2 Endovascular Management of Carotid Cavernous Fistulas

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2.1 Classification of Carotid Cavernous Fistulas

The management of carotid cavernous fistulas (CCFs) depends on their physiopathology. The classification into traumatic and spontaneous CCFs is usually considered obsolete; it is, however, the first question that we ask when a patient with a CCF is referred to us. Knowing that a fistula is traumatic immediately tells us that we have a 95% chance of treating this fistula with a detachable balloon and with preservation of the carotid blood flow (CBF). Similarly, knowing that there is no history of trauma, one may conclude that a middle-aged patient with a red eye and a sixth nerve palsy probably has a spontaneous fistula of the dural type, while in the case of an older patient with this presentation one must consider the possibility of a ruptured preexisting cavernous aneurysm. Therefore, the age of the patient and the presence or absence of a history of trauma are important in the classification of CCFs.

With regard to therapy, however, the most important task is to classify the fistula as a fast flow or a slow flow fistula. The fast flow fistulas include the traumatic cases and the rare cases of ruptured cavernous aneurysms. The external carotid artery (ECA) is usually not involved in this type of fistula. The slow flow fistulas include most of the dural type CCFs. The ECA is almost always involved in this type of fistula, often from both sides, and the internal carotid artery (ICA) is frequently involved, at least on the ipsilateral side.

We will adhere to this classification throughout the chapter, referring to two types of CCF – type A and type B (DEBRUN et al. 1988b).

2.1.1 Type A CCFs

Type A CCFs are fast flow fistulas, which means that there is a sufficiently large tear between the ICA and the cavernous sinus (CS) to allow the passage of a balloon through the tear. The treatment for these fistulas consists in use of the detachable balloon technique, via the endarterial route. Other treatment modalities are considered only when the endarterial route fails. The ECA usually does not participate in the filling of the CS. As already mentioned, traumatic CCFs and ruptured cavernous aneurysms are type A CCFs.

2.1.2 Type B CCFs

Type B CCFs are slow flow fistulas. The communications between the ICA and the CS involve, when they exist, the small branches of the carotid siphon to the dura of the CS. They are too small to allow the passage of any type of balloon, with the consequence that this technique has no indication in most of these fistulas. It would in fact be an unacceptable mistake to occlude permanently the ICA with a balloon in this type of fistula. The potential risks of permanent occlusion of the ICA are unjustifiable in a disease which is usually benign, which has a substantial percentage of spontaneous cure, and which often involves both sides, simultaneously or sequentially.
The ECA is almost always involved in slow flow fistulas. According to the balance between the participation of the ECA and the ICA, three subgroups can be identified:

Type B1 involves only the ICA. It is exceptional. The relatively substantial number of these cases in certain reports is probably due to the fact that the cases in question were studied before the era of superselective catheterization of the ECA branches, causing the participation of the ECA to be overlooked.

Type B2 involves only the ECA branches. This type is relatively frequent and can be treated and cured with embolization of the ECA feeders only.

Type B3 involves both the ICA and the ECA. It is the most frequent type and represents 90% of the slow flow fistulas of the dural type. The treatment consists in embolizing the ECA feeders in the first stage. When the fistula is incompletely cured or recurs, the CS can be reached through the venous route, via either the inferior petrosal sinus (IPS) or the superior ophthalmic vein (SOV). The material used for embolization will typically be either solid particles or liquid polymerizing agents or coils but rarely detachable balloons introduced through the venous route (the IPS or SOV).

2.2 Traumatic Carotid Cavernous Fistulas

2.2.1 Clinical Presentation

Patients with traumatic CCFs develop an ipsilateral severe cavernous syndrome a few days or weeks after a major head injury. The fistula will rarely occur after a direct injury through the orbit or as a complication of rhizotomy, of transsphenoidal pituitary surgery, or of embolectomy of the carotid siphon with a Fogarty catheter (EGGERS et al. 1979; FLANDROY et al. 1988; FUENTES et al. 1985; SEKHAR et al. 1979). It is amazing how often these fistulas are diagnosed late. The symptomatology is in fact obvious but is sometimes neglected among the multiple injuries that these patients suffer from their trauma. If it were standard practice to auscultate the eyes of patients who develop any ocular symptom after a trauma, CCFs would be detected early.

The proptosis and chemosis are usually impressive. The cranial nerves are frequently involved, the sixth more often than the third. The vision is preserved unless the optic nerve is damaged by a fracture of the optic canal. The ocular pressure has to be checked by a neuro-ophthalmologist and the treatment should be performed rapidly if the ocular pressure rises to more than 40 mmHg. Even when the ocular pressure remains lower, the arterialization of the orbital veins induces a hypertensive venous retinopathy which sooner or later will cause vision to deteriorate (KUPERSMITH et al. 1986).

2.2.2 Angiographic Workup

The angiographic workup (Figs. 2.1–2.4) must provide the following information:
- Status of the carotid bifurcation
- Existence or not of atheroma at the origin of the ICA
- Presence of a loop of the ICA below the base of the skull
- Size of the CS and its relation to the subarachnoid space and the sphenoid sinus
- Existence or not of a complete steal
- Type of venous drainage of the CS
- Presence or absence of cortical venous drainage
- Location of the fistula on the carotid siphon
- Quality of the circle of Willis
- Absence (in most cases) of ECA contribution

This information will be provided by performing:
- Ipsilateral common carotid angiography
- Ipsilateral internal carotid angiography
- Ipsilateral external carotid angiography
- Contralateral common carotid angiography; posteroanterior view of the arterial phase only with rectangular collimation over the orbits. This procedure typically can be carried out without ipsilateral compression of the ICA: such compression is reserved for cases in which there is no cross-flow through the anterior communicating artery
- Vertebral angiography (usually on the left side) with ipsilateral compression of the ICA. The lateral view is the most important one. It will show whether the posterior communicating artery is patent and will demonstrate the size and location of the fistula on the carotid siphon.

Let us analyze the aforementioned items of information (Figs. 2.1–2.4):

1. The status of the carotid bifurcation is of great importance for the strategy of the treatment via the endarterial route. Sometimes there is a