Periorbital emphysema after a dry hyperbaric chamber exposure

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Abstract

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We report a case of a patient developing extensive periorbital, facial, and neck emphysema during hyperbaric oxygen treatment for his facial osteoradionecrosis after sequestrectomy. Hyperbaric physicians should be alert for the potential development of this complication during the treatment and have a contingency plan.

Introduction

Middle ear barotrauma is the most common complication of hyperbaric oxygen therapy (HBOT), with reported incidence rates up to 43.2%.[1] While Valsalva manoeuvre is the most effective pressure-equalising techniques, it may rarely cause cervical surgical emphysema, particularly in patients with pre-existing anatomical defects.[2,3] Here we describe a case of a patient who developed extensive periorbital, facial, and neck emphysema during HBOT for osteoradionecrosis.

Case report

The patient reported here provided written consent for publication of his case history and images.

Our patient was a 70-year-old man with a history of nasopharyngeal carcinoma treated with radiotherapy in 1996. This was later complicated with bilateral sensorineural hearing loss, empty sella syndrome, and bilateral temporal bone osteoradionecrosis. His medical history also included isolated idiopathic right 6th nerve palsy, tuberculosis of the kidney for which a left nephrectomy was performed, and hyperlipidaemia. Around half a year ago, he had dental extractions (sites 41 to 47). In this index admission, he developed fever, right buccal swelling, jaw pain, and headache. Physical examination showed pus discharge on expression at the 46–47 dental extraction site. Computed tomography with contrast was performed on day two of admission, and it showed osteolytic lesions at the right mandible retromolar area and the right posterior maxilla. Right mandibular and maxillary osteoradionecrosis was diagnosed. Debridement and sequestrectomy of the right facial osteoradionecrosis were performed on day four of admission in view of active infection. Necrotic bone was removed with placement of a buccal fat graft during the surgery. A total of 30 sessions of hyperbaric oxygen therapy was planned to promote wound healing postoperatively.

On Day five of his admission, we arranged his first session of hyperbaric oxygen therapy (U.S. Navy Treatment Table 9, maximum pressure at 243 kPa (2.4 atmospheres absolute [atm abs]). During the compression, the patient reported no difficulty in equalising the pressure in both ears with Valsalva manoeuvres. However, at 50 kPa, we noticed he developed progressive, painless right periorbital and facial swelling. He continued the compression and reached the treatment pressure. He reported difficulty in opening his right eye, but he experienced no pain or discomfort. Physical examination showed right periorbital and facial crepitus, with normal bilateral pupillary light reaction, and his ocular movement was the same as before the session. Chest examination was also performed to ensure he had no pneumothorax. There was no chest wall emphysema and the air entry was equal for both sides. Emergency equipment for needle thoracocentesis, chest drain insertion, lateral canthotomy, and inferior cantholysis was prepared outside the chamber for use in case of pneumothorax or orbital compartment syndrome development before the decompression. During the decompression, the swelling in his right periorbital and facial areas continued to increase. We closely monitored the patient's symptoms and, in particular, any development of pain in the eyes or chest. We performed the decompression at 9.7 kPa per minute. Although there was a visible increase in the right periorbital and facial swelling during the decompression, he reported no pain or shortness of breath.

Figure 1
Extensive non-tender swelling over the right periorbital and facial region

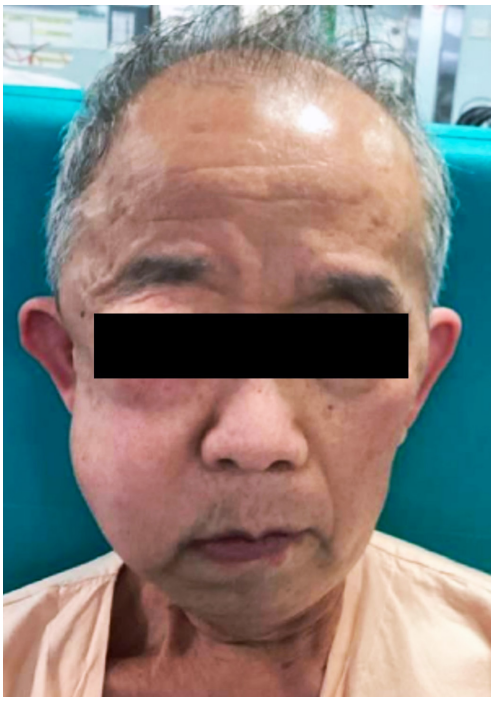
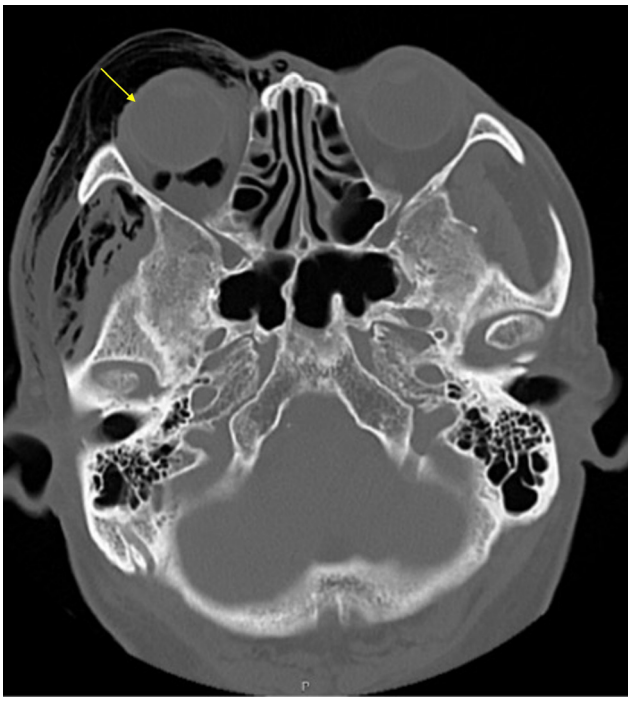


Figure 2
Axial plain computed tomography of the head showed extensive right orbital emphysema with the involvement of the retro-orbital area (with arrow pointing to affected region)



The HBOT session lasted 125 minutes. After decompression, a repeated physical examination was performed and showed extensive non-tender swelling over the right periorbital and facial region (Figure 1) with crepitus on palpation. Plain computed tomography imaging of his face and orbit was also performed. It showed extensive subcutaneous emphysema at the right masticator space, left parapharyngeal and left masticator space, left posterior cervical space, and left carotid space, as well as extensive right orbital emphysema with the involvement of the retro-orbital area (Figures 2 and 3). There was no tenting of the posterior sclera of the right globe or right eye proptosis. A lateral neck X-ray showed prevertebral gas (Figure 4), and a chest X-ray demonstrated left neck surgical emphysema. There was no pneumothorax or pneumomediastinum. The patient was then assessed by an otorhinolaryngologist; tracking of gas from the Valsalva manoeuvre via the right pterygopalatine fossa defect created during surgery was suspected. He was also assessed by an ophthalmologist. The slit lamp examination was normal. We carefully reviewed the benefits and risks of HBOT and decided to continue with additional HBOT sessions. Bilateral myringotomy with gold plate insertion was performed to prevent any further need of the Valsalva manoeuvre during the therapy. The patient continued to receive the remaining planned daily session of HBOT uneventfully. Three days afterwards, his right periorbital and facial swelling completely subsided.

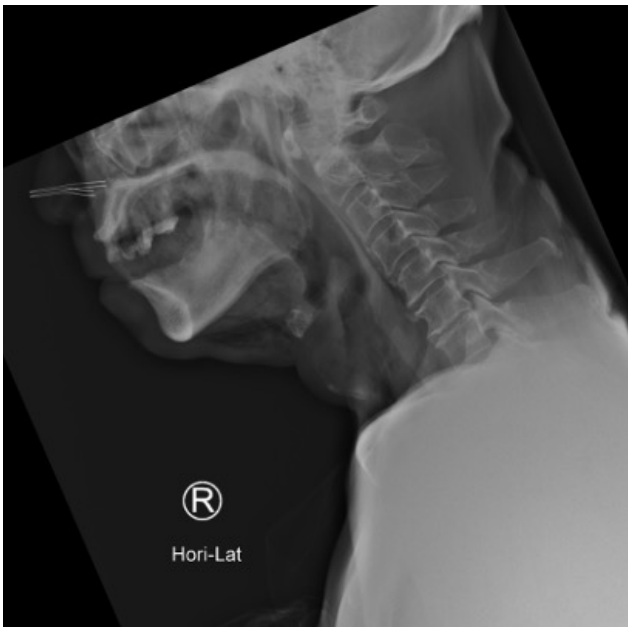
Discussion

The current treatment strategy for osteonecrosis of the jaw is aimed at a multimodal approach, which combines surgery and HBOT as adjuvant therapy.[4] The famously quoted protocol used in the treatment of osteonecrosis is the Marx protocol, which had 30 sessions arranged before surgery, such as dental extraction, and 10 more sessions scheduled after the surgery.[5] In this case, we were unable to provide pre-surgical hyperbaric oxygen treatment due to the emergency nature of the surgery.

Periorbital emphysema, although uncommon, has been reported in literature after both wet and dry diving. The proposed risk factors included facial trauma, repeated forceful Valsalva manoeuvres and recent upper respiratory tract infection.[6] In our patient, he just had the facial surgery the day before, and he performed repeated forceful Valsalva manoeuvres during his first HBOT session. The defect over the pterygopalatine fossa secondary to the surgery allows the passage of gas to the subcutaneous layer. The reported intraoral pressure during the Valsalva manoeuvre could reach up to 40 mmHg.[7] This high pressure further pushes gas to the subcutaneous layer, resulting in progressive swelling over the patient's right face and periorbital region. Subcutaneous emphysema has also been reported after other head and neck surgery, such as tonsillectomy.[8] Yet, in a randomised controlled trial looking into hyperbaric

Figure 3
Axial plain computed tomography of the head and face showed extensive subcutaneous emphysema at right masticator space, left parapharyngeal and left masticator space (with arrows pointing to affected region)

Figure 4
Lateral neck X-ray showing prevertebral gas



oxygen to prevent osteoradionecrosis of the irradiated mandible (HOPON study), which included 47 patients in the hyperbaric oxygen therapy arm, none developed head and neck surgery emphysema.[9]

According to Boyle's law, surgical emphysema is expected to further increase in both size and area as the pressure decreases during the decompression phase of HBOT. Gas in the retro-orbital area can lead to an increase in intra-ocular pressure, potentially resulting in orbital compartment syndrome. Blindness resulting from orbital emphysema had been reported.[10] Fortunately, this didn't occur in our patient, despite his severe periorbital emphysema.

If the patient developed pneumothorax or pneumomediastinum during the decompression, this could result in tension pneumothorax and tension pneumomediastinum. Orbital compartment syndrome could also occur during the decompression phase. Our contingency plan was an emergency stop should he develop any shortness of breath, chest pain, or eye pain. If pneumothorax was suspected, immediate needle thoracocentesis would be performed. Recompression was planned if the patient showed any signs of arterial gas embolism. If the patient developed rapidly worsening visual acuity and eye pain, we planned a lateral canthotomy and inferior cantholysis. After these potential emergencies settled, the decompression rate would be slowed to 3 kPa per minute to minimise the risk of sudden re-expansion of the gas phase.

Conclusions

Any communication between the nasopharyngeal tract and subcutaneous tissues could allow gas entry, especially if nasopharyngeal pressures are elevated by attempts to Valsalva. Bilateral myringotomy or grommet insertion could therefore prevent the development of facial and periorbital surgical emphysema by eliminating the need for the Valsalva manoeuvre. It may be difficult to predict who may need a prophylactic myringotomy to prevent this complication because the defect could be minor and hard to detect. Although a decision whether to perform prophylactic myringotomies in similar patient would be debatable, hyperbaric physicians should be alert for the potential development of facial and periorbital emphysema and have a contingency plan ready.

References

1 Heyboer M 3rd, Wojcik SM, Grant WD, Chambers P, Jennings S, Adcock P. Middle ear barotrauma in hyperbaric oxygen therapy. Undersea Hyperb Med. 2014;41:393–7. PMID: 25558548.

2 Tanya SM, Kulbay M, Kherani F, Mydlarski MB. Valsalva-induced orbital and subcutaneous periorbital emphysema secondary to lamina papyracea dehiscence: a case report. Case Rep Ophthalmol. 2025;16:202–206. doi: 10.1159/000544098. PMID: 40241927. PMCID: PMC11908810.

3 Paouris D, Barkociová J, Pavlík Š, Šebová I. Deep subcutaneous cervical emphysema related to mastoid

fracture in an adolescent patient - case report. Clin Case Rep. 2022;10(9):e6306. doi: 10.1002/ccr3.6306. PMID: 36110334. PMCID: PMC9465693.

4 Ceponis P, Keilman C, Guerry C, Freiberger JJ. Hyperbaric oxygen therapy and osteonecrosis. Oral Dis. 2017;23:141–51. doi: 10.1111/odi.12489. PMID: 27062390.

5 Marx RE, Johnson RP, Kline SN. Prevention of osteoradionecrosis: a randomized prospective clinical trial of hyperbaric oxygen versus penicillin. J Am Dent Assoc. 1985;111:49–54. doi: 10.14219/jada.archive.1985.0074. PMID: 3897335.

6 Tseng WS, Lee HC, Kang BH. Periorbital emphysema after a wet chamber dive. Diving Hyperb Med. 2017;47:198–200. doi: 10.28920/dhm47.3.198-200. PMID: 28868601. PMCID: PMC6159621.

7 Kumar CM, Van Zundert AAJ. Intraoperative Valsalva maneuver: a narrative review. Can J Anaesth. 2018;65:578–85. doi: 10.1007/s12630-018-1074-6. PMID: 29368315.

8 Barengo JH, Yuen SN, Kennedy P, Shott SR. Subcutaneous emphysema with pneumomediastinum after tonsillectomy: Case report and review of the literature. Int J Pediatr Otorhinolaryngol. 2020;131:109885. doi: 10.1016/j.ijporl.2020.109885. PMID: 31981917.

9 Shaw RJ, Butterworth CJ, Silcocks P, Tesfaye BT, Bickerstaff M, Jackson R, et al. HOPON (Hyperbaric Oxygen for the Prevention of Osteoradionecrosis): a randomized controlled trial of hyperbaric oxygen to prevent osteoradionecrosis of the irradiated mandible after dentoalveolar surgery. Int J Radiat Oncol Biol Phys. 2019;104:530–9. doi: 10.1016/j.ijrobp.2019.02.044. PMID: 30851351.

10 Fleishman JA, Beck RW, Hoffman RO. Orbital emphysema as an ophthalmologic emergency. Ophthalmology. 1984;91(11):1389–91. doi: 10.1016/s0161-6420(84)34135-5. PMID: 6514309.

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