American Journal of Ophthalmology Case Reports 10 (2018) 35–37

Contents lists available at ScienceDirect

American Journal of Ophthalmology Case Reports

journal homepage: www.elsevier.com/locate/ajoc

Case report

Aerial drone misadventure: A novel case of trauma resulting in ocular globe rupture

Eliza E. Moskowitz[a,b,*], Yonaton M. Siegel-Richman[c], George Hertner[c], Thomas Schroeppel[b]

[a] Department of Surgery, University of Colorado Health-South, Memorial Hospital, 1400 E Boulder St, Colorado Springs, CO 80909, United States
[b] Department of Surgery, University of Colorado School of Medicine, 12631 E. 17th Avenue, C-305, Aurora, CO 80045, United States
[c] Department of Emergency Medicine, University of Colorado Health-South, Memorial Hospital, 1400 E Boulder St, Colorado Springs, CO 80909, United States

ARTICLE INFO

Keywords:
Drone
Trauma
Globe injury
Globe rupture
Ocular trauma
Corneal trauma
Scleral trauma

ABSTRACT

Purpose: The purpose of this case report is to present the novel findings of a drone causing such a traumatic ocular injury and provide recommendations for how it might be prevented.
Observations: We report on a recent case where a child presented to our Emergency Department after incurring a blow to the face by the propeller of a remote controlled drone. The patient suffered significant trauma including rupture of the right globe.
Conclusions: As drone sales continue to rise, it is important that physicians be prepared to treat the potential injuries that may result from using these devices. Furthermore, in an attempt to reduce the number of visits associated with remote controlled drones, physicians should be prepared to provide advice as to how patients can reduce the risks of injury.
Importance: We hope that the framework and recommendations below will help physicians decrease adverse outcomes related to this unusual injury pattern.

1. Introduction

Over the past year, the Federal Aviation Administration estimates that over 2.5 million drones have been sold and this number is expected to triple over the next few years.[1] Many of these unmanned aircraft can travel up to 100 miles per hour (MPH)—and as such can deliver a significant force, strong enough to inflict serious bodily harm. Previous research has demonstrated that a 500-g drone traveling between 17 and 37 MPH can create forces between 14 and 69 J; which in cadaveric studies is significant enough to fracture the human skull.[2] The rapid proliferation of inexpensive models has made these devices more readily available to consumers. As their use continues to become more prevalent, it seems inevitable that injuries from these devices are likely to rise as well. Our chart review demonstrated a dearth of reported cases in the literature relating to drone-related injuries. A single case of skull fracture following drone impact was reported earlier this year,[3] however, there have been no reported cases of injuries to the face and/or eye as a result of drone aircraft reported to date. This article reviews the clinical presentation, implications, and management of facial trauma as a result of injury from a drone.

2. Case report

A nine year-old male presented to our Emergency Department (ED) after he was accidentally struck in the face by a drone propeller he was flying with his father. They lost control of the equipment, and he sustained lacerations to the right orbital region, left ear, nasal bridge and left lateral neck. The patient was brought to the ED by emergency medical service (EMS) who applied loose bandages over the bleeding areas. The patient denied loss of consciousness. Primary survey was intact. His vital signs were within normal limits taking into account his age. The patient complained of significant right periorbital pain. Secondary survey demonstrated a laceration to the right periorbital region. Examination revealed 20/20 visual acuity in the left eye with significant right-sided hemianopsia on the contralateral eye. Fundoscopic exam of the right eye revealed anterior chamber hyphema and neither the iris nor pupil could be visualized. There was partial avulsion of the right upper eyelid involving the margin that traverses superiorly and laterally forming an acute triangular tag of tissue that was attached at the base in the central upper lid. Additionally, a full thickness corneal laceration was present that traveled horizontally through the superior cornea (Fig. 1). No peripheral retinal findings

* Corresponding author. University of Colorado Hospital, Department of Surgery, 12631 E. 17th Avenue, C-305, Aurora, CO 80045, United States.
E-mail addresses: eliza.moskowitz@ucdenver.edu (E.E. Moskowitz), Yonaton.Siegel-Richman@ucdenver.edu (Y.M. Siegel-Richman), george.hertner@uchealth.org (G. Hertner), thomas.schroeppel@uchealth.org (T. Schroeppel).

https://doi.org/10.1016/j.ajoc.2018.01.039
Received 29 December 2017; Received in revised form 18 January 2018; Accepted 22 January 2018
Available online 04 February 2018

Fig. 1. Injury secondary to drone trauma. Image of the patient after irrigation demonstrating anterior chamber hyphema and lid avulsion.

were appreciated. Visualization of the orbit was difficult on exam due to pain with retraction of the eyelid as well as blood.

A non-contrast CT demonstrated a ruptured right globe with significant soft tissue swelling anterior to the right globe. No fractures of the facial bones were visualized.

The patient was transferred to a pediatric trauma center for urgent oculoplastic repair to close the globe as well as to prevent permanent deformity of the margin and levator. Intraoperative findings included ruptured globe with a 10mm corneal laceration and 11mm scleral laceration temporally. The limbus was re-approximated with interrupted 9–0 nylon sutures. Subsequently, the corneal wound was re-approximated with interrupted 10–0 nylon sutures. Thereafter, the scleral laceration was further explored. Exposed uveal tissue was removed. Interrupted 8–0 nylon sutures were then used to close the scleral wound. Margin of the eyelid was closed with 6–0 vicryl sutures and superficial lid laceration was closed with 6–0 plain gut sutures. Patient was discharged home the next day.

Over the next few months the patient showed significant improvement in his vision. He currently can differentiate shapes and faces, but still has difficulty with finer focus. He has followed up with his Ophthalmologist closely. Six months after his injury, he underwent a repeat examination under anesthesia and corneal suture removal. Following his EUA, his vision was noted to be improved. At his most recent follow-up examination, visual acuity was 20/400 with a +10 Diopter lens. Fundus examination revealed full perfusion of the optic disc with normal vessels, cup-to-disc ratio of 0.2, and grossly flat macula. Visual field testing demonstrated his right eye to have a total superior nasal visual field deficit and partial superior temporal visual field deficit. There was no evidence of any traumatic cataract or an APD at last follow up.

3. Discussion

The diagnosis of open globe injuries is typically made by visual inspection of the eye, which often depicts obvious signs of a ruptured globe. Classical findings that are highly suggestive of a globe rupture include: eccentric/teardrop pupil, extrusion of vitreous humor, external prolapse of the uvea, cornea or scleral tenting, and volume loss of the eye. If the eye injury is more subtle, a Seidel test can be performed. This test utilizes Fluorescin dye to identify either post-traumatic or post-operative leaks from the cornea, sclera, or conjunctiva under a slit lamp examination. A positive Seidel sign will help in diagnosing a globe injury. Lastly, a peaked pupil with tissue prolapse through a sclera and/or corneal wound is highly suggestive of a globe injury.[4]

Once the diagnosis of an open globe has been made or when there is high clinical suspicion, then certain precautions should be taken and an ophthalmologic consultation is indicated. Until formal consultation is obtained, no drops should be placed into the eye and a hard eye shield should be used to cover the eye.[5] Antiemetics and analgesics should be employed as needed to control pain and nausea respectively, but also as a means to prevent an increase in pressure from crying and Valsalva. Lastly, it is recommended that prophylactic antibiotics be given to help prevent post-operative endophthalmitis.[4]

As drone sales continue to rise in the coming years, it is likely that there will be an associated increase in the number of Emergency Room visits secondary to these devices. As has been demonstrated by this report, drone accidents involving the eye can easily cause devastating injuries that place patients at risk for ophthalmologic emergencies among other emergent treatment. It is necessary that emergency room physicians and trauma surgeons be prepared for such mechanisms of injury so that they can assess such patients in a timely and efficient manner.

From a public health perspective, we felt that it is essential to present this case report to warn the public of the dangers associated with operating a remote controlled drone and to provide suggestions to help prevent injury. The first recommendation to prevent future traumatic injuries to the eye would be that anyone flying a drone should use protective eyewear. The pilot of the drone would then be at a much lower risk to incur damage both from a direct blow by the drone (or propeller) as well as by flying debris. While a globe rupture appears to be a rare outcome from trauma caused by aerial drones, lacerations are a relatively common and can be equally dangerous. In recent articles, there have been numerous lacerations caused by the propellers as a result of their forced and sharp edges.[6,7] Therefore, we also recommend that individuals do not approach a drone until it has landed and the propeller has come to a complete halt. Another means to aid in the prevention of this type of injury would be the requirement of completely encasing the propellers in a protective screen—similar to household fans. One group recommended adding bumpers, enclosed rotors, and airbags to reduce the damage of a potential drone impact and increase the safety of operating the drone.[8] This would require companies to acknowledge the risk that users encounter every time they fly drones and a willingness to alter the design of future models. Another means by which injuries could be prevented would be to require people to land their drone more than 100 feet away from individuals to help prevent accidentally crashing the drones into individuals. Currently there are recommendations by the Academy of Model Aeronautics to maintain constant line of sight of aerial drones when flying and to remain at least 25 feet away from individuals and vulnerable property.[9] The Federal Aviation Authority (FAA) has issued regulations for commercial aircraft and has begun issuing regulations for the use of drones by civilians.[10] Specifically, flight over people is still explicitly prohibited.[10,11] We urge the FAA to educate civilians about the dangers inherent in drone flight.

4. Conclusions

As drone sales continue to rise, it is important that physicians be prepared to treat the potential injuries that may result from using these devices. Furthermore, in an attempt to reduce the number of visits associated with remote controlled drones, physicians should be prepared to provide advice as to how patients can reduce the risks of injury. It is our hope that some of the above framework will provide both physicians as well as the drone industry with options to decrease these adverse outcomes.

Patient consent

This report does not contain any personal identifying information.

Acknowledgements and disclosures

No funding or grant support.

Conflicts of interest

No conflicts of interest.

Authorship

All authors attest that they meet he current ICJME criteria for authorship.

Acknowledgements

None.

References

1. FAA Aerospace Forecasts. Available at: https://www.faa.gov/data_research/aviation/aerospace_forecasts/. Accessed 9 December 2017.
2. Yoganandan N, Pintar FA, Sances Jr A, et al. Biomechanics of skull fracture. *J Neurotrauma.* 1995;12:659–668.
3. Chung LK, et al. Skull fracture with effacement of the superior saggital sinus following drone impact: a case report. *Child's Nerv. Syst.* 2017 Sep;33(9):1609–1611.
4. Harlan Jr JB, Pieramici DJ. Evaluation of patients with ocular trauma. *Ophthalmol Clin North Am.* 2002;15(2):153.
5. Duch-Samper AM, Chaqués-Alepuz V, Menezo JL, et al. Endophthalmitis following open-globe injuries. *Curr Opin Ophthalmol.* 1998;9(3):59.
6. Lauber S. Indians' trevor bauer exits in first with bloody finger from drone injury. http://www.espn.com/mlb/story/_/id/17820105/2016-alcs-trevor-bauer-cleveland-indians-leaves-first-inning-bleeding-finger; 18 Oct. 2016, Accessed date: 9 December 2017.
7. Heslam, J. Guests Suing Groom Over Drone Crash. Available at: http://www.bostonherald.com/news/columnists/jessica_heslam/2016/12/heslam_guests_suing_groom_over_drone_crash. Accessed 9 December 2017.
8. Assessing Injury Risk from Unmanned Aircraft Will Pave the way for New Applications. Available at: https://vtnews.vt.edu/articles/2017/01/ictas-droneinjuryresearch.html. Accessed 9 December 2017.
9. Safety Guidelines for sUAS. Know Before You Fly Website. Available at: http://knowbeforeyoufly.org/for-recreational-users. Accessed 9 December 2017.
10. Unmanned Aircraft Systems Frequently Asked Questions. Available at: https://www.faa.gov/uas/faqs/. Accessed 9 December 2017.
11. Campolettano ET, Bland ML, Gellner RA, et al. Ranges of injury risk associated with impact from unmanned aircraft systems. *Ann Biomed Eng.* 2017;45(12):2733–2741.