Complete Globe Avulsion in a 13-Year-Old Young Boy with Maxillofacial Injury: A Case Report and Review of Literature

Prashanthi Gurram, MDS1 Karthik Ramakrishnan, MDS1 Vivek N., MDS1 Sarvanan Chandran, FDSRCS1 Priyadarshini Parthasarathy, MDS1 Saravana Kumar S., MDS1

1Department of Oral and Maxillofacial Surgery, SRM University, SRM Kattankulathur Dental College and Hospital, Kanchipuram, Tamil Nadu, India

Address for correspondence Prashanthi Gurram, MDS, Department of Oral and Maxillofacial Surgery, SRM University, SRM Kattankulathur Dental College And Hospital, SRM Nagar, Potheri, Kanchipuram 603203, Tamil Nadu, India (e-mail: drprashanthig@yahoo.com).

Maxillofacial trauma is associated with cosmetic deformities as well as functional morbidities of the facial structures such as breathing, jaw movements (mastication, speech), hearing, and vision. Stabilization of the airway is done during the primary survey as an emergency. Other functions will be gradually restored as the fractures are addressed by concerned specialists.

Loss of vision accounts for 24 to 85% disability, even though eyeball represents 0.3% of the total surface area on the human body.1 The main etiology for loss of vision in maxillofacial trauma may be due to direct/indirect optic nerve injury or retrobulbar hemorrhage. This, if managed immediately and accurately, can be restored, but not in all cases. On the other hand, severe trauma to the zygomatico-orbital bones can lead to rare conditions, such as orbital apex syndrome and globe avulsion, causing total blindness. The estimated incidence of blindness associated with midface fractures is 20%.2

In this paper, we present one such case of a 13-year-old young boy sustaining zygomatico-orbito-maxillary complex fracture with complete globe avulsion and blindness due to road traffic accident (RTA). The main purpose of this paper is to discuss the possible biomechanism and to emphasize the protocol for planning anophthalmic surgeries of the orbit along with prosthetic rehabilitation of the same.

Case Report

A 13-year-old boy was brought to the accident and emergency department of SRM Kattankulathur tertiary health care center, Chennai, India. The patient sustained severe...
facial trauma, during an RTA while traveling in a two-wheeler as a pillion rider without wearing a helmet. The patient was admitted 2 hours after the incident. The patient’s Glasgow Coma Scale (GCS) score ranked 11/15 (E4V2M5). He sustained multiple deep lacerations over the frontal, supraorbital, zygomatic, and nasal bone regions with profuse bleeding. Emergency management protocol was followed to secure the airway and to maintain the hemodynamic status of the patient (►Fig. 1).

Secondary clinical examination revealed that the patient had left eyeball proptosis along with edema of the eyelid. Left pupil was nonreactive without any ocular motility. The eye was completely severed from all the extraocular muscle attachments and was literally “popped out” of the orbital fossa. The contralateral eye was intact with normal pupillary reflex and motility. A computed tomography (CT) of the brain and orbit were taken immediately to ascertain the extent of the injury and to formulate a treatment plan. The CT images revealed distorted anatomy of the extraocular muscle cone with dislocation of the left eye ball along with complete detachment of the optic nerve. Grossly displaced fracture of the left zygomatic buttress, orbit involving all the four walls along the infra orbital rim, and frontal bone on that side were observed (►Fig. 2A and B). No evidence of intracranial abnormalities were detected.

Immediate opinion for the management of the orbital injury was obtained from two different ophthalmologists. Based on the clinical and radiological findings and opinions from the ophthalmologists, emergency enucleation of the left eye was planned followed by fixation of the fractured zygomatico-orbito-maxillary complex. The patient was taken up for the procedure under general anesthesia after obtaining required consent from the parents.

During exploration under general anesthesia, all the extraocular muscles and the optic nerve were found to be shredded. There was no visible stump of either the nerve or the muscle. The globe was totally suspended out of the orbit. As the globe was unsuitable for repositioning, surgical enucleation procedure was performed by the ophthalmologist. Incision was made through the conjunctiva, separating it from the cornea. The conjunctiva was also separated from the globe. The severely disrupted extraocular muscles along with the avulsed optic nerve got detached easily without any dissection. Minimal bleeding was present at this stage, as anticipated. Pressure pack had been applied for 10 minutes. After achieving hemos-tasis, the wound was closed in two layers, first the Tenon’s capsule and then the conjunctiva creating a pouch for future prosthetic rehabilitation. Through the existing lacerations, open reduction and internal fixation of the frontozygomatic

Fig. 1  "Popped out" left eyeball as on presentation to the accident and emergency department.

Fig. 2 (A) Coronal section of the CT scan image showing comminuted fracture of all the four walls of the left orbit. (B) 3D reconstruction of the same showing the shattered left orbit. CT, computed tomography; 3D, three-dimensional.
buttress, infraorbital rim, and the zygomatic buttress were done to restore the orbital and midfacial bony architecture (►Fig. 3A–D). Antibiotic ointment and a firm pad and bandage were applied over the enucleated orbital socket.

Following completion of the surgery, the patient was shifted to a surgical intensive care unit. Healing of the surgical site along with the orbital socket was uneventful and satisfactory. Patient was under physiotherapy regimen to regain facial movements. Regular follow-up visits were scheduled. Over a period of 3 months, the patient showed a remarkable recovery and no functional deficit in relation to the facial nerve (►Fig. 4).

**Discussion**

Orbital fractures are most common in young adults and adolescent males. In a retrospective series describing orbital fractures in 92 adults, the mean age was 32 years, and 72% were male. A similar series describing orbital fractures in children reported a mean age of 12.5 years, and 81% were boys. Literature review suggests low incidence of orbital fractures in children due to small face in relation to the head, elasticity of the facial bones, prominent buccal fat pad in the malar region, less exposure to occupational trauma, assaults, and major trauma with motor vehicle crashes. Children are more prone to orbital fractures during sports and play as mechanism of injury. However, in our patient, the age of the patient was 13 years as suggested in the literature, but the mechanism of injury was RTA.

Traumatic luxation of the globe is a rare condition. Only 34 cases have been reported so far in the English language.
literature indexed in PUBMED. This kind of injury is usually a result of high-energy trauma. The data suggest that mean age of patients with traumatic globe luxation was 29.5 years. It is more prevalent in young male adults who suffered RTAs. These data are in accordance with an epidemiological study in which maxillofacial trauma were evaluated.

Luxation of the globe is a rare ocular condition following trauma, where there is a forward displacement of the eyeball so that the eyelids spasmodically close behind it, but the eye muscles and the optic nerve generally remain intact. Avulsion of the globe is where the muscles and the optic nerve are partially or totally severed.

Avulsion can be classified as incomplete, when the optic nerve alone is severed and complete where there is disruption of the extraocular muscles along with the optic nerve. The optic nerve and the globe are resistant to mild-to-moderate trauma. An example to this is “gouging” where a combatant would press the adversary’s eye, and surprisingly, no serious damage has been reported. The forces directed in this region are absorbed by the surrounding bony structures. Soft tissue ligaments, optic nerve, extraocular muscles, and orbital fat prevent the luxation of the globe. However, in our case, the patient sustained severe craniofacial trauma with avulsion of the left eyeball with detachment of the optic nerve and extraocular muscles along with grossly displaced zygomatico-orbital complex and frontal bone fracture, as observed in the CT images.

Etiology of avulsion of the globe can be due to the following three reasons: (1) avulsion due to forces during delivery, (2) self-enucleation in psychotic patients, and (3) craniofacial trauma. Traumatic globe luxation can result in forward displacement of the globe from the orbit or displacement into the paranasal sinuses. Three hypothetical causes of globe luxation were proposed by Morris et al: (1) an elongated object enters the medial orbit using the nasal sidewall as the fulcrum, propelling the globe forward; (2) a wedge-shaped object enters the object medially and displaces the globe anteriorly; and (3) direct transection of the optic nerve occurs due to the penetrating object. Displacement of the globe into the paranasal sinuses is attributed to the mechanism similar to blow out fracture when the forces are strong and blunt, fracturing the thin orbital walls. This is the most common cause of traumatic globe luxation (38.2%) followed by the first mechanism described by Morris et al (26.5%). Other possible mechanisms of injury are narrowing of the posterior orbit by orbital fractures (11.8%), deceleration force, sudden intraorbital rise in pressure, and direct traction of the globe.

The mechanism of optic nerve avulsion is not completely understood. Several theories have been postulated, such as direct trauma to the globe, shearing forces resulting from extreme rotation of the globe, a sudden massive increase in intraocular pressure resulting in rupture of lamina cribrosa and expulsion of the globe, sudden forward displacement of the globe, and focal or diffuse vasospasm in the optic nerve. Another mechanism describes concussion waves arising from facial injury, which are conducted through surrounding bones and tissues into the orbit. Taking into account the above-mentioned theories for globe luxation and optic nerve avulsion, the probable mechanism in our case would have been a combination of two such theories—first, the concussion waves arising due to high velocity injury fracturing all the four orbital walls and associated rims and second, a sudden rise in intraocular pressure resulting in complete detachment of the optic nerve and disruption of the extraocular muscles.

Decision and management of globe luxation is a challenge and should be managed as an emergency, as the situation gives two options—first, to successfully reposition the globe into the orbit and second, to detect and repair the damaged extraocular muscles. Initial globe repositioning is necessary as it allows for patient’s psychological recovery and increases the cosmetic results. Furthermore, the presence of intact globe prevents the development of contracture of the socket for future ocular prosthesis. A stepwise approach for eye salvage in traumatic globe luxation, including globe protection with sterile surgical dressing, repair of the avulsed muscles, lateral canthotomy/orbital hematoma evacuation has been discussed in detail by Himika et al.

Enucleation and evisceration are the two types of anophthalmic surgeries indicated in severe ocular trauma. The indications for anophthalmic surgeries in descending order are severe trauma, glaucoma, endophthalmitis, keratitis, Benchet’s disease, and tumors. Ocular enucleation is an acceptable surgery for end-stage ocular diseases, such as inexciable trauma damage, malignancies, and phthisis bulbi. Evisceration is another alternative with better cosmetic outcome procedure and is used when the required resection margins are minimal. In enucleation, the entire eyeball is removed whereas in evisceration sclera and extraocular muscles are left intact for cosmosis.

Controversy remains regarding the advantages and disadvantages of each procedure. In the past, enucleation was preferred because of the fear of sympathetic ophthalmia over evisceration. Sympathetic ophthalmia is a potentially devastating and blinding autoimmune condition characterized by pan uveitis, in which the injured eye incites inflammation in the fellow sympathizing eye. Shah–Desai et al found no difference in postoperative pain between evisceration and enucleation and recent studies have reported low risk of sympathetic ophthalmia with evisceration. Recently, evisceration has become increasingly popular due to less surgical manipulation, inflammation, and scarring of the extraocular muscles resulting in better implant motility and cosmetic outcome in comparison to enucleation. Furthermore, evisceration is simpler, faster, associated with lower risk of bleeding intraoperatively, and fewer postoperative complications such as ptosis, implant migration, implant extrusion, socket contracture, and the deep superior sulcus syndrome.

In the present situation, as the globe was unsuitable for repositioning due to extensive globe disruption along with optic nerve avulsion, the ophthalmologist planned for an anophthalmic surgery. Enucleation was opted for the present...
case as it might better safeguard the patient against retained uveal tissue. The patient was also treated for zygomatic-orbital fracture simultaneously. The patient was not planned for any primary implantation procedure, as it was taken up as an emergency procedure for gross disruption of the anatomy of the eye. Fortunately, the young boy recovered well after the treatment without any neurological sequelae that may be associated with traumatic enucleation. The sequelae might include orbital infection, intracranial or subarachnoid hemorrhage, cerebrospinal fluid meningoitis, or hypothalamic infarcts. He was thereafter referred to a higher center specialized in orbital implant rehabilitation procedures for prosthesis.

In view of orbital implantation procedures in one of the retrospective studies published by Sundelin et al, primary implantation showed to have fewer complications as compared with secondary implantation. Schellini et al compared the different materials used for orbital implants namely integrated, whereby the implant receives a blood supply from the body that allows for the integration of the prosthesis within the tissue, and non-integrated where the implant remains separate. They found that different integrated (porous) materials, such as hydroxyapatite, porous polyethylene, and composites, had no added advantage over non-integrated (nonporous) material, such as polymethyl methacrylate (PMMA) and silicone. However, PMMA and silicone are the most popularly used orbital implant material among the ophthalmologists. Majority of the orbital implants involved minor complications such as eye discharge, implant exposure, and migration, which resolved spontaneously or could be easily treated.

**Conclusion**

Globe avulsion due to maxillofacial trauma is a rare phenomenon. The mechanism of injury should be always sorted as it plays a crucial role in management. We would like to emphasize the need to take up such a case as an emergency at the same time as following stepwise protocol guiding in prompt decision making and treatment planning. The primary focus should always be on preservation of the globe whenever feasible, which improves the psychological status of the patient after sustaining a devastating experience of physical trauma. Rescuing the vision by initial repositioning of the globe in a partially avulsed optic nerve and muscles needs to be considered. Enucleation of the eyeball is the last resort when all other preventive measures fail to regain the lost vision and when infection is the concern. Fixation of the fractures in patients sustaining concomitant orbito-maxillofacial fractures must be addressed immediately to restore the displaced anatomy and volume in view of future function and cosmesis.

**Conflicts of Interest**

None.

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