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Reconstruction of Orbital Roof Fracture using Titanium Mesh- Case Report and Review of Literature

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Abstract

Orbital roof fractures are frequently associated with high energy impact to the craniofacial region. Displaced orbital roof fractures can cause ophthalmic and neurological complications, occasionally requiring open surgical intervention. Orbital roof fractures are more common in males due to automobile accidents. Early diagnosis of this condition and prompt intervention is critical in the management because any delay can cause loss of vision secondary to optic nerve involvement. Urgent ophthalmic evaluation is important to know visual acuity and assess for optic nerve injury or oedema, retrobulbar haemorrhage, retinal detachment and intraorbital emphysema. Computed tomography with reconstructed images is the investigation of choice. We report a rare case of isolated right orbital roof fracture. The fracture was an isolated blow in fracture with the fractured segment impinging on the globe. Reconstruction of the orbital roof was performed using an extra cranial approach to elevate the fracture with a titanium mesh to stabilise the fragment. The case report is followed by a brief overview of orbital roof fractures including pertinent review of literature.

Key Words- *Roof of orbit, fracture, titanium mesh, extracranial approach.*

Introduction

The incidence of orbital roof fractures in patients who sustain facial fractures is described as approximately 5% [1]. These fractures are usually either undisplaced or blow-out type [2,3,4]. However, blow-in fractures of the orbital floor have also been described [5]. A blow-in fracture is defined as an inwardly displaced fracture of the orbital rim or wall resulting in decreased orbital volume. The clinical features are primarily related to this decrease in volume, which include proptosis, limitation of eye movement, inferior dystopia of the globe, upper eyelid ptosis, diplopia, increased width of the palpebral fissure, scleral show, conjunctival ecchymosis or edema, ocular discomfort, and epiphora. There also may be neurologic involvement and intracranial damage. Operative treatment is usually not necessary for undisplaced or minimally displaced roof fractures. However, fractures with significant displacement require early open treatment and surgical orbital decompression [6].

Case Report

An 50-year-old male patient presented with trauma to the right fronto-orbito- maxillary region and both hands following an assault. On admission, his Glasgow Coma Scale was 15/15. Local examination revealed contusions and sutured lacerations of the right forehead. Upon admission there was no visual acuity loss or change in colour perception. Edema, subconjuctival haemorrhage, mild proptosis of the right eye and inferior dystopia of the globe were present along with limitation of supraduction. On assessment of gaze there was presence of diplopia on the upward gaze. No change in the intercanthal distance was noticed. The patient had a through ophthalmic evaluation done to rule out differential diagnosis with similar signs and symptoms such as, carotid-cavernous fistulae, retrobulbar hematoma, superior orbital fissure syndrome, and orbital apex syndrome [Figure 1].

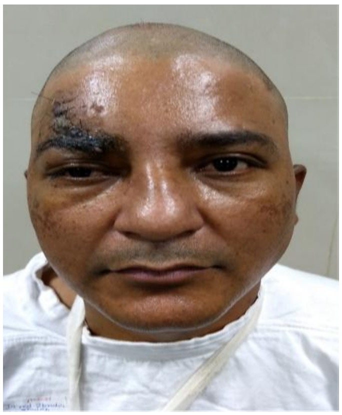

Figure 1: Clinical photograph showing lacerated wound on right side of forehead. Note edema, subconjuctival haemorrhage and mild proptosis of the right eye.

3D reconstructed computerized tomographic (3D-CT) scan revealed fracture of the right orbital roof with displacement of the fracture fragment deep into the orbit. There was also involvement of supraorbital rim.

Figure 2 : Computed tomography showing fracture of the right orbital roof with displacement of the fracture fragment deep into the orbit . 3D Reconstructed images (Left) and Bone window (Right).

The brain parenchyma showed no abnormality. There were comminuted, depressed fractures of frontal bone. There were no fractures around the orbital apex or impinging on the optic nerve. The fronto-nasal ducts were intact. There was minimum involvement of frontal sinus. Presence of Epidural haematoma was ruled out. A decision was reached to do a limited intervention through an extra-cranial approach. The right eyebrow laceration was reopened with medial and lateral extensions to expose the supraorbital region [Figure 3]. The periorbital and orbital contents were carefully separated from the fracture fragment, which was found lying deep within the orbit. The fragment was gently elevated and repositioned at the orbital roof and was fixed in place with a contoured titanium mesh and 1.5-mm titanium screws (Fig. 3).

Figure 3: Right eyebrow laceration was re-opened (Left) and contoured titanium mesh was fixed (Right).

Suturing was done in layers with 3-0 vicryl and 5-0 PDS. The post operative phase was uneventful. Diplopia persisted in the postoperative phase which gradually resolved in 2-3 weeks. Post operative CT scans showed that the mesh was firmly in place (Fig 4).

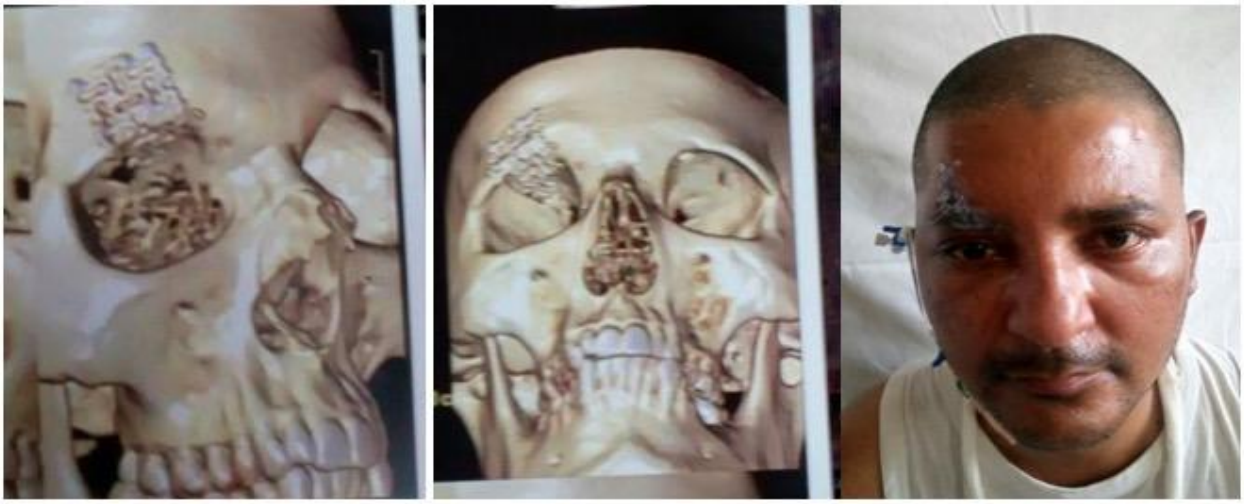

Figure 4: Post Operative 3D-CT reconstructed image showing mesh in place (Left). Note the clinical improvement and resolution of proptosis (Right).

Discussion

Orbital roof fractures Epidemiology

Although isolated orbital roof fractures are considered rare, it is estimated that 1% to 9% of facial bone fractures involve the orbital roof. Adults who sustain orbital roof fractures are generally between 20 and 40 years of age, and there is a very high male predilection (89%-93%). These fractures are associated with high-energy impacts, with motor vehicle collisions being the most frequently reported aetiology (49%-53%). Statistical information is unavailable for the frequency of non-displaced or isolated orbital roof fractures, although anecdotal information exists and case reports appear in the literature [7]. It is generally accepted that isolated adult orbital roof fractures are rare and that the majority of them are associated with other forms of craniofacial injury (as high as 95%) [8]. This association has been reported to be 95% with the frontal sinus, 60% with the orbital rims, 60% with complex injuries of the naso-orbital-ethmoid region, 33% with some other orbital wall fracture, and 27% with some form of LeFort level fracture. Many of these patients (13%- 19%) have multisystem injuries, most of which are neurological (57% to 90%) [9].

Orbital Roof Fractures, Pathophysiology

There are several different configurations of orbital roof fractures including: non-displaced, isolated "blow-in," isolated "blow-out" (or "blow-up"), supraorbital rim involvement (without frontal sinus), frontal sinus involvement, and combination fracture [10].

The isolated orbital roof "blow-up" fracture, also known as "blow-out" fracture, is defined as superior displacement of the fracture fragment into the anterior cranial fossa without involvement of the supraorbital rim, with possible herniation of orbital contents outside of the orbital confines. The isolated "blow-up" fracture is thought to be the result of direct orbital blunt force with subsequent increased intraorbital pressure, hydraulic forces, and/or shear strain. The isolated "blow-in" fracture is defined as inferior displacement of the roof without involvement of the supraorbital rim or the frontal sinus, and is thought to be the result of increased intracranial pressure, a shift of the cranium, and/or a shift of the intracranial contents [11]. The blow-in fracture effectively reduces the volume of the orbit and can cause associated intraorbital injuries including extra-ocular muscle entrapment and optic nerve injury. Although the terms "blow-in" and "blow-up" fractures refer to isolated injuries of the internal superior orbit, these injuries occur far more commonly in conjunction with supraorbital rim and frontal sinus involvement. When other craniofacial injuries are identified, it is thought that the mechanism of injury is direct transmission of force from displacement of the adjacent injury. Very rarely the orbital roof will fracture without displacement of fractures fragments, resulting in the non-displaced orbital roof fracture [12].

Opthalmic Considerations

Ophthalmic evaluation is mandatory to document visual acuity and assess for common causes of visual impairment including optic nerve compression or laceration, retrobulbar haemorrhage, globe rupture, detached retina, and intraorbital emphysema [13]. Thin-slice CT scan with 3-D reconstruction is the imaging modality of choice for assessment of orbital fractures, as the surgeon can delineate the degree of fracture displacement and need for reduction as well as any intracranial injury. Though superior in visualisation of intraorbital soft tissues including the optic nerve, magnetic resonance imaging is of limited value in acute orbital injuries due to its insensitivity to assessment of bone fragments and wood/glass particle foreign bodies, and its relative contraindication in case of ferromagnetic foreign body in the vicinity of the orbital tissues [14].

Treatment modalities available for Blow in Fracture with Supraorbital rim involvement There are two approaches to the orbital roof: the transcranial and the extra-cranial approach.

The transcranial approach is commonly performed through a bicoronal incision for a frontal craniotomy. This is advantageous because intracranial injuries can also be dealt with at the same time. It must be stressed that the coexisting neurocranial, frontal sinus, and supraorbital rim fractures take priority over the management of orbital roof fractures. The extra-cranial approach is generally through a superior blepharoplasty incision or through a preexisting laceration, as we have done. Once an adequate subperiosteal plane has been identified, a thorough exploration should be undertaken that identifies the fracture and reveals stable, non-injured bony segments of the orbital roof. A safe range for dissection has been documented as 44.5 ± 1.73 mm from the superior orbital roof, posterior; 39.4 ± 2.8 mm, superolateral; and 46.3 ± 2.7 mm, superomedial, before encountering the muscular insertions in the orbital apex and important structures in the superior and inferior orbital fissures[15].

Reconstruction of Roof of Orbit

Reconstruction of the orbital roof is the key step and should be performed in every case of displaced fractures impinging on the globe. There is a wide variety of materials available for reconstruction of the orbital roof including bone grafts, high density porous polyethylene (Medpor), titanium mesh (TiMesh), and composites (Medpor with TiMesh, Synthes Medical Ltd., Switzerland). The ideal material for roof reconstruction should allow bending to an anatomic shape, be radiopaque (to allow for postoperative radiological confirmation of placement), and be stable over time [16].

Bone grafts are optimally biocompatible and radiopaque, have a smooth surface from which periosteum can be easily dissected in secondary reconstruction, and have no additional cost. The disadvantages include longer operating time, additional donor site (antral bone, calvarium, ribs, iliac crest) with the attendant morbidity, and chances of resorption. They also require additional implants in the form of plates and/or screws to hold them in place [17,18].

High-density porous polyethylene (Medpor) is stable, biocompatible, easily contoured and allows tissue incorporation with a low risk of infection; no additional donor site is required. Relative disadvantages include its radiolucency, higher cost, and requirement of additional implants to fix the sheet. Titanium mesh is available in a wide variety of shapes and sizes including preformed anatomic orbital plates. The advantages include ease of contouring (which decreases operating time), radiopacity, low risk of infection, stability and no additional donor site needed. The spaces within the mesh allow for the drainage of fluids and may also allow tissue in growth. The disadvantages of titanium mesh are the high cost and possible sharp edges if not properly trimmed [19,20].

Review of operated patient

Our patient was from an older age group than as mentioned in the previous epidemiological studies by about 10 years. Sex of the patient correlated with the studies. History of the patient revealed assault as the aetiology, in contrast to RTA of high impact which seem to be the most common cause. The patient had multi system injury without neurological involvement. The fracture was blow-in fracture with the involvement of supraorbital rim. There were no serious ophthalmic complications except for diplopia. The fracture was identified using 3-D CT scanning as per recommendations. During the operation roof of the orbit was accessed through the existing laceration and fractured segments were reconstructed using a titanium mesh. Post-operative results were excellent with resolution of diplopia and proptosis.

Conflict of Interest: None

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