

Case Study

Peculiar case of orbital emphysema caused by high-pressure water jet

ABSTRACT

Aim: To report an unusual case of orbital emphysema secondary to high pressure water jet injury.

Presentation of Case: A 26-year-old Indian male sustained a two-centimeter facial laceration after a compressed water jet hit the left infra-orbital region. Ophthalmic examination showed extensive inferior commotio retinae without any clinical signs of conjunctival laceration or globe rupture. Computed tomography showed orbital emphysema with undisplaced fracture of the orbital floor. Follow-up examination 1 month after the injury showed total resolution of orbital emphysema.

Discussion and Conclusion: Our case illustrates the dangers of water jet injuries and the unique mechanism of injury provides supporting evidence of our current existing orbital fracture theory. This mechanism of injury is most peculiar and to our knowledge, not previously reported in the literature.

Keywords: Orbital emphysema, water jet injuries, *orbital floor fracture*, *commotion retinae*

1. INTRODUCTION

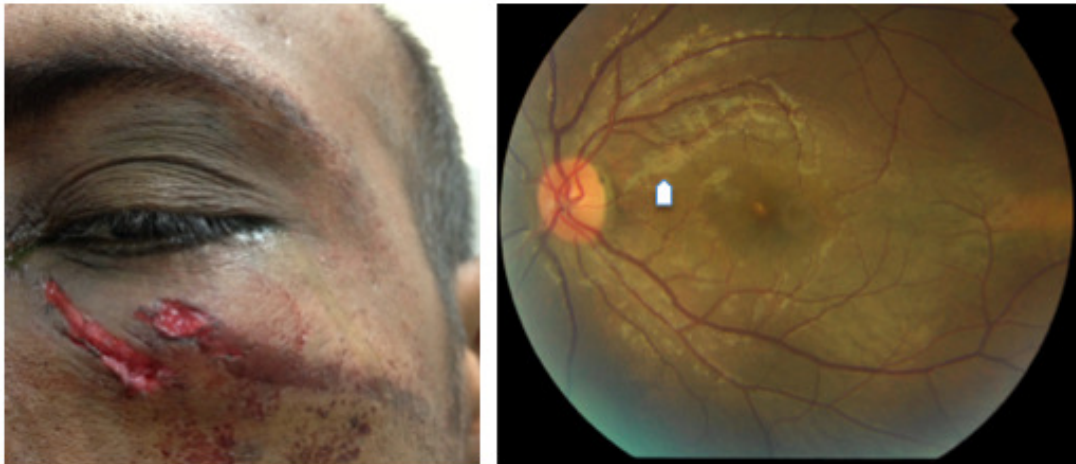
High-pressure water jet is commonly used for surface cleaning of driveways, walls and drains. Our case presents a unique mechanism in which a high-pressure water system caused a penetrating injury of the orbit resulting in an orbital fracture and emphysema without significant globe injury.

We describe a case of orbital and subcutaneous emphysema with orbital floor fracture following penetrating water jet injury. This mechanism of injury, to our knowledge, has not been reported in literature.

2. PRESENTATION OF CASE

A 26-year-old Indian male presented to our centre with a left lower eyelid laceration with blurring of vision after he was hit over his face accidentally by a high-pressure water jet used for floor cleaning 2 hours earlier. Best-corrected visual acuity (BCVA) was 6/6 in the right eye and 6/12 over the left eye. There was a linear 2 cm laceration 0.5 cm below the left lower lid margin (Fig. 1a) with fullness over the lower lid. There was subconjunctival hemorrhage over the lateral part of eye without any laceration. Rest of the anterior segment

31 examination was within normal limits. There was no limitation in eye movements. Fundal
32 examination revealed extensive inferior commotio retinae with Berlin's edema (Fig. 1b).



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34 **Figure 1a (left) showing 1cm infra-orbital laceration**
35 **Figure b (right) showing extensive commotio retinae (arrowhead)**
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37 Computed tomography (CT) of the orbits revealed extensive subcutaneous and orbital
38 emphysema extending from the laceration. There was a small, un-displaced anterior, inferior
39 orbital floor fracture with fluid in the maxillary sinus (Fig. 2).

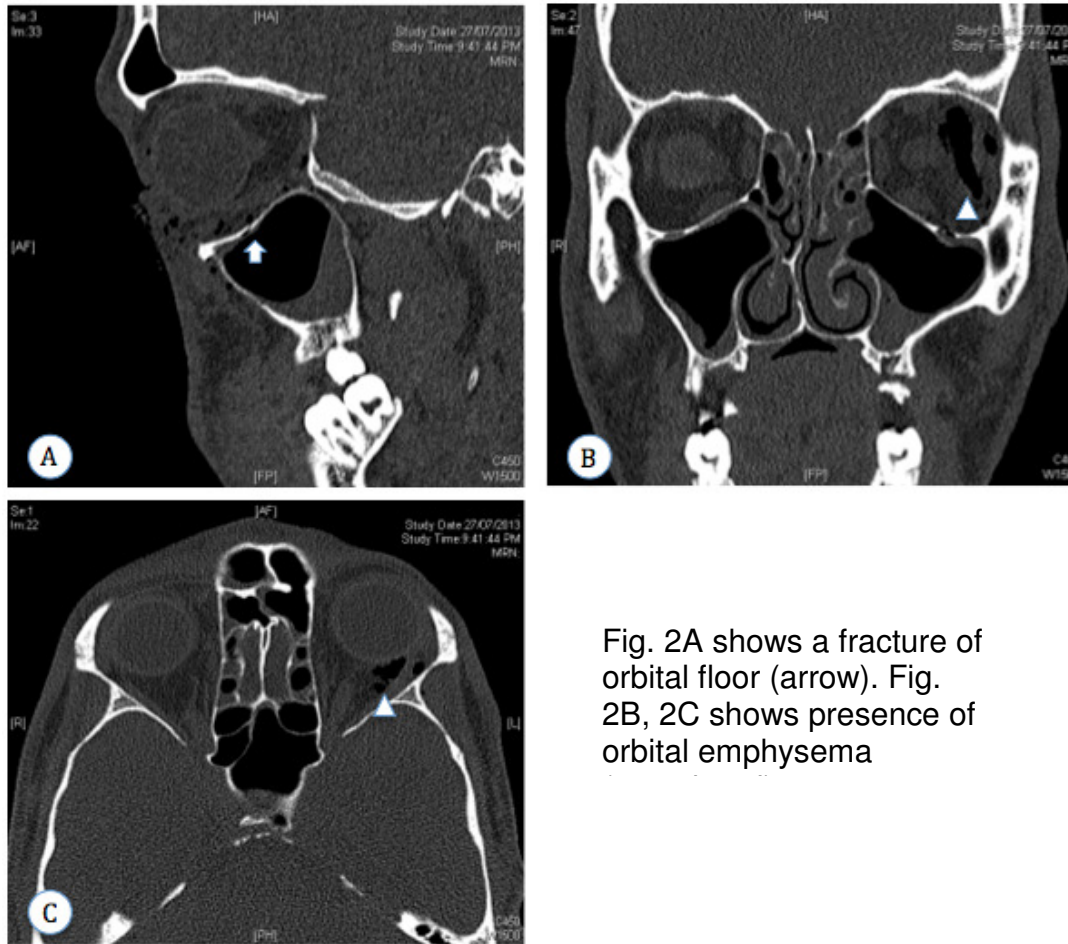


Fig. 2A shows a fracture of orbital floor (arrow). Fig. 2B, 2C shows presence of orbital emphysema

40 Left lower lid wound was sutured. Patient was treated with oral Augmentin and tetracycline
 41 skin ointment to the lid laceration. He was monitored daily for the first 48 hours with
 42 improvement of left BCVA to 6/6.

43 A repeat CT of the orbits was done 1 month after injury that showed complete resolution of
 44 the orbital emphysema (Fig. 3). Visual acuity remained 6/6 and commotio retinae resolved.

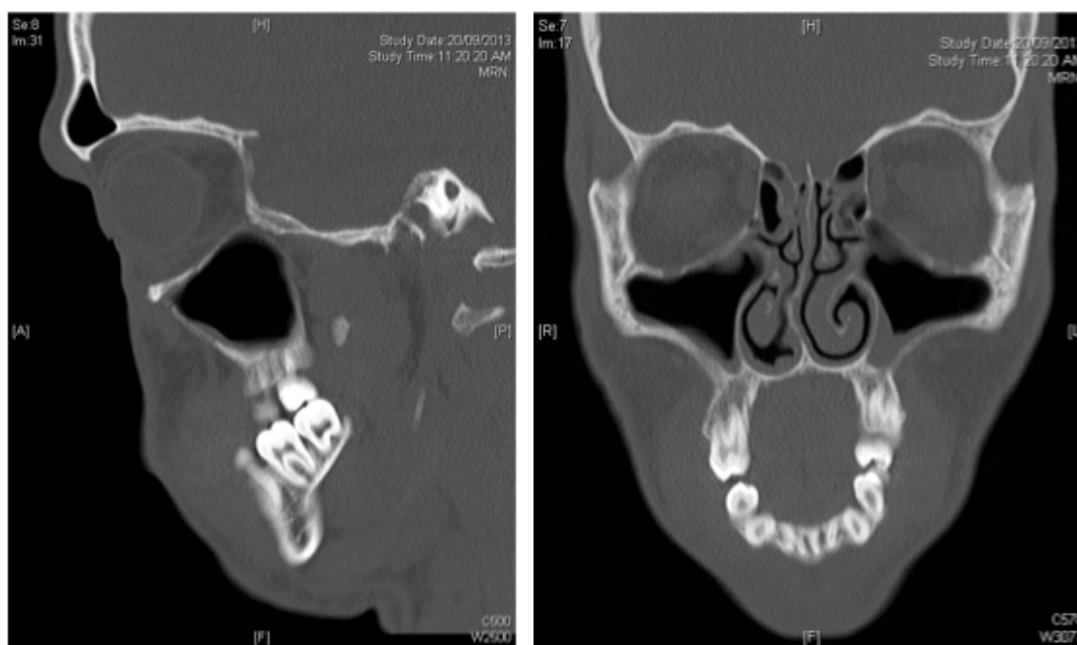


Figure 2 shows interval resolution of orbital emphysema

3. DISCUSSION

Orbital emphysema with or without orbital fracture due to compressed air has been reported a number of times (1-4). High-pressure water jet orbital injury, on the other hand is relatively uncommon, and it causing orbital emphysema is, to the best of our knowledge, not been reported before. A search on Scopus, MEDLINE, EMBASE, and Cochrane library using the following keywords “water jet injuries”, “orbital emphysema”, “water jet injury”, “orbital fracture” did not show any case reports of water jet injury causing orbital emphysema.

The mechanism of orbital fractures has been a source of debate in many journal articles. Two theories has been offered, the “buckling” and the “hydraulic” mechanism.

The buckling theory, first proposed by Le Fort, suggests that trauma to the infraorbital rim may transmit force directly to the thinner orbital floor, causing disruption of the floor without fracture of the rim (5). In contrast, Pfeifer, who first propose the hydraulic theory, contends that trauma directed to the globe results in transmission of hydraulic pressure to the walls of the orbit (6).

Biomechanical studies (7, 8) from cadavers and theoretical models have shown that predominant buckling mechanism results in a small fracture usually confined to anterior to mid-medial wall of the orbit and herniation of orbital contents is unusual. Rarely does impact to the living eye occur in such isolation to allow us to attribute the injury to one particular mechanism; usually both hydraulic and buckling mechanisms exist. Our case, with the lack of significant anterior globe injuries, the presence of lower lid laceration indicating the main force of impact, suggests that the inferior orbital rim received the bulk of the force from the water jet. The pattern of injury, i.e. small anterior floor fracture without rim fracture helps to validate current theoretical knowledge known about the buckling theory.

73 In a review of the literature on orbital emphysema following high-pressure compressed air jet
74 by Hiraoka et al (9), the authors reported that of the 15 cases reported to date, 14 cases had
75 direct entry of air into the orbit via the conjunctiva, and 1 case via the eyelid. All of the cases
76 had conjunctival chemosis / emphysema. In contrast, our case did not have any conjunctiva
77 laceration or chemosis, likely due to the main impact of the water jet hitting the inferior orbital
78 rim, providing a route of entry for air. The ocular injuries associated with air jet injuries were
79 mostly limited to anterior segment injuries (10 out of the 15 cases). Only 4 of the cases had
80 commotio retinae, and 1 case developed optic atrophy. Of the high-pressure water jet
81 injuries reported to our knowledge, the injuries were more severe (10-14). All of the cases
82 had posterior segment injuries. Our case also illustrates the possibility of orbital emphysema
83 caused by high-pressure water jet injuries, which was not previously reported.

84 The source of orbital emphysema may be the result of nose blowing with resultant passage
85 of air from the paranasal sinuses through the floor fracture into orbit. However, given the
86 close proximity of the site of laceration to the floor fracture, it is likely that air from the
87 paranasal passages would exit from the site of laceration instead of going retrobulbarly. The
88 involvement of orbital emphysema from the wound of entry into the orbit in an upward
89 fashion (Fig 2a) leads the authors to also postulate that the air may have been introduced
90 together with the water jet.

91 High-pressure water jet injuries provide an entry for potential pathogens. Fairley C et al.
92 reported a case of rhino-orbital-cerebral mucormycosis following high-pressure water jet
93 injury in an immunocompetent patient occurring 12 hours following injury (15). The authors
94 recommend a close follow-up following initial trauma to watch for any signs of orbital
95 infection and high index of suspicion for non-bacterial pathogens should the infection not
96 respond to antibiotics.

97 **4. CONCLUSION**

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99 Our case illustrates the dangers of water jet injuries. Close early follow-up is necessary to
100 watch for any signs of orbital infection following trauma.

103 **CONSENT (WHERE EVER APPLICABLE)**

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105 All authors declare that written informed consent was obtained from the patient (or other
106 approved parties) for publication of this case report and accompanying images. A copy of
107 the written consent is available for review by the Editorial office/Chief Editor/Editorial Board
108 members of this journal.

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