Endovascular Treatment of a Large Venous Pouch Direct Carotid Cavernous Fistula

M. MAHMOUD¹, M.H. ELSISSY²

¹Faculty of Medicine, Ain Shams University; Cairo, Egypt

²Neurosurgery Department, Cairo University; Cairo, Egypt

Key words: carotid cavernous fistula, ICA occlusion

SUMMARY – *Endovascular treatment of direct carotid cavernous fistula (CCF) can be performed by either arterial or venous approaches. The aim is to disconnect the fistula with or without preservation of the internal carotid artery (ICA). The aim of this article is to describe a technique for embolization of the cavernous sinus and the ICA in direct CCF using coils. Trapping the distal aspect of the fistula using a retrograde navigation via the vertebrobasilar system and the posterior communicating artery was performed in two cases. Clinical and radiological evolutions are described.*

Introduction

CCF is a pathological communication between the internal or external carotid artery or both and the cavernous sinus. Barrow¹ classified this condition into direct (Type A) and indirect (Types B, C and D) CCF. Type A is a direct communication between the internal carotid artery (ICA) and the cavernous sinus, Type B between the meningeal branches of the ICA and the cavernous sinus, Type C between the meningeal branches of the external carotid artery (ECA) and the cavernous sinus and Type D between the meningeal branches of both the ECA and the ICA with the cavernous sinus.

Endovascular treatment of direct CCF aims to disconnect this abnormal communication with either carotid preservation or sacrifice. Many methods for endovascular treatment using detachable balloons with or without preservation of the ICA have been described starting with Serbinenko and Debrun et al.^{2,3}

Guglielmi electrically detachable coils (GDC) were introduced in 1991 and have been used described for CCF occlusion since 1997⁴.

Direct CCF (Type A) is caused by head trauma, ruptured cavernous segment aneurysm or collagen disease like Ehlers-Danlos IV syndrome^{5,6}.

Methods

This was a retrospective cohort study of consecutive traumatic CCF treated in our Institution. All medical data were reviewed to determine the treatment offered, immediate result, procedure-related complications and clinical evolution.

Patients and clinical presentation

Twelve patients (seven females and five males aged ten to 52 years) were treated by occlusion of the fistula and the ICA. Trauma was the predisposing factor in all cases.

The associated symptoms are listed in Table 1.

Inclusion criteria

Patients enrolled in this study were symptomatic complaining of diplopia, retrobulbar pain, headache, ptosis, chymosis, proptosis (Table 1). All patients enrolled in this study had a large tear in the ICA leading to large venous pouches making preservation of the ICA challenging.

Table 1 Patients and CCF demographics.

Case number	Age	Sex	Drainage	Contralateral cavernous sinus	Diplopia	Ecchymosis	Proptosis	Decreased visual acuity	Headache	Duration before treatment
1	10	M	SOV, IPS	Y	Y contralateral side	N	N	Y	N	2 m
2	19	F	SOV	N	Y	Y	Y	Y	Y	3 m
3	47	F	SOV	Y	Y	Y	Y	Y	Y	9 y
4	42	F	SOV, IPS	N	N	N	N	N	Y	2 m
5	25	F	SOV	N	Y	N	N	N	Y	6 m
6	42	M	SOV	Y	N	N	N	Y	N	8 m
7	35	F	SOV, IPS	N	N	N	N	N	N	3 m
8	39	F	SOV, IPS	Y	Y	N	N	Y	Y	1 m
9	52	F	SOV	Y	N	Y	Y	N	Y	1 m
10	41	M	SOV	N	N	N	Y	Y	Y	3 m
11	37	M	SOV, IPS	N	Y	N	N	Y	Y	2 m
12	33	M	SOV	N	Y	Y	Y	N	Y	1 y

Abbreviations: M=Male, F=Female, m= month, y=year, SOV=Superior Ophthalmic Vein, IPS=Inferior Petrosal Sinus, N=No, Y=Yes.

Exclusion criteria

Patients with a small tear and small venous pouches who could be treated by selective fistula occlusion with preservation of the ICA patency were excluded from this study.

Hypoplastic or aplastic A1 segment patients were another exclusion criteria, but none of the referred patients had this angiographic finding.

Angiographic characteristics

Of 12 cases, seven drained solely via the cavernous sinus and superior ophthalmic vein, five drained to the cavernous sinus, the superior ophthalmic vein and the inferior petrosal sinus. An intercavernous communication was present in five cases.

Technique

All cases were treated under general anaesthesia using bilateral femoral access. Systemic heparinization was given using 5000 IU of heparin as a bolus then continuous infusion of 1000 IU of heparin every hour. A 6 french Envoy catheter (Cordis, Miami, FL, USA) was

used as a guiding catheter; the other femoral access was used for control angiography in both ICA and the vertebral system. No balloon test occlusion (BTO) was done in five cases as there was filling of the anterior and middle cerebral arteries from the contralateral side via the anterior communicating artery. BTO was used in the remainder to assess the circle of Willis.

Angiographic assessment was performed by injecting the contralateral internal carotid artery while occluding the ICA using a Hyperglide 4×10 balloon. (ev3 Neurovascular, Irvine, CA, USA) Less than two seconds delay between both hemispheres was observed in the arterial, capillary and venous phases in all cases. We started by occluding the cavernous sinus then the ICA using coils. In two cases retrograde occlusion of the fistula was achieved using the posterior communicating artery (Pcom) approach after packing of the cavernous sinus and the ICA (Figure 1A-F).

Figure 1 A,B) 3D CTA and conventional angiography showing bilateral large venous pouches. C) Left ICA angiography following occlusion of the cavernous sinus and ICA with coils. D) Right ICA angiography showing no filling of the fistula following left ICA occlusion. E) Left vertebral angiography showing filling of the fistula via the Pcom. F) Left vertebral angiography showing occlusion of the fistula via retrograde approach.

As filling of the fistula was noted during vertebrobasilar angiography, an Excelsior 1018 microcatheter (Boston Scientific, Fremont, CA, USA) was used to navigate in the vertebrobasilar system, catheterizing the Pcom to reach the ICA below the level of the ophthalmic artery origin.

Coils were used to trap the fistula by occlusion of the ICA above the level of the fistula. This allowed complete exclusion of the fistula during control four axis angiography.

Results

Patients have been followed up for six months by clinical and radiological examination (MRI and or CT). No radiological evidence of CCF patency was noticed in any of the patients. No angiographic follow-up was performed in any of the patients.

Headache, proptosis and chymosis disappeared in all patients. Diplopia and abducens nerve palsy disappeared in four out of seven cases in the course of follow-up.

Discussion

There are two types of carotid cavernous fistula (CCF): direct fistula which is a direct communication between the ICA and the cavernous sinus and the dural type where there is an abnormal communication between the cavernous sinus and the meningeal arteries. Symptoms are related to the pattern of venous drainage. Anterior drainage via the valveless ophthalmic veins will lead to orbital symptoms. Posterior drainage via the petrosal sinuses will give less pronounced orbital symptoms. 76% of CCF are traumatic in origin⁷. The cavernous segment of the ICA is completely surrounded by a venous structure (the cavernous sinus). As the ICA is fixed to the dura at this level this will lead to a shearing effect in case of trauma leading to a fistulous communication between the arterial

side in the ICA and the venous side in the cavernous sinus⁸.

Other causes of direct CCF include ruptured intracavernous aneurysm, iatrogenic following transsphenoid surgery and Ehlers-Danlos Syndrome type IV⁹⁻¹¹. Preservation of the ICA was not possible in these cases. This is due to the large tear in the ICA, the large volume of the dilated cavernous sinus to be occluded and relative long duration of the disease in some cases. The lack of a 3D conventional angiography facility in our angiosuite made it more difficult to occlude the fistula selectively with preservation of the ICA. In two cases, following ICA occlusion, the fistula was opacified by the vertebrobasilar system via the posterior communicating artery (Pcom) which was not visualised in the pretreatment angiogram probably due to wash out of the contrast via the high flow fistula. Disappearance of this effect following occlusion of the ICA with partial occlusion of the cavernous sinus allowed opacification of the fistula via the posterior communicating artery. Navigation via the P1 segment to reach the cavernous segment of the ICA was feasible, the ICA was occluded at this level distal to the fistula and proximal to the origin of the ophthalmic artery. Trapping of the CCF fistula was previously described¹²⁻¹⁴ as an alternative and effective endovascular treatment of inaccessible CCF. Embolization using a transvenous approach is another way to treat inaccessible CCF from the arterial side. However venous rerouting may lead to cortical venous diversion which increases the risk of cerebral hemorrhage¹⁵.

Occlusion of the ICA without occluding the cavernous sinus may allow recanalization of the fistula. Samarawickrama et al. reported CCF recurrence two months after ICA occlusion using coils with the need to re-embolize the cavernous sinus using n-BCA¹⁶. Occluding the cavernous sinus, the fistula and the ICA with proximal trapping via the Pcom if needed theoretically lowers the probability of recanalization.

References

- 1 Barrow D, Spector R, Braun I, et al. Classification and treatment of spontaneous carotid cavernous sinus fistulas. *J Neurosurg.* 1985; 62: 248-256.
- 2 Serbinenko FA. Balloon catheter and occlusion of major cerebral vessels. *J Neurosurg.* 1974; 41: 125-143.
- 3 Debrun GM, Lecour P, Caron J. Experimental approach to the treatment of carotid cavernous fistulae with inflatable and isolated balloon. *Neuroradiology.* 1975; 9: 9-12.
- 4 Siniluto T, Seppanen S. Transarterial embolization of direct carotid cavernous fistula with GDC coils. *Am J Neuroradiol.* 1997; 18: 219-256.
- 5 Debrun GM, Viñuela F, Fox A, et al. Indications for treatment and classification of 132 carotid-cavernous fistulas. *Neurosurgery.* 1988; 22: 285-289.
- 6 Phatouros CC, Meyers PM, Dowd CF, et al. Carotid artery cavernous fistulas. *Neurosurg Clin North Am.* 2000; 11: 67-84.
- 7 Biousse V, Mendicino M, Simon D, et al. The Ophthalmology of Intracranial Vascular Abnormalities. *Am J Ophthalmol.* 1998; 125: 527-544.
- 8 Fabian T, Woody J, Ciraulo D, et al. Posttraumatic Carotid Cavernous Fistula: Frequency Analysis of Signs, Symptoms, and Disability Outcomes after Angiographic Embolization. *J Trauma.* 1999; 47: 275-281.
- 9 Van Rooj WJ, Sluzewski M, Beutels GN. Ruptured Cavernous Sinus Aneurysms Causing Carotid Cavernous Fistula: Incidence, Clinical Presentation, Treatment, and Outcome. *Am J Neuroradiol.* 2006; 27: 185-189.
- 10 Chuman H, Trobe JD, Petty EM, et al. Spontaneous direct carotid-cavernous fistula in Ehlers-Danlos syndrome type IV: two case reports and a review of the literature. *J Neuroophthalmol.* 2002; 22 (2): 75-81.
- 11 Pigott TJ, Holland IM, Punt JA. Carotico-cavernous fistula after trans-sphenoidal hypophysectomy. *Br J Neurosurg.* 1989; 3 (5): 613-616.
- 12 Debrun GM, Ausman JI, Charbel FT, et al. Access to the cavernous sinus through the vertebral artery: technical case report. *Neurosurgery.* 1995; 37: 144-147.
- 13 Luo CB, Chong FC, Teng MM, et al. Endovascular embolization of carotid-cavernous fistula using the posterior communicating artery approach: a case report. *Kaohsiung J Med Sci.* 2001; 17: 112-115.
- 14 Coley SC, Pandya H, Hodgson TJ, et al. Endovascular Trapping of Traumatic Carotid-Cavernous Fistulae. *Am J Neuroradiol.* 2003; 24: 1785-1788.
- 15 Lewis Ai, Tomsick TA, Tew JM. Management of 100 consecutive direct carotid-cavernous fistulas: result of treatment with detachable balloons. *Neurosurgery.* 1995; 36: 239-245.
- 16 Samarawickrama D, Somers S, Basu S, et al. E-073 n-BCA salvage of a recanalized carotid sacrifice in a patient with a direct carotid cavernous fistula. *J Neuro Intervent Surg.* 2012; 4: A77-A78.

Dr Mostafa Mahmoud, MD
Faculty of Medicine Abbassia
Ain Shams University
Cairo, 11566 Egypt
Tel.: 00201223627324
Fax: 0020226741265
E-mail: mmahmoud70@hotmail.com