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# A rare case of pre-hospital globe enucleation after a penetrating injury to the orbit during an assault: A case report and literature review

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ABSTRACT

*INTRODUCTION:* Ocular trauma is a common occurrence in trauma settings but often occurs with little to no effect on the vision of the patient. Traumatic enucleation is a rare but devastating injury.
*CASE PRESENTATION:* A 40-year-old male presented to our trauma center after an assault resulting in right globe enucleation. CT confirmed absence of the globe with disruption of the ipsilateral orbital contents and distal optic nerve disruption. The patient was started on intravenous antibiotics and the right orbit was packed. He was taken to the operating room for exploration of the right orbit and placement of an implant. His remaining hospital course was unremarkable.
*DISCUSSION:* Documented mechanisms of injury for traumatic enucleation are diverse, but often involve significant retro-ocular force to completely dislodge the globe from the orbit. Optic nerve avulsion may cause associated optic nerve chiasm damage leading to temporal hemianopia in the uninjured contralateral eye. Treatment involves stabilization and preparation for future implant placement.
*CONCLUSION:* Traumatic enucleation is extremely rare. Development of a grading system applicable to traumatic enucleation may be helpful in guiding management in this complex patient population.
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## 1. Introduction

Penetrating ocular traumas can range from a contusion of the globe to a devastating complete evisceration or enucleation. In 1996, Kuhn et al. developed the Birmingham Eye Trauma Terminology (BETT), which classifies ocular injuries into closed and open globe types [1]. Closed globe types include contusion and lamellar laceration, whereas open globe types include rupture and laceration. Laceration injuries are further divided into penetrating, intraocular foreign bodies, or perforating [1].

About 2.4 million ocular injuries occur in the United States on a yearly basis [2]. Ocular injuries are more common in the male gender and in lower socioeconomic backgrounds [3–5]. Assault is the most common traumatic ocular injury that leads to enucleation with gunshot and stab wounds being responsible for the majority of injuries [6]. We present a case of a young male who was brought to our hospital with his right eye enucleated after being a victim of assault. We also review the literature pertaining to traumatic eye injuries, sequelae of traumatic enucleation, and subsequent management. This case was reported in line with SCARE criteria [7].

## 2. Case presentation

A 40-year-old male presented to our hospital as a trauma team activation after an assault. On arrival, his right eye had been enucleated and was brought in, stored in a bag of ice. The patient was conscious and talking but had a concussion with retrograde amnesia and was unable to recall the details of the events leading up to his injury. Initial examination revealed that his intact left eye was also non-reactive to light and he was unable to move it laterally or inferiorly. CT imaging confirmed a diffuse extrusion of the right eye globe, diffuse gas within the right orbit and disruption of the intra-orbital structures including the distal aspect of the optic nerve (Fig. 1A & B).

The ophthalmology team evaluation revealed a right globe enucleation and temporal hemianopia in the left eye, secondary to chiasm damage with central vision mostly intact. The enucleated right orbit was packed, intravenous antibiotics were provided, and recommendation for a right implant placement within 48 h was given.

Two days after his initial presentation, the patient was taken for surgical re-exploration of the right orbit, placement of a right orbital implant, and repair of a right lower eyelid laceration. Evidence of muscle and fascial prolapse at the lateral aspect of the orbit was observed on inspection, which were debrided and removed. No additional abnormalities were identified in the operating theater. The tissues were irrigated with a bacitracin-containing solution and

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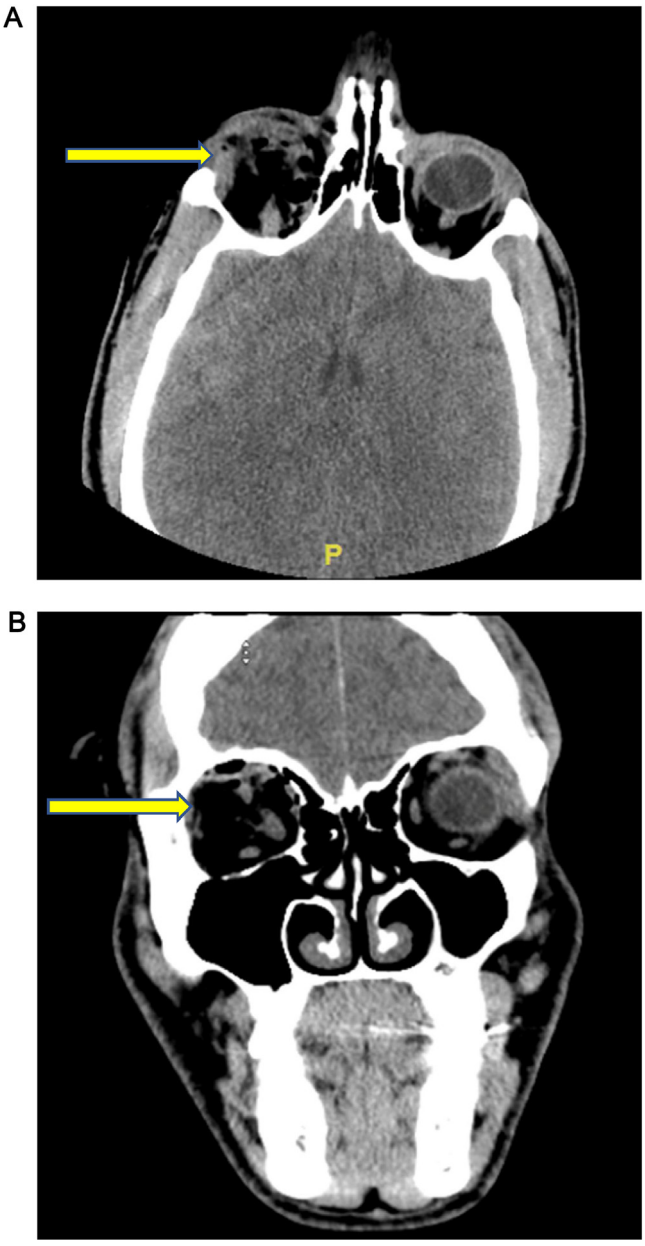


**Fig. 1. A**. Axial CT scan showing absence of the right globe with diffuse gas and disruption of intraorbital structures. Arrowing pointing to area of interest. **B**. Coronal CT scan showing absence of the right globe with diffuse gas and disruption of intra-orbital structures. Arrow pointing to area of interest.

an 18 mm plastic orbital implant was subsequently placed toward the back of the orbit.

The patient's post-operative course was unremarkable. He was discharged with an appointment to follow up with an ocularist in 6 weeks for design of a scleral shell.

## 3. Discussion

We present a rare case of traumatic eye enucleation managed successfully with orbit packing, infection prophylaxis and surgical orbit implant placement. Traumatic injury to the eye is a relatively common phenomenon with penetrating injuries often being the causative factor for open globe injuries such as laceration, foreign body injury, etc. [1]. On the other hand, traumatic enucleation is a rare phenomenon not commonly reported in the literature. In one population-based study conducted by Erie et al., an incidence rate

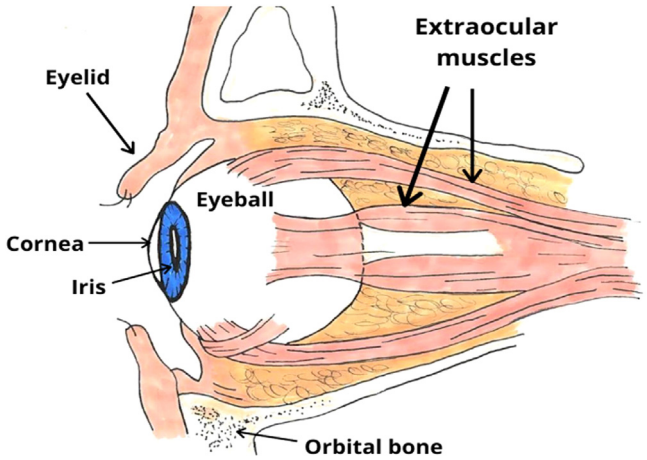


**Fig. 2.** Extraocular anatomy.

of traumatic enucleation occurred in only 12 per 100,000 persons from 1956 to 1988 [8]. Based on our review of the literature, those rare reports of traumatic enucleation secondary to physical assault were seen in the setting of blunt force injury due to digital trauma, either by an assailant or self-induced in psychiatric contexts [9,10].

Our patient's incidence of enucleation is unique. This, in part, is due to the difference in mechanism of complete enucleation vs. far more common globe injury (contusion, penetration, etc.). A relatively substantial retro-ocular force creating a significant anterior displacement allowing for dislocation from the orbit has been described as the mechanism behind traumatic enucleation in prior studies (i.e "gouging" of the eyes) [11]. DeAngelis et al. have described a case of traumatic enucleation secondary to a high-pressure water jet injury to the eye. Here, retro-orbital water entry with rapid pressure accumulation was hypothesized as the possible explanation for enucleation and optic nerve avulsion [12]. Literature also exists describing traumatic eye enucleation secondary to a blunt mechanism of injury. A case report by Khadamy et al. describes a traumatic enucleation after a motorcycle accident whereby the globe was not present when the patient presented to the hospital [13]. In this case, the patient's traumatic enucleation was hypothesized to be due to a retro-bulbar posterior-to-anterior force that led to globe luxation. In addition to the globe luxation, two theories were used to describe the transection of the optic nerve that would have resulted into enucleation of the globe, which was missing on presentation to the hospital: a possible retro-bulbar foreign body or inward displacement of the orbital walls by high-energy trauma that were described in other case reports [14,15]. The exact mechanism of injury in our patient remains unclear, but the appearance of the presented enucleated eye suggests that our patient experienced a similar accumulation of retro-bulbar forces produced by either the assailant "gouging" or performing some form of intentional disruption of the surrounding orbital tissues with the patient unconscious. These hypotheses arise from the fact that all four extra-ocular muscles remained partially connected to the enucleated globe but overall disrupted, in addition to a significant length of avulsed optic nerve also remaining connected. Creation of such findings require substantial force and intention by the assailant. Prior case reports have described avulsion of the optic nerve, but extra-ocular muscle attachment to the enucleated eye (Fig. 2) has not, to our knowledge, been documented in the current literature.

In addition to right eye enucleation, our patient experienced temporal visual field loss in the contralateral left eye. The traumatic avulsion of the optic nerve that occurred with enucleation of the right eye likely disrupted crossing fibers from the contralat-

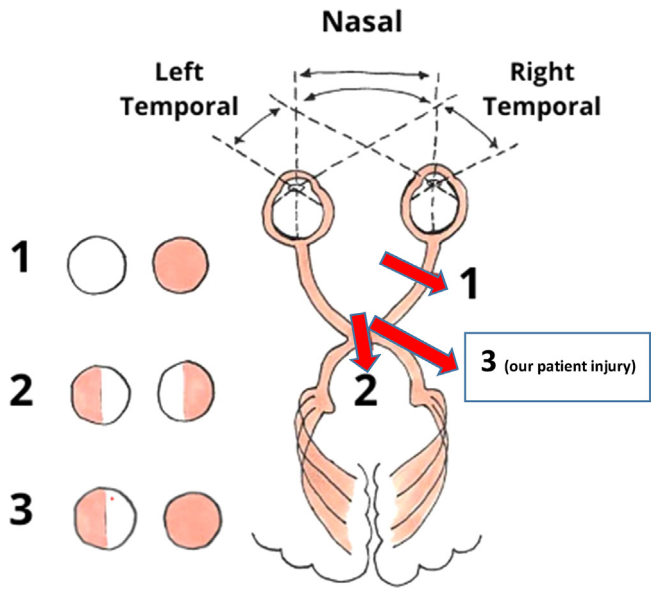


**Fig. 3.** Optic tracts with associated injury location and visual defects. Lesion 1 correlates to complete transection of the right optic nerve resulting in complete right eye blindness. Lesion 2 involves damage to the optic chiasm and crossing fibers of the lateral visual fields resulting in bitemporal hemianopia. Lesion 3 is the lesion exhibited in our patient's case in which avulsion of the right optic nerve (Lesion 1) also causes subsequent damage to crossing fibers from the left temporal field (Lesion 2) resulting in complete right eye blindness with left hemianopia.

eral visual fields at the optic chiasm ultimately owing to the left temporal hemianopia observed on examination (Fig. 3; injury #2). Fibers responsible for signal transduction from the medial aspect of the retina cross bilaterally and ultimately reach their contralateral visual centers (Fig. 3; injury #2). While these fibers originate medially, they are responsible for image recognition from the lateral, temporal visual fields. Due to this complex pathway, it is possible that an optic nerve avulsion could produce a significant shear force at the chiasm allowing for disruption of these delicate crossing fibers. This proposed mechanism is supported by previous case reports of traumatic enucleation describing similar phenomena. Parmar et al. discuss a case in which an assault victim had complete optic nerve avulsion due to enucleation via a "gouging" mechanism of injury [11]. Goldmann field testing revealed a temporal hemianopia in the contralateral eye similar to our patient's case. Krausse et al. also report contralateral temporal hemianopia secondary to a self-inflicted traumatic unilateral enucleation in a psychiatric patient [9]. While our patient did have a suspected left globe contusion injury, his isolated temporal hemianopia makes it unlikely that this played a significant role in his visual deficit.

In regards to management, open globe injuries, that being rupture or laceration, can usually be repaired with secondary enucleation typically only being performed in the context of a blind and painful eye [16]. However, in traumatic enucleation prior to hospital presentation, there is no role for attempting to reattach the enucleated globe. Rather, the main goal of treatment is to place an implant to maintain the structure of the orbit for eventual prosthesis in the future. Preoperative packing and eventual surgical debridement of the traumatized orbit is the mainstay of initial management in traumatic enucleation with preservation of the extra-ocular musculature being performed, if possible, to allow connection to a future implant and allow for subsequent mobility [12]. Depending on the extent of associated optic nerve avulsion, treating physicians should be aware of the presence of potentially serious intracranial sequelae. A case report and review by Suzuki et al. revealed reports of hypothalamic involvement (i.e ischemia) as well as subarachnoid hemorrhage in the context of significant optic nerve avulsion in traumatic enucleation. They concluded that such findings may be more likely to be observed in optic nerve avulsions over 40 mm in length [17]. Regardless, in the case of traumatic enucleation with optic nerve avulsion, adequate imaging to rule out intracranial injuries should be considered due to the potential extent of damage. While traumatic enucleation remains a rare injury, current grading systems for open/closed globe injuries are not applicable to guide management. Development of an enucleation grading system that accounts for additional avulsed structures (extraocular muscles, optic nerve, etc.) and associated intracranial sequelae may be beneficial to help guide physician management in future cases of traumatic enucleation.

## 4. Conclusion

Traumatic enucleation of the globe is rare. Potential mechanisms of action are diverse; however, significant retro-ocular force is required to completely dislodge the globe from the orbit. Optic nerve avulsion in the setting of traumatic enucleation may cause associated chiasm damage leading to temporal hemianopia. Treatment involves stabilization and preparation for future implant placement. Development of and implementation of an updated grading system that divides these patients based on extent of enucleation, avulsed structures and associated intracranial sequela may be helpful in guiding management in this patient population.

## Declaration of Competing Interest

The authors report no declarations of interest.

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## Ethical approval

This report was conducted in compliance with ethical standards. Informed written consent has been obtained and all identifying information is omitted.

## Consent

Informed written consent has been obtained and all identifying information is omitted.

## Author contribution

AE, EM, KK, DB, MM Conception of study, acquisition of data, analysis and interpretation of data, drafting the article, and revision of article.

DB, MM – Management of case.

AE, EM, KK, DB, MM – Approval of the final version for submission.

## Registration of research studies

This is a case report study.

## Guarantor

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