

Carotid-cavernous fistula caused by laceration of persistent fetal trigeminal artery treated with single catheter coil embolization

Benjamin L. Brown, Anthony H. Sin, Hugo H. Cuellar

Department of Neurosurgery, Louisiana State University Health Sciences Center, Shreveport, Louisiana, United States of America

ABSTRACT

We present the endovascular treatment of traumatic carotid-cavernous fistula from persistent fetal trigeminal artery (PFTA) laceration. To date, there are six such cases of traumatic PFTA-cavernous fistulas reported in the literature. These injuries can pose a unique challenge in that rupture of a PFTA in its course through the cavernous sinus may produce a fistula feeding from both anterior and posterior circulations. Previously, these have been treated with dual catheter coil embolization from the carotid and basilar systems. We utilize a single catheter technique accessing the cavernous sinus through the origin of the PFTA on the internal carotid. Both anterior and posterior fistula components may be embolized through this single access. This represents a simple yet safe treatment option.

Key words: Carotid cavernous fistula, coil embolization, endovascular, neurosurgery, persistent fetal circulation, traumatic carotid cavernous fistula

INTRODUCTION

Traumatic cavernous carotid fistula is a rare vascular complication of head trauma. It is estimated to occur in 3.8% of head trauma patients with basilar skull fractures.^[1] Rarer still is rupture of a fetal trigeminal artery within the cavernous sinus resulting in an indirect carotid cavernous fistula. To date, there are seventeen such cases in the literature.^[2] Only six of these are traumatic in origin, and none have been treated with single catheter coil embolization. We present a case of traumatic indirect carotid cavernous fistula due to persistent fetal trigeminal artery injury treated successfully with single catheter coil embolization.

CASE REPORT

A 33-year-old healthy male passenger was involved in a motor vehicle collision with loss of consciousness.

On arrival to the emergency department, he had a Glasgow Coma Scale of 15 with no focal deficits. He suffered fractures of the right orbital roof, squamous portion of the right temporal bone, and body of the sphenoid [Figure 1a]. Computed tomography (CT) of the brain did show a small right frontal epidural hematoma. CT angiography of the brain was negative. The patient also had a fracture of his radius which was treated operatively by orthopedics. An ophthalmologic exam revealed no visual deficits, and he had full extra-ocular movements. His right frontal epidural hematoma was treated conservatively, and the patient was able to be discharged on hospital day 4 to home. Approximately one week later the patient began feeling left eye fullness and reported to ophthalmology clinic reporting difficulty moving his left eye resulting in double vision. A bruit was auscultated over the left eye. Magnetic resonance imaging (MRI) showed large flow voids in the left superior and inferior ophthalmic veins as well as the cavernous sinus (CS) indicating venous hypertension and likely carotid-cavernous fistula. Cerebral angiography revealed what was thought to be a carotid cavernous fistula arising from the left C4 internal carotid artery (ICA) segment with drainage anteriorly toward the superior and inferior ophthalmic veins, posteriorly toward the inferior petrosal sinus, and across to the contralateral cavernous sinus [Figures 1b and c]. Injection of the left vertebral

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Address for correspondence: Dr. Benjamin L. Brown, Department of Neurosurgery, 1501 King's Highway, PO Box 33932, Shreveport, LA 71130, USA. E-mail: bbrown@lsuhsc.edu

artery, however, demonstrated a PFTA with a fistulous connection to the posterior cavernous sinus and drainage to the inferior petrosal sinus on the left [Figures 1d and e]. Embolization was planned with access to the CS from the C4 takeoff of the PFTA.

Technique

A three-dimensional digital subtraction angiogram (DSA) of the left ICA and basilar trunk accurately depicted the origin of the PFTA in the C4 segment and the communication of the posterior aspect of the CS to the PFTA [Figures 1f and g]. An Excelsior SL10 microcatheter (Boston Scientific; Natick, MA) was advanced over a 0.014 micro guidewire to selectively catheterize the origin of the PFTA in the wall of the

C4 segment. The microcatheter was advanced into the posterior aspect of the cavernous sinus. A series of nine Deltapaq (Micrus; Raynham, MA) detachable coils were inserted into the cavernous sinus from posterior to anterior fashion. Final angiographic control revealed complete occlusion of the fistula and patency of the internal carotid artery and its distal branches. Selective angiography of the left vertebral artery revealed complete occlusion of the fistula from posterior circulation [Figures 1h and i]. Following embolization, the patient's proptosis resolved with residual left lateral rectus weakness. He has since undergone a muscle shortening procedure with good results. Follow up 3 months after the procedure showed stable closure of the fistula from the ICA and the basilar trunk.



Figure 1: (a) Basilar skull fracture involving the body of the sphenoid bone; (b) AP view: Left internal carotid artery angiography illustrating fistulous connection between the carotid artery and cavernous sinus; (c) Lateral view: Left internal carotid artery angiography illustrating fistulous connection between the carotid artery and cavernous sinus; (d) AP view: Left vertebral artery angiography illustrating fistulous connection between a persistent fetal trigeminal artery and the cavernous sinus; (e) Lateral view: Left vertebral artery angiography illustrating fistulous connection between a persistent fetal trigeminal artery and the cavernous sinus; (f) Three-dimensional digital subtraction angiography of the left internal carotid artery revealing the exact point of fistulous connection to the cavernous sinus; (g) Three-dimensional digital subtraction angiography of the left vertebral artery revealing the connection between the persistent fetal trigeminal artery and the posterior cavernous sinus; (h) Lateral view: Left internal carotid artery angiography illustrating complete resolution of fistula; (i) AP view: Left vertebral artery angiography illustrating complete resolution of fistula

DISCUSSION

The classification of carotid-cavernous fistulas was first proposed by Barrow in 1985. Four types were discussed, types A-D. Type A is a direct fistula between the carotid artery and cavernous sinus. These are often traumatic in origin and present rapidly after injury. Types B-D are indirect “dural shunts.”^[3] Persistent fetal trigeminal artery (PFTA) is the most common carotid-basilar anastomosis^[4] and was first demonstrated on angiogram by Sutton in 1950.^[5] Rarely this anastomosis has been implicated in traumatic cavernous-carotid fistula. Carotid-cavernous fistula (CCF) from a PFTA most closely mimics a Type B CCF as it is a result of communication of a primary ICA branch with the cavernous sinus. As in our case the symptoms are often of delayed onset.

Classically two types of PFTA were described by Saltzman in 1959. In type I, the ipsilateral posterior communicating artery and proximal basilar trunk are hypoplastic. Thus the distal basilar trunk relies on patent PFTA for perfusion. In type II, the distal basilar artery is supplied both by the vertebral arteries and the PFTA.^[6,7] All CCF with PFTA reports thus far, including the present case, have been of Type II. Kobayashi *et al.* suggest this may be due to Type II PFTA having structural fragility.^[2]

To date, there are seventeen reported cases of cavernous-carotid fistula associated with a persistent fetal trigeminal artery. Of those, only six were of traumatic origin.^[2] The most recent of these was treated by Cook, *et al.* with balloon occlusion of the fistula.^[8] Because a DSA run accurately depicted the origin of the fistula in our case, we felt the simplest solution was coil embolization through the takeoff of the PFTA.

In their review of the literature, Kobayashi *et al.* argue for dual arterial catheterization of FTA from anterior and posterior circulation to embolize a PFTA-cavernous

fistula.^[2] We argue that if the microcatheter is advanced into the posterior cavernous sinus from the ICA, coil embolization can obliterate both shunts. This simplifies the procedure and reduces the possible morbidity of dual superselective catheterization.

Carotid-cavernous fistula with associated fetal trigeminal artery can be modeled as an indirect CCF. This pathology was treated in our patient effectively and safely using single catheter coil embolization, and this serves as a viable treatment option.

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