery or direct CCFs with small tears, indirect CCFs fed by multiple branches from both the internal and external carotid arteries, on one or both sides, or recurrent CCFs after trapping of the internal carotid artery. However, these procedures are often accompanied by intraorbital bleeding, and cannulation of the SOV is not always successful [12,15,23,24]. Uflacker et al [24] reported that this approach should be used only in patients with an old CCF and in whom the SOV is thickened and arterialized in order to avoid perforating the SOV. Extreme care should be taken to minimize possible laceration or perforation of the arterialized SOV, even with a softer tracker catheter and steerable guidewire.

The authors used the external jugular vein for catheter introduction because this vein is almost always easily available in the lateral neck area. A real-time digital subtraction technique with retrograde injection of the contrast medium was used for navigating the tracker catheter into orbit through the retromandibular vein and the superficial temporal vein. When the tip of the catheter neared the required orbit, a new road map was made from the later phase of the carotid angiogram. The catheter was then navigated into the cavernous sinus.

A



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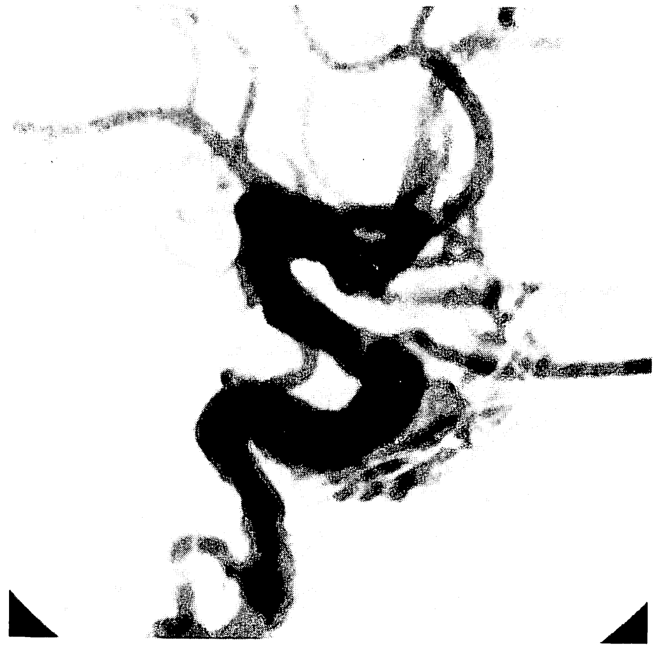

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Figure 5. *(A, B) Skull x-ray. Three platinum wires made from the distal tips of 0.016-in. steerable guidewires are located in the anterior part of the cavernous sinus and the distal SOV. (C) The right internal carotid angiogram carried out 1 month later faintly shows the CCF, but the clinical symptoms were markedly improved.*

This venous approach to the cavernous sinus does not require cut-down or puncture of the SOV, thus minimizing hemorrhagic complications. This approach also does not require general anesthesia. Our method is thought to be promising because it does not sacrifice this vein, enabling repeated catheterization of the vein. Furthermore, the dose of ionizing radiation received by the neuroradiologists is reduced, since the work can be performed away from the source of x-rays by using a longer guiding catheter from the external jugular vein. To our knowledge, this technique has not been previously described.

Many embolic materials have been used to occlude the cavernous sinus. Among them, platinum wire offers a number of advantages including availability, radioopacity, thrombogenicity, biocompatibility, and deliverability through microcatheters [26]. The small number of platinum wires used for embolization of the indirect CCF in our case may account for why it was not completely obliterated.

In conclusion, transvenous embolization from the external jugular vein through the SOV using a tracker catheter provides the following advantages: 1. preservation of the carotid flow, 2. less chance of hemorrhagic complications, 3. repeated access to the SOV, 4. no need for general anesthesia, and 5. reduction of untoward radiation to the neuroradiologist. This method offers a good alternative for the treatment of indirect CCFs and possibly direct CCFs.

References

1. Barrow DL, Spector RH, Braun IF, Landman JA, Tindall SC, Tindall GT. Classification and treatment of spontaneous carotid-cavernous sinus fistulas. J Neurosurg 1985;62:248–56.
2. Berenstein A, Kricheff II, Ransohoff J. Carotid-cavernous fistulas: intraarterial treatment. AJNR 1980;1:449–57.
3. Courtheoux P, Labbe D, Hamel C, Lecoq PJ, Jahara M, Theron J. Treatment of bilateral spontaneous dural carotid-cavernous fistulas by coils and sclerotherapy. J Neurosurg 1987;66:468–70.
4. Debrun GM, Vinuela F, Fox AJ, Davis KR, Ahn HS. Indications for treatment and classification of 132 carotid-cavernous fistulas. Neurosurgery 1988;22:285–9.
5. Grossman RI, Sergott RC, Goldberg HI, Savino PJ, Zimmerman RA, Bilaniuk LT, Schatz NJ, Bosley TM. Dural malformations with ophthalmic manifestations: results of particulate embolization in seven patients. AJNR 1985;6:809–13.
6. Halbach VV, Hieshima GB, Higashida RT, Reicher M. Carotid cavernous fistulae: indications for urgent treatment. AJNR 1987;8:627–33.
7. Halbach VV, Higashida RT, Hieshima GB, Hardin CW. Embolization of branches arising from the cavernous portion of the internal carotid artery. AJNR 1989;10:143–50.
8. Halbach VV, Higashida RT, Hieshima GB, Hardin CW, Pribram H. Transvenous embolization of dural fistulas involving the cavernous sinus. AJNR 1989;10:377–83.
9. Halbach VV, Higashida RT, Hieshima GB, Hardin CW, Yang PJ. Transvenous embolization of direct carotid cavernous fistulas. AJNR 1988;9:741–7.
10. Halbach VV, Higashida RT, Hieshima GB, Reicher M, Norman D, Newton TH. Dural fistulas involving the cavernous sinus: results of treatment in 30 patients. Radiology 1987;163:437–42.
11. Hamby WB. Carotid-cavernous fistula. Report of 32 surgically treated cases and suggestions for definitive operation. J Neurosurg 1964;21:859–66.
12. Hosobuchi Y. Electrothrombosis of carotid-cavernous fistula. J Neurosurg 1975;42:76–85.
13. Isamat F, Ferrer E, Twose J. Direct intracavernous obliteration of high-flow carotid-cavernous fistulas. J Neurosurg 1986;65: 770–5.
14. Manelfe C, Berenstein A. Treatment of carotid cavernous fistulas by venous approach. Report of one case. J Neuroradiology 1980;7:13–9.
15. Mullan S. Treatment of carotid-cavernous fistulas by cavernous sinus occlusion. J Neurosurg 1979;50:131–44.
16. Newton TH, Hoyt WF. Dural arteriovenous shunts in the region of the cavernous sinus. Neuroradiology 1970;1:71–81.
17. Parkinson D. Carotid cavernous fistula: direct repair with preservation of the carotid artery. J Neurosurg 1973;38:99–106.
18. Peterson WE, Valbert J, Whittingham DS. Electrically induced thrombosis of the cavernous sinus in the treatment of carotid cavernous fistula. In Drake CG, Duvoisin R, eds. Proceedings of the Fourth International Congress of Neurological Surgery. New York, 1969. International Congress Series No. 193. Amsterdam: Excerpta Medica, 1969: 105 (abstract).
19. Seeger JF, Gabrielsen TO, Giannotta SL, Lotz PR. Carotid-cavernous sinus fistulas and venous thrombosis. AJNR 1980;1: 141–8.
20. Serbinenko FA. Balloon catheterization and occlusion of major cerebral vessels. J Neurosurg 1974;41:125–45.
21. Shimizu T, Waga S, Kojima T, Tanaka K. Transvenous balloon occlusion of the cavernous sinus: an alternative therapeutic choice for recurrent traumatic carotid-cavernous fistulas. Neurosurgery 1988;22:550–3.
22. Teng MMH, Guo WY, Huang CI, Wu CC, Chang T. Occlusion of arteriovenous malformations of the cavernous sinus via the superior ophthalmic vein. AJNR 1988;9:539–46.
23. Tress BM, Thomson KR, Klug GL, Mee RRB, Crawford B. Management of carotid-cavernous fistulas by surgery combined with interventional radiology. J Neurosurg 1983;59:1076–81.
24. Uflacker R, Lima S, Ribas GC, Piske RL. Carotid-cavernous fistulas: embolization through the superior ophthalmic vein approach. Radiology 1986;159:175–9.
25. Vinuela F, Fox AJ, Debrun GM, Peerless SJ, Drake CG. Spontaneous carotid-cavernous fistulas: clinical, radiological, and therapeutic considerations. Experience with 20 cases. J Neurosurg 1984;60:976–84.
26. Yang PJ, Halbach VV, Higashiga RT, Hieshima GB. Platinum wire: a new transvascular embolic agent. AJNR 1988;9:547–50.