

Case Report

Angiographic change on time interval in traumatic-direct carotid cavernous fistula without venous reflux, and treatment with LVIS stent alone^{☆,☆☆}



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ABSTRACT

Traumatic carotid cavernous fistula (CCF) is usually high flow, direct type and typically manifested by venous hypertension and reflux, therefore it can lead to various neurologic deficit as well as severe ophthalmic symptoms including exophthalmos, congestion and visual disturbance. On the contrary, in traumatic-direct CCF without high flow that causes venous hypertension and/or reflux, the natural clinical course is obscure, and the diagnosis may be difficult. The treatment has not been well documented in detail. We are reporting on sequential angiographic change on time interval in traumatic-direct CCF without venous hypertension and/or reflux, and experience of treatment using LVIS stent.

1. Introduction

Carotid-cavernous fistula (CCF) results from an abnormal arteriovenous communication between the carotid artery and cavernous sinus. CCF is classified according to blood flow characteristics and causes, which can be divided into low flow or high flow, traumatic or spontaneous, direct or indirect. The direct type is a form in which the internal carotid artery (ICA) itself has an abnormal connection with the cavernous sinus and is usually caused by head trauma (violence, falls, car accident or iatrogenic) [1]. In the traumatic direct type, a traumatic tear in the wall of the internal carotid artery usually makes a high pressure conduit to the cavernous sinus, which usually leads to venous hypertension and reflux within a short time interval. Therefore, symptoms are usually presented within days after injury of ICA. When a traumatic-direct type does not show initial symptoms such as exophthalmos, congestion or visual disturbance due to low flow, which does not cause venous hypertension or reflux, the diagnosis may be difficult and in such cases the natural course and management plan has not been so well reported in the literature. We experienced two cases of direct CCF without venous reflux and confirmed the contradictory angiographic changes in time interval in each case. In addition, we report our experience on the use of with Low-profile Visualized Intraluminal Support (LVIS) device in early-onset, non-symptomatic traumatic-direct types CCF.

2. Case reports

2.1. Case I

A 45-year-old male was transferred to our hospital after a penetrating injury by a steel rod while working. As the patient slipped, the steel rod had penetrated the skull base through the nose. He had facial pain, headache and decreased consciousness. Neurological examination showed drowsy consciousness and oculomotor, abducens nerve palsy on the ipsilateral side. Computerized tomography (CT) scan revealed intracerebral hemorrhage in the left temporal lobe with central skull base fracture, especially a lateral wall fracture of the sphenoid sinus on the left side (Fig. 1A and B). There was no enlargement of ophthalmic vein nor ocular symptoms suggesting CCF, but considering the type, site of injury and accompanying cranial nerve injury, vascular evaluation was performed. Conventional angiogram defined a very low flow, small leakage from cavernous portion of ICA, but there was no reflux into the draining vein such as the ophthalmic vein (Fig. 1C and D). Initially, active management was not considered because, despite being a direct type of CCF, there was no venous reflux causing ophthalmic vein enlargement nor any overt symptoms. In follow up angiogram one week later, flow velocity had increased and the amount of leakage was more aggravated (Fig. 1E and F). Over time, the lesion was thought to be worse, and active treatment was considered. In a CCF without reflux, total occlusion of Cavernous sinus via a trans-venous approach was considered inappropriate. Selection of fistula portion of microcatheter

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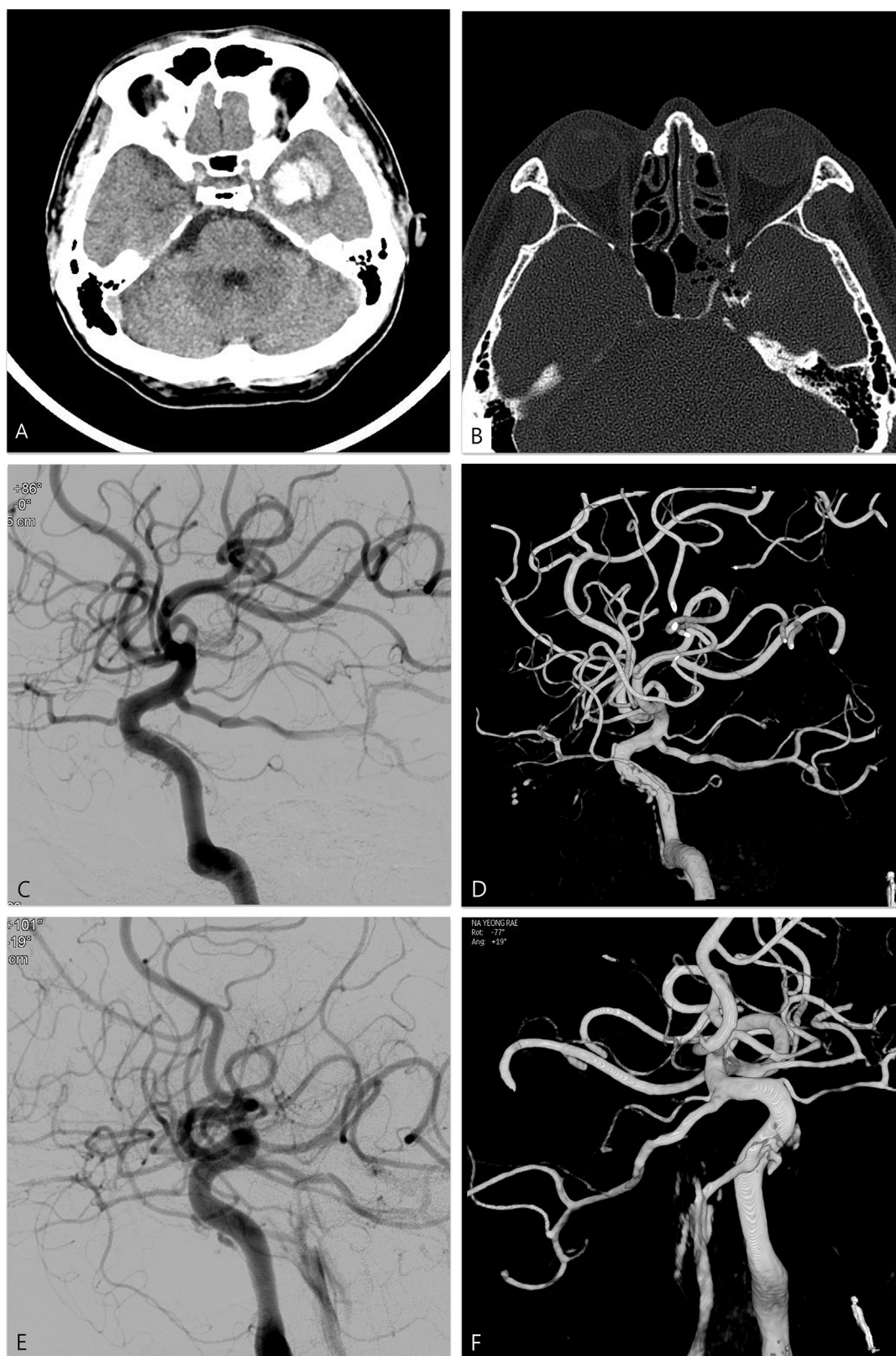


Fig. 1. A. Initial CT scan revealed traumatic ICH in the left temporal lobe.

B. Bone setting image of CT showed central skull base fracture, especially lateral wall fracture of sphenoid sinus on left side.

C and D. Conventional angiogram defined very low flow and small leakage from cavernous portion of ICA, but there was no reflux of draining vein such ophthalmic vein.

E and F. In follow up angiogram of one week later, flow velocity was more faster and amount of leakage was more aggravated.

G. LVIS stent was deployed in fistula portion.

H. After 10 min, complete occlusion of fistula was achieved.



Fig. 1. (continued)

via a trans-arterial approach was also not easy because of the small leakage opening. To facilitate hemodynamic changes in the reflux, we planned to install a stent. Due to the coverage permitted in our insurance policy, because there is a limitation on the use of flow diversion stent such as Pipeline for CCF, Low-profile Visualized Intraluminal Support (LVIS®; MicroVention-Terumo, Tustin, CA, USA) device characterized by small cell size and higher degree of metal coverage (approximately 23%) which is more dense than the conventional assist stent such as Enterprise (8%) or Neuroform, but lower than the flow diverter (FD) such as the Pipeline device (approximately 30–35%) was used (Fig. 1G). There was no angiographic change immediately after stent deployment. But, as time passed, there was a distinctive decrease in the leakage as well as the velocity of the flow, and after 10 min, complete occlusion of fistula was achieved (Fig. 1H). Flow diversion effect had occurred with the stent alone. The neurological symptoms were gradually improved and the cranial nerve palsy and diplopia had fully recovered after 3 months.

2.2. Case II

A 63-year-old male was transferred to our ER with complaints of drowsy consciousness after a Motor vehicle accident. CT scan revealed epidural, subdural hemorrhage and extensive fractures on the skull base: right frontotemporal bone, anterior and lateral wall of temporal fossa, orbit and maxillary sinus. There were no ocular symptoms suggesting CCF, but because of the extensive skull base fractures vascular evaluation was done. Conventional angiogram demonstrated very low flow and small leakage without reflux into cortical and/or ophthalmic veins from cavernous portion of ICA, and also additional dural arteriovenous fistula in the frontal area (Fig. 2A). Because there was no reflux nor symptoms, we initially decided to observe closely at the onset. In the follow up angiograms after 1 week, the flow velocity as well as the amount of leakage had decreased markedly. One week thereafter, there was spontaneous complete occlusion as seen on the cerebral angiogram (Fig. 2B and C).

3. Discussion

CCFs can be classified into several forms depending on the etiology (traumatic or spontaneous), flow velocity (high flow or low flow), or the angiographic architecture (direct or indirect). According to Barrow's classifications, depending on the arterial supply, type A is the direct communications between the internal carotid artery (ICA) and the

cavernous sinus. Types B, C, and D are dural arteriovenous fistulas (DAVFs) supplied by the meningeal arteries of the ICA and/or the external carotid artery (ECA) [2]. In direct CCF, arterial blood flows directly through a defect in wall of the ICA and usually has high flow. It changes venous blood more rapidly to arterialized blood. The most common symptoms of CCF are ocular symptoms such as exophthalmos or proptosis caused by anterior venous drainage [2,3]. Although aggressive neurological symptoms such as intracranial hemorrhage are not frequent in the benign venous drainage pattern, but fistulas with dangerous venous drainage patterns can have potential risk of hemorrhage, infarction, cerebral edema or blindness: cortical venous reflux without other venous drainages (hemorrhagic infarction), dominant deep venous drainage (hemorrhage, edema) and thrombosis of the central retinal vein (blindness). In cases of rapidly deteriorating ocular symptoms and/or cortical venous drainage, urgent interventional therapy is indicated [4].

On imaging studies such as CT and MRI, CCF may present with enlarged SOV, thick extraocular muscles and evidence of enlarged cavernous sinus with a convexity of the lateral wall [5]. These changes can only make one suspect a fistula. Serial dynamic enhanced CT has been found to be useful for the initial diagnosis of both high- and low-flow CCFs [6]. MR angiogram may demonstrate some of the higher-flow fistulas, but may not provide the detection or details for complete evaluation and treatment in low flow or mild conditions. Color Doppler images may demonstrate arterialized blood flow in dilated SOV [7]. Bilateral selective arteriography may be necessary to completely characterize the blood supply and drainage of fistula. In our case, despite being a direct type, because there is no venous reflux that causes SOV enlargement and symptoms due to relatively low flow, it was difficult to diagnose using CT or MRI. In the direct type, even if there is a small amount of leakage in the early stage after trauma, we think it may be worsen over time. Therefore, if there is a trauma that can cause CCF, even if there are no obvious findings on CT or MRI, cerebral angiography may need to be considered.

The goal of treatment in direct CCFs is to occlude the site of communication between the ICA and the cavernous sinus while preserving the patency of the ICA. This goal is usually accomplished through either transarterial obliteration of the fistulas with a detachable balloon or transvenous obliteration of the ipsilateral cavernous sinus with coils, other embolic materials [6,8]. Deployment of a covered stent across the fistula may be options of treatment [9]. Transvenous may be an option in direct CCFs that cannot be treated by a transarterial route because of inaccessibility of the proximal ICA secondary to traumatic injury,

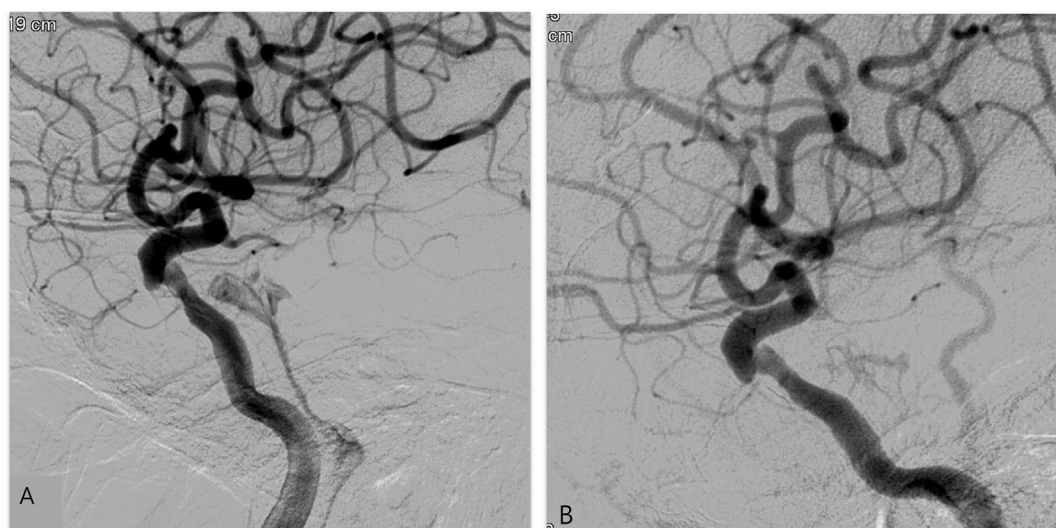


Fig. 2. A. Conventional angiogram demonstrated not only very low flow and small leakage without no reflux into cortical and/or ophthalmic vein from cavernous portion of ICA.

B and C. In follow-up angiogram after 1 week, flow velocity and amount of leakage was marked decreased without any treatment. After one week thereafter, complete occlusion was achieved spontaneously in cerebral angiogram.

severe tortuosity, and/or inability to catheterize the ICA tear. Treatment with detachable balloons is reported to have a high incidence of pseudoaneurysms of 30–44% due to ICA wall defects in the previous fistula. Detachable coils also may have their limitations such as parent artery occlusion or thrombo-embolism by herniation or jumping of coils into the parent vessel [10]. Covered or grafted stents may be difficult to access if the vessel is severe tortuous. Each treatment has its advantages and disadvantages. It is important to choose the appropriate treatment according to the clinical situations. In CCF with very small outflow opening and low flow, the stent-induced blood flow can be expected. LVIS stent is a self-expanding single-wire braid, closed-cell microstent. With a cell size of 1.0 mm. LVIS is characterized by small cell size and more coverage compared to other assist stents. Therefore, the flow diverter effect may be expected more than other assist stent. On limitation on the use of flow diversion stent for CCF, stent with small cell size and more coverage such as LVIS stent may be more helpful.

4. Conclusion

In traumatic-direct CCF with very small outflow opening and low flow, we have experienced one case that healed spontaneously and another that required intervention. In cases of traumatic-direct CCF with favorable angiographic characteristics, without overt symptoms, close sequential observation and short term follow-up may be important option. Progressively worsening symptoms and hemodynamic change will require repeated angiograms and definite endovascular treatment. LVIS stents with small cell size and more coverage device may be helpful in CCF with low flow and small opening.

Conflict of interest

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