The Radiology of
Orbital Trauma

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The Radiology of
Orbital Trauma
Outline

* Epidemiology of Orbital Trauma
* Orbit Anatomy
* Imaging Indications in Orbital Trauma
* Menu of tests for Orbital Trauma
* "Cookbook Approach" to CT evaluation
* "Differential Diagnosis" with interpretation
* Application: Index Case
* Summary
Epidemiology of Orbital Trauma

* 3% of all emergency department visits in the US*
* Usually seen in patients with multiple trauma*
* Most common in teens/young adults & males (upwards to 81%) ^^*
  - Mechanism of action in children most often sports related → orbital blow-out (floor)
  - Mechanism of action in older youth/adults → assaults and MVA lateral (zygomatic) fractures & complex injuries

Ref: *Kabul, ^UpToDate.com
Anatomy of Orbital Trauma: Orbital Bones

Image ref: UpToDate.com
Anatomy of Orbital Trauma: Soft Tissue

- Frontal sinus
- Supraorbital nerve
- Ethmoidal sinuses
- Lacrimal duct system
- Medial canthal ligament
- Med. rectus m.
- Infraorbital nerve
- Maxillary sinus
- Levator palpebrae m.
- Sup. rectus m.
- Sup. oblique m.
- Optic nerve
- Lat. rectus m.
- Lateral canthal ligament
- Inf. rectus m.
- Inf. oblique m.

Image Ref: UpToDate.com
Anatomy of Orbital Trauma: Normal Orbital Anatomy on CT

Axial non-contrast head CT at level of orbit

AC = anterior chamber
L = lens
PS = posterior chamber
ON = optic nerve within optic cone

Indications for Imaging in Orbital Trauma

* evidence of fracture on clinical examination
* limitation of EOM
* decreased visual acuity in setting of trauma
* severe pain
* inadequate examination due to soft tissue swelling

Ref: UpToDate.com
Menu of Tests for Orbital Trauma: 
Plain Films

- Sensitive for detecting orbital floor fractures ranges from ~ 50%^ to 78%*

- Limited in ability to delineate soft tissue structures#

- Recommended as screening tool only with children who had minor mechanism as can show clouding of a sinus indicating either blood or fat extrusion from orbital floor fracture*

Ref: *Kabul & #Lee
Menu of Tests for Orbital Trauma: Plain Films

Blue arrow: fluid density in maxillary sinus

Yellow arrow: orbital floor fracture

Frontal plain film of face

Menu of Tests for Orbital Trauma: 

**Ultrasound**

* Insensitive for delineating fractures and lack of soft tissue differentiation
* Can decipher contents of the globe
  * BUT: C/I if suspect a traumatized globe
* **Rarely used.**


Text Ref: Lee & Kabul

Blue circle: hyperechoic density in orbit

Ultrasound of right orbital globe
Menu of Tests for Orbital Trauma:

MRI

* most sensitive of all tests for depiction of intraorbital contents
* insensitive for visualization of bony fragments
* some foreign bodies not easily visible (esp. wood and glass)
* not easily accessible and not appropriate for emergent patients
  * C/I if possible ferromagnetic foreign bodies within or near orbits
* can be used after initial emergent trauma has abated

Text Ref: ^UpToDate.com & *Kabul
Menu of Tests for Orbital Trauma: 
General Head CT

* Better than plain film and MRI at bony resolution
* Much greater sensitivity than plain films for soft tissues findings
  - sensitivity for ~75% for open globe*

Ref *Kabul, rest of information from UpToDate.com
Modality of Choice for Orbital Trauma: Thin-Cut Orbital CT

* can better visualize fractures, foreign bodies, and soft tissue injuries over standard head CT

* base of skull to vertex at thin sliced (0.625-1.25mm) axial CT and coronal images needed to evaluate the superior orbital surface, floor of orbit, SR and IR muscles, and identification of an optic nerve sheath hematoma via either
  * 3 mm coronal intervals coronal acquisition OR
  * a subsequent multiplanar reformation if patient unable to sit prone for coronal acquisition

Ref: ^Lee, *Kabul, & UpToDate.com
“Cookbook” Approach to Evaluation

Start anteriorly then progress deep….

1. evaluate for external *soft tissue changes*
2. evaluate *anterior chamber*
3. evaluate position of the *lens*
4. evaluate *globe* including posterior segment
5. evaluate *bony orbit* for fractures
6. evaluate for *foreign bodies*
7. ** evaluate *vessels* and *optic nerve*
8. ** always look for associated *intracranial injury* to CNS

Ref: Kabul with edits
“Differential Diagnosis” of Orbital Trauma: Soft Tissue Changes

- proptosis &/or orbital edema &/or hematoma suggestive of underlying bony fractures or extrusion of intraocular contents from ruptured globe

Blue arrow: complex fluid density and soft tissue swelling (hematoma)

Axial non-contrast head CT at level of orbit

Text Ref: Kabul
“Differential Diagnosis” of Orbital Trauma:
Anterior chamber injuries

Corneal lacerations: (yellow arrow) look for decreased volume of anterior chamber
- Hyphema: (blue arrow) look for increased attenuation in anterior chamber
- Open globe: look for herniations of orbital contents especially at orbital apex

Axial non-contrast head CTs at level of orbit

Text Ref: Kabul
Left: Courtesy of Dr. Gul Moonis, BIDMC and MEEI
“Differential Diagnosis” of Orbital Trauma: Lens Injury

**Subluxation/dislocation**
- posterior are more common as iris impedes anterior direction
- look for lens floating within dependent portion of the vitreous humor
- tends to pair with corneal lac
- if b/l consider underlying condition (CT disease such as Marfan's)

Text Ref: Kabul
"Differential Diagnosis" of Orbital Trauma: Lens Injury Examples

Yellow arrow: complete dislocation of L lens in dependent portion of globe

Blue arrow: lateral subluxation of R lens

Axial non-contrast head CTs at level of orbit

“Differential Diagnosis” of Orbital Trauma:
Open Globe Injuries

- very emergent, a "must-not-miss" finding
- most common at insertion of EOM where sclera is thinnest
  so look for scleral discontinuity
- look for change in volume esp change in volume or "flat-tire sign"
- intraocular air
- Fake Out: for retinal detachment is to inject perfluoropropane gas into the vitreous and can mimic open globe free air

Text Ref: Kabul
“Differential Diagnosis” of Orbital Trauma: Open Globe Injuries Examples

**Yellow arrows:** s/p trauma with flat tire sign (**thin arrow**) and free air (**thick arrows**)

**Blue arrow:** *Fake out!* patient s/p head trauma with orbital gas placed for detached retina

Axial non-contrast head CT’s at level of orbit

“Differential Diagnosis” of Orbital Trauma:
Open Globe Injuries via Anterior Chamber Changes

Yellow arrow: narrowed anterior chamber suggesting anterior ruptured globe (full corneal lac)

Blue arrow: widened anterior chamber suggesting posterior ruptured globe with corresponding posteriorly extruding contents
“Differential Diagnosis” of Orbital Trauma: Posterior Globe Injury

**Retinal injury/detachment:**
- collections of subretinal fluid leading to a "V" shaped configuration
  (blue arrow)

Axial non-contrast head CT at level of orbit

Text Ref: Kabul  
“Differential Diagnosis” of Orbital Trauma; Orbital Fractures Overview

* Fracture to one or more walls of the orbit, orbital rim, or both

* Signs of orbital fracture on routine head CT include #**
  - non-anatomic linear lucencies
  - cortical defect
  - bone fragments overlapping causing a "double-density"
  - opacification of adjacent paranasal sinuses
  - asymmetry of face
  - periorbital subcutaneous emphysema
  - entrapment of extraocular muscles
  - injury to canthal ligament and/or lacrimal duct system

Ref: #Lee, ^UpToDate.com, **Dolan
“Differential Diagnosis” of Orbital Trauma:

**Orbital zygomatic fracture**

* usually high-impact blow to lateral orbit - follows LeFort lines of resistance
* look for assoc. fracture of orbital floor (maxillary bone)

**Yellow arrow**: zygomatic fracture


“Differential Diagnosis” of Orbital Trauma:

**Nasoethmoid fracture**

* occurs as medial wall is formed by papyracea (thin) bondy septum
* look for assoc. disruption of medial canthal ligament, lacrimal duct system, and MR muscle (trapped in medial wall)
  - ex: Widened intracanthal distance → disruption of medial canthal ligament

Yellow arrow:
left medial wall fracture

Axial non-contrast head CT at level of orbit

**Text Ref:** UpToDate.com

“Differential Diagnosis” of Orbital Trauma:  
**Orbital floor fracture** or **“Blow-out” fracture**

* **most common** orbital facture*
* typically occur when small round object (i.e. ball) strikes eye
* floor formed by palatine and maxilla which is thin and with a central groove
  - in children look for linear pattern that snaps back (i.e. "trap-door" effect) from flexible bone
  - in adults look for shattered bone
* look for associated entrapment of IR muscle or orbital fat & expect intraorbital nerve Sx^
“Differential Diagnosis” of Orbital Trauma:

**Orbital floor fracture example**

Coronal non-contrast head CT at level of orbit

**Black Arrow**: inferior orbital wall (maxillary and/or palatine) fracture

**White Arrow**: entrapped orbital contents can be seen in the maxillary sinus

“Differential Diagnosis” of Orbital Trauma: Orbital Roof Fracture

* more common pts < 10 yo
* least common orbital fracture #
* BUT: high assoc with intracranial injury!

Yellow arrow: orbital roof (frontal bone) fracture

Coronal non-contrast head CT at level of orbit

“Differential Diagnosis” of Orbital Trauma: Intraorbital foreign bodies

- thin sliced has can pick up 96% of 1.5mm glass bodies
  but only 48% of 0.5mm glass
- Fake Out: buckle for scleral band can mimic foreign body

Axial non-contrast head CT at level of orbit

Yellow arrow: metal-density (scleral band) outside of bone mimicking penetrating injury in patient with head trauma

Application: Patient with ball to left eye

Now that you know about Orbital Trauma Imaging….
What are your findings?

Yellow Arrow: orbital floor fracture with entrapment of inferior rectus and fat

Blue Arrow: repair with rib reconstruction

Ref: Courtesy of Dr. Moonis, BIDMC & MEEI
Coronal non-contrast head CT at level of orbit
Application: Patient with blunt trauma to left eye

Now that you know about Orbital Trauma Imaging….
What are your findings?

Blue Arrow: comminuted orbital floor blow-out

Yellow Arrow: medial wall fracture with medial rectus entrapment

Ref: Courtesy of Dr. Moonis, BIDMC & MEEI
Coronal non-contrast head CT at level of orbit
Application: Patient with blunt trauma posterior skull

Now that you know about Orbital Trauma Imaging....
What are your findings?

Blue Arrow:
Comminuted posterior wall orbital blow in fracture

Axial non-contrast head CT at level of orbit

Ref: Courtesy of Dr. Moonis, BIDMC & MEEI
Application: Patients in motor vehicle accident

Now that you know about Orbital Trauma Imaging….
What are your findings?

Blue Arrow: Flat Tire Sign designating ruptured globe

Axial non-contrast head CT’s at level of orbit

Ref: Courtesy of Dr. Moonis, BIDMC & MEEI
Application: Patient with blunt trauma to right eye

Now that you know about Orbital Trauma Imaging…. What are your findings?

Blue Arrow: Posterior lens dislocation

Axial non-contrast head CT at level of orbit

Ref: Courtesy of Dr. Moonis, BIDMC & MEEI
Summary:
Orbital Trauma Imaging

* Epidemiology of Orbital Trauma -- young adults in MVA or children in sports

* Orbit Anatomy -- bony orbit and soft tissue apparatus of eye

* Imaging Indications in Orbital Trauma -- any trauma or severe pain

* Menu of tests for Orbital Trauma -- CT is emergent modality of choice

* "Cookbook Approach" to CT evaluation -- from superficial skin deep to back of orbit

* "Differential Diagnosis" with interpretation -- must not miss: open-globe
References:


* "Orbital Fractures" www.UpToDate.com, October 1, 2008 (abbreviated in presentation as “UTD”)

* Dolan, K. "Facial and Mandibular Fractures" UW Department of Radiology. http://www.rad.washington.edu/academics/. This website and all its content are © 2007-2008

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