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Traumatic Carotid-Cavernous Fistula: The Crucial Role of Multimodality Imaging in Diagnosis and Management - A Case Report

Nouhaila Ait Said[1]*, H. El Mansouri[1], Y. Bouktibe[1], A. Elhajjami[1], B. Boutakioute[1], N. Cherif Idrissi El Ganouni[1]

[1]Radiology Department, Ibn Tofail Hospital

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***Corresponding author:** Nouhaila Ait Said
Radiology Department, Ibn Tofail Hospital

Abstract **Case Report**

Direct carotid-cavernous fistulas (CCFs) are high-flow arteriovenous shunts that typically occur following head trauma. We report the case of a 28-year-old female presenting with a post-traumatic palpebral swelling, whose radiological workup led to the diagnosis of a direct CCF associated with an intracavernous aneurysm. This article details the clinico-radiological correlation and highlights the respective roles of Computed Tomography (CT), CT angiography (CTA), and Digital Subtraction Angiography (DSA), which remains the diagnostic and therapeutic gold standard.

Keywords: Carotid-cavernous fistula, Intracavernous aneurysm, Head trauma, Computed tomography angiography.

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1. INTRODUCTION

Direct carotid-cavernous fistulas (CCFs) classified as Barrow type A represent an abnormal, direct communication between the main trunk of the internal carotid artery (ICA) and the cavernous sinus. They most frequently arise in the setting of moderate or severe head trauma with basilar skull fractures. The classic clinical triad combines pulsatile exophthalmos, chemosis, and an orbital bruit, sometimes complicated by cranial nerve palsies (III, IV, VI) housed within the lateral wall of the cavernous sinus. Imaging plays a pivotal role in establishing the diagnosis, which is often initially misdiagnosed as simple orbital cellulitis or post-traumatic hematoma given the absence of infectious signs.

2. CASE PRESENTATION

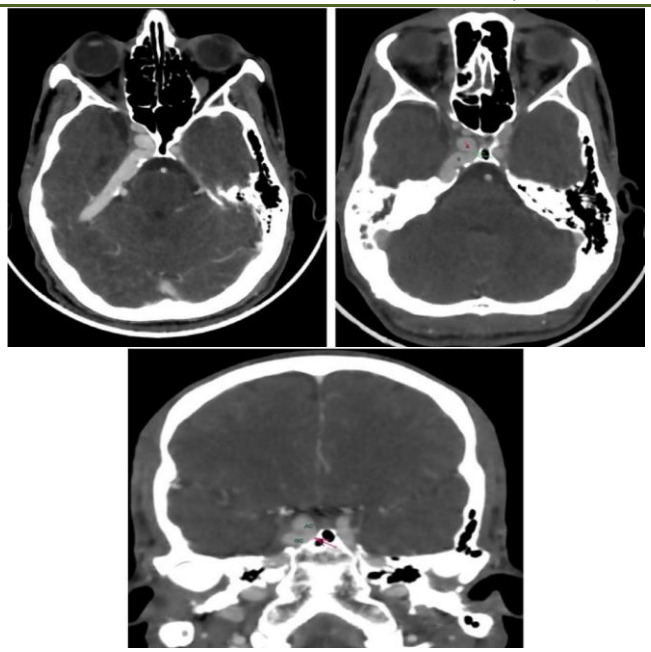
- **Anamnesis:** A 28-year-old female with a documented history of head trauma with a cranial impact point on March 27, 2025.
- **Clinical Presentation:** She presented on April 4, 2025 (approximately one week post-trauma) with right palpebral swelling, clinically associated with diplopia, grade 3 exophthalmos, and ophthalmoplegia.
- **Laboratory Findings:** Her infectious workup was strictly negative (absence of fever, normal white blood cell count), immediately ruling out infectious orbital cellulitis and redirecting the diagnostic hypothesis toward a vascular etiology.

IMAGING AND RADIOLOGICAL SEMIOLOGY

A. Role of Computed Tomography and CT Angiography (CTA)

The cerebral and orbital CT angiography performed on the patient revealed highly characteristic direct and indirect signs:

- **Orbital Findings:** Grade 3 right exophthalmos, major intra- and extraconal fat infiltration indicating orbital congestion, combined with a striking, early dilatation of the superior ophthalmic vein (SOV), which enhanced prematurely during the arterial phase and appeared arterialized on color Doppler. Pre-septal and jugal soft tissue palpebral thickening was also noted, alongside a lateral orbital wall fracture without significant muscle incarceration.
- **Intracranial Findings (Cavernous Sinus):** Analysis of coronal and axial cuts centered on the skull base revealed an expanded, heterogeneous appearance and bulging of the right cavernous sinus, with early and intense arterial phase enhancement confirming a direct arteriovenous shunt (Barrow type A CCF).



B. Correlation with Digital Subtraction Angiography (DSA) - The Gold Standard

Digital subtraction angiography, performed for diagnostic confirmation and treatment planning, detailed the vascular mapping of this case:

- **Shunt Characterization:** Direct visualization of a large aneurysm at the initial segment of the intracavernous right ICA, directly feeding the cavernous sinus.
- **Venous Drainage Pathways:** A dual venous drainage pattern was identified: anterior drainage via the superior ophthalmic vein and facial vein (explaining the exophthalmos and palpebral swelling), and posterior drainage via the superior petrosal sinus. Additionally, a pial collateral network supplying the right sylvian territory was observed.

3. DISCUSSION AND THERAPEUTIC MANAGEMENT

This patient's case perfectly illustrates the diagnostic pitfall of delayed-onset post-traumatic CCFs, where post-traumatic eyelid swelling can easily be mistaken for a simple hematoma or cellulitis. The negativity of the infectious workup coupled with morphological imaging (SOV dilatation and asymmetric cavernous sinus enlargement) should immediately raise suspicion of a shunt.

Management of this direct form (Barrow Type A) relies on emergency endovascular treatment to preserve visual function and prevent severe ischemic or hemorrhagic complications. In similar cases, treatment consists of transarterial or transvenous endovascular embolization (such as deploying metallic coils into the aneurysmal pouch or cavernous sinus), achieving complete fistula exclusion while maintaining the patency of the internal carotid artery.

4. CONCLUSION

Post-traumatic carotid-cavernous fistula must be systematically suspected in the presence of any exophthalmos or orbital swelling appearing secondarily after head trauma, even in the absence of major facial bone fractures. CT angiography provides rapid, non-invasive screening by demonstrating the arterialization of the superior ophthalmic vein and cavernous sinus enlargement. Digital subtraction angiography remains the indispensable reference examination for planning and performing curative endovascular treatment.

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