Traumatic carotid-cavernous fistula due to transection of the intracavernous carotid artery

Case report

IBRAHIM A. SBEIH, M.D., CH.B., AND SEAN A. O'LAOIRE, M.D., F.R.C.S.I., F.R.C.S.

Department of Neurosurgery, Atkinson Morley’s Hospital, Wimbledon, London, England

The authors report a case of a high-flow posttraumatic carotid-cavernous fistula, with complete steal of the blood flow from the ipsilateral internal carotid artery (ICA). Direct attack on the intracavernous carotid artery was performed using the approach of Parkinson with temporary isolation of the ICA. Complete transection of the artery within the cavernous sinus was encountered. The fistula was occluded by clipping the two ends of the ICA within the sinus. The implications of this previously unreported finding are discussed.

KEY WORDS carotid artery • carotid-cavernous fistula • surgical treatment • cavernous sinus

Since Winslow first named the cavernous sinus in 1732, there have been different and sometimes conflicting descriptions of this sinus. In most classical textbooks the trabeculated cavernous sinus is described as being located between two layers of dura, with the third and fourth cranial nerves and first and second divisions of the fifth cranial nerve embedded in the lateral wall of the sinus. Parkinson, however, came to the conclusion that the cavernous sinus is a venous plexus incompletely surrounding the internal carotid artery (ICA) with various sizes of veins dividing and anastomosing with each other, as had been suggested by Taptas. He suggested that the trabeculae seen in the sections of the sinus are merely cross sections of the numerous veins. He described a triangular area in the lateral wall of the sinus through which he was able to operate within the sinus cavity, but still outside the arterial and venous components of a carotid-cavernous fistula, without damage to the cranial nerves within the sinus.

Other authors reached completely different conclusions, describing the sinus as an unbroken trabeculated venous channel with no plexus of veins. This controversy in description of the sinus was outlined in a recent study by Umansky and Nathan. We report one further case, which was treated surgically by Parkinson’s approach, and discuss an unusual finding.

Case Report

This 16-year-old girl was involved in a road traffic accident in Iraq in March, 1981, when she was hit by a motor vehicle while walking home from school. She suffered a head injury and fractures of the right femur and left clavicle. On admission to the hospital in Iraq, she was unconscious; she did not respond to painful stimuli and had no lateralizing neurological deficits. Twenty-four hours after admission her left pupil became fixed and dilated. Left frontal and temporal burr holes revealed no abnormality. She remained unconscious for 7 days, then recovered fully, although she had a posttraumatic amnesia of a month’s duration. As she recovered she was aware that she had lost the vision in her left eye; both eyes protruded, the left more than the right. She also developed severe headaches and constant noise in her head, which persisted until her present admission. She was referred to the United Kingdom for further management, and was admitted to the Atkinson Morley’s Hospital on July 28, 1982.

Examination. The patient was in good general condition and was fully mobile, with no intellectual or emotional impairment. There was severe bilateral pulsating exophthalmos, more on the left side. A loud bruit was heard over her cranium and the left side of her neck. She was blind in her left eye and the optic disc.
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FIG. 1. Left internal carotid artery angiograms. Left: Arterial phase showing a left carotid-cavernous fistula filling from the left internal carotid artery. Right: Venous phase showing filling of the right cavernous sinus from the left carotid-cavernous fistula. There is dilatation of the superior orbital veins on both sides.

FIG. 2. Right internal carotid artery (ICA) angiogram showing spontaneous cross-flow, filling of the left anterior and middle cerebral arteries, and filling of the distal 5 mm of the left ICA.

FIG. 3. Left vertebral artery angiogram showing contrast material entering the top of the carotid-cavernous fistula via a large posterior communicating artery.

appeared pale with normal fundus vessels, suggesting a direct injury to the optic nerve. All movements of that globe were lost. There was chemosis and engorgement of the conjunctival vessels. In her right eye the visual acuity was normal with normal appearance of the fundus, but there was considerable reduction of all eye movements, more apparent on abduction and upward gaze. There was impairment of pain sensation in the first division of the fifth cranial nerve with absent corneal reflex on the left. There were no long-tract deficits.

Cerebral angiography with left ICA injection showed a very large carotid-cavernous fistula taking up the entire blood supply from the left cervical ICA (Fig. 1 left). There was a considerable flow to the right cavernous sinus, with marked dilatation of both superior orbital veins on both sides (Fig. 1 right). Right ICA injection revealed excellent spontaneous cross-flow, with filling of both anterior cerebral arteries and the left middle cerebral artery, and filling of the distal 5 mm of the left ICA (Fig. 2). Left vertebral artery injection revealed a large posterior communicating artery with contrast material entering the top of the fistula via the supraclinoid portion of the ICA (Fig. 3). There was no filling of the left ophthalmic artery from either the left vertebral or ICA injection. A fractured base of the skull was reported on the x-ray films that were made in Iraq; however, we were unable to demonstrate a fracture on our x-ray films.

Operation. On July 30, the patient was operated on (S.A.O'L.) with the aim of closing the fistula and preserving blood flow in the ICA. The ICA was first identified and isolated in the neck to allow proximal control of blood flow. A left temporal craniotomy was performed followed by a direct attack on the cavernous sinus while the left ICA was temporarily occluded in the neck and intracranially. An incision was made in the lateral wall of the cavernous sinus, as described by Parkinson. An enormous varix was seen and it was possible to dissect around it, revealing several other enlarged veins running in several directions. The intracavernous portion of the carotid artery was found to be completely transected, with the two ends 1 cm apart.
and feeding into different dilated veins within the sinus. The cranial end was feeding into a varicose superior petrosal sinus. It was not possible to maintain patency of the carotid artery, and its two avulsed ends were clipped. Some arterial blood oozed into the region of the sinus from the enlarged hypophyseal branches, but was stopped by a muscle embolus inserted into the cervical ICA and flushed upward. The temporary clip on the subarachnoid ICA was replaced by a permanent clip, which was placed just proximal to the posterior communicating artery. The ophthalmic artery could not be seen. The ICA was also ligated in the neck.

Postoperative Course. On recovery from anesthesia, the patient noticed complete disappearance of the noise in her head. There was no bruit, and her proptosis was slightly reduced. She made an uncomplicated recovery and was discharged from the hospital on the 5th postoperative day. When she was evaluated as an outpatient on the 10th postoperative day it was noted that her proptosis had subsided, and had completely disappeared on the right side. She had no bruit, and her upward gaze in the right eye was back to normal. However, her left ophthalmoplegia and blindness remained. She returned to Iraq a few days later, and further correspondence until May, 1983, showed that she has continued to do well. She reports moderate recovery of movement in the left eye, which remains blind.

Discussion

The difficulty in developing a satisfactory surgical treatment of carotid-cavernous fistulas is indicated by the multiplicity of methods reported, including the now abandoned procedure of proximal ligation of the feeding vessels, isolation of the arterial input by trapping of the feeding vessels intra- and extracranially, occlusion of the feeding vessel at the site of the fistula by embolization with muscle, Gelfoam, gauze, or porcelain beads, and balloon catheterization and occlusion of the feeding vessel at the fistula site. The most recently developed and desirable method is occlusion of the fistula with preservation of ICA flow. This has been achieved in many cases by placement of detachable intra-arterial or intravenous balloons. It has also been achieved by puncture techniques in the lateral wall of the cavernous sinus and the induction of thrombosis in the venous component by electrical current, by thrombogenic material, and by obliteration of the fistula by cyanoacrylate glue.

Parkinson demonstrated that the so-called “cavernous sinus” is a plexus of veins incompletely surrounding the carotid artery, and that a carotid-cavernous fistula is merely an endothelialized side-wall connection between the parent artery and an adjacent vein, as amenable to closure as a standard peripheral arteriovenous fistula. There have been few other reports in the literature describing a direct intracavernous approach for treatment of carotid-cavernous fistulas and intracavernous ICA aneurysms.

Our experience confirmed that the cavernous sinus is indeed merely a plexus of veins, accessible through the lateral wall of the sinus, lying between the cranial nerves.

Although Parkinson and others have recommended that the cavernous sinus be opened with the patient under hypothermia and cardiac arrest, we found that temporary isolation of the carotid artery yielded excellent operative conditions and carried no risk of cerebral ischemia in the presence of angiographically demonstrated high-volume cross-flow.

The majority of anatomical studies of carotid-cavernous fistulas reported side-wall lacerations, single or multiple, in the intracavernous carotid artery, with an average fistula size of 1 to 3 mm. Complete transection of the intracavernous carotid artery has not been previously described, to our knowledge. A thorough search of the literature yielded one case of transection of the cervical ICA following blunt trauma. However, one case reported by Dandy and one of Parkinson’s original cases have features that suggest to us that the authors unknowingly encountered cases similar to ours. Dandy described autopsy findings in which the external surface of the proximal and distal carotid artery merged imperceptibly into a large thin-walled venous channel, which, on being opened, revealed typical arterial intima and media in the obviously arterial segments, without any such tissue lining the dilated vessel. In one of his cases, Parkinson was unable to identify the carotid artery within the sinus, but was successful in occluding the fistula by dividing all the veins therein. We suspect that the retracted ends of the carotid artery may have prevented their visualization. We believe that transection of the intracavernous carotid artery in cases of carotid-cavernous fistula of traumatic origin may be a not infrequent occurrence. Such a lesion would explain the persistence of carotid-cavernous fistulas following embolization procedures, in particular in situations where balloon occlusion of the carotid artery at the site of the fistula fails to occlude the latter.

The high success rate of detachable balloon embolization by endarterial and venous routes, both in occluding the fistula and in preserving the carotid artery, makes these methods appear the most promising technique for occluding carotid-cavernous fistulas. However, it should not be forgotten that 10% of fistulas, both spontaneous and posttraumatic, become occluded spontaneously by thrombosis.

Conclusions

In cases of high-flow carotid-cavernous fistula in which there is total steal of ipsilateral carotid flow, complete transection of the carotid artery should be suspected. Complete transection should also be suspected when standard balloon techniques fail to occlude the fistula. In such cases a direct approach to the
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intracavernous segment of the carotid artery would be indicated. Intracavernous occlusion of the carotid artery distal to the fistula would preserve the ophthalmic artery, minimizing the risk of blindness in patients without primary optic nerve damage, while preventing the ophthalmic artery from causing persistence of the fistula as can happen with trapping procedures.\(^{15,17,31}\)

Such a direct intracavernous approach would clearly not be possible following attempted occlusion of the fistula by a puncture technique through the lateral wall of the cavernous sinus, which would suggest that the detachable balloon technique must be the method of choice as the first line of treatment.

References


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Address reprint requests to: Ibrahim A. Sbeih, M.B., Ch.B., Department of Neurosurgery, Atkinson Morley’s Hospital, 31 Copse Hill, Wimbledon, London SW20 0NE, England.