Post-Traumatic Cavernous Fistula Fed by Persistent Trigeminal Artery: Treatment by GDC Embolisation

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Summary

A case of traumatic persistent primitive trigeminal artery (PPTA) cavernous sinus fistula treated with GDC embolisation is reported. Because of the small lumen of PPTA, posteriorly directed course and flow contribution from the posterior circulation, balloon embolisation via the carotid system was not considered appropriate. The fistula was successfully closed by GDC embolisation.

Introduction

The frequency of angiographic demonstration of carotid basilar anastomosis of the persistent trigeminal artery type is 0.1 to 0.2%¹. In this patient, the presenting neurological signs and symptoms that led to angiography were not thought to be related to this anatomic variant. We report a case of traumatic PPTA – cavernous sinus fistula treated by endovascular route using Guglielmi detachable coils (GDC) (Target Therapeutics Inc., San Jose, Calif.) with a good angiographic and clinical result. GDC occlusion of PPTA – cavernous sinus fistula has not been previously reported and this represents the first such report in the English literature.

Case Report

A 22-year-old recently married woman with a history of accidental fall from the first floor of her residence presented two weeks after injury with progressive proptosis in the left eye and diplopia. After hospitalization, bruit, blurred vision and restriction of external ocular movement were detected in the left eye.

Contrast CT scan revealed a fracture in the left petrous apex, bulging left cavernous sinus and dilated superior ophthalmic vein consistent with a diagnosis of carotidocavernous fistula. MR imaging showed a tortuous vascular structure coursing through Meckel's cave and entering the dilated left cavernous sinus (figure 1).

Left internal carotid angiogram demonstrated a carotidocavernous fistula between a small branch arising from C5 segment of the carotid artery (the PPTA) and the cavernous sinus (arrow in figure 2A). The left posterior cerebral artery was foetal. Left vertebral artery angiogram demonstrated a fistula between an artery arising from the basilar artery (the PPTA), proximal to the origin of the superior cerebellar artery, opening into the dilated cavernous sinus (figure 2B). Right internal carotid angiogram demonstrated a foetal right posterior cerebral artery as well. The patient underwent endovascular treatment of the PPTA cav-

Figure 1 Coronal T1 MR image showing prominent fistulous flow void of the PPTA in the left cavernous sinus (arrow in A). CT scan demonstrating the petrous bone fracture (hatched arrow in 1B).

ernous sinus fistula under general anaesthesia. Through the right femoral artery a 6F guiding catheter (Omniguide, Meditronic, Sunnyvale, CA) was placed in the right internal carotid artery. A Tracker 18 catheter (Target Therapeutics Inc., San Jose, Calif.) was introduced into

the fistula through the internal carotid artery. The fistula was occluded by a single soft GDC (5 x 12 mm). Post embolisation control angiogram revealed complete closure of fistula (figure 3). The patient withstood the procedure uneventfully. The fistula has remained occluded in the three month follow-up angiogram.

Discussion

Paget in 1948 suggested the name persistent trigeminal artery for this carotid basilar anastomosis because of its intimate relation to the Gasserian ganglion. The trigeminal artery is first seen in the 3 mm embryo as the second of two branches of the first aortic arch, which leaves the origin just lateral to the first branch (the first branch represents the primitive internal carotid artery). It crosses just medial to the trigeminal ganglion and communicates with the cranial end of primordial hind brain channel, the primitive rhombencephalic vessel of Sabin which serves as the principal blood supply to the primitive hind brain. During the 4 mm stage the primitive trigeminal artery communicates with fragments of the paired longitudinal neural arteries, which are being formed in the region of the future basilar artery. At the 7-12 mm, stage the paired longitudinal neural arteries fuse to form the basilar artery and involution of the trigeminal artery begins and is completely involuted by the 14 mm stage².

Several factors assist in the retrogression of PPTA. The developing posterior communicating artery usurps the role of trigeminal artery as a communication between the internal carotid artery and arteries of hindbrain. The basal sphenoid cartilage develops between the internal carotid artery and basilar ends of the PPTA and the axis of the trigeminal artery changes from a craniodorsal to a caudodorsal direction with respect to the internal carotid artery, while the formation of PPTA is related to the precocity of the trigeminal ganglion³.

The PPTA has its origin proximal to the meningo-hypophyseal trunk from the internal carotid artery and courses inferior and lateral to the abducens nerve, yet medial to the first division of the fifth nerve. In the cavernous sinus, the sixth cranial nerve lies inferior to this anomalous vessel which passes either lateral to the dorsum sellae or through it to reach the basilar artery between the origin of the superior

Figure 2 A) Digital subtraction left carotid angiogram lateral view showing the fistula from the PPTA (arrow pointing to the origin of PPTA). B) Digital subtraction left vertebral angiogram lateral view (hatched arrow pointing to the PPTA fistula and arrow points to the external carotid filling through occipital vertebral anastomosis) and anteroposterior view (C) demonstrating the persistent trigeminal cavernous fistula and the occipital vertebral anastomosis (arrow).

Figure 3 A) Lateral view of post-embolisation left vertebral angiogram (arrow pointing to GDC in the occluded fistula) and left internal carotid angiogram (B) showing complete closure of the fistula. The small stump of the PPTA is noticeable (arrow in B). Unsubtracted AP view of the left vertebral injection showing GDC in place (arrow in C).

cerebellar and anterior inferior cerebellar arteries^{4,7}. In Meckel's cave the PPTA may arch downwards internal to the trigeminal ganglion, turn medially, pierce the inner dural wall of the cave to enter the cavernous sinus and join the lateral aspect of the internal carotid artery at its most proximal cavernous portion or it may bypass Meckel's cave completely and enter the cavernous sinus through a separate foramen to join the internal carotid artery⁶.

PPTA may harbour structural defects that predispose them to the formation of aneurysms and/or rupture. If the weakened area in the vessel wall ruptures near its origin from the cavernous carotid artery, it results in a fistula^{4,8,9}. In

our case, the shear injury due to fall and fracture of the petrous apex aggravated the structural defects in the PPTA wall resulting in a fistula.

Saltzman described the angiographic anatomy and classification in 1959. In Saltzman type 1 anatomy, the basilar artery proximal to the insertion of the PPTA is hypoplastic and the posterior communicating arteries may be absent. Thus, PPTA is the main supply to the distal basilar artery, posterior cerebral artery and the superior cerebellar artery territories. In Saltzman type 2 anatomy the PPTA joins below the origin of superior cerebellar arteries and the posterior cerebellar arteries receive

their blood supply predominately through patent posterior communicating arteries. Saltzman type 3 is a combination of the first two types in which the ipsilateral posterior cerebral artery receives its blood supply through the posterior communicating arteries, while the anastomosis supplies the superior cerebellar artery bilaterally and the contralateral posterior cerebral artery¹⁰. Saltzman type I is a foetal type PPTA¹¹ and so it should not be occluded during treatment. In types 2 and 3 (adult PPTA), the basilar artery totally fills from one or both vertebral arteries and in this situation, the PPTA not being a mandatory collateral channel is dispensable. An understanding of this arterial anatomy is important especially when the PPTA is to be sacrificed during treatment¹². The direction of physiologic blood flow of the PPTA is usually from the internal carotid artery¹³. It is reversed in our case, probably because of a steal phenomenon by the carotid cavernous fistula.

The goal of therapy in repairing carotid cav-

ernous fistula is to preserve vision, eliminate intracranial shunt and obviate ischaemic and haemorrhagic complications while preserving the parent artery. Emergency treatment of this lesion is necessary when there is progressive vision loss and development of cortical and/or deep cerebral venous drainage^{14,15}.

The ideal endovascular approach in an adult type PPTA cavernous sinus fistula would be occlusion of PPTA. This can be achieved by balloon^{11,12,16,17} or coil¹⁸ placement to occlude the PPTA.

In the instant case, trauma with a resultant shear stress and fracture of petrous bone possibly caused the rupture of proximal PPTA whose wall might be congenitally weak. Angiography determined that our patient had an adult type PPTA (Saltzman type 2). The collateral channel thus being not functional, it was easier for us to decide on the occlusion of PPTA. GDC occlusion of fistulous point in PPTA in PPTA cavernous sinus fistula can close the fistula as is demonstrated in our case.

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