Case reports

Periorbital emphysema after a wet chamber dive

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Key words
Barotrauma; Diving medicine; Military diving; Risk factors; Simulation; Training; Valsalva manoeuvre

Abstract

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Although periorbital emphysema (PE) is commonly associated with orbital fractures, it may develop without any fracture or significant trauma in circumstances such as post-surgery, infection, forceful nose blowing, sneezing, and weight lifting. We report on a healthy military diver who developed PE following a wet chamber dive. A diagnosis of PE secondary to sinus barotrauma was reached. He was treated conservatively without medication and his symptoms recovered completely within 10 days. To the best of our knowledge, only five cases of diving-related PE have been reported in the literature. Analysis of these cases and ours revealed that facial trauma, repeated forceful Valsalva manoeuvres and recent upper respiratory tract infection are probable risk factors for diving-related PE.

Introduction

Before their training/missions in the open sea, navy divers receive training in the wet-and-dry recompression chamber at the Diving Medical Centre of the Zuoying Branch of Kaohsiung Armed Forces General Hospital. Divers are immersed in the water within the chamber and the pressure is increased to simulate descending in the water. This training process allows divers to become familiar with diving sequences and with their equipment in a monitored and relatively safe environment. The medical problems that could occur during diving include middle ear barotrauma, sinus barotrauma, oxygen toxicity, pulmonary barotrauma, air embolism, and decompression sickness.[1] Here we describe the case of a diver who developed periorbital emphysema (PE) immediately after a simulated dive.

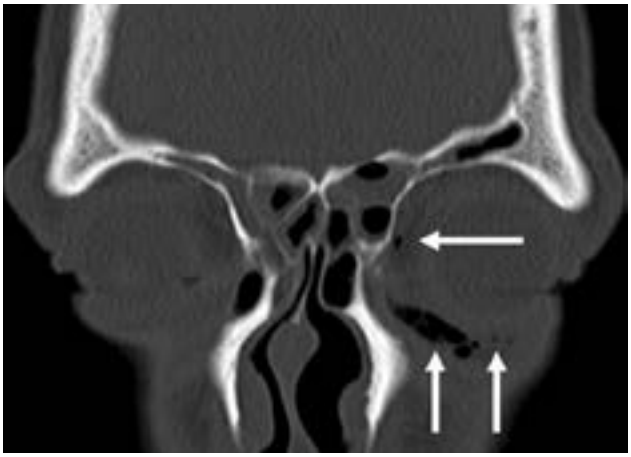
Case report

A healthy, 26-year-old, experienced, male military diver without a previous history of smoking, rhinitis, sinusitis or barotrauma had a scheduled wet training dive to a simulated depth of 36.6 metres' sea water (msw). The diver experienced difficulty in equalizing pressure in both ears during descent but managed to equalize middle ear pressure by the Valsalva manoeuvre and reached a simulated depth of 12.2 msw. However, gradual development of a sensation of pressure over the left medial orbital region was noted and he asked to abort the dive. Pain and swelling of the left periorbital region developed immediately after surfacing. Ptosis and mild ecchymosis around the left orbit were also noted (Figure 1). On examination, ocular movements, pupillary light reactions and dilated fundus examination were normal. There was a non-tender left periorbital swelling with crepitus on palpation. An antero-posterior X-ray view of the head showed air around the left superior orbital margin (Figure 2). Coronal computed tomography (CT) imaging of paranasal sinuses revealed multiple air bubbles in the subcutaneous tissue of the left periorbital region (Figure 3). No definitive bone fracture could be identified in this region. PE secondary to sinus barotrauma was diagnosed. Reviewing his history, there was a recent episode of upper respiratory tract infection (URTI), which is likely the main contributing factor leading to his difficulty equalising, sinus barotrauma and the associated PE. The patient was treated conservatively without medication and advised to avoid diving for one month. His symptoms gradually subsided with complete resolution after 10 days. There has been no recurrence on return to diving for up to one year of follow-up.

Figure 1
Peri-orbital emphysema secondary to sinus barotrauma after finishing a simulated wet-chamber dive; swollen left eye and palpable subcutaneous emphysema

Figure 2
Radiograph of orbit, showing air in superior left orbit (black eyebrow sign, arrows)

Figure 3
A coronal plane of CT scan showing air in left orbit (arrows)



Discussion

PE is a relatively uncommon condition in which air is present within the eyelids or orbit.[2] Periorbital air most commonly comes from a fracture or perforation of one of the orbital bones due to direct or indirect trauma.[3] Frequently, this fracture involves the fragile part of the medial orbital wall, the *lamina papyracea*.[2,3] Other mechanisms include post-surgery, infection, forceful nose blowing, sneezing, weight lifting, bungee jumping and pressure changes during airplane travel or free diving, as a complication of sinus barotrauma.[4] To the best of our knowledge, there are only five previously reported cases of diving-related PE (Table 1).[4–7] All of these cases, except one that was not documented, were male. Images with radiography or CT showed no bony fracture. Recovered was complete within two weeks. According to these articles, facial trauma, repeated forceful Valsalvas, and recent URTI were probable risk factors for PE.

In our diver, we presume that increased intranasal pressure as a result of repeated and forceful Valsalvas caused a tear in the thin medial orbital wall. In accordance with Boyle's law, the volume of air within the orbit expanded proportionally to the decrease in pressure during ascent, further exaggerating his left PE.

The diagnosis of PE is usually made by patient history and physical findings, confirmed with orbital CT. Although CT is the primary imaging modality for evaluating patients with trauma, conventional radiography is often the first and valuable imaging study performed. For intra-orbital air, mostly caused by orbital fracture, air rises into the superior side of the orbit in a linear fashion, simulating a black eyebrow. The black eyebrow sign on plain radiography is very useful and easily observed for physicians working in the emergency department.[8]

PE is generally a benign, self-limiting condition, as the air is absorbed within two weeks.[2,9] The role of antibiotic prophylaxis in PE remains controversial. Administration of an antibiotic might be considered in cases with a concomitant URTI such as acute sinusitis.[2,3] Rarely, tension PE can lead to visual loss due to retinal artery occlusion and optic nerve ischaemia.[2] Thus, immediate ophthalmologic examination and treatment are warranted if the patient presents with a painful eye and visual changes. Additionally, patients need to be educated to avoid activities that may raise intranasal pressure or allow expansion of air within the orbital soft tissues such as nose blowing, sneezing, diving, flying, or climbing to high altitudes for at least two weeks.[9]

Table 1

Summary of this and five other cases of diving-related peri-orbital emphysema reported in the literature;[5,7–9] HRCT – high-resolution computed tomographic scan; CT – computed tomography; URTI – upper respiratory tract infection

Article	Age/Sex	Type of diving	Depth (metres)	Symptoms and signs	Treatment	Probable precipitating factors	Images	Total recovery time
Leith 1969[7]	?/male	Simulated diving	79	Left cheek and eyelids swollen	Needle aspiration	Facial trauma 1 day before diving	X-rays: no fracture	5 days
	?	?	31	Right cheek and side of forehead swollen	?	?	X-rays: no fracture	?
Bolognini 2008[8]	26/male	Freediving	25–30	Tinnitus, right upper eyelid swollen + ptosis	Antibiotics, nasal spray decongestants	Repeated and forceful Valsalvas	HRCT: no fracture	2 weeks
Hall 2013[9]	?/male	Boat diving	?	Left orbital swelling	?	?	CT: no fracture	?
Pennell 2014[5]	23/male	Boat diving	4	Pain + right orbital swelling	?	Recent URTI with nasal stuffiness	CT: no fracture	?
Our case	26/male	Simulated diving	12	Pain + left orbital swelling + ptosis	None	Recent URTI; repeated forceful Valsalvas	CT: no fracture	10 days

In conclusion, diving complications can occur even in the monitored and relatively safe environment of a recompression chamber. Physicians/diving instructors should always keep in mind the importance of a careful evaluation of trainees before committing them to a diving task or training programme. Divers should be aware of the risk factors related to middle ear/sinus barotrauma and report their discomfort and terminate diving in a timely fashion to avoid major diving complications.

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