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Traumatic Supraclinioid Internal Carotid Artery Pseudoaneurysm and Carotid-Cavernous Fistula: A Case Report and Review of Literatures

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Abstract

We present a teen scooter rider who suffered from a major traffic accident. Multiple skull base fractures, subarachnoid hemorrhage (SAH), and a supraclinoid ICA pseudoaneurysm with transdural connection to the Cavernous Sinus (CS), forming Carotid-Cavernous Fistula (CCF), were diagnosed by brain computed tomography (CT) and angiography. Endovascular treatment was done 4 days later, and initial complete occlusion was achieved by combined transarterial and transvenous coil embolization. However, the recurrent pseudoaneurysm was found 19 days later and ruptured before the 2nd session of treatment. We did a thorough search of Pubmed and reviewed the 17 cases of intradural pseudoaneurysm with CCF. Concomitant SAH (7/17) is relatively common in this subgroup of CCF. Most of them (12/17) received endovascular treatment. Four of them received surgery. Complete occlusion of pseudoaneurysm and fistula was achieved in 14 of them. Recurrence after complete occlusion was noted in 1 case. Including our case, recurrent pseudoaneurysm is uncommon but not rare (2/16). Early angiography following up in less than 14 days after treatment was suggested.

Background

Traumatic direct Carotid-Cavernous Fistula (CCF) usually results from a defect at the wall of the cavernous segment of the internal carotid artery (ICA) and subsequent communication between ICA and the Cavernous Sinus (CS). Subarachnoid Hemorrhage (SAH) may be found in less than 5% of CCF patients [1]. On the other hand, traumatic CCF associated with the injury of the supraclinoid segment of the ICA is a rare condition. In this report, we present a traumatic supraclinoid ICA pseudoaneurysm with CCF treated with endovascular coiling, and recurrence occurred 19 days after initial complete occlusion.

Case report

A teen scooter rider collided with a car and was sent to our hospital. The patient's Glasgow Coma Scale was 7 (E1V2M4), and the patient was emergently intubated for airway protection. The first brain Computed Tomography (CT) revealed diffuse SAH, Intraventricular Hemorrhage (IVH), and fractures of sphenoid, ethmoid, and frontal bones **(Figure 1(c))**. CT angiography revealed abnormal contrast opacification at the left CS and a connected structure abutting the left aspect of the clivus **(Figure 1(b)(d)(e))**. A defect at the supraclinoid segment of the left ICA was suspected. The angiography and 3D Digital Subtrac-

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tion Angiography (DSA) confirmed a defect at the supraclinoid segment of the left ICA just proximal to the anterior choroidal artery and formation of a pseudoaneurysm **(Figure 2)**. The blood in the pseudoaneurysm drained into the left CS **(Figure 2(b))**. Fracture of left sphenoid sinus near the dural defect was noticed on cone-beam CT **(Figure 2(c))**. Contrast injected into the right ICA flowed through the anterior communicating artery (AComA) and into the left Middle Cerebral Artery (MCA), faintly opacifying the left CS, which was suggestive of retrograde blood flow into the terminal left ICA. Balloon occlusion test was not performed due to altered mental status.

According to angiographic findings, it was reasonable to sacrifice the diseased left ICA or deploy a covered stent at it. However, preservation of the opening of the nearby anterior choroidal artery is difficult after these treatments. It may result in grave neurological outcomes if the blood flow of the anterior choroidal artery was compromised. Therefore, he was treated on the fourth day of admission by combined transarterial and transvenous coil embolization of the pseudoaneurysm and fistula with the help of a retrievable stent (Solitaire AB Neurovascular Remodeling Device, Medtronic) in the left ICA for protection. The CS was left free of coils. The stent was removed at the end of embolization. The final DSA showed complete obliteration of the pseudoaneurysm and CCF **(Figure 4)**. Patency of the left ICA and the anterior choroidal artery was preserved. However, a follow-up angiography done 19 days after treatment revealed a recurrent pseudoaneurysm and suspicious coil compaction **(Figure 5)**. Flow diverter deployment was arranged after discussion with the patient's family. Unfortunately, the pseudoaneurysm ruptured before the procedure, and the patient passed away 28 days after the trauma.

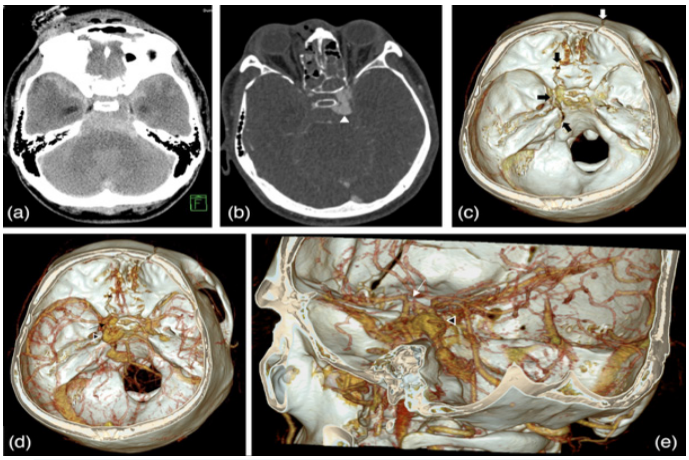

Figure 1: Initial brain CT and CTA. **(a)** Non-enhanced CT in axial view. Note subarachnoid hemorrhage which spread extensively but mostly at prepontine cistern; **(b)** CTA in axial views. Note early opacification of left cavernous sinus (arrow head); **(c)** VRT (volume rendering technique) of non-enhanced CT after removal of overlying skull. Note fracture of right frontal bone (thick white arrow) and left skull base extending posteriorly into dehiscence between clivus and petrous bone (thick black arrow); VRT of CTA after removal of the overlying skull in cranial-caudal view **(d)** and left posterior oblique view **(e)**. Note the pseudoaneurysm (arrow head) and its drainage route abutting the left aspect of clivus. Note the defect of supraclinoid ICA (thin arrow).

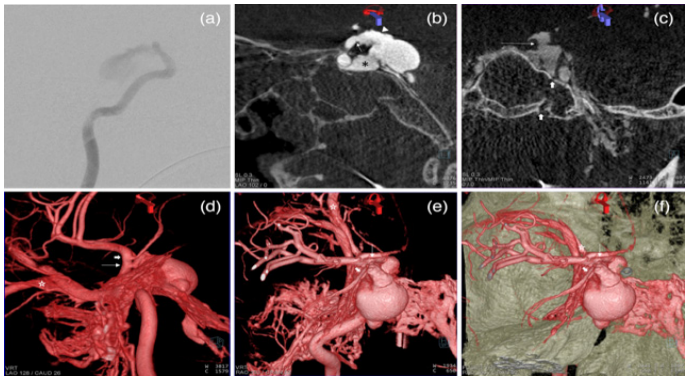

Figure 2: Diagnostic angiography before embolization. **(a)** DSA during left ICA injection in lateral view. Note early opacification of pseudoaneurysm from the supraclinoid segment of left ICA. **(b)** MPR (multiplanar reconstruction) of 3D DSA during left ICA injection in oblique sagittal view. Note the defect (thin arrow) of supraclinoid ICA, the associated pseudoaneurysm (arrow head) and the early opacification of cavernous sinus (asterisk). **(c)** MPR of 3D DSA during left ICA injection in coronal view. Note the suspected dural tear (long arrow) and nearby fracture (thick arrow). Reconstruction of 3D DSA of left ICA in left posterior oblique view **(d)**, cranial posterior oblique view **(e)** and cranial posterior oblique view with underlying bony structure **(f)**. Note a small defect (thin arrow) at supraclinoid ICA and the nearby anterior choroidal artery (thick arrow). Note the engorged superior ophthalmic vein (star).

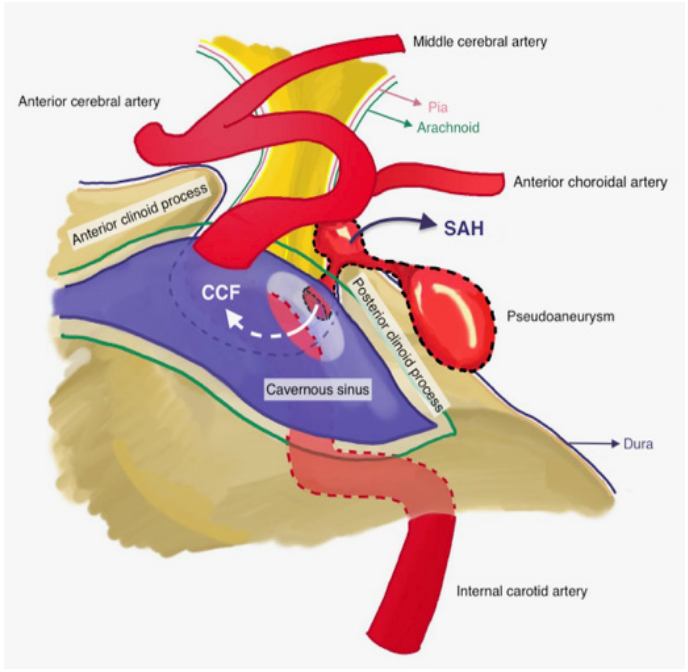

Figure 3: Schematic demonstration of the location of the pseudoaneurysm and its association with the cavernous sinus (SAH: Subarachnoid Hemorrhage; CCF: Carotid-Cavernous Fistula).

Table 1: Summary of treatment for posttraumatic intradural CCF in reported case.

Authors (year)	Presenting symptoms	Fracture	Trauma treated at another hospital	SAH	Interval*	Aneurysm site	Treatment	Procedure outcome (follow up angiography)
Reddy et al. (1981)[10]	Proptosis, bruit, blindness	Orbital rim, ethmoid sinus	-	-	5 months	ICA	ICA ligation	Success (Yes. Unknown time interval.)
Komiyama et al. (1991)[11]	CCF triad	Frontal base	-	+	10 days	ICA	Transarterial balloon embolization (ICA preservation)	Minimal residual fistula. Post-procedure SAH and IVH managed with ICA trapping. (Residual aneurysm pouch. No fistula.)
Masana et al. (1992)[12]	CCF triad	Frontal bone	+	+	4 months	ICA	clipping of aneurysm neck	Success (Yes. After 2 weeks)
Kinugasa et al. (1995)[23]	CCF triad	-	+	-	1 month	PComA	Transvenous coiling	Success (Yes. Unknown time interval.)
Tytle et al. (1995)[13]	Proptosis, bruit	Frontal bone	+	-	31 years	PComA	Clipping of anterior origin of PComA	Residual fistula (No)
Fu et al. (2002)[7]	Chemosis	Frontal base	-	+	1 month	ICA	Clipping of aneurysm neck and posterior portion of PComA	Success (Yes. Unknown time interval.)
Weaver et al. (2003)[9]	Proptosis, chemosis, blindness, CN III palsy	Frontal bone, petrous pyramid	-	+	1.5 months	PComA	Transarterial ESC+ PComA trapping	Success (No)
Oran et al. (2004)[14]	Proptosis, chemosis	Sella turcica, anterior cranial base	+	-	2 years	ICA	Transarterial ESC+ ICA trapping with coils	Success (No)
Cho et al. (2006)[15]	Proptosis, bruits, blindness	-	+	-	8 months	ICA	Transarterial ESC and ECA feeder glue embolization	Initial occlusion. Recurrence after 2 weeks and managed with repeated coiling. (No)
Gandhi et al. (2009)[6]	Nonspecific	Carotid canal, clivus, and posterior clinoid process	-	+	7 days	PComA	Transvenous coiling with HES	Success (No)
Chen et al. (2009)[17]	CCF triad	Petrous pyramid and sphenoid bone	-	-	1 month	PComA	Transarterial ESC	Success (Yes. After 1 year.)
Zhao et al. (2012)[16]	Chemosis, bruit, tinnitus	Skull base	+	-	2 months	ICA	Transarterial ESC+ balloon-assisted Onyx embolization	Success (Yes. After 2 weeks.)
Karanam et al. (2014)[18]	Proptosis, chemosis	Depressed skull	-	+	4 days	ICA	Transarterial ESC	Success (No)
Jinbo et al. (2015)[19]	Bruit, blurred vision	+	+	-	7 months	ICA	Transarterial ESC+ Onyx embolization	Success (No)
Ko et al. (2017)[20]	Massive epistaxis	Skull base	+	-	8 months	ICA	Transarterial stent-assisted ESC	Success (No)
Narayan et al. (2018)[8]	Proptosis, chemosis, blindness	Sphenoid bone	+	-	3 months	ICA	Transarterial ESC	Success (Yes. After 1 year.)
Ani et al[21]	epistaxis	Depressed skull	-	+	-	ICA	No	Pass away 2 days after trauma.
This case	chemosis	Frontal and sphenoid bone	-	+	4 days	ICA	Transarterial and transvenous ESC	Initial occlusion. Recurrence after 19 days.

Interval: time from trauma to treatment (or diagnosis if treatment day was not available); ICA: internal carotid artery; PComA: posterior communicating artery; CCF triad: proptosis, chemosis, bruit; ESC: endosaccular coiling; HES: HydroCoil Embolic System

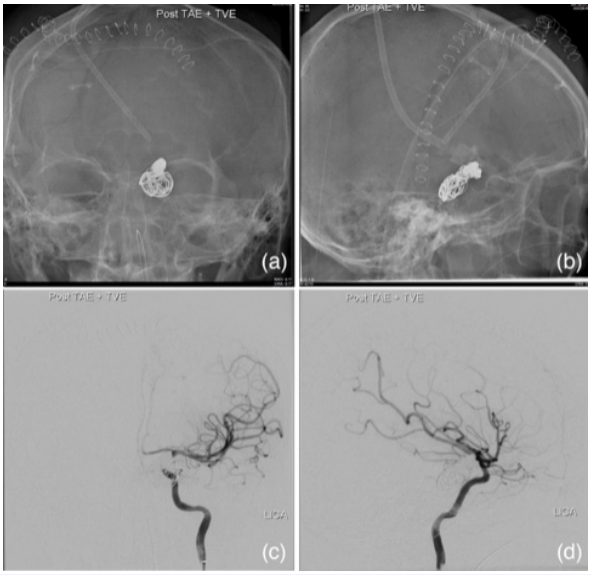

Figure 4: PA view **(a)** and lateral view **(b)** of head immediately after coil embolization; DSA during left ICA injection in PA **(c)** and lateral **(d)** view. Note complete occlusion of the pseudoaneurysm and non-opacification of cavernous sinus.

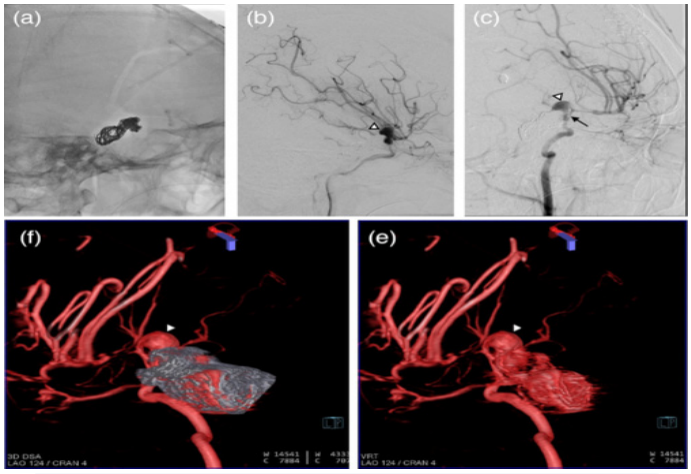

Figure 5: Angiography follow up after embolization. Lateral view of head **(a)** and DSA during left ICA injection in lateral view **(b)** and right anterior oblique view **(c)**. Note coil compaction and recurrent vascular defect (arrow) and pseudoaneurysm (arrow head); Reconstruction of 3D DSA of left ICA in left posterior oblique view with coil (d) and with removal of coil **(e)**. Note recurrent pseudoaneurysm (arrow head) and vasospasm of supraclinoid ICA and MCA.

Conclusion

Traumatic CCF associated with a pseudoaneurysm at supraclinoid ICA or PComA is a rare entity and a challenge for diagnosis and treatment. It should be considered when a patient presents with skull base fracture, SAH, and symptoms of CCF. Advanced imaging is necessary to confirm the diagnosis, and meticulous planning is crucial to achieving the best outcome. More investigation is required to determine the best treatment modality.

Conflict of interest

There is no external funding sources for this study and all author have no conflict of interest to declare.

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