

# Orbital compartment syndrome after a penetrating traumatic incident

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Dear Editor,

Orbital compartment syndrome (OCS) is an ophthalmic surgical emergency that both emergency physicians and trauma surgeons should be familiar with. The orbit is an enclosed space with limited capacity to expand. In addition, the eyeball and the retro-bulbar space are wrapped in a continuous cone-shaped fascial envelope which is contained on all sides by 7 rigid bones, except anteriorly, where the orbital septum and eyelids form another less flexible boundary [1, 2]. OCS is one of the few ophthalmic surgical emergencies occurring when a sharp increase in confined volume within the orbit results in an acute increase in orbital strain. Normal intraocular pressure is between 3 and 6 mm Hg (0.4–0.8 kPa). The orbit is able to compensate for small increases in orbital volume with anterior globe movement and fat prolapse; however, large and rapid increases in pressure are not tolerated, resulting subsequently in an acute ischemic process. The volume of the orbital content is around 30 mL, including the eyeball, vessels, nerves, fat, muscles and the lacrimal glands. Although the orbit is not a fully confined space, it follows the pressure-volume dynamics with a pathophysiology similar to other compartment syndromes [1, 3].

In OCS, impairment of the optic nerve and retina can develop rapidly, causing irreversible loss of vision. Studies suggest that 60 to 100 min of elevated intraocular pressure may lead to permanent visual sequelae [4].

Common causes include acute orbital hemorrhage due to trauma, surgery, local injections, and pre-existing medical conditions. There are other important etiologies such as fulminant orbital cellulitis or infra-orbital abscess, orbital emphysema, inflammation, and tumors. Less commonly, prolonged hypoxia with capillary permeability, foreign material in orbit, massive volume replacement after burning, or position-dependent edema may result in an acute increase in orbital pressure [1, 5].

In cases of trauma, retro-bulbar hematoma is the most common cause of OCS. Hemorrhage in this case usually results from the lesion of the infra-orbital artery or one of its branches often associated with complex facial fractures of the Le Fort II and III type [4, 5].

The diagnosis of OCS is clinical and early recognition with subsequent emergency orbital decompression is essential to prevent permanent loss of vision [1]. Anamnesis and physical examination are obviously essential, but in a trauma setting, anamnesis is not always possible for the emergency physician to attend, depending on the trauma mechanism and severity. Symptoms such as eye pain, visual loss, diplopia and reduced mobility of the eyeball are possible findings. At ophthalmologic examination, eyebrow proptosis, eyelid ecchymosis, ophthalmoplegia, papilledema, and pulsation of the central retinal artery are commonly observed. A rare finding is the macula in cherry blotch. Still in this scenario of trauma, the presence

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of bradycardia from the oculo-cardiac reflex must be strongly suspected in patients presenting with this sign in the trauma room [6]. Case management in the trauma room therefore includes measures dictated by the advanced trauma life support (ATLS) protocol and a good secondary examination including serial eye examination and visual acuity check periodically. The expert's assessment should be as early as possible. No urgent laboratory examination is indicated in the evaluation of these patients. Imaging examinations include computed tomography (CT) scan or magnetic resonance imaging, restricted to when the patient is stable and in physiological conditions suitable for transporting and performing these complementary examinations. Hybrid emergency rooms that enable patient resuscitation and concomitant CT scan are certainly a time advantage for this trauma mechanism population. The main function of the imaging examination is to identify the etiology of compression, excluding differential diagnosis. The finding of retro-bulbar hematoma for example in trauma patients and clinical signs of OCS are confirmed by tomography; however, this examination should not delay therapy in patients with OCS [7].

The surgical procedure of choice is lateral canthotomy, associated with inferior cantholysis, with retrograde orbital hematoma drainage, and can be performed at bedside in severe cases. Proptosis, intraocular pressure (IOP) > 40 mm Hg (> 5 kPa), bradycardia, and patients with lowering of the level of consciousness are indications of the procedure. The emergency surgical procedure is known to actively reduce orbital hypertension and consequently decrease the incidence of visual loss [3]. OCS with loss of visual acuity is associated with a poor prognosis whereas permanent blindness occurs if effective therapy is not initiated in a timely manner. This emergency surgical procedure has the potential to save sight, particularly in cases of trauma. Pictures are under signed patient's consent and therefore authorized for publication.

## CASE PRESENTATION

A 16-year-old Latin American girl with no significant past medical history was conducted by the EMS to the emergency department (ED) with a gunshot wound to the upper face with an entrance wound at the supra-orbital topography to the right and no exit wound. Paramedics reported that a friend of the victim was handling a 0.22 caliber revolver when the weapon incidentally fired against her face. The patient was intubated at the scene due to agitation and arrived at the emergency room (ER) with secured airways, cervical collar on site, regular breath sounds, SpO<sub>2</sub> 100%, hemodynamically stable with systolic blood pressure (SBP) of 110 mm Hg, MAP of 75 mm Hg, and heart rate ranging from 35 to 45 bpm. At presentation she was sedated with midazolam and fentanyl with Glasgow Coma Scale of 3, isochoric and photo-reactive pupils to the left but not to the injured side. The ER team immediately noted a periorbital hematoma on the right close to the entrance wound, with no active bleeding and eyeball proptosis.

ATLS primary survey was performed as routine, with no other injury evidence. The trauma surgery team noted bradycardia and two hypotheses were raised: A) OCS or B) traumatic brain/spinal injury. Atropine was administered at the dose of 1 mg, with a temporary response to bradycardia. A secondary survey was focused on ophthalmological evaluation. Ocular proptosis, decreased eyeball mobility and periorbital ecchymosis were reported (Figure 1A). Ophthalmologist and neurosurgery consultations were immediately required.

A CT scan was performed prior to specialist evaluation. On the image of the skull and face the following were observed: diffuse cerebral edema, right subarachnoid hemorrhage, right acute subdural hematoma, right temporal lobe contusion, absence of signs of intracranial hypertension, and the projectile located in the right temporal lobe. Extensive intravitreal hemorrhage in the right eyeball, comminuted fracture of the ceiling and

posterior wall of the right orbit were also noted (Figure 1B).

The neurosurgery team opted for conservative treatment with CT scan follow-up in 24 hours or earlier in the case of clinical changes. On the presence of OCS the ophthalmology team decided on an immediate surgical procedure in the trauma room with drainage of moderate amount of clots from the posterior compartment of the right orbit and canthotomy (Figure 1C). A Penrose drain was positioned at the posterior right orbit compartment. After the ophthalmologic procedure heart rate was established at a regular level. The patient was then transferred to the Trauma Intensive Care Unit (TICU) for neurological critical care.

At the TICU the patient was kept sedated with midazolam and fentanyl, on mechanical ventilation. The TICU team started antibiotic prophylaxis with 2 g of oxacillin. 24-hour CT scan follow-up revealed a stable brain injury with no worsening signs. After returning from the CT scan, sedation vacation was initiated and extubation performed within the next 24 hours with no neurological deficits.

The Penrose drain was withdrawn after 72 hours of the surgical ophthalmologic procedure with minimum output. The patient was then discharged home after 10 days with visual acuity without light perception and therefore probable irreversible blindness due to optic nerve penetrating injury (Figure 1D).

## DISCUSSION

OCS is a consequence of rapid increased pressure within the orbital space. Typically, an IOP greater than 40 mm Hg is considered high enough to promote important symptoms, compression of the optic nerve and its vasculature [3, 8]. Several studies suggest that the delay in the treatment of OCS increases the likelihood of permanent visual loss. In contrast, patients promptly treated with orbital decompression and clinical management regained vision completely, reinforcing the need for immediate recognition and intervention. In 77 cases of OCS

found in the literature, 81% of cases occurred in patients over 20 years of age, most commonly associated with trauma (45%) and surgery (32%) [1].

In the case presented here, although the traumatic brain injury played a confusing factor for the bradycardia, other signs called the attention of the ER team. As anamnesis was impossible in this specific case due to orotracheal intubation, once the patient arrived at the trauma bay clinical signals of intracranial hypertension were excluded and evidence of OCS was immediately recognized such as eyebrow proptosis, eyelid ecchymosis, and ophthalmoplegia (Figure 1A). Rapid recognition of emergent bradycardia due to oculo-cardiac reflex can be achieved and reversion is possible with atropine at a dose of 0.5 mg repeated every 3 to 5 minutes up to a maximum total dose of 3.0 mg or 0.04 mg kg<sup>-1</sup>. After stabilization of the patient at the ER according to the ATLS protocols, the ER team requested a CT scan for brain and ophthalmologic evaluation (Figure 1B).

Imaging studies, such as CT and/or MRI scans, can be helpful to make an accurate diagnosis, but it is universally agreed that surgical decompression of the orbit should not be delayed on the basis of obtaining imaging [7–9]. Because of its availability and celerity, CT scan is the preferred imaging technique to identify the location and source of elevated orbital pressure [1, 8, 9]. In this specific case, the CT scan was also helpful for the evaluation of the penetrating traumatic brain injury, facilitating the neurosurgery team in the management decision.

To protect against visual loss in the setting of a retrobulbar hemorrhage, it has been recommended that decompression of the affected orbit should be performed within 100 to 120 minutes of symptom onset. Immediate lateral canthotomy and inferior/superior cantholysis are recommended to prevent visual loss owing to optic nerve compression in OCS [3, 7–9]. The major goal of these external procedures is to allow anterior prolapse of



**FIGURE 1.** A) Injury observed at the emergency room. B) Computed tomography scan after emergency room stabilization. C) Canthotomy and superior cantholysis with drainage of retrobulbar hematoma. D) Aspect on hospital discharge day

the orbital contents to rapidly reduce the IOP and reestablish retinal arterial blood flow. A full-thickness incision should be made from the lateral canthus extending toward the orbital rim. Releasing the crus of the lateral canthal tendon results in complete lower eyelid laxity and mobility, achieved by performing inferior and/or superior cantholysis [8–10]. It should be noted that the orbital contents and eyelid soft tissues are highly edematous and under tension in these emergent scenarios, such that reliable hand instrumentation and mental commitment as to the necessity of the procedure are mandatory for achieving successful decompression.

Unfortunately, in the case presented herein this young patient also sustained optic nerve injury, not only OCS due to retrobulbar hematoma, leading to probable irreversible blindness.

## CONCLUSIONS

OCS is a rare but important ophthalmic surgical emergency that both emergency and trauma response team must be aware. A missed diagnosis can rapidly lead to permanent visual impairment.

Symptoms such as eye pain, visual loss, diplopia and reduced mobility of the eyeball are possible findings. At ophthalmologic examination, eyebrow proptosis, eyelid ecchymosis, ophthalmoplegia, papilledema, and pulsation of the central retinal artery are commonly observed.

After primary survey of trauma, patients eye balls must be examined in order to detect early possible OCS and avoid major consequences such as preventable blindness.

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