Radiologic imaging of globe injuries

Emily Gross, Harvard Medical School Year III
Gillian Lieberman, MD
Why care about globe injuries?

- 55 million eye injuries/year restricting activities for >1 day
- 200,000 open-globe injuries
- 1.6 million people worldwide blind from ocular injury
- 19 million with unilateral blindness or low vision from ocular injury

Agenda

• Review anatomy of the globe
• Discuss menu of tests for globe injuries
• Types of globe injuries by anatomical location
  – Anterior Chamber
  – Lens
  – Posterior Segment
  – Open Globe
  – Intraocular Foreign Body
• Review two patient cases of globe injury
Anatomy of Globe

Anatomy of Globe

Anatomy of Globe

Cornea

Iris

Ciliary body

Choroid

Retina

Sclera

Anatomy of Globe

Anatomy of Globe

Anatomy of Globe

Agenda

• Review anatomy of the globe
• Discuss menu of tests for globe injuries
• Types of globe injuries by anatomical location
  – Anterior Chamber
  – Lens
  – Posterior Segment
  – Open Globe
  – Intraocular Foreign Body
• Review two patient cases of globe injury
Menu of Tests for Globe Injuries

- CT
- MRI
- Ultrasound
- Plain film
Menu of Tests: CT

- **Images**: Non-contrast, thin axial cuts with reconstructions

- **Strengths**
  - Fast, easily accessible
  - Good resolution of bones (fractures) and soft tissues

- **Weaknesses**
  - Ionizing radiation -> cataract formation

- **Contraindications**:
  - None

- **Use**:
  - Most cases of ocular trauma

Menu of Tests: CT example


Menu of Tests: MRI

- **Images:** Axial, coronal, sagittal views
- **Strengths:**
  - Superior depiction of soft tissues
  - No ionizing radiation
- **Weaknesses:**
  - Slow, not good for emergencies
  - Limited availability
- **Contraindications:**
  - Suspected metallic intra-orbital foreign body
- **Use:**
  - Subtle findings not detected on CT

Menu of Tests: MRI example


Menu of Tests: Ultrasound (B-scan)

- **Images:** Through-lid imaging, axial view
- **Strengths:**
  - Fast, real-time, dynamic imaging
  - Readily accessible
  - No ionizing radiation
- **Weaknesses:**
  - Operator dependent
  - Less sensitive than CT for foreign body detection
- **Contraindications:**
  - Suspected globe rupture
- **Use:**
  - Suspected retinal detachment, lens dislocation

Menu of Tests: Ultrasound (B-scan) example

Menu of Tests: Plain Film

• **Uses:**
  – Orbital fractures
  – Radio-opaque foreign bodies

• Rarely used, as CT is more sensitive for fractures, foreign bodies, and soft tissue changes

---

# ACR Appropriateness Criteria: Head injury with visual loss

<table>
<thead>
<tr>
<th>Radiologic Procedure</th>
<th>Rating</th>
<th>Comments</th>
<th>RRL*</th>
</tr>
</thead>
<tbody>
<tr>
<td>CT head without contrast</td>
<td>7</td>
<td>Thin slices dedicated to the orbits are useful for orbit disease and may be substituted for the complete head examination in selected patients.</td>
<td>⭐⭐⭐</td>
</tr>
<tr>
<td>MRI head and orbits without contrast</td>
<td>7</td>
<td>If MRI is safe.</td>
<td>O</td>
</tr>
<tr>
<td>MRI head and orbits without and with contrast</td>
<td>5</td>
<td>If MRI is safe. See statement regarding contrast in text under “Anticipated Exceptions.”</td>
<td>O</td>
</tr>
<tr>
<td>CT head with contrast</td>
<td>5</td>
<td>Thin slices dedicated to the orbits are useful for orbit disease and may be substituted for the complete head examination in selected patients.</td>
<td>⭐⭐⭐</td>
</tr>
<tr>
<td>CT head without and with contrast</td>
<td>5</td>
<td>Thin slices dedicated to the orbits are useful for orbit disease and may be substituted for the complete head examination in selected patients.</td>
<td>⭐⭐⭐</td>
</tr>
<tr>
<td>CTA head and neck with contrast</td>
<td>4</td>
<td>If vascular disease is suspected.</td>
<td>⭐⭐⭐</td>
</tr>
<tr>
<td>MRA head and neck without contrast</td>
<td>3</td>
<td></td>
<td>O</td>
</tr>
<tr>
<td>MRA head and neck without and with contrast</td>
<td>3</td>
<td></td>
<td>O</td>
</tr>
<tr>
<td>X-ray orbit</td>
<td>2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Rating Scale:** 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate

*Relative Radiation Level*
## ACR Appropriateness Criteria: Head injury with visual loss

<table>
<thead>
<tr>
<th>Radiologic Procedure</th>
<th>Rating</th>
<th>Comments</th>
<th>RRL*</th>
</tr>
</thead>
<tbody>
<tr>
<td>CT head without contrast</td>
<td>7</td>
<td>Thin slices dedicated to the orbits are useful for orbit disease and may be substituted for the complete head examination in selected patients.</td>
<td>☢️ ☢️ ☢️</td>
</tr>
<tr>
<td>MRI head and orbits without contrast</td>
<td>7</td>
<td>If MRI is safe.</td>
<td>O</td>
</tr>
<tr>
<td>MRI head and orbits without and with contrast</td>
<td>5</td>
<td>If MRI is safe. See statement regarding contrast in text under “Anticipated Exceptions.”</td>
<td>O</td>
</tr>
<tr>
<td>CT head with contrast</td>
<td>5</td>
<td>Thin slices dedicated to the orbits are useful for orbit disease and may be substituted for the complete head examination in selected patients.</td>
<td>☢️ ☢️ ☢️</td>
</tr>
<tr>
<td>CT head without and with contrast</td>
<td>5</td>
<td>Thin slices dedicated to the orbits are useful for orbit disease and may be substituted for the complete head examination in selected patients.</td>
<td>☢️ ☢️ ☢️</td>
</tr>
<tr>
<td>CTA head and neck with contrast</td>
<td>4</td>
<td>If vascular disease is suspected.</td>
<td>☢️ ☢️ ☢️</td>
</tr>
<tr>
<td>MRA head and neck without contrast</td>
<td>3</td>
<td></td>
<td>O</td>
</tr>
<tr>
<td>MRA head and neck without and with contrast</td>
<td>3</td>
<td></td>
<td>O</td>
</tr>
<tr>
<td>X-ray orbit</td>
<td>2</td>
<td></td>
<td>☢️</td>
</tr>
</tbody>
</table>

**Rating Scale:** 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate

*Relative Radiation Level*
Agenda

• Review anatomy of the globe
• Discuss menu of tests for globe injuries
• Types of globe injuries by anatomical location
  – Anterior Chamber
  – Lens
  – Posterior Segment
  – Open Globe
  – Intraocular Foreign Body
• Review two patient cases of globe injury
Anterior Chamber: Hyphema

- Collection of blood in anterior chamber
- Blood-fluid level

- Hyperattenuation in anterior chamber

Anterior Chamber: Corneal Laceration

- Often due to penetrating trauma
- May have iris prolapse, globe rupture

CT orbit C-

Decreased volume of left anterior chamber volume compared to right due to leakage of anterior chamber contents.


Lens Dislocation: mechanism

Lens Dislocation: mechanism

Blunt Trauma → **FORCE** → Lens

Lens Dislocation: mechanism

Partial dislocation: partial zonular dehiscence

Lens Dislocation: mechanism

Blunt Trauma

FORCE

Complete dislocation: complete zonular dehiscence

Lens Dislocation

Partial

CT orbit C-

Complete

CT orbit C-


Posterior segment: retinal detachment

**Complete tear:** “V” with retinal tethering at optic disc
Posterior segment: retinal detachment

Complete tear: “V” with retinal tethering at optic disc

Hemorrhage: high attenuation/ high signal/ hyperechoic

Vitreous: low attenuation/ hypoechoic

Open-globe injury

- Any full thickness injury to cornea, sclera, or both
  - AKA “globe rupture”
- Radiologic findings:
  - Abnormal globe volume and contour
  - Change in size of anterior chamber
  - Scleral discontinuity
  - “Flat tire” or “umbrella” signs
  - Intraocular air
  - Intraocular foreign body

Open-globe injury

- Abnormal globe contour (flattening)
- Scleral discontinuity
Open-globe injury

Increased anterior chamber size

“Flat tire” sign
Intraocular foreign body

- Puts patient at risk for damage to intraocular structures, infection, and retinal toxicity (Fe, Cu)

- **Plastic**, metal, glass-detected best on CT

- Look for intraocular air

- Assess for associated globe rupture

Intraocular foreign body

- Wood may show up on CT hypoattenuated geometric shape
- Depending on pattern, may be confused for air
- MRI can better characterize wood, show reactive inflammation
Agenda

• Review anatomy of the globe
• Discuss menu of tests for globe injuries
• Types of globe injuries by anatomical location
  – Anterior Chamber
  – Lens
  – Posterior Segment
  – Open Globe
  – Intraocular Foreign Body
• Review two patient cases of globe injury
Patient 1: Clinical Presentation

- **HPI:** 94M presenting after a fall in the bathroom during which he struck his right face, now with swelling around the right orbit and no light perception.

- **PMH:**
  - Parkinson’s
  - CAD s/p multiple MIs and CABG (1981)
  - Glaucoma
  - Cataracts

- **Relevant meds:**
  - Aspirin 81mg
  - Tamsulosin 0.4 mg

- **Workup:**
  - CT Head, C- : negative
  - CT C-spine, C- : negative
  - CT Orbits, C- : See next slide
Patient 1: Imaging

- **Anterior chamber**
- **Lens**
  - Calcified
  - Left lens: pseudophakic (haptic can sometimes be appreciated)
- **Posterior segment**
  - Hyperattenuation-> hemorrhage
  - Sc/Ch/Re cannot be evaluated because isodense with blood
- **Open-globe**
  - Abnormal shape/size, scleral discontinuity
- **Intraocular foreign body**
  - Radio-opaque object in anterior segment?

*Posterior globe tenting*: mass effect, proptosis with optic nerve tethering

Image courtesy of: Dr. Rafeal Rojas, BIDMC PACS
Patient 1: Management

• **Diagnosis:**
  – Right globe proptosis
  – Intraocular and retrobulbar hemorrhage
  – Globe rupture
  – Foreign body vs. calcified, deformed lens

• **Management:**
  – Primary enucleation
Patient 2: Clinical presentation

- **HPI:** 43F with shrapnel to her right eye in the setting of explosion, with subsequent loss of vision in her right eye.
- **PMH:** None
- **Relevant meds:** None
- **Workup:**
  - CT Head C- : negative
  - CT Orbit C- : see next slide
  - B-scan ultrasound : see patient follow-up
Patient 2: Imaging

- Anterior chamber
- Lens
  - Thickened, no dislocation
- Posterior segment
  - Hyperattenuation->hemorrhage
  - Sc/Ch/Re cannot be evaluated because isodense with blood
- Open-globe
  - Abnormal size and contour, intraocular air, “flat tire” sign, scleral discontinuity
- Intraocular foreign body
  - Radio-opaque with streak artifact
Patient 2: Management

- **Diagnosis:**
  - Globe rupture
  - Intraocular foreign body
  - Intraocular air
  - Vitreous hemorrhage

- **Management:**
  - 4/15 PM: Surgery #1 - Open globe repair
  - 4/16 AM: Final CT read, B-Scan show round intraocular foreign body
  - 4/16 AM/PM: Surgery #2 - Vitrectomy, lensectomy, extraction of metal and glass foreign bodies, perfluorocarbon and silicone oil tamponade of anterior and posterior segments
Summary

• **Review anatomy of the globe**
  – Anterior and posterior segments: separated by lens
  – Anterior segment divided into anterior and posterior chambers: separated by iris

• **Discuss menu of tests**
  – ** CT orbit C-**
  – MRI orbit
  – Ultrasound (B-scan)

• **Types of globe injuries**
  – Anterior Chamber
    • Hyphema
    • Corneal laceration
  – Lens
    • Complete or partial dislocation
  – Posterior Segment

• “V” sign of complete retinal detachment
  – Open Globe
    • Abnormal globe volume, contour
    • Change anterior chamber size
    • Scleral discontinuity
    • “Flat tire” or “umbrella” signs
    • Intraocular air
    • Intraocular foreign body

• **Intraocular Foreign Body**
  – Metal: CT, streak artifact
  – Glass: CT
  – Wood: may require MRI

• **Review two cases of globe injury**
References


Acknowledgements

• Dr. Gillian Lieberman
• Dr. Rafael Rojas