

Case series: Traumatic ocular lacerations secondary to pressure washers

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ABSTRACT

Purpose: Numerous causes of ocular lacerations, including, open globe injuries have been extensively reported but to our knowledge this is first time that pressure washers have been reported to be the culprit. Thus, in this case series we describe the uniqueness of ocular findings secondary to high-power pressure washer injuries that are a result of their mechanistic function.

Observations: Here we report a case series of 3 patients who presented in an emergency department with pain and decreased visual acuity following usage of high-pressure washer machines. All three patients presented with features of both blunt and sharp mechanisms of ocular injury. Most lacerations caused injury that encompassed more than one zone. Two of the patients experienced an open globe injury, and all patients had poor final visual outcomes. Extraocular involvement included fractures and lid lacerations. All patients were managed surgically with repair of the ocular defects. Visual outcome in the first patient was hand motion, while the second patient received a prosthesis following enucleation due to lack of recovery after four months. Lastly, we were unable able to obtain visual outcome for the third patient due to lack of follow up.

Conclusion: Ocular injuries due to pressure washers have not been reported in literature, however, this case series serves to elucidate that pressure washers can cause ocular injuries with both blunt and laceration mechanical effects. Moreover, special care should be taken in preventing and managing these injuries due to their high ocular morbidity.

1. Introduction

The most common cause of monocular blindness in the world is trauma.¹ Ocular injury can be classified as either closed or open globe injury, with open globe injury (OGI) defined as a full thickness perforation in the cornea or sclera.² OGI is the most severe form of ocular trauma, not only because of the extent of injury but also due to numerous complications that greatly affect final visual acuity. Most adult OGIs are caused by domestic or occupation related trauma that involve manipulation of machinery.³

Ocular injuries from pressure washers are rarely reported. Pressure washers use a pump to push water out at variable pressures. They are used by businesses or homeowners to remove dirt and grime from surfaces such as vehicles, concrete, or buildings. Pressure washer machines can produce pressures up to 3000 psi. A standard pressure washer consists of an electric motor or gas engine, water pump, high pressure hose, and a cleaning attachment. Water pumps create a flow of 1–2

gallons per minute, and the cleaning attachment dispenses the water through a nozzle in a high-pressure stream. Nozzles can vary from a simple trigger gun with a water valve to multiple high-pressure jets on a spinning wand. While numerous hazards have been reported to be the culprits of OGI, to our knowledge this is the first time OGI secondary to pressure washers has been reported in literature. Non-ocular injuries from pressure washers that have been documented in case reports range from superficial wounds to multilayer soft tissue injuries and compartment syndrome.⁴ A common consequence of high-pressure injection injuries is air in subcutaneous tissue, which can lead to compartment syndrome, infection, and eventual limb amputation.⁵

2. Findings: case presentation

2.1. Case #1

A 40-year-old Hispanic male with no past medical history (PMH)

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presented after losing control of a high-pressure washer at work and suffering an injury in the form of a linear abrasion stretching from his right neck up to the right eye (OD) and forehead. Immediately after the incident, he reported significantly blurred vision and a superior vision loss, which he described as a “shade over the top part of my vision”. He endorsed OD pain, floaters, and foreign body sensation.

At presentation, visual acuity (VA) was count fingers (CF) inferiorly OD and 20/20 OS. Extra ocular motility (EOM) was intact. Confrontational visual fields (CVF) showed a superior visual field defect OD. The OD pupil was non-reactive. Pressures were 19 OD and 18 OS. Anterior segment exam revealed 3+ injection and chemosis OD, a small conjunctival laceration stretching from 6 (one mm posterior to the limbus) circumferentially to 9 o'clock, a corneal abrasion, and hyphema. Dilated fundus exam (DFE) revealed an inferior retinal detachment OD, extending superiorly to involve the macula and ending at the superior vascular arcade. Preretinal and vitreous hemorrhage was concentrated inferiorly, commotio retinae was seen in the superior periphery, and a traumatic macular hole was present.

The patient's conjunctiva was sutured the same day. The patient did not receive tetanus prophylaxis as it was not recommended but topical antibiotics were administered. Follow-up outpatient retinal surgery was scheduled. Due to retinal detachment, severe proliferative vitreoretinopathy, vitreous in the anterior chamber and a traumatic cataract, the patient required trans pars plana vitrectomy (PPV), lensectomy, scleral buckle, endophotocoagulation, air fluid exchange, and silicone vitreous substitute. Follow up at a year yielded a final VA of hand motion (HM) OD and glaucoma secondary to ocular trauma.

2.2. Case #2

A middle-aged male with no significant PMH presented after a pressure washer sprayed into his left eye (OS). He stated he lost vision to eye immediately and complained of severe left sided facial and peri-orbital pain.

At presentation, VA was 20/25 OD and no light perception (NLP) OS. EOM OS was limited in all directions secondary to edema and trauma. No view of the pupil was appreciated OS. Pressures were 15 OD and deferred OS. External exam revealed 4+ upper and lower lid edema OS. A small 2 mm full thickness laceration was present through the upper lid margin midway across the lid, as well as a 1.2 cm superficial arched laceration just beneath the eyebrow. Anterior segment exam showed total subconjunctival hemorrhage (SCH) and chemosis OS. A full-thickness laceration through the cornea, starting at the lateral limbus and extending medially through the full horizontal length of the cornea, continued through the sclera in a linear fashion and extended around the side of the globe through the medial rectus muscle insertion. Uvea was prolapsing through the wound and there was complete hyphema of the anterior chamber. DFE was deferred. Computed tomography (CT) imaging without contrast revealed a large left orbital floor fracture, medial wall fracture, maxillary sinus fractures, and a zygomaticomaxillary fracture. Of note, CT angiography also showed an asymptomatic left internal carotid artery grade I dissection. The calculated ocular trauma score of the patient's injured eye (OS) was thirty-seven.

The patient had his corneoscleral and lid lacerations repaired the same day. The patient received tetanus prophylaxis and intravitreal antibiotics were administered. His orbital fractures were managed by the otolaryngology service. Due to lack of recovery, his left eye was enucleated four months later, and he received a prosthesis.

2.3. Case #3

A middle-aged male with no PMH presented after his friend accidentally struck him in the right eye with a pressure washer jet stream at work. He immediately noted loss of vision in the right eye and experienced bleeding from both his upper and lower eyelids.

At presentation, his VA was NLP OD and 20/20 OS. His EOM in his

OD was restricted secondary to pain. The pupil could not be appreciated OD. Pressures were deferred OD and 13 OS. On anterior segment exam, there was perforation of the superior lid OD with laceration of skin and superficial tissues of the medial upper and lower lids. 9 mm posterior to the limbus, a full-thickness scleral laceration was found with significant uveal prolapse and extended approximately 9 mm in length from just behind the medial aspect of the superior rectus muscle medially to the 2 o'clock position, along with partial laceration of the medial rectus muscle. No corneal laceration was noted. There was total hyphema. CT orbit (shown below) revealed extensive laceration to the right orbit with rupture and hemorrhage of the right globe, no lens identification, extensive extraconal and intraconal air with suggestion of a small retrolbulbar hemorrhage, and no fractures of the orbital walls (Fig. 1). The calculated ocular trauma score of the patient's injured eye (OD) was forty-six.

The patient's scleral lacerations were repaired within 24 hours. The patient did not receive tetanus prophylaxis but intravitreal and topical antibiotics were administered. The patient did not follow up and his final VA OD was unable to be obtained.

3. Discussion

Injury from high pressure water jets is relatively rare but causes severe damage to ocular structures. The high pressure of water ejected from pressure washers make them very dangerous appliances, and account for their high ocular morbidity. Although OGI secondary to pressure washers have not been reported in literature, multiple high pressure water jet injuries from other appliances have been reported. Most common are fire hose injuries. Rare causes of OGI secondary to agriculture irrigation systems, diesel piston engines, and industrial pipes have been documented as well.⁶⁻⁸ OGI secondary to fire hose present similarly with eyelid edema and ecchymosis and severely decreased visual acuity. On exam, most patients have conjunctival hemorrhage, vitreous hemorrhage, hyphema, iridodialysis, lens detachment, retinal detachment, and commotio retinae.⁹⁻¹² Fire hose injuries usually result in severe bilateral ocular injuries due to the larger hose diameter.

In contrast, pressure washers eject a concentrated water stream more likely to cause unilateral OGI. In our case series, two patients were found to have zone III injuries with involvement of extraocular muscles. All of our patients presented with injuries that have features of both blunt and sharp mechanisms of injuries. Evidence of blunt trauma included retinal detachment, retinal commotio, and traumatic macular hole. Evidence of sharp injury were seen with conjunctival lacerations and delineated corneoscleral lacerations with uveal prolapse. In addition, extraocular comorbidities including fractures, often seen with blunt trauma, and lid lacerations, often seen with sharp trauma, were present. Of particular note, even in the one case of injury without an open globe injury, a poor visual outcome was still seen, presumably due to the blunt force trauma of the pressure washer. All of the injuries due to pressure washers have a poor presenting VA and poor prognosis overall.

Based on the extent of ocular injury and poor prognosis, basic safety measures can prevent injuries due to high-pressure washers. Users should thoroughly review and understand the operator's manual and safety guidelines. Safety glasses or goggles should always be worn when operating a pressure washer. Users should be aware of the work environment and nearby people, and avoid electric wiring, receptacles, and junction boxes. Hands and feet should be kept away from the spraywand nozzle. A distance of 8-24 inches should be maintained between the nozzle and surface being cleaned.

4. Conclusion

We present a rarely reported cause of OGI: pressure washers. Unlike other culprits, pressure washers can cause OGIs with both blunt and laceration mechanical effects. In addition, these OGI lacerations can cause injury that encompasses more than one zone. Patients who present

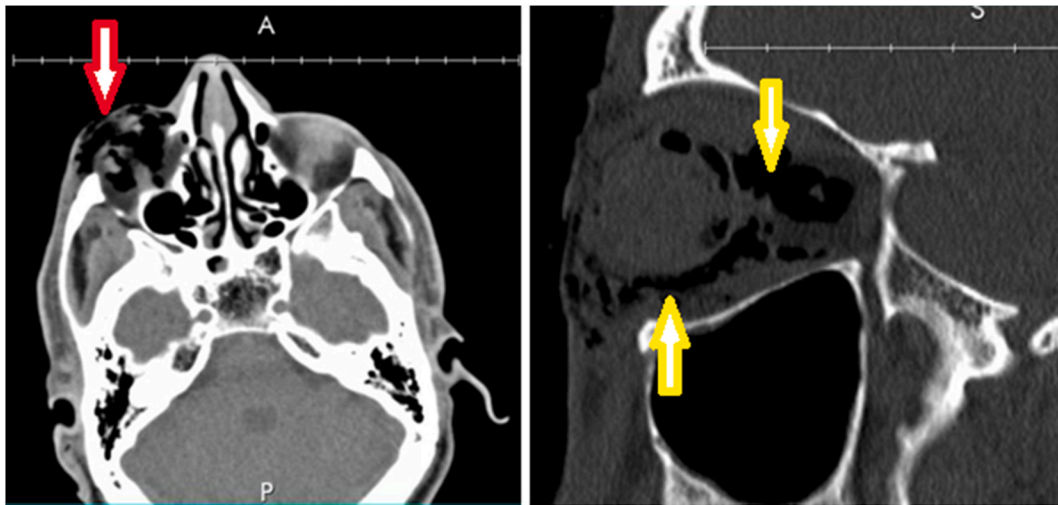


Fig. 1. CT Orbit

Extensive laceration to the right orbit with rupture and hemorrhage of the right globe, the lens is unable to be identified (red arrow). Extensive extraconal and intraconal air with suggestion of a small retrobulbar hemorrhage (yellow arrows).

with ophthalmological complaints after operating pressure washers need a thorough exam to ensure an OGI is not missed.

5. Patient consent

- o He patient in the first consented to publication of the case orally via a phone call.
- o Consent for publication of the last two cases was not obtained. So, we deidentified their clinical HPI to the fullest extent, without changing data, in order to maintain complete anonymity and prevent identification. This report does not contain any personal information that could lead to the identification of the patient.

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Authorship

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IRB approval

IRB for this project was obtained

Intellectual property

We confirm that we have given due consideration to the protection of intellectual property associated with this work and that there are no impediments to publication, including the timing of publication, with respect to intellectual property. In so doing we confirm that we have followed the regulations of our institutions concerning intellectual property.

Research ethics

We further confirm that any aspect of the work covered in this manuscript that has involved human patients has been conducted with the ethical approval of all relevant bodies and that such approvals are acknowledged within the manuscript.

IRB approval was obtained (required for studies and series of 3 or more cases).

Written consent to publish potentially identifying information, such as details or the case and photographs, was obtained from the patient(s) or their legal guardian(s).

We confirm that the manuscript has been read and approved by all named authors.

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Can you please grant dual first authorship to the following author: **John Placide** and **Melissa Y. Yang**, as they have contributed equally to the development of this project and manuscript.

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Declaration of competing interest

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References

- Batur M, Seven E, Esmer O, Akaltun MN, Yasar T, Cinal A. Epidemiology of adult open globe injury. *J Craniofac Surg*. 2016. <https://doi.org/10.1097/SCS.0000000000003001>.
- Batur M, Seven E, Akaltun MN, Tekin S, Yasar T. Epidemiology of open globe injury in children. *J Craniofac Surg*. 2017. <https://doi.org/10.1097/SCS.0000000000004033>.
- Atik SS, Ugurlu S, Egrilmez ED. Open globe injury: demographic and clinical features. *J Craniofac Surg*. 2018. <https://doi.org/10.1097/SCS.0000000000004156>.
- Ritz M, Davitt A. *Pressure! Pushing Down on Me, Pushing Down on You: The Underlying Danger of Pressure Washer Injuries*. EM Resident; 2020. <https://www.emra.org/emresident/article/pressure-washer-injuries/>. Accessed December 21, 2020.
- Hogan CJ, Ruland RT. High-pressure injection injuries to the upper extremity: a review of the literature. *J Orthop Trauma*. 2006. <https://doi.org/10.1097/00005131-200608000-00010>.
- Salminen LO, Ranta AN. Orbital laceration caused by a blast of water: report of 2 cases. *Br J Ophthalmol*. 1983. <https://doi.org/10.1136/bjo.67.12.840>.
- Oosuka S, Sato T, Tajiri K, et al. A case of a ruptured eyeball caused by high-pressure water jets. *Ophthalmic Surgery, Lasers & Imaging Retina*. 2018. <https://doi.org/10.3928/23258160-20180601-11>.
- DeAngelis DD, Oestreicher JH. Traumatic enucleation from a high-pressure water jet. *Arch Ophthalmol*. 1999;117:123–124.
- Gracner B, Pahor D. Bilateral eye injury caused by a high-pressure water jet from a fire hose. *Wien Klin Wochenschr*. 2001;113(Suppl 2):62–64.
- Georgalas I, Ladas I, Taliantzis S, Rouvas A, Koutsandrea C. Severe intraocular trauma in a fireman caused by a high-pressure water jet. *Clin Exp Ophthalmol*. 2011. <https://doi.org/10.1111/j.1442-9071.2010.02467.x>.
- Landau D, Berson D. High-pressure directed water jets as a cause of severe bilateral intraocular injuries. *Am J Ophthalmol*. 1995. [https://doi.org/10.1016/s0002-9394\(14\)72679-0](https://doi.org/10.1016/s0002-9394(14)72679-0).
- Acheson JF, Wong D, Chignell AH. Eye injuries caused by directed jets of water from a fire hose. *Br Med J*. 1987. <https://doi.org/10.1136/bmj.294.6570.481-a>.