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*Case Report*

# Comprehensive endovascular treatments of traumatic pseudoaneurysm of the posterior communicating artery combined with cavernous sinus fistula: a case report and literature review

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**Abstract:** A 23-year-old woman experienced a serious accident, resulting in multiple fractures of the skull base. Forty-five days after the injury, the patient presented with symptoms such as conjunctival congestion, ptosis of the eyelids, and blurred vision. Head CTA (CT angiography); revealed an arterial aneurysm in the cavernous sinus region. Angiography revealed a giant posterior communicating artery aneurysm combined with a cavernous sinus fistula. Subsequently, the patient was treated using a covered stent, coils, and Onyx- 18. After treatment, both the aneurysm and cavernous sinus fistula were embolized, and the clinical symptoms improved significantly. The combination of a covered stent, coils, and Onyx- 18 is a safe and effective treatment method for post-traumatic pseudoaneurysm of the posterior communicating artery combined with cavernous sinus fistula.

**Keywords:** Traumatic aneurysm, carotid-cavernous fistula, posterior communicating artery, endovascular, coil embolization, covered stent

## Introduction

Traumatic cavernous sinus fistulas refer to an abnormal vascular shunt between the cavernous sinus and surrounding vessels. The distribution of vessels around the cavernous sinus is complex, and complicated cavernous sinus fistulas are easily formed after trauma, which produces a variety of symptoms. The treatment for this condition is also complex. We report the case of a patient with a rare post-traumatic pseudoaneurysm of the posterior communicating artery combined with a cavernous sinus fistula, who was admitted to our center and was successfully treated using integrated approaches.

## Case report

The 23-year-old woman sustained a head injury in an accident on October 6, 2016, and received treatment at another hospital. The right eye showed cyanosis and swelling, while the left eye was asymptomatic. Head CT revealed subarachnoid hemorrhage, cerebral contusion and laceration, intracranial pneumatocele, fracture in the right frontal temporal bone, and multiple fractures of the skull base (**Figure 1A** and **1B**). The following clinical diagnoses were made: multiple injury, cerebral contusion and laceration, subarachnoid hemorrhage, intracranial pneumatocele, fracture of the right frontal temporal bone, multiple fractures of the skull base, and forehead scalp laceration. The forehead scalp laceration was treated by debridement and stitching. Meanwhile, drug therapy was administered, after which, the patient's condition gradually improved. On November 20, 2016, the patient was found to have ptosis of the left eyelid, and was readmitted to the other hospital for treatment. A physical examination revealed such symptoms as the enlargement of the left pupil by about 5 mm, the absence of direct and indirect light reflexes, limited eyeball adduction, conjunctival congestion, drooping eyelids, blurred vision, no murmur behind the

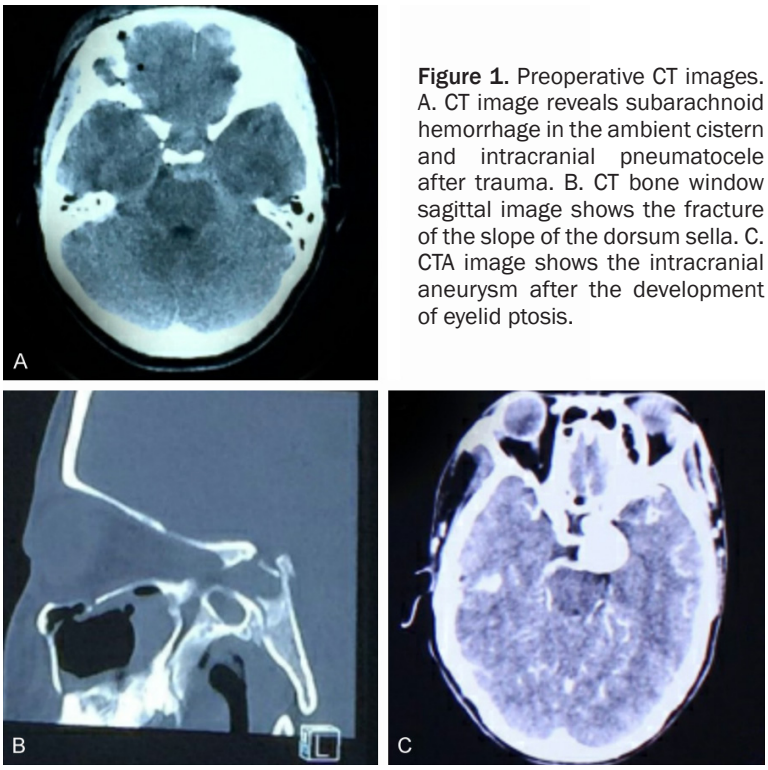


**Figure 1.** Preoperative CT images. A. CT image reveals subarachnoid hemorrhage in the ambient cistern and intracranial pneumatocele after trauma. B. CT bone window sagittal image shows the fracture of the slope of the dorsum sella. C. CTA image shows the intracranial aneurysm after the development of eyelid ptosis.

eyeball, and dysdipsia. Head CT and CTA performed at the other hospital revealed a giant aneurysm in the left cavernous sinus region (**Figure 1C**). For further diagnosis and treatment, the patient was transferred to our hospital.

Endovascular treatment was performed under general anesthesia on December 22, 2016. Both femoral arteries were punctured. A 5F Navien catheter (EV3, Plymouth, MN, USA) was placed in the left internal carotid artery, and a 5F Guiding catheter (Godman USA) was placed in the right vertebral artery. A 4 mm × 7 mm Hyperform balloon (EV3, Plymouth, MN, USA) was placed at the fistula of the posterior communicating segment in the left internal carotid artery. Angiography of the left internal carotid artery revealed no development of aneurysm and cavernous sinus fistula in the proximal to the balloon after balloon inflation, thus illustrating that no rupture existed in the cavernous segment of the internal carotid artery. Angiography of the right vertebral artery revealed that the posterior communicating artery pseudoaneurysm developed and the cavernous sinus was inflated. The balloon was emptied, and an Echelon-10 microcatheter (EV3, Plymouth, MN, USA) was placed at the rupture of the left posterior communicating artery via the right vertebral artery. Micro angiography revealed the location of the rupture. The coil could not be installed as planned because of the fast blood flow. Occlusion of the posterior segment of the left internal carotid artery with a balloon was performed again to reduce the blood flow. Thereafter, three ev3 coils (3D 4 mm × 12 cm; 3 mm × 8 cm; and Helix 2 mm × 8 cm) (EV3, Plymouth, MN, USA) were placed quickly and successively from the far end to the near end via the Echelon-10 microcatheter to block the posterior communicating artery aneurysm fistula. Angiography revealed that the fistula still developed. Approximately 0.1 ml of Onyx-18 (EV3, Plymouth, MN, USA) was injected via the Echelon-10 microcatheter to completely block the aneurysm fistula. The contrast injection via the vertebral artery confirmed that the aneurysm and cavernous sinus fistula had not developed. The left internal carotid artery balloon was withdrawn, and left internal carotid angiography revealed the development of the aneurysm. A 4 mm × 10 mm WILLIS covered stents (MicroPort, Medical Company Shanghai, China) covered stent was placed at the posterior communicating artery segment of the internal carotid artery (**Figure 2A-G**). Postoperative angiography revealed that the left internal carotid artery had been repaired, the distal branch had developed well, and the pseudoaneurysm and cavernous sinus fistula had not developed (**Figure 2H**).

Two hours before the surgery, the patient was given 200 mg of aspirin and 300 mg of clopidogrel at a draught. Moreover, 8 ml of tirofiban (dosage: 5 mg, 100 ml) was intravenously injected and micropumped at the rate of 3 ml/h until 12:00 noon the following day. Bayaspirin (100 mg qd) and clopidogrel (75 mg qd) were given since 8:00 am the following day.

On the 3rd day post operation, the patient's left pupil diameter was about 5 mm, direct and indi-

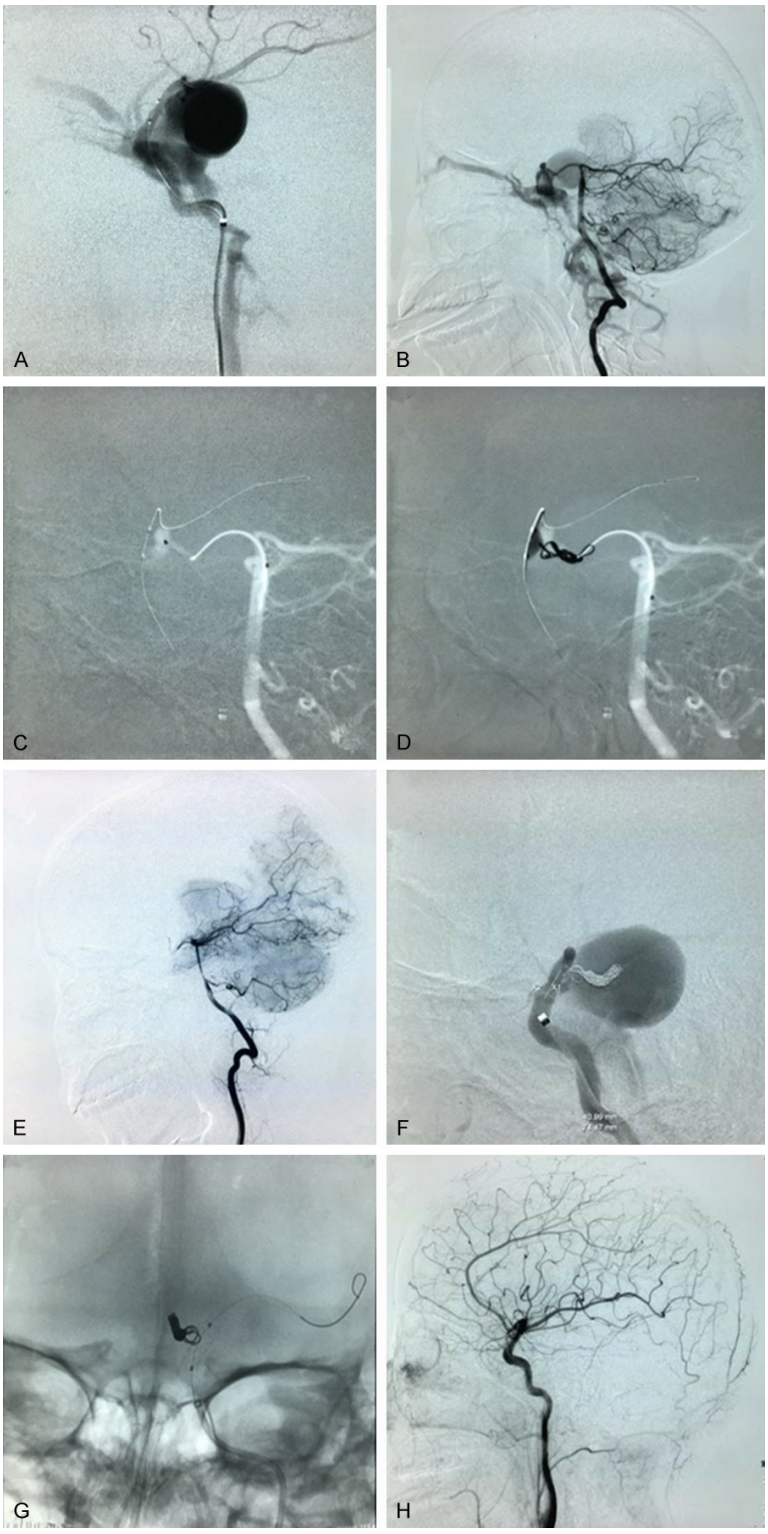


**Figure 2.** Angiograms in the operative. A. Lateral image of the left internal carotid artery showing the balloon placed at the suspicious rupture of the posterior communicating artery segment of the internal carotid artery. B. Lateral angiography of the right vertebral artery shows the rupture of the posterior communicating artery and the formation of the pseudoaneurysm and fistula. C. Lateral image of the right vertebral artery showing the Echelon-10 microcatheter placed at the rupture of the posterior communicating artery. D. Coil embolization is performed via the Echelon-10 microcatheter with the assistance of a balloon. E. Lateral angiography of the vertebral artery after coil embolization and Onyx 18 injection shows the disappearance of the pseudoaneurysm and cavernous sinus fistula. F and G. A WILLIS stent is placed in the posterior communicating artery segment of the internal carotid artery. H. Left internal carotid artery angiography after the treatment reveals the disappearance of the pseudoaneurysm and cavernous sinus fistula.

rect light reflexes disappeared, limitation of eye adduction was better than the preoperative level, conjunctival congestion was absent, and ptosis of the eyelid was better than before treatment. The patient's blurred vision and hoarse voice both improved compared to preoperative levels. The dysdipsia symptom was absent. Review of cranial MRI showed thrombosis in the aneurysm and its shrinkage.

Angiograms at 3 months after the operation. There revealed that the pseudoaneurysm and cavernous sinus fistula disappearanced (**Figure 3A** and **3B**). The patient's left and right pupils diameter was about 3mm with normal, direct and indirect light reflexes. Such symptoms as limitation of eye adduction, conjunctival congestion and eyelid ptosis were absent. The patient's blurred vision and hoarse voice both improved compared to preoperative levels.

## Discussion

Barrow [1] classified carotid cavernous fistulas into two types: high flow and low flow. Traumatic carotid cavernous fistula is often a high-flow fis-

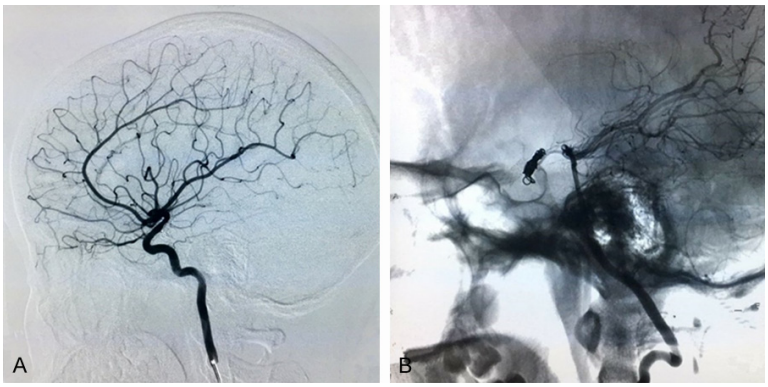


**Figure 3.** Angiograms at 3 months after the operative. A. Left internal carotid artery angiography reveals the disappearance of the pseudoaneurysm and cavernous sinus fistula. B. Angiography of the right vertebral artery reveals the disappearance of the pseudoaneurysm and cavernous sinus fistula.

tula. The general treatment for this condition is balloon occlusion.

The combination of a pseudoaneurysm with a cavernous sinus fistula induced by the posterior communicating artery after trauma is rare. Only seven cases of this condition have been reported to date [2-8]. The anatomic relationship around the cavernous sinus determines the pathogenesis of the disease. The possible mechanism underlying the formation of an internal carotid artery aneurysm in the dura after trauma is as follows: 1) the fracture of the skull base directly injures the internal carotid artery; 2) the head injury excessively stretches and twists the siphon segment of the internal carotid artery; and 3) the internal carotid artery is impacted by the surrounding bony structures [9, 10]. In this case, the CT scan performed after injury did not reveal an aneurysm, but a review of the head CT scan performed 30 days after the injury revealed a parasellar aneurysm. We considered that the aneurysm was caused by trauma without any congenital cause. It is well-known showed that the posterior communicating artery originates from subdural [11, 12]. Cavernous sinus fistulas do not form naturally after a posterior communicating artery injury. In this case, the patient had a clear trauma history and extensive bone fractures in the slope and dorsum sella. These structures are adjacent to the area of the posterior communicating artery from the internal carotid artery. Therefore, we considered that both excessive stretch-induced posterior communicating artery injury and cavernous sinus dural rip caused by the fractures led to the pseudoaneurysm and cavernous sinus fistula. We analyzed the phenomenon by which the pseudoaneurysm and cavernous sinus fistula were not formed in the seven previously reported cases and in our patient immediately after trauma. We considered that the pseudoaneurysm and cavernous sinus fistula might have gradually formed in our patient because of the gradual errhysis at the rupture of the posterior communicating artery, the lower venous drainage pressure in the cavernous sinus region, and the induced pressure differences between the posterior communicating artery and the cavernous sinus. If the cavernous sinus fistula had not formed, the pseudoaneurysm would have bursted as the pressure increased, and this would have been very dangerous for the patient.

The clinical symptoms of these diseases are generally as follows: cavernous sinus and oculomotor nerve compression symptoms, conjunctival congestion, proptosis, ptosis of the eyelids, eyeball movement disorder, blurred vision, and murmur in the orbital region. The case reported by Chen [6] presented polyuria and hyponatremia. They argued that the posterior communicating artery provided pituitary blood supply, and the injury to this artery disrupted the transportation of antidiuretic hormone produced by the pituitary stalk, thereby resulting in diabetes insipidus and electrolyte disorder. In the present case, the cavernous sinus symptoms were less severe and chemosis was mild, with no proptosis and murmur in the orbital region, which could be attributed to the shorter time of onset from injury. These symptoms may also occur over time. Our patient also presented supervened dysdipsia, which was absent in the patients reported in the other cases. This may be related to the posterior circulation ischemia resulting from blood steal induced by the posterior communicating artery rupture into the cavernous sinus. After treatment, however, these symptoms also improved significantly.

At present, the treatment of this rare disease is complicated. Tytle [2] and Fu [3] performed craniotomy and clipped the pseudoaneurysm. Weaver [4] performed coil embolization at the posterior communicating artery via the vertebral artery. Oran [5] performed coil embolization via the internal carotid artery and vertebral artery. Chen [6] and Du [8] performed coil embolization via the internal carotid artery. Jin bo [7] performed coil embolization at the posterior communicating artery via the vertebral artery with simultaneous sealant embolization. The purpose of the treatment is to eliminate the cavernous sinus fistula and pseudoaneurysm. Moreover, these treatments differ from the common balloon occlusion of the carotid cavernous fistula. The risk of craniotomy is high and pseudoaneurysms lack a vessel wall; this may lead to massive hemorrhage during surgery. Therefore, endovascular treatment is the best choice. We used the following procedure for endovascular treatment: coil and Onyx- 18 embolization was used to eliminate the posterior cerebral artery pole of the posterior communicating artery via the vertebral artery. Although we encountered difficulties when placing the first coil because of the high blood flow, we could still place the coil successfully with the assistance of a balloon. The placement of a covered stent in the internal carotid artery blocked the internal carotid artery pole of the posterior communicating artery, so that the cavernous sinus fistula and pseudoaneurysm were trapped. The placement of a covered stent to place the covered stents was relatively simple and fast, and helped maintain the normal anatomy of the internal carotid artery [13-16]. If we have used many coils to pack the pseudoaneurysm instead of a covered stent, the coils would have led to severe occupation effect. To our knowledge, this is the first report on the use of such a variety of treatments in a case of post-traumatic pseudoaneurysm of the posterior communicating artery combined with cavernous sinus fistula. Moreover, the treatments proved safe and effective in treating this rare condition.

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## Disclosure of conflict of interest

None.

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