

## Diffuse Traumatic Subarachnoid Hemorrhage Mimicking Aneurysmal Bleeding Secondary to Ophthalmic Artery Avulsion: Case Report and Review of the Literature

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### Key words

- Cantholysis
- Globe enucleation
- Ophthalmic artery avulsion
- Tarsorrhaphy
- Traumatic subarachnoid hemorrhage
- tSAH

### Abbreviations and Acronyms

CT: Computed tomography  
 EVD: External ventricular drain  
 ICA: Internal carotid artery  
 OA: Ophthalmic artery  
 SAH: Subarachnoid hemorrhage  
 TBI: Traumatic brain injury  
 tSAH: Traumatic subarachnoid hemorrhage

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### INTRODUCTION

Traumatic subarachnoid hemorrhage (tSAH) is common in traumatic brain injuries (TBI), with up to 60% of patients showing evidence of tSAH on computed tomography (CT) scans following severe TBI.<sup>1</sup> It is caused by bleeding of cortical arteries, veins, and capillaries of the contused brain. A tSAH can rarely be attributed to rupture of bridging veins or traumatic aneurysms.<sup>2</sup> Several studies have demonstrated that tSAH is one of the most independent negative prognostic factors in TBI outcomes.<sup>3</sup> Here we present a case of traumatic enucleation with avulsion of the ophthalmic artery (OA), resulting in subarachnoid hemorrhage (SAH) with associated hydrocephalus mimicking aneurysmal SAH both in terms of

■ BACKGROUND: Traumatic subarachnoid hemorrhage (SAH) is a common finding following traumatic brain injury. In some cases, it can be associated with hydrocephalus. This type of hemorrhage is mostly caused by the rupture of small vessels in the brain and is usually managed conservatively.

■ CASE DESCRIPTION: We present a case of a 60-year-old woman who presented with traumatic luxation of the eye following a fall. This resulted in diffuse SAH (Fisher grade IV) with associated hydrocephalus. We also report on 3 previous similar cases found in the literature. Avulsion of the ophthalmic artery was found to be the cause of the traumatic SAH. Apart from cerebrospinal fluid diversion using an external ventricular drain, the case was managed conservatively. There was no evidence of delayed clinical or radiologic vasospasm.

■ CONCLUSIONS: Traumatic avulsion of the ophthalmic artery may result in diffuse SAH, mimicking that of aneurysmal rupture. This case shows that management of early complications, such as hydrocephalus and seizures, should be the main aim. Surgical or endovascular treatment of the injured artery, however, would be unnecessary.

hemorrhage pattern and clinical course. We also review the literature for the small number of cases of tSAH due to avulsion of the OA.<sup>4-6</sup>

### CASE DESCRIPTION

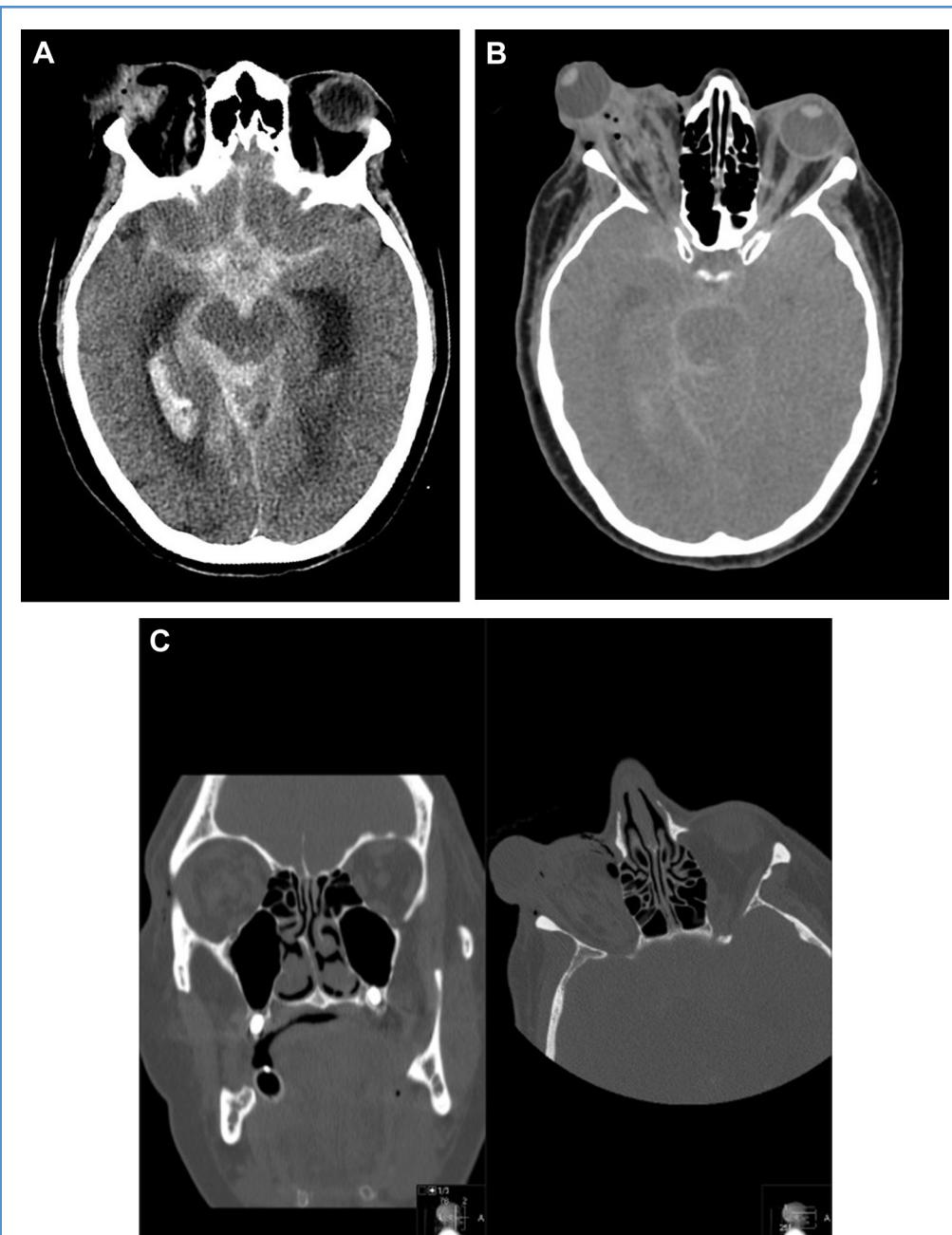
A 60-year-old woman tripped and fell, hitting her head on a ledge at home. She was found unconscious and was urgently transferred to the hospital. On arrival, she had a Glasgow Coma Scale score of 13/15; she was eye-opening to verbal commands (E3), confused (V4), and obeying commands (M6). She also suffered complete luxation of the right eye and had a fixed dilated pupil on the same eye. She had no light perception in this eye. Further neurologic examination showed no other pathologies or injuries. Her only past medical history was a newly diagnosed lung cancer. Consent for publication was obtained from the patient's husband.

Given the patient's history and the mode of trauma, CT head and orbit protocol were performed. Scans showed extensive SAH extending into the sulci, basal cisterns, the Sylvian fissures, and the

ventricles leading to obstructive hydrocephalus (Fisher grade IV). CT orbit showed overt extrusion of the right globe with acute infraorbital emphysema but no orbital fractures (Figure 1).

Based on the clinical status of the patient and the CT findings, a decision was made for urgent intervention. A combined emergency operation was performed for insertion of a right frontal external ventricular drain (EVD) for cerebrospinal fluid diversion. At the same setting, surgical exploration of the right orbit was performed by ophthalmologists with the aim of salvaging the eye. Repair of the right globe injury and lid laceration was performed. Blood was drained from the posterior compartment, and lateral, medial, and inferior orbitotomy was performed with lateral lower lid cantholysis. This was followed by tarsorrhaphy to keep the globe in place. Optic nerve was contused, yet intact. The integrity of the OA was not confirmed intraoperatively.

Postoperatively she was kept sedated and intubated. CT angiogram was performed 2 days later showing avulsion of the right OA as the primary cause of SAH



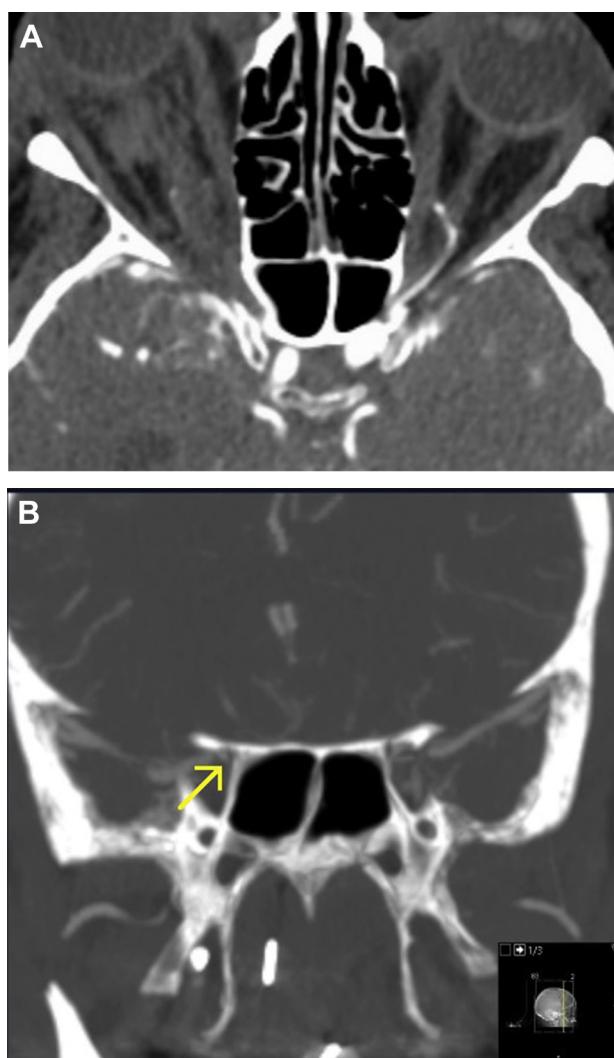
**Figure 1.** (A) Plain axial computed tomography (CT) head brain window, showing Fisher grade IV traumatic subarachnoid hemorrhage with associated

hydrocephalus; (B) CT head bone window, showing right globe extrusion; (C) CT orbit bone window, showing no orbital fissures/fractures.

with absence of any aneurysmal malformations (Figure 2). Nimodipine was not administered given the fact that the primary cause of the SAH was traumatic. The patient was weaned off sedation slowly and eventually extubated 4 days

after the event with gradual recovery of her conscious level to normal. It was also then possible to remove the EVD with close neurologic monitoring. Ophthalmologic examination revealed lack of light perception in the right eye

and also temporal hemianopia in the left eye correlating with optic pathway contusion. Intraocular pressure in the right eye remained stable throughout, hence enucleation was not needed, and right eye was left in place for aesthetic



**Figure 2.** (A) Opacification of the right ophthalmic artery (OA) with interruption of the flow and intact normal flow left OA; (B) a blunt stump at the origin of the right OA. Yellow arrow represents a blunt stump at the origin of the right ophthalmic artery

reasons, although not functioning. A CT scan of the brain prior to discharge to the rehabilitation unit 2 weeks later showed resolution of the blood and hydrocephalus (Figure 3).

## DISCUSSION

Traumatic avulsion of the OA is rare with only 3 previous cases reported in the literature (Table 1). Its recognition as a potential cause of SAH, however, is important as it

can mimic aneurysmal rupture of internal carotid artery (ICA) or OA aneurysm, especially when associated with hydrocephalus. This is particularly important because although tSAH may serve as a marker of severity of TBI, it does not commonly lead to hydrocephalus. This is in contrast to tSAH because of the avulsion of OA as acute hydrocephalus was a prominent feature in 3/4 cases described thus far. In terms of mechanism of avulsion, it may be associated with

fractures in the orbit or optic canal depending on the mode of trauma and the pattern of injury. Such fractures are not, however, always present, as in the present case, and therefore clinical suspicion and awareness remain important.

The management is tripartite in nature focusing on the eye/globe, OA avulsion/SAH, and the hydrocephalus.

In terms of managing the eye/globe, emergency lateral canthotomy was performed as soon as the patient was admitted in the A&E due to suspected retrobulbar hemorrhage, with the aim of orbital decompression to release the pressure on sensitive orbital contents, such as the optic nerve and vessels.

This is consistent with the systematic review by Christie et al.,<sup>3</sup> concluding that retrobulbar hematoma outcomes were extremely time-sensitive.

Whether the eye can be preserved, albeit for cosmetic reasons, or enucleation is needed will depend on the extent of the injury, and surgical exploration may be required to determine this. In our case, the integrity of the optic nerve was confirmed, however, visible contusions were apparent throughout its course, which could reasonably be the cause of blindness in addition to retinal ischemia caused by the OA avulsion. Surgical reduction of the eyeball in the orbit was possible despite the presence of retrobulbar partially coagulated hematoma.

Owing to the structural integrity of the ocular apparatus and a normal intraocular pressure in the postoperative phase, surgical enucleation of the eyeball was avoidable, thereby minimizing surgical complications, preventing subsequent need to place prosthesis, and achieving better aesthetic outcomes.

In terms of managing the OA avulsion/SAH, the first step is confirming the pathology on imaging. This can be challenging as features may be subtle. In our case, the final diagnosis of arterial avulsion was based on the absence of an observed OA on a common carotid injection during digital subtraction angiography, with the suggestion of a stump at the expected anatomic position. Although the stump may have been more reliably established by a selective ipsilateral ICA



**Figure 3.** Computed tomography scan showing reduced ventricular size and absorption of the subarachnoid hemorrhage.

injection, the common carotid injection clearly showed the vessel's absence, either at its expected origin off the ICA, or arising from the middle meningeal artery

or alternate branch of the external carotid artery. Based on our current experience, combined with the literature, CT angiogram appears sufficient to establish the

diagnosis of OA avulsion, with opacification of flow in the suspected side compared with normal flow in the contralateral side. Once the diagnosis is established, conservative management of intracranial OA avulsion has been the main route taken. Other options include endovascular coiling or surgical intervention; however, the small dimension of the stump and the absence of active bleeding make these options challenging and of questionable benefit. Patients with tSAH can develop vasospasm, although this does not seem to be a common feature in those with OA avulsion (1/4 patients). If present, standard interventions for vasospasm, including nimodipine, will be indicated. Hydrocephalus, however, can be a significant problem in a patient with tSAH due to OA avulsion (3/4 cases), and thus cerebrospinal fluid diversion procedures, such as insertion of an EVD, may be required.

## CONCLUSIONS

Traumatic avulsion of OA may result in diffuse SAH mimicking that of aneurysmal rupture. Although rare, awareness of this entity is warranted both to make the correct diagnosis and to exercise vigilance in early detection and management of serious complications, such as hydrocephalus and vasospasm, that can occur with this condition.

**Table 1.** Literature Review of Similar Case Reports of Ophthalmic Artery Avulsion Resulting in Traumatic Subarachnoid Hemorrhage

Authors/Year	Age (years)/ Sex	Mode of Trauma	Computed Tomography Findings			Management	
			Brain	Orbit	Angiogram	OA Avulsion	Orbit
Limbrick et al., 2009 <sup>5</sup>	60/F	Falling down over a concrete step	Fisher grade 3 SAH and early hydrocephalus	Extrusion of the right globe	OA avulsion + mild vasospasm on postoperative day 6	Conservative + EVD for hydrocephalus	Enucleation
Ali Nabavizadeh et al., 2015 <sup>4</sup>	51/F	Self-inflicted dislocation of the right globe	Diffuse SAH in the basal cisterns	Proptosis of the right globe	OA avulsion + no vasospasm	Conservative	Reposition to the socket
Prior et al., 2018 <sup>6</sup>	66/M	Falling down over an edge	Fisher grade 4 SAH and early hydrocephalus	N/A	OA avulsion	Conservative + EVD for hydrocephalus	Emergent lateral canthotomy followed by temporary lateral tarsorrhaphy
Raslan et al. 2020	60/F	Falling down over an edge	Fisher grade 4 SAH and early hydrocephalus	Extrusion of the right globe	OA avulsion + no vasospasm	Conservative + EVD for hydrocephalus	Emergent cantholysis followed by lateral tarsorrhaphy

A&E, accident and emergency; OA, ophthalmic artery; F, female; M, male; SAH, subarachnoid hemorrhage; N/A, not available; EVD, external ventricular drain.

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*Conflict of interest statement:* The authors declare that the article content was composed in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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