Ocular Emergency

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Ocular Trauma

Blow out fracture occurs when a blunt object greater in diameter than the orbital rim such as fist, tennis or cricket ball strikes the orbital cavity (Figure 2). The mechanisms proposed for blow out fracture are:

a) Hydraulic theory or Retropulsion theory or Direct injury theory:

b) Buckling theory or transmission theory or Indirect injury theory:

During the course of injury, the force which is transmitted to bony walls of orbit may also cause concussion ocular trauma leading to angle recession, hyphema, vitreous hemorrhage, commotio retinae etc. Hence complete ophthalmologic evaluation is necessary.

Relevant orbital anatomy

The adult orbital floor is formed by the maxillary, zygomatic bones anteriorly and palatine bones posteriorly (Figure 1). Orbital floor measures about 35 – 40 mm anteroposteriorly and it is the shortest of all the walls. It forms the roof of maxillary sinus. Floor of the orbit contains infraorbital groove which forms infraorbital foramen. Infraorbital nerve, a branch of maxillary division of trigeminal nerve passes through the groove, providing sensory innervations to the ipsilateral orbital floor, mid face, and posterior upper gingival area. The infraorbital artery, a branch of the maxillary artery, and the infraorbital vein also are found within the infraorbital groove. The portion of orbital floor in front of inferior orbital fissure weakened by infraorbital groove is the most common site of blowout fracture.

Pathophysiology

Sudden compression and backward displacement of globe raises the intra orbital pressure leading to fracture of orbital floor.
Types

a) **Pure blowout fracture**: Fracture of the orbital floor with intact orbital rim

b) **Impure blowout fracture**: Associated fracture of the orbital rim

**Orbital blowout fracture in children**

The bones of a child’s orbit are more elastic than adults. Thus injury in children causes more anteroposterior buckling creating a fracture with overlapping segments. This leads to ‘trapdoor-type’ fracture where prolapsed orbital tissue gets caught in the fracture site leading to severe motility restriction and diplopia in absence of marked congestion or ecchymosis. The condition is also called the ‘white-eyed’ blow-out fracture.

**Medial wall fracture**

Blow out fracture of medial wall is much less common than floor and seen along with naso-ethmoid fractures than as an isolated entity. Horizontal diplopia is usually the primary complaint when medial orbital tissues are involved. However, a vertical or oblique component is often found in such cases.

**Clinical features**

Detailed history regarding mode of injury should be taken to assess the mechanism and extent of injury. General condition of patient and other non ocular injury should be checked.

a) **Periorbital haematoma**: The acute stage of orbital trauma is often associated with a peri-orbital haematoma and swelling (Figure 3), more or less making opening of the eye impossible without manual assistance. Also proptosis of variable degree seen initially due to orbital edema and hemorrhage.

b) **Epistaxis**: Result due to bleeding from maxillary sinus into the nose.

c) **Emphysema**: Subcutaneous emphysema with crepitus seen in fractures communicating with air filled sinuses.

d) **Paraesthesia over ipsilateral lower lid, cheek and upper lip due to injury to infraorbital nerve.**

e) **Diplopia**: Due to restriction of ocular motility. With the entrapment of inferior orbital tissue and inferior rectus muscle, vertical diplopia is more prominent in upgaze.

f) **Enophthalmos**: Caused by displacement of the eye globe due to an enlargement of the bony orbit. Also displacement of orbital contents into maxillary sinus and traction over globe caused by entrapped tissue leads to posterior and inferior displacement of globe. Pseudoptosis occurs due to loss of support.

It has been shown that a 0.8–1 ml increase of bony orbital volume corresponds to 1 mm of enophthalmos on the Hertel exophthalmometer. Clinically significant enophthalmos (≥2 mm) occurs with increase in the bony orbital volume of 1.5–2 ml.

The orbital rims and malar prominence are unaffected in pure blow-out fractures, while in other zygomatico-orbital fractures the cheek contour is often flattened to varying degrees owing to dislocation of the zygomatic bone.

**Expanded orbit syndrome**

Multiple fractures in and around the orbit may lead roomy orbit with extensive prolapse of orbital tissues. This expansion can be seen in orbital fracture along with mid facial fracture as in tripod or Le Fort type III. Clinically patient has gross enophthalmos, inferior displacement of globe (hypoglobus), deep superior sulcus, eyelid asymmetry and diplopia.
Evaluation
External force causing blow out fracture can also cause concussion injury to eyeball leading to extensive damage. Hence thorough ocular examination is necessary to record ocular status and manage patient accordingly.

Recording of visual acuity at presentation has medico-legal importance in ocular trauma cases. If required eyelids can be gently separated to allow patient to read the chart. Palpate orbital rim to look for deformity and crepitus. Slit lamp evaluation of cornea and anterior segment should be performed. Pupillary reflex should be checked as presence of RAPD points towards optic nerve injury. Fundus evaluation should be done to note for Berlin’s oedema which can be the cause of unexplained diminution of vision.

Ocular motility: Entrapment of orbital contents and inferior rectus muscle leads to motility restriction especially in upgaze (Figure 4).

Hertel exophthalmometer: To document enophthalmos. With passage of time and absorption of orbital fat over period can lead to increase in enophthalmos.

Force Duction Test (FDT): FDT is useful in determining whether dysmotility is restrictive or paralytic. In blow out fracture with inferior rectus entrapment FDT is ‘positive’ indicating mechanical cause.

Force Generation Test (FGT): In testing force generation, the muscle insertion is grasped and the patient is asked to look into the muscle’s field of action. A paretic muscle will feel weak when compared with the fellow eye.

Diplopia charting: With red green glass, diplopia charting with streak light shows diplopia worsening in upgaze Hess screen or Lee screen test can be done.

Imaging
a) Plain X-rays: Easily available and cost effective imaging modality. Water’s view is the most useful projection for detecting an orbital floor fracture (Figure 5). X ray shows bony discontinuity in orbital floor with herniation of soft tissue in maxillary antrum seen as ‘hanging drop’ sign².

b) Computerized tomography (CT) scanning: CT gives detailed visualization of bony and soft tissue injury where entrapment of muscle can be appreciated. Coronal sections are particularly useful (Figure 6).

c) Magnetic resonance imaging (MRI): Can be utilized when there is need for greater soft tissue evaluation. MRI is insufficient in assessing the bony structures and therefore needs to be combined with CT.

Management protocols
In case of isolated orbital floor fracture the two main strategies have been either to perform early surgical
explorations or to ‘wait and see’. Both approaches have their own disadvantages. It is to be understood that restriction in ocular movement and diplopia is caused not only by entrapment of muscle but soft tissue edema, hemorrhage and motor nerve palsy can also be the cause. A better evaluation can be made if time is allowed for clearing of initial edema and hemorrhage. It is generally accepted that a 2 week window of observation can be allowed in absence of urgent surgical indications.

Clinical recommendations for repair of isolated orbital floor fracture:

A) Immediate intervention

- Diplopia present with CT evidence of an entrapped muscle or periorbital tissue associated with a nonresolving oculocardiac reflex: bradycardia, heart block, nausea, vomiting or syncope
- “White-eyed blow-out fracture.” Young patients (<18 yrs), history of periocular trauma, little ecchymosis or edema (white eye), marked extraocular motility vertical restriction, and CT examination revealing an orbital floor fracture with entrapped muscle or perimuscular soft tissue
- Early enophthalmos/hypoglobus causing facial asymmetry

B) Within 2 weeks

- Symptomatic diplopia with positive forced ductions, evidence of an entrapped muscle or perimuscular soft tissue on CT examination, and minimal clinical improvement over time
- Large floor fracture causing latent enophthalmos
- Significant hypo-ophthalmos
- Progressive infraorbital hypesthesia

C) Observation:

- Minimal diplopia (not in primary or downgaze),
- Good ocular motility
- No significant enophthalmos or hypo-ophthalmos

**Medical treatment**

Patient are given short course of oral steroids which reduces edema of soft tissue and extra ocular muscle. Oral antibiotics given on empirical basis. Patient advised not to blow nose as it can worsen orbital emphysema. Nasal decongestants can be used if not contraindicated.

**Surgical technique**

Clinical recommendations as mentioned above gives guidelines regarding timing the surgical intervention in patients. It is generally accepted that unresolved diplopia with soft tissue entrapment, significant enophthalmos (2 mm or more), marked hypo-ophthalmus, fracture more than 50% of the floor, or trapdoor type fracture will require surgical intervention.

Surgical principle in blow out fracture is to assess orbital floor, release soft tissue and muscle entrapment and strengthen the floor with use of implants.

a) Subciliary approach

- Incision given 2-3 mm below the lash line.
- Skin flap elevated and dissection carried anterior to orbital septum till inferior orbital rim is exposed. Care taken not to damage the septum.
- Periosteum incised at the rim and elevated with a hand-over-hand technique using sharp periosteal elevators until adequate exposure is obtained. Meticulous hemostasis is achieved.
- Fracture site visualized and release of entrapped soft tissue of muscle is carried out. It is helpful to carry out FDT during surgery.
- Once adequate release obtained, orbital floor is reinforced using an implant. Sizing of implant is done according to the defect to give adequate support as well as volume replacement.
- Implant is placed under the periosteum. Periosteum sutured back using 6-0 vicryl. Skin closed with 6-0 silk.

Subciliary approach has advantage of better scar camouflage. However post operative ectropion and lower lid retraction can occur.

b) Subtarsal approach: Incision below tarsal plate over orbital rim giving direct access to floor with good exposure. But it gives cosmetically unacceptable scar.

c) Transconjunctival approach: Incision given in lower fornix 3 mm below tarsal plate and can be combined with a lateral canthotomy for better exposure. This approach gives no visible scar.

d) Transantral approach: Orbital floor reached via the maxillary sinus using Caldwell-Luc incision. It is not a favored approach for an ophthalmologist.

e) Endoscopic approach: With advances in endoscopic surgery, transmaxillary and transnasal endoscopy has been described which eliminate the need for eyelid incisions and gives improved visualization of fractures.

**Implants**

Orbital floor is reinforced with either autogenous or synthetic implant. Surgeon should size the implant so as to cover the defect adequately and to prevent displacement or extrusion later. While cutting the implant it should be
tapered posteriorly so as to fit orbital floor configuration. Table 1 enumerates various implants.

**Complications of surgery**
- Intra operative bleeding
- Residual or new onset diplopia
- Extra ocular muscle dysfunction
- Post operative neuralgia
- Residual enophthalmos
- Implant extrusion
- Possible loss of vision

Although the surgery may be a complete success in the eyes of the surgeon, the patient may view the outcome as unsatisfactory. To minimize this, the surgeon and patient should be in mutual agreement regarding the realistic outcome of the repair.

**Treatment of persistent visually handicapping diplopia**

Few patients will have persistent diplopia even after adequate surgical repair of floor fracture. Diplopia in primary gaze and in down gaze (functional gaze) are more troublesome. Such cases will require muscle surgery. To correct diplopia in down gaze ‘Reverse Knapp procedure’ performed placing medial and lateral recti behind inferior rectus muscle. Fresnel prisms can be employed in selective cases.

**Late treatment of cosmetically unacceptable enophthalmos**

Resurgery with adequate size orbital implant if downward sinking of eye along with enophthalmos is unacceptable to patient. Correction of pseudoptosis done with mullerectomy which will increase palpebral height.

**References**