The Injured Eye
What the radiologist must ‘see’

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Disclosure of commercial interest

• Neither I nor my immediate family members have a financial relationship with a commercial organization that may have a direct or indirect interest in the content.
Learning Objectives

By the end of this exhibit the participant will be able to:

• Appreciate radiological anatomy in relevance to orbital trauma

• Identify and classify the various imaging manifestations of orbital injuries

• Evaluate orbital injuries with a structured algorithm
Problem Statement

• 3% of all ER visits

• Prevalence of 2-6%

• Most common cause of unilateral blindness

• Estimated 500,000 years of lost eyesight occur annually in the United States

• Male : female = 4 : 1
Orbital Trauma
Skeletal trauma

- Blow out
  - Hydraulic
  - Buckling
  - Trapdoor
- Orbital roof
  - Blow up
  - Blow in
- Zygomatico-maxillary complex
- Naso-orbito-ethmoid complex
- Le Fort complex
- Orbital apex fracture
Orbital blowout - mechanism

**Hydraulic**
- Force directed on orbit
- Acute increased intra-orbital pressure
- Fracture of the weakest wall

Features
- Large defect
- Medial wall is involved
- Herniation of orbital contents common

**Buckling**
- Force directed on orbital rim
- Force transmitted posteriorly
- Buckling of the involved wall

Features
- Smaller anterior defect
- Medial wall NOT involved
- Herniation is unlikely

## Blowout fracture - hydraulic

- Most common inferior wall followed by medial wall
- Factors favouring surgery (usually after 2 weeks)
  - Involvement of >50% of orbital floor
  - Large fracture fragment (>1 cm²)
  - Extraocular muscle entrapment
  - Hypoglobus or Enophthalmos (>2 mm)

‘Blow out fracture’ with inferior fat herniation and enophthalmos

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Blowout fracture - buckling

- Smaller more anterior defect
- No medial wall involvement
- No herniation of intraorbital contents
- Likely to be managed conservatively

‘Blow out fracture’ – buckling mechanism with force acting on infraorbital rim. Note the smaller fracture defect and absence of herniation
Called ‘White Eye Blowout fracture’ (WEBOT)
More common in children due to increased elasticity of bones
A flap of bone displaced outwards which then snaps back into place
Fracture line may not be seen !!!
Look for abnormal fat or soft tissue in inferior aspect of orbital floor to make a diagnosis
Entrapment requires early surgical intervention (1-5 days)

‘Orbital trapdoor fracture’
There is entrapment of the inferior rectus and fat as the flap of bone has snapped back into its original position. No fracture line.

Orbital blow in

- Blunt trauma to forehead
- Isolated inferior displacement of roof
- ‘Pure fractures’ do not have involvement of frontal sinus or supraorbital rim
- Causes proptosis
- Orbital CSF leak may be present

‘Blow in’ fracture
Depressed fracture fragment decreasing intraorbital volume. No frontal sinus or supraorbital rim involvement.

Zygomatico-maxillary

- Direct blow to malar eminence
- ‘Tripod fracture’ is a misnomer
  1. Zygomaticofrontal
  2. Zygomaticomaxillary
  3. Zygomaticotemporal
  4. 4th component – Zygomaticosphenoid (extends to inferior orbital floor)
- A rotational deformity about this suture needs surgical intervention

‘Tripod fracture – The ‘Four’ components’
Naso-orbito-ethmoid

- Blow to nasal region
- Severe comminution and telescoping of medial orbital wall
- Proptosis
- Telecanthus (medial canthal tendon injury)
- CSF rhinorrhea (cribriform fossa)
- Lacrimal fossa involvement

Nasoorbitoethmoid fracture
Note involvement of nasal bones, nasal septum and bilateral medial orbital walls in a case of facial smash injury
Le Fort complex

- All involve fractures of pterygoid
- Le Fort I (floating palate) – No orbital injury
- Le Fort II (floating maxilla) – Involvement of inferior orbital wall is unique; nasolacrimal duct may be involved
- Le Fort III (floating face)– craniofacial dissociation; may extend to optic canal
- Involvement of medial orbital wall common to both Le Fort II and III
Orbital apex fracture

- Involvement of superior orbital fissure – orbital fissure syndrome
- Involvement of optic canal – orbital apex syndrome
- Impingement by bony fragment or compression by edema and hemorrhage

Orbital apex fracture
Fracture of the left orbital apex with impingement on the left optic nerve
Birmingham Eye Trauma Terminology System (BETTS)
International Society of Ocular trauma
http://isotonline.org/betts
Decrypting the BETTS

- Closed globe injury
- Open globe injury

Blunt
- Partial thickness - Contusion
- Full thickness - Rupture

Sharp
- Full thickness
- Partial thickness - Lamellar laceration

One wall injured with Intraocular foreign body

Two walls injured - Perforating

Only one wall injured - Penetrating
Traumatic globe injury

- Anterior chamber
  - Hyphema
  - Corneal laceration
- Lens
  - Traumatic cataract
  - Partial subluxation
  - Complete subluxation
- Posterior segment
  - Vitreous hemorrhage
  - Subhyaloid hemorrhage
  - Retinal detachment
  - Choroidal detachment
  - Subtenon hemorrhage
Traumatic hyphema

- Disruption of vessels in iris or ciliary body
- High density in anterior chamber (between the cornea and the iris)
- Presence of hyphema prompts search for other injuries

Traumatic hyphema
Note the diffusely increased attenuation of the left anterior chamber. Compare with normal attenuation in the right anterior chamber
Corneal laceration

- Superficial injuries not seen on imaging
- Laceration with complete corneal penetration causes
  - Decreased volume of the globe especially anterior chamber
  - Buckling of scleral margins
- Differential diagnosis is anterior subluxation of lens

‘Corneal laceration’: Note the decreased anterior chamber depth on right compared with normal on left (blue arrow)
Sagittal image shows buckling of scleral margin
Partial subluxation of lens

- Secondary to compression injury to globe
- Partial disruption of the zonular fibers
- Asymmetric displacement of lens away from ruptured ciliary attachments
- Subtle subluxation may be missed on clinical examination

Bilateral traumatic ‘partial lens subluxation’ worse on the right with persistent attachment at the medial ciliary bodies.
Complete subluxation

- Complete disruption of zonular fibers
- Lens lies in a dependent position in the vitreous humour
- ‘Floating lens sign’ – misnomer as lens ‘sinks’ and settles down
- Rarely may be displaced into anterior chamber
Gallery of lens dislocation

- Partial subluxation
- Chronic partial subluxation with calcification
- Complete dislocation
- Chronic complete dislocation with calcification
- External dislocation outside the globe
- Partial subluxation of implanted intraocular lens (IOL)
Traumatic cataract

- Stellate or rosette shaped posterior axial opacities
- Lens capsular disruption
- Ingress of fluid
- Edema of lens
- On CT may be seen as diffuse low attenuation
- Decrease in attenuation of 30HU compared with the contralateral normal lens

Traumatic cataract
Inferotemporal part of right lens
Vitreous
- Vitreous Hemorrhage

Hyaloid Membrane
- Hyaloid Hemorrhage

Retina
- Retinal Detachment

Choroid
- Choroidal Detachment

Sclera
- Subtenon Hemorrhage

Tenon's capsule
Vitreous hemorrhage

- Heterogenously increased attenuation on CT
- Comparison of attenuation with the normal eye
- Fluid levels may be seen

Vitreous hemorrhage
Diffusely increased attenuation in the right posterior segment. (compare with normal left side)
Also note fluid level from settled blood components.
Subhyaloid hemorrhage

- Also known as ‘posterior vitreous detachment’
- Hemorrhage external to hyaloid membrane between hyaloid membrane and retina
- Hyperdensity anterior to the optic discs, covering the optic disc
- Sharp margin between hemorrhage and vitreous

Terson syndrome
Bilateral subhyaloid hemorrhages in a patient with severe closed head trauma. Extensive subarachnoid hemorrhage (blue arrow).

Retinal detachment

- Subretinal fluid accumulates between the neurosensory retina and the retinal pigment epithelium
- Characteristic V shaped with apex at optic disc due to firm attachment of retina at the optic disc
- Anteriorly limited by ora serrata

Retinal detachment
Characteristic ‘V’ shaped hemorrhages of retinal detachment on T1 and T2 images. Note that the hemorrhage is limited anteriorly at the ora serrata
Choroidal detachment

- Blood between choroid and sclera in the ‘suprachoroidal space’
- Ocular hypotony is the usual cause
- Biconvex or lentiform appearance extends anywhere between vortex veins and ciliary body
- Spares posterior third of the globe without extension to optic nerve insertion
- May extend to ciliary body beyond the ora serrata

Choroidal detachment
Note extension anteriorly beyond ora serrata and relative sparing of posterior third of eye
Subtenon hemorrhage

- Hemorrhage between the sclera and Tenon capsule
- Lentiform hyperdensity along posterior outer aspect of globe
- Mimics retrobulbar hemorrhage
Open globe injury

- Direct signs
  - Scleral discontinuity
  - Decreased globe volume
  - Altered globe contour (‘flat tire sign’)

- Indirect signs
  - Altered anterior chamber depth. Depth is
    - increased in posterior segment rupture
    - decreased in corneal laceration
  - Foreign body or air within the globe

Open globe injury
Note altered globe contour and intraocular air
Open globe injury

Posterior scleral rupture with increased anterior chamber depth

Anterior corneal rupture with reduced anterior chamber depth
Optic nerve transection

- Causes of globe luxation
  - finger poke during sports injuries
  - severe orbital fractures from motor vehicle accidents
  - attempted traumatic enucleation by gouging
- Optic nerve transection either at lamina cribrosa or 30-50mm behind globe

Traumatic globe luxation and optic nerve transection following alleged assault using a screwdriver. Surgical enucleation with prosthetic replacement was performed.
Intraocular foreign body

Fish hook

Glass shard

Nail

Knife
Intraocular foreign bodies
CT attenuation

- Metals: 3000 to 3100 HU maximum attenuation at core
  - Lead and silver – significant scatter and shadow
  - Brass, copper and steel – shadow with some scatter
  - EXCEPTION – aluminium 715-815 HU
- Glass and slate: 2000 to 3000 HU
- Polyvinylchloride: 500 HU
- Plastic: 100 – 400 HU (may not be visible)
- Wet wood: -100 HU (may not be visible)
- Dry wood: -300 to -400 HU

Checklist

- Globe: shape and contour
- Lens: position and density
- Anterior chamber depth
- Posterior segment density
- Foreign bodies, air foci
- Retrobulbar Area
- Orbital bones
Mimics of hemorrhage

Silicone injection

Prosthetic eye

Mimics of Foreign body

Retinoblastoma

Retinal astrocytic hamartoma in a patient with tuberous sclerosis

Senile limbic calcification

Optic nerve head drusen
Mimics of Globe rupture (abnormal contour)

Staphyloma

Coloboma

Phthisis bulbi

Pathological myopia
Conclusion

- Imaging helps in comprehensive assessment of
  - Orbitoskeletal injury
  - Traumatic globe injury
  - Intraocular foreign bodies

- Knowledge of injury patterns and common mimickers is essential in prompt diagnosis and management of orbital trauma.

“The eyes cannot see, what the mind does not know”

-Anonymous
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