

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 injury provides supporting evidence of our current existing orbital fracture theory. **This injury is most peculiar and to our knowledge, not previously reported in the literature.**

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

1. INTRODUCTION

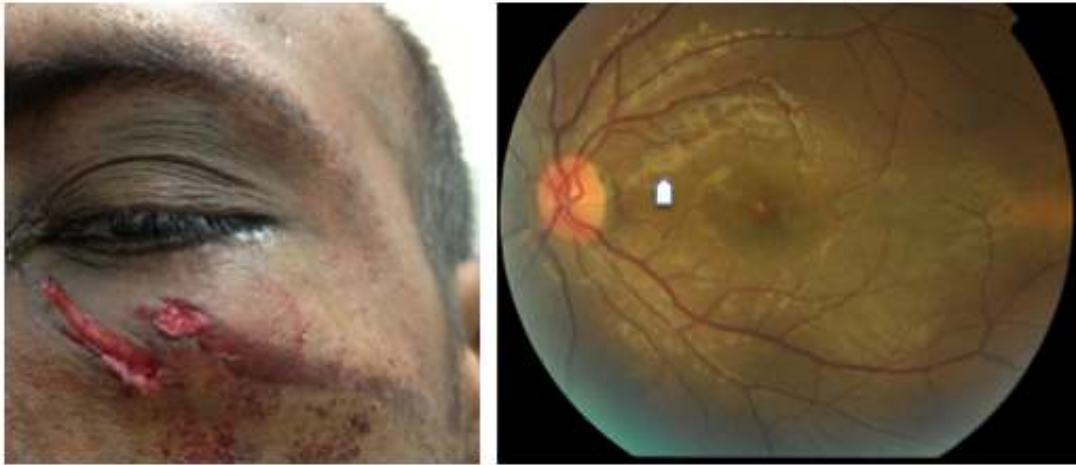
High-pressure water jet is commonly used for surface cleaning of driveways, walls and drains. Our case presents a unique mechanism in which a high-pressure water system caused a penetrating injury of the orbit resulting in an orbital fracture and emphysema without significant globe injury.

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

2. PRESENTATION OF CASE

A 26-year-old Indian male, **with no past medical or surgical history of note,** 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. **He was standing opposite a friend holding the water hose and was hit momentarily over the face by the water jet inadvertently. He denies blowing his nose after the incident.** Best-corrected visual acuity (BCVA) was 6/6 in the right eye and 6/12 over the left eye. **Color vision tested on Ishihara chart was full in both eyes. There was no relative afferent pupillary defect.** There was a linear 2 cm laceration 0.5 cm below the left lower lid margin (Fig. 1a) with fullness

33 over the lower lid. There was subconjunctival hemorrhage over the lateral part of eye without
34 any laceration. Rest of the anterior segment examination was within normal limits. There
35 was no limitation in eye movements. Fundal examination revealed extensive inferior
36 commotio retinae with Berlin's edema (Fig. 1b).



37

38 **Figure 1a (left) showing 1cm infra-orbital laceration**

39 **Figure 1b (right) showing extensive commotio retinae (arrowhead)**

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41 Computed tomography (CT) of the orbits revealed extensive subcutaneous and orbital
42 emphysema extending from the laceration. There was a small, un-displaced anterior, inferior
43 orbital floor fracture with fluid in the maxillary sinus (Fig. 2).

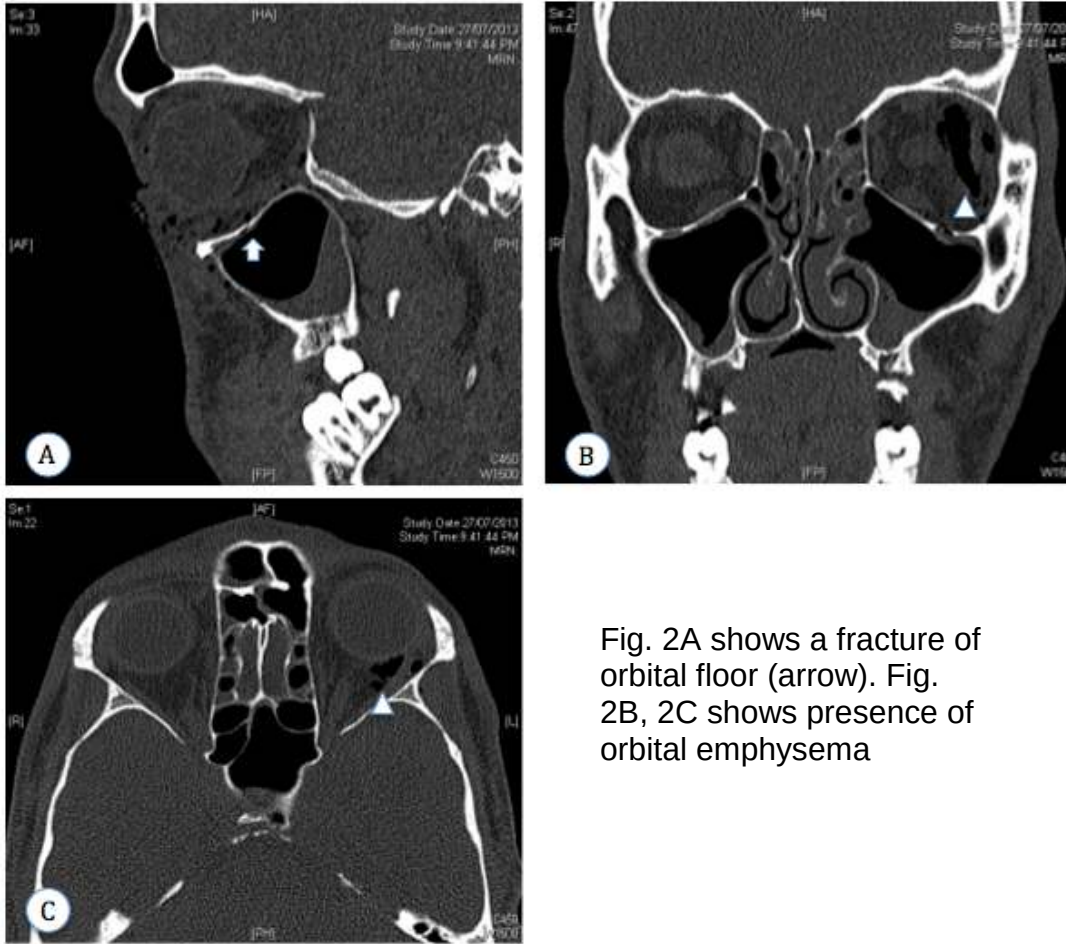


Fig. 2A shows a fracture of orbital floor (arrow). Fig. 2B, 2C shows presence of orbital emphysema

- 44 Left lower lid wound was sutured. Patient was treated with oral **Amoxicillin/clavulanic acid**
 45 and tetracycline skin ointment to the lid laceration. He was monitored daily for the first 48
 46 hours with improvement of left BCVA to 6/6.
- 47 A repeat CT of the orbits was done 1 month after injury that showed complete resolution of
 48 the orbital emphysema (Fig. 3). Visual acuity remained 6/6 and commotio retinae resolved.

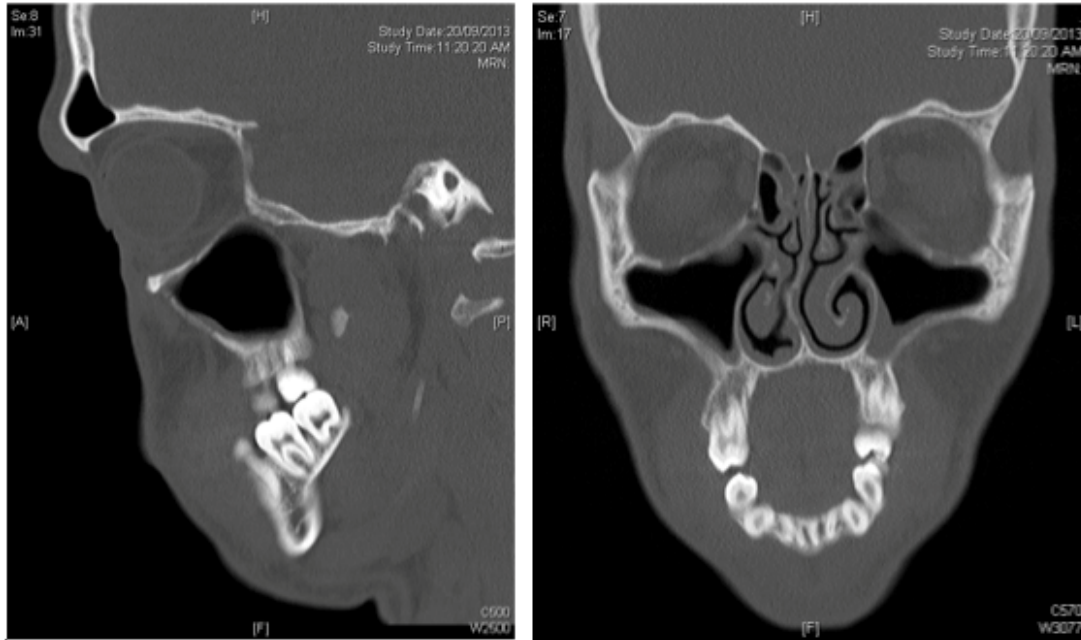


Figure 2 shows interval resolution of orbital emphysema

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.

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

The mechanism of orbital fractures has been a source of debate in many journal articles. Three theories have emerged, the “buckling”, the “hydraulic” mechanism and the “globe-to-wall contact” mechanism. The former two theories were the more known and accepted of the three.

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

79 the orbit, which tends to fracture medially (6). In addition, first espoused by Pfeiffer in 1943
80 (6), the “globe-to-wall” mechanism results in a fracture in the inferomedial orbital wall via
81 direct contact with the globe due to posterior movement of the globe in response to an
82 external force.

83 Biomechanical studies (7, 8) from cadavers and theoretical models have shown that
84 predominant buckling mechanism results in a small fracture usually confined to anterior to
85 mid-medial wall of the orbit, and herniation of orbital contents is unusual. Rarely does impact
86 to the living eye occur in isolation to attribute the injury to one particular mechanism; usually
87 both hydraulic and buckling mechanisms exist. Our case, with the lack of significant globe
88 injury, as well as the presence of lower lid laceration indicating the main force of impact,
89 suggests that the inferior orbital rim received the bulk of the force from the water jet. The
90 pattern of the injury and the location of fracture lead the authors to postulate that the
91 buckling mechanism is predominantly the cause of fracture in this case.

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

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

105 **4. CONCLUSION**

106
107 Our case illustrates the dangers of water jet injuries. Infra-orbital trauma caused by a water-
108 jet can cause orbital emphysema. Close early follow-up is necessary to watch for any signs
109 of orbital infection following trauma.
110

111 112 **CONSENT (WHERE EVER APPLICABLE)**

113
114 All authors declare that written informed consent was obtained from the patient (or other
115 approved parties) for publication of this case report and accompanying images. A copy of
116 the written consent is available for review by the Editorial office/Chief Editor/Editorial Board
117 members of this journal.
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120 **REFERENCES**

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