13 Orbital Foreign Bodies

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Abstract

Orbital foreign bodies are uncommon, can be vision threatening, cause serious consequences and often poses a great challenge not only to diagnose but for management as well. Although they may occasionally be missed, they are frequently diagnosed based on clinical suspicion and appropriate imaging. A conceptual approach to clinical examination, appropriate imaging and interpretation, determining the timing and threshold to intervene, and techniques of removal are discussed in the chapter below.

Keywords

Orbit foreign bodies · Orbital trauma
Orbitotomy · Orbital foreign bodies · Metallic foreign bodies · Non-metallic foreign bodies
Organic foreign bodies

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13.1 Introduction

Any foreign or particulate material trapped within the orbital region is referred to as the orbital foreign body. Orbital injuries in general and foreign bodies in particular are an important cause of ophthalmic morbidity, especially among the young population, the significance of which is sometimes poorly recognised.

The wound of entry can be either through the eyelids, through the globe, or sometimes, in rare cases as in blast injuries, can be through the orbital walls [1]**.** The presence of an orbital foreign body can either be "overt" where the wound of entry is obvious and the history is suggestive, or "latent," especially with self-sealing wounds and unwitnessed injuries. Foreign bodies may either be completely embedded within the orbit, partially extruding or less commonly penetrating into the adjacent intracranial cavity or paranasal sinuses, labeled as transorbital foreign bodies.

The vast majority of affected patients are males owing to their occupation, mode of transportation, and high-risk behavior—assaults, alcohol consumption, etc. High-velocity injuries are generally devastating visually, especially in the presence of open globe injuries, traumatic optic neuropathy or associated intracranial injuries at presentation.

It should be remembered that patients with globe ruptures, severe relative afferent pupillary

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defect (RAPD), poor or no light perception at presentation, delayed presentations with infections, etc., may signify a poorer final visual prognosis and should be attended to immediately.

13.2 Classification

Orbital Foreign bodies can be classified according to the material, location, nature and severity of impact [2, 3].

Material: Based on type, it can be broadly divided into Metallic and Non-Metallic.

1. Metallic foreign bodies may be ferromagnetic (iron, steel, etc.) or non-ferromagnetic (copper, lead, etc.). They may arise from industrial injuries, striking hammer on chisel, assaults or pellets and splinters related to grenade or bomb blasts.

2. Non-metallic foreign bodies may be further divided into Organic or Inorganic FBs.

(a) Organic FBs may be vegetative matter (plant, wood, etc.) or rarely animal substrate.
(b) Inorganic foreign bodies may be made of plastic (spectacle lenses, toys, etc.) and glass (e.g., windshield, bottles etc.).

Location: Based on the location, they may be classified into Intraorbital and Transorbital foreign bodies.

1. Intraorbital FBs may be either penetrating and perforating.
   (a) Penetrating FBs—some part of the FB will be outside the septum with the other end embedded within the orbit.
   (b) Embedded FBs—the whole of the FB will be inside the orbital boundary. These may be Occult or Latent.
2. Transorbital FBs extended beyond the bony orbit and lodged partially within the cranium or paranasal sinuses. These are commonly associated with bony orbital disruption. They can be termed as.
   (a) Transorbital cranial foreign bodies [4]
   (b) Transorbital sinus foreign bodies

Nature and Severity of Impact: According to the nature of the impact, clinical consequences and ease of access, orbital foreign bodies can be divided into simple and complex.

Isolated, well-delineated, and anteriorly located FBs, which may be directly and easily accessed and extracted with minimal consequences, may be considered Simple foreign bodies (Fig. 13.1). Multiple, contaminated and organic foreign bodies that may be missed, easily fragmented with a high risk of residual material, especially if lodged deeply within the orbit against vital structures in the orbit, and the brain may be considered Complex foreign bodies (Fig. 13.2).

Fig. 13.1 CT scan axial view showing radio-opaque metallic foreign body in the left anterior and inferomedial orbit

Fig. 13.2 CT scan axial view showing pellet foreign body lodged in the retrobulbar space abutting the left optic nerve

High-velocity and blast injuries are most destructive as apart from orbital involvement, the patient might suffer facial injuries including fractures, extensive soft tissue damage, cervical spine with airway injuries or intracranial injuries.

13.3 Etiopathogenesis

Sources of injury predisposing to orbital foreign bodies include road traffic accidents, industrial accidents, assaults, blast injuries, pellet injuries from accidental or intentional release from weapons such as rifles and guns, which may be encountered in regions of social unrest or border wars. In urban environments and high-income countries, most injuries are industrial, road traffic accidents or assault-related. Affected patients often have a definite history of trauma, and studies have shown that more than 75% of the patients are young working males [4–7]. Domestic accidents and school injuries are often associated with plastic or wooden orbital foreign bodies, where the history may be unreliable. In rural areas, especially in low-income countries, organic orbital FBs are common as manual agriculture is prevalent.

In law and order disturbed regions and in regions with border conflicts or warzones, FBs encountered maybe pellets (lead, rubber bullets, etc.) or related to a grenade or bomb blasts. Penetrating orbital injuries with retained FB is more common in people involved in military services. In such situations, multiple foreign bodies should be suspected as they are commonly encountered.

13.4 Clinical Presentation

Most patients present with a history of injury to the face and periorbital region. Findings at clinical presentation depend on the mode of injury, size and velocity of impact and the type of foreign body. A detailed history of the nature of the injury, the geographical location and circumstances, the severity of the injury, including objects involved at the site of impact, both from the patients and witnesses, should be obtained and documented [5].

Patients may present with variable pain, swelling, visual loss, double vision or in late presentations, even severe infection. Not infrequently in rural accidents and following severe trauma, organic orbital foreign bodies may be discovered late in the convalescence period, especially when the patient is unconscious at presentation or in unwitnessed injuries. In situations where the patient is unable to recall the nature of the injury, an orbital injury with the retained foreign body often presents a confusing and critical clinical picture, especially when the initial entry wound was small and self-sealing or when a foreign body had been partially removed earlier [6, 7].

Depending on the duration and nature of the injury, clinical signs include subconjunctival hemorrhage, chemosis, orbital hematoma, ocular dysmotility, proptosis, and varying visual acuity.

High-velocity injuries are most destructive, as in such cases, apart from orbital involvement, the patient might suffer facial injuries including facial fractures, extensive soft tissue damage, cervical injuries with airway obstruction, or even intracranial injuries (Fig. 13.3). In unconscious and critically ill patients, the diagnosis and management maybe even more challenging, as the orbits and the facial injuries may get attention only after life-saving interventions.

Rarely atypical presentations of orbital or intracranial foreign bodies include secondary consequences presenting as orbital cellulitis or even an orbital abscess. Occasionally, a traumatic Carotico-cavernous fistula with an acute presentation of proptosis, erythema, etc., may be mistaken for underlying orbital cellulitis and mismanaged, as shown below (Fig. 13.4).

13.5 Evaluation

Assessment of life-threatening situations, associated polytrauma, head, neck, and intracranial injuries should be performed first. A suspected open globe should be shielded (not patched) from further injury. Patients should be given adequate analgesia or even sedation as indicated to facili-

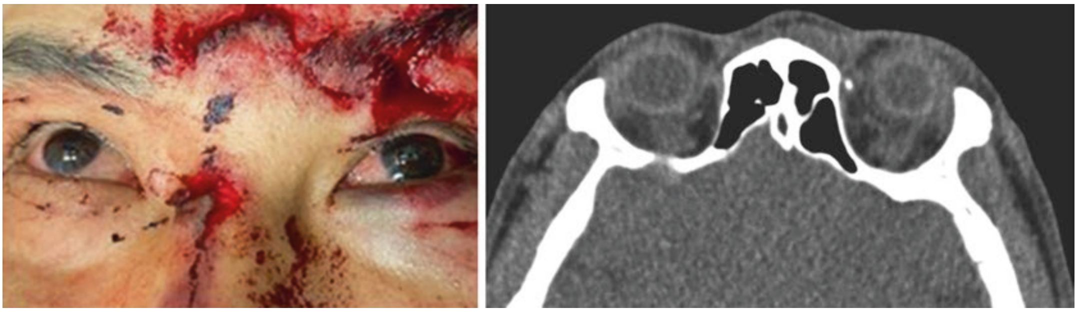

Fig. 13.3 Young patient following motorcycle accident with multiple periorbital lacerations and embedded orbital foreign body seen on axial CT scan

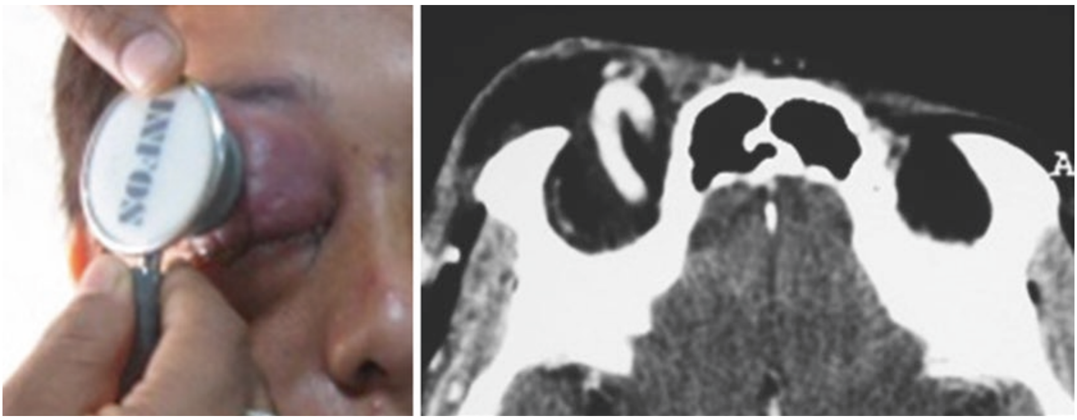

Fig. 13.4 A high flow carotid-cavernous fistula post-trauma managed as orbital cellulitis following orbital trauma. CT scan showing dilated right superior ophthalmic vein

tate a better clinical examination and prevent further injury from a traumatic examination. Evaluation of the orbital injury includes obtaining a detailed history, performing a meticulous examination with a high suspicion for foreign body presence complemented by appropriate imaging studies. History should also include the time, location, nature, and circumstances, emergency interventions, if any, and interval changes from initial injury to the time of presentation.

As part of a general head and neck examination, a comparison to the unaffected contralateral face and orbit should be made. A quick and focused ophthalmic examination including crude visual acuity, inspection for intactness of the globe and pupillary evaluation should be performed atraumatically. Periorbital soft tissue assessment for eyelid and canalicular lacerations, subcutaneous emphysema, foreign bodies, orbital rim step off, or tenderness and periorbital hyper or hypoesthesia should be looked for. A palpable thrill, if present, is suspicious for high flow carotid-cavernous fistula. Gentle finger insinuation may also be considered once globe injury and orbital compartment syndrome has been ruled out, to feel for embedded foreign bodies.

The rest of the ophthalmic examination should include assessment of globe movement limitation, gaze-evoked amaurosis [8], anterior segment and dilated posterior segment examination. In patients with visual loss and intact globe, a detailed posterior segment examination, including for the presence of vitreous hemorrhage, retinal detachment, choroidal rupture or signs of optic neuropathy, should be looked for and documented. Where globe injuries are present, appropriate documentation using the BETT terminology system with the calculation of the Ocular Trauma Score (OTS) [9, 10] should be performed. It should be remembered that an essential part of the initial assessment is maintaining an accurate electronic medical record with good photographic documentation as well.

13.6 Investigations

13.6.1 Imaging

Radiological investigations play a very important and often decisive role to avoid misdiagnosis of a retained intraorbital or intracranial FB [11], particularly if the history is unreliable or injury is unwitnessed [12]. This is true, especially in children and patients who are unconscious or intoxicated at presentation.

In general, plain X-ray and ultrasonography have a limited role in the diagnosis and management of orbital FB owing to low sensitivity and limited localisation. Plain X-rays may, however, serve as a screening tool in the emergency room not only to recognize gross facial skeletal disruption but also to identify potential radiopaque foreign bodies prior to further Magnetic Resonance neuroimaging MRI (Fig. 13.5).

Non-contrast CT scan remains the imaging modality of choice for studying the bony skeleton and the orbital, facial and intracranial soft tissues in trauma [13]. In addition to detectingandcharacterizing orbital and orbitofacial fractures, it helps detect the presence of foreign bodies and also aids in characterizing and localizing them, including extension into the paranasal or intracranial spaces [7, 14], and thus guide management. Ideally, CT imaging should be performed with the Imaging Guidance Study (IGS) protocol with sub-mm fine cuts, which can be viewed in axial, coronal, and sagittal planes (Fig. 13.6a–c). The radiodensity of foreign bodies often provides reliable clues on the nature of the material by assessment of the Hounsfield Units (HU), shown in Table 13.1. Cone beam CT scans (CBCT) may also be considered in special situations, partly to diagnose, monitor, and assess for residual radiopaque foreign bodies, which may also minimize cost and radiation exposure [15].

Fig. 13.5 Plain x-ray lateral view demonstrating radiopaque foreign body of inferior orbit

A CT Angiogram of the head and neck region may also be performed as an emergency screening tool in cases of severe head and neck injuries to provide preliminary bony, soft tissue and vascular anatomy of the patient, especially in the unconscious patient suspected to have an intracranial bleed.

Likewise, when diagnosing and planning management of orbital and orbitofacial fractures, the presence of intraocular or intraorbital foreign bodies plays a key role in prioritization, timing, and approach to removal of such foreign bodies. A useful mnemonic "ABCDEFGH" used in the management of such orbitofacial fractures is shown in Table 13.2 where "F" stands for Intraocular or Orbital Foreign Body [16].

Although CT scans provide quick, cost-effective, and very useful information about bones and soft tissues, MRI provides more accurate information about the soft tissues, including the brain, optic nerve-sheath complex and in detecting radiolucent torganic foreign bodies invisible to CT scans (Fig. 13.7a–c) guiding re-exploration and foreign body removal (Fig. 13.7d, e). In addition to the detection of embedded organic foreign bodies [17, 18], it is also useful in detecting plastic and "unleaded" glass foreign bodies. It should be remembered that MRI is contraindicated in acute situations, especially when ferromagnetic metallic FB has not been ruled out along with its

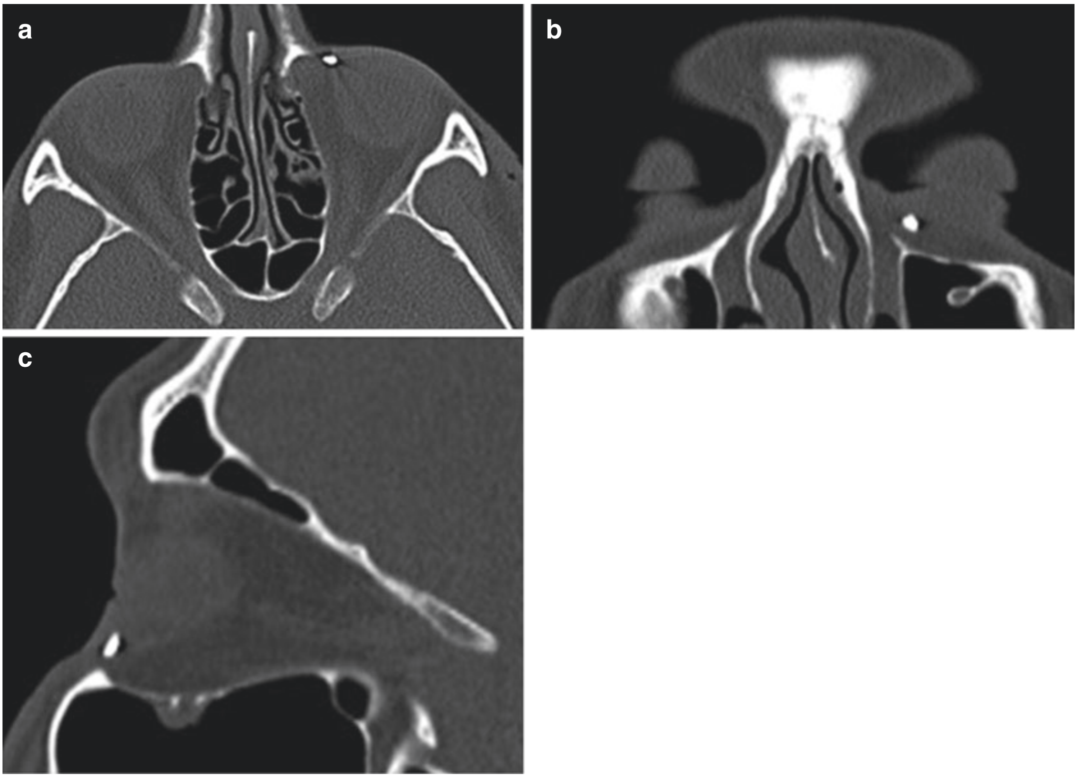

Fig. 13.6 (**a, b, c**) CT scan bone windows: Axial, Coronal, and Sagittal bone windows aiding in three-dimensional localization of left anterior orbital radiopaque foreign body

Table 13.1 Hounsfield Units of various orbital soft tissue structures and foreign bodies

Material	Hounsfield unit (HU)
Metal	4000
Glass	2407
Wood	60
Stone	1876
Acrylic resin	193
Graphite	742
Tooth	1881
Bone	700 to 3000
Muscle	71
Blood	45 to 65
Hematoma	40 to 90
Plastic	112 to 133
Air	−932 to −1000
Water	0

limitation of movement artefacts in an agitated patient.

In summary, imaging not only helps to detect FBs but also aids localization and its proximity to radiologic landmarks and vital structures within the orbit and the brain.

13.6.2 Perimetry

Visual field testing when possible is often useful for baseline documentation, assessment, and severity of intraocular/optic nerve injury. Apart from confrontational visual fields and red-dot perimetry, automated perimetry, where possible, should be performed to assess the severity of optic nerve and /or intracranial injury in alert and cooperative patients.

13.6.3 Electrophysiological Tests

Visual evoke potential (VEP) recordings provide information about the status of the optic nerve. It is very helpful to detect early optic nerve injury

Table 13.2 Patient modifiers regarding the impact of foreign bodies in orbitofacial trauma management

Patient modifiers in orbital and orbitofacial trauma		
Age	Infant, child, young adult, elderly	Urgency, the timing of intervention
Bilateral or Unilateral	Prioritizing unilateral or bilateral repairs	Need for simple techniques vs. advanced technology, e.g., treatment planning, intraoperative navigation, etc.
Complex or Simple orbital fractures	Oculoplastic or multidisciplinary approach	Simple vs. multidisciplinary, multiple incisional approaches, complex implants
Displaced or non-displaced fractures	Threshold for intervention	
Entrapment or not	Orbital soft tissues (EOM-IMS Complex), globe, etc.	Urgency of intervention, larger incisions
Foreign body presence	Intraocular, Intraorbital or both	Antibiotics, localize and plan early removal
Globe and/or optic nerve injuries	Management closed or open globe injury, prevent additional damage	Address after life-threatening injuries before specific orbital interventions
High-risk patient or not	Low-risk patients: young healthy, adults or children without intracranial injuries/polytrauma High-risk patients: elderly, comorbidities, intracranial injuries/polytrauma	Multispecialty approaches with life preservation and if indicated delayed orbital intervention.

as even in cases of normal visual acuity, the VEP may be altered. Likewise, when the clinical examination is normal, but patient complains of profound visual loss, electroretinography (ERG) along with VEP may be useful to differentiate organic from non-organic causes of visual loss.

13.7 Management

Management of the patient with traumatized orbit and foreign body depends on the severity of the injury, visual morbidity and the general fitness of the patient. It may thus range from conservative management to complex surgery [19]. Initial management of trauma is the stabilization of systemic conditions and proper control of bleeding. Broad-spectrum antibiotics, systemic anti-inflammatory agents and analgesics play a very important role in the management of orbital trauma with a retained foreign body. Corticosteroids may be used judiciously when indicated once infections have been ruled out.

Indications and timing of removal of orbital foreign bodies depend on the nature of the injury, type of foreign body (material, size, and location), as well as other associated conditions related to the injury.

Most small inorganic and inert orbital foreign bodies may be left alone if inaccessible without significant subsequent morbidity. Anteriorly located inorganic foreign bodies may be explored and easily removed with good preoperative localization (Fig. 13.8a–c). Posteriorly located foreign bodies, especially against vital structures, e.g., optic nerve, superior orbital fissure, optic canal, may either be observed or, if indicated, be removed with meticulous atraumatic approach with good preoperative and intraoperative localization. Intraconal lesions may be accessed by disinsertion of the corresponding extraocular muscle(s) (Fig. 13.9). In the case of firearm and blast injury, apart from removing the foreign bodies, the tract containing gun powder and debris should also be removed where possible as they may cause severe postoperative inflammation (Fig. 13.10).

Retained wooden orbital foreign bodies often shows a tendency to fragment during attempted removal, especially in case of old injury (Fig. 13.11). To overcome all intraoperative difficulties of FB removal along with residual

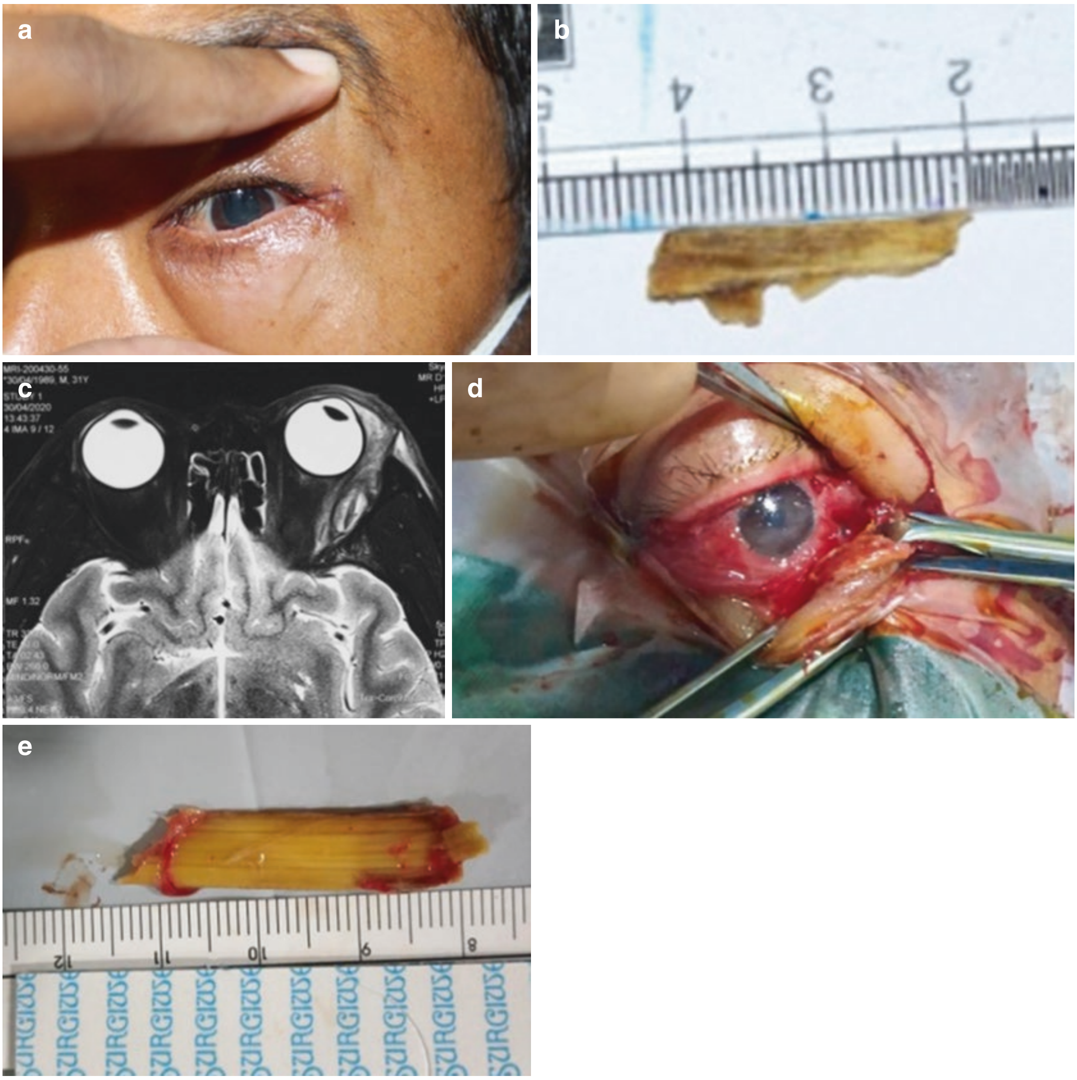

Fig. 13.7 Young male with previous orbital exploration with foreign body removal (**a, b**). MRI for recurrent lower eyelid abscess showed a residual foreign body against the left lateral rectus (**c**), which was extracted with a transconjunctival orbitotomy (**d, e**)

debris, a special technique is to use a gauze piece as a fishing net. The saline-soaked gauze piece with dilute adrenaline is passed along the tract to extract the foreign body along with the debris minimizing soft tissue trauma while ensuring complete removal of the foreign body along with particulate material. Complete removal is confirmed by a clean gauze coming out of the FB tract, which can be verified by endoscopy along the tract. After the removal of FB, the specimen is sent for microbial assessment of culture and sensitivity from the surface of the foreign body, which can guide further antimicrobial therapy.

An unusual but very serious type of injury causing orbital foreign bodies are blast injuries. These may occur from landmines, quarry blasts, riots and crowd control situations from firecracker injuries as well. More often than not, multiple foreign bodies are present despite maximal removal of foreign bodies.

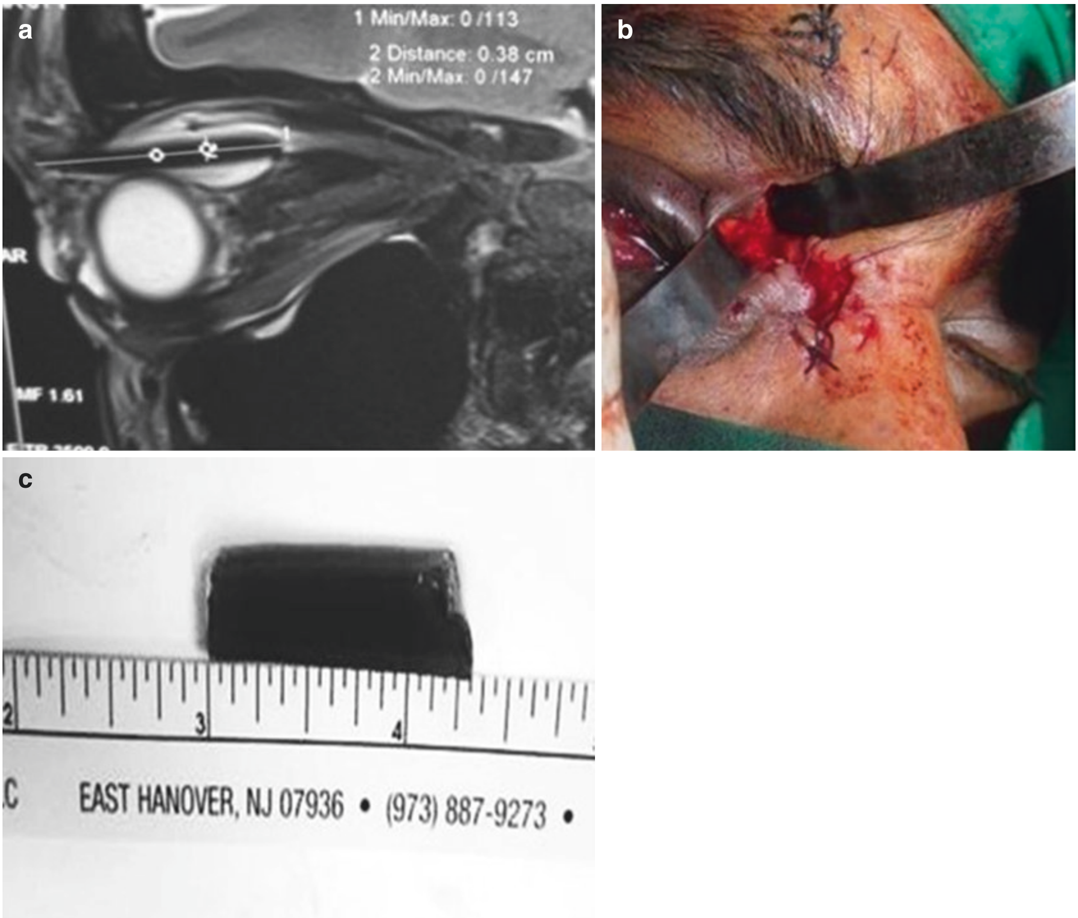

Fig. 13.8 (**a–c**) Anteriorly palpable linear glass foreign body visualized on MRI removed through an anterior orbitotomy approach

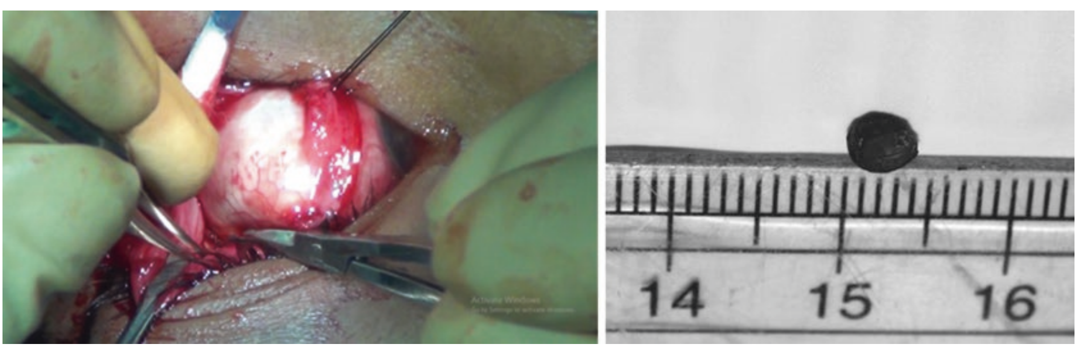

Fig. 13.9 Orbital foreign body removed after globe injury repair followed by orbital exploration with disinsertion of the lateral rectus

Fig. 13.10 Late presentation as chronic inflammation in an elderly old bomb blast injury victim. Plain x-ray followed by CT scan demonstrating the lodged radiopaque foreign body in the lateral wall of the orbit. Transconjunctival orbitotomy with foreign body removal including the tract showing siderotic tissue changes on Perl's stain

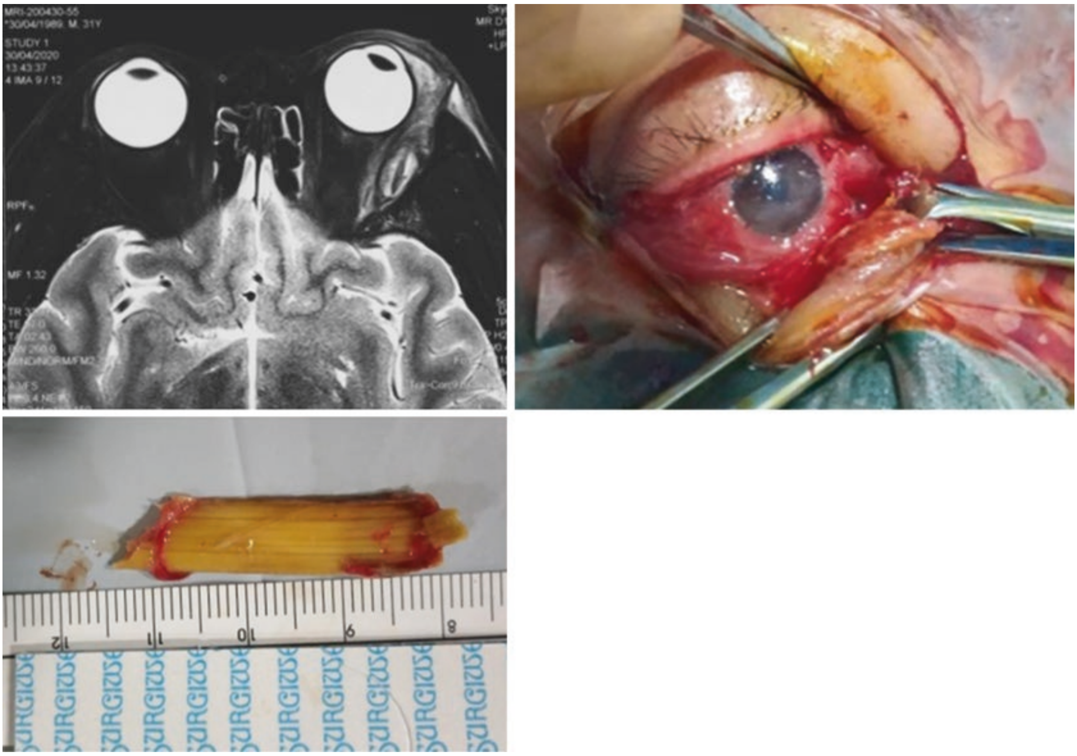

Fig. 13.11 Recurrent draining left orbital wound as a sentinel sign of retained residual or incompletely removed the organic foreign body

13.8 Complications

Despite advances in the recent era, sometimes a proper diagnosis is challenging, and patients may land up with poor outcomes due to missed foreign bodies, chronic infections and inflammations with residual fibrosis and globe limitation causing intractable diplopia and visual loss. The final outcome depends on various factors like initial visual acuity, the involvement of the optic nerve, location of the FB, the time elapsed between the injuries and reporting time and the expertise of management.

13.9 Prevention

To avoid blast and grenade injury, reforms of law and order situation along with the socio-economic development in that disturbed areas is probably the best way to prevent. Regarding orbital injury following road traffic accidents, the best possible prevention is the strict obedience of traffic rules and by introducing compulsory seat belt legislation. Airbags have gained extensive popularity in the recent era for the prevention of orbital trauma as well as morbidity and mortality of victims. Protective shatter-proof eye goggles and face shields go a long way in preventing shrapnel and projectile foreign bodies of the eyes and orbit.

13.10 Conclusion

A proper history, clinical examination with suspicion of foreign bodies, imaging followed by the appropriate threshold, timing and technique of foreign body extraction protecting the globe and other vital structures go a long way in the optimal management of afflicted patients.

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