Traumatic Supraclinoid 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-
Digital Subtraction 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.
<table>
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<tr>
<th>Authors (year)</th>
<th>Presenting symptoms</th>
<th>Fracture</th>
<th>Procedure outcome follow up angiography</th>
<th>Procedure</th>
<th>Treatment</th>
<th>Interval*</th>
<th>Aneurysm site</th>
<th>SAKH</th>
<th>Treatment</th>
<th>Outcome (follow up)</th>
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<tbody>
<tr>
<td>Reddy et al. (1981)[10]</td>
<td>Proptosis, bruit, blindness</td>
<td>Orbital rim, ethmoid sinus</td>
<td>ICX ligation</td>
<td>ICX</td>
<td>Minimal residual fistula. Post-procedure SAH and IVH managed with ICX trapping.</td>
<td>5 months</td>
<td>ICX</td>
<td></td>
<td>No residual aneurysm (No)</td>
<td>Success (Yes. Unknown time interval.)</td>
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<tr>
<td>Komiyama et al. (1991)[11]</td>
<td>CCF triad</td>
<td>Frontal base</td>
<td>ICA ligation</td>
<td>ICA</td>
<td>Transcatheter balloon embolization (ICA preservation)</td>
<td>10 days</td>
<td>ICX</td>
<td></td>
<td>Unknown time interval</td>
<td>Success (Yes. Unknown time interval.)</td>
</tr>
<tr>
<td>Mapana et al. (1992)[12]</td>
<td>CCF triad</td>
<td>Frontal bone</td>
<td>PComA ligation</td>
<td>PComA</td>
<td>Clipping of aneurysm neck</td>
<td>4 months</td>
<td>PComA</td>
<td></td>
<td>No fistula (No)</td>
<td>Success (Yes. Unknown time interval.)</td>
</tr>
<tr>
<td>Kingfajar et al. (1992)[13]</td>
<td>CCF triad</td>
<td>Frontal bone</td>
<td>ICA ligation</td>
<td>ICA</td>
<td>Transcatheter balloon embolization (ICA preservation)</td>
<td>1 month</td>
<td>ICX</td>
<td></td>
<td>No residual aneurysm (No)</td>
<td>Success (Yes. Unknown time interval.)</td>
</tr>
<tr>
<td>Telle et al. (1995)[14]</td>
<td>Proptosis, bruit, blindness</td>
<td>Frontal bone, petrous pyramid</td>
<td>PComA ligation</td>
<td>PComA</td>
<td>Clipping of aneurysm neck and posterior portion of PComA</td>
<td>1.5 months</td>
<td>PComA</td>
<td></td>
<td>Unknown time interval</td>
<td>Success (Yes. Unknown time interval.)</td>
</tr>
<tr>
<td>Fu et al. (2002)[15]</td>
<td>Proptosis, bruit, blindness</td>
<td>Carotid canal, orbit, and posterior clinoid base</td>
<td>PComA ligation</td>
<td>PComA</td>
<td>Transcatheter balloon-assisted Onyx embolization</td>
<td>7 days</td>
<td>PComA</td>
<td></td>
<td>No fistula (No)</td>
<td>Success (Yes. After 2 weeks.)</td>
</tr>
<tr>
<td>Cho et al. (2003)[16]</td>
<td>Proptosis, bruit, blindness</td>
<td>Petrous pyramid and sphenoid bone</td>
<td>PComA ligation</td>
<td>PComA</td>
<td>Transcatheter balloon-assisted Onyx embolization</td>
<td>1 month</td>
<td>PComA</td>
<td></td>
<td>No fistula (No)</td>
<td>Success (Yes. After 2 weeks.)</td>
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<tr>
<td>Chao et al. (2005)[17]</td>
<td>CCF triad</td>
<td>Petrous pyramid and sphenoid bone</td>
<td>PComA ligation</td>
<td>PComA</td>
<td>Transcatheter balloon-assisted Onyx embolization</td>
<td>2 months</td>
<td>PComA</td>
<td></td>
<td>No fistula (No)</td>
<td>Success (Yes. After 2 weeks.)</td>
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<tr>
<td>Ganesh et al. (2006)[18]</td>
<td>Non-specific</td>
<td>Sella turica, anterior clinoid base</td>
<td>PComA ligation</td>
<td>PComA</td>
<td>Transcatheter balloon-assisted Onyx embolization</td>
<td>8 months</td>
<td>PComA</td>
<td></td>
<td>No fistula (No)</td>
<td>Success (Yes. After 2 weeks.)</td>
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<tr>
<td>Zhao et al. (2007)[19]</td>
<td>CCF triad</td>
<td>Skull base</td>
<td>ICX ligation</td>
<td>ICX</td>
<td>Transcatheter balloon-assisted Onyx embolization</td>
<td>4 months</td>
<td>ICX</td>
<td></td>
<td>No fistula (No)</td>
<td>Success (Yes. After 2 weeks.)</td>
</tr>
<tr>
<td>Karanam et al. (2010)[20]</td>
<td>Proptosis, chemosis</td>
<td>Depressed skull</td>
<td>PComA ligation</td>
<td>PComA</td>
<td>Transcatheter and transvenous ESC+ balloon-assisted Onyx embolization</td>
<td>3 months</td>
<td>PComA</td>
<td></td>
<td>No fistula (No)</td>
<td>Success (Yes. After 2 weeks.)</td>
</tr>
<tr>
<td>Jiibco et al. (2015)[21]</td>
<td>Proptosis, chemosis</td>
<td>Depressed skull</td>
<td>PComA ligation</td>
<td>PComA</td>
<td>Transcatheter and transvenous ESC+ balloon-assisted Onyx embolization</td>
<td>4 days</td>
<td>PComA</td>
<td></td>
<td>No fistula (No)</td>
<td>Success (Yes. After 2 weeks.)</td>
</tr>
<tr>
<td>Ko et al. (2017)[22]</td>
<td>Massive epistaxis</td>
<td>Skull base</td>
<td>PComA ligation</td>
<td>PComA</td>
<td>Transcatheter and transvenous ESC+ balloon-assisted Onyx embolization</td>
<td>4 days</td>
<td>PComA</td>
<td></td>
<td>No fistula (No)</td>
<td>Success (Yes. After 2 weeks.)</td>
</tr>
<tr>
<td>Narayan et al. (2018)[23]</td>
<td>Proptosis, chemosis</td>
<td>Epistaxis</td>
<td>PComA ligation</td>
<td>PComA</td>
<td>Transcatheter and transvenous ESC+ balloon-assisted Onyx embolization</td>
<td>3 months</td>
<td>PComA</td>
<td></td>
<td>No fistula (No)</td>
<td>Success (Yes. After 2 weeks.)</td>
</tr>
<tr>
<td>Ani et al.[24]</td>
<td>This case</td>
<td>Frontal and sphenoid bone</td>
<td>PComA ligation</td>
<td>PComA</td>
<td>Transcatheter and transvenous ESC+ balloon-assisted Onyx embolization</td>
<td>No</td>
<td>PComA</td>
<td></td>
<td>No fistula (No)</td>
<td>Success (Yes. After 2 weeks.)</td>
</tr>
</tbody>
</table>

Table 1: Summary of treatment for post-traumatic intradural CCF in reported case.

Interval: time from trauma to treatment (or diagnosis if treatment day was not available); ICX: Internal carotid artery; PComA: posterior communicating artery; CCF: carotid-cavernous fistula; ESC: embolic coating; HES: HydroCoil Embolic System.
Conclusion

Traumatic CCF associated with a pseudoaneurysm at supraclini-
roid 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 inves-
tigation 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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