No Disclosures
**Objectives**

Discuss indications for conducting an ocular ultrasound

Discuss relevant anatomy

Review technique for the proper acquisition of ocular ultrasound images

Examine normal and pathological ultrasound images
Ocular US

Why?

Eye complaints make up around 3% of ED Visits ¹

Retrospective review found that non-ophthalmologists diagnosed only 72% eye injuries - frequently underestimated potential eye issues ²

Ultrasound can help evaluate for ocular injuries, which in one study have been found to occur in 12% of patients presenting with facial trauma ³

Physical exam is often difficult and unreliable

<table>
<thead>
<tr>
<th>Structural</th>
<th>Facial Trauma</th>
<th>Severe Edema</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual Axis Obstruction</td>
<td>Corneal Scar</td>
<td>Hyphema</td>
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<tr>
<td></td>
<td></td>
<td>Hypopyon</td>
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<tr>
<td></td>
<td></td>
<td>Vitreous Hemorrhage</td>
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</tbody>
</table>

Specialized equipment and ophthalmologic specialists are often unavailable

Miosis makes examining the retina difficult

Ultrasound is accurate for the evaluation of many ocular and orbital emergencies

Can help differentiate which patients need immediate consultation and which can have outpatient follow up

Indications

- Eye / Head Trauma
- Change in Vision
- Headache
- Altered Mental Status
- Pain in Eye

Ocular US
Scan Technique

High Frequency Linear Transducer

Patient should be at a 45 degree angle with head back or supine

Can place sterile gel on closed eyelid or use film barrier

Rest hand on ridge of nose to stabilize

Make good contact but do not apply pressure
Ocular US

Human Eye Anatomy

- Cornea
- Iris
- Anterior Chamber
- Lens
- Vitreous
- Optic Nerve Sheath
- Retina
Scan Through
Pupillary Response & Eye Movements

Exam may be limited by pain or swelling

Pupillary Response

Eye Movements
### What to evaluate for:

<table>
<thead>
<tr>
<th>Condition</th>
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<tbody>
<tr>
<td>Retinal Detachment</td>
</tr>
<tr>
<td>Vitreous Hemorrhage / Detachment</td>
</tr>
<tr>
<td>Foreign Body</td>
</tr>
<tr>
<td>Lens Dislocation</td>
</tr>
<tr>
<td>Globe Rupture</td>
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<tr>
<td>Central Retinal Artery &amp; Vein</td>
</tr>
<tr>
<td>Retrobulbar Hematoma</td>
</tr>
<tr>
<td>Intracranial Pressure</td>
</tr>
</tbody>
</table>
Bedside by ED Docs:
Sensitivity: 97%
Specificity: 92% 1-2

Separation caused by fluid into the sensory layer of the retina 3

Highly reflective membrane floating within vitreous

Mobile with eye movements (initially) 4
Retina remains fixed to choroid

Is macula still attached?
Retinal Detachment
Vitreous Hemorrhage

Hyperechoic area within the vitreous

Initially dots/spot $\rightarrow$ Membranes (with time)

Vitreous Detachment

Vitreous & Retinal Detachment:
Foreign Body

Thin slice CT is the best test for intraocular foreign body detection

Ultrasound can allow for more precise location of the foreign body itself

Porcine model showed that negative predictive value of ultrasound at 85.2%

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Lens Dislocation

Can be partial (subluxation) or complete

Generally caused by trauma (could be from Marfan’s Syndrome)

Hyperechoic lens floating in vitreous

A series found lens dislocation occurred in 12 out of 71 consecutive patients presenting with ocular trauma.

Globe Rupture

IF OBVIOUS: DO NOT PERFORM ULTRASOUND

Seek immediate ophthalmologic consultation

Usually from Trauma: blunt force or laceration from foreign body
Small, high speed foreign body may show no external signs ¹

Findings include:
Anterior chamber collapse
Buckling of the sclera
Decreased size of the globe ²-³
Central Artery & Vein Occlusion

May present as unilateral, visual loss

May or not be complete

Comparison to the other side may be helpful with relative inexperience \(^1,^2\)
Retrobulbar Hematoma

Important to recognize as immediate intervention necessary
Ischemia of 60 minutes can cause permanent damage

Hypoechoic structure causing pressure on the posterior globe

As pressure increases, doppler of blood vessels may be helpful
Intracranial Pressure (Optic Nerve Sheath)

Evaluation of the optic nerve for those with presumed increased intracranial pressure

Physical exam can be limited in those: altered, unconscious, intubated or paralyzed

(Papilledema may be difficult to appreciate)

ICP transmitted through CSF onto space of the optic nerve

Measure the optic nerve sheath in retrobulbar space - 3mm posterior to globe

Upper Limits of Normal:

<table>
<thead>
<tr>
<th>Adults</th>
<th>5mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Children (1-15)</td>
<td>4.5mm</td>
</tr>
<tr>
<td>Infants (&lt;1)</td>
<td>4mm</td>
</tr>
</tbody>
</table>

Amount of dilation is not proportional to the change in ICP

Intracranial Pressure (Optic Nerve Sheath)

Intracranial Pressure (Optic Nerve Sheath)

“Optic nerve ultrasound for the detection of raised intracranial pressure”

Neurocritical Care

Prospective, blinded, observational
536 ONSD done on 65 patients by Neurointensivists
Patients with EVD or Intraparenchymal ICP monitors
Optimal ONSD to detect ICP > 20 was ~4.8mm
Sensitivity 96%, Specificity 94%

“Emergency department sonographic measurement of optic nerve sheath diameter to detect findings of increased intracranial pressure in adult head injury patients”

Annals of Emergency Medicine

Prospective, blinded, observational
59 patients, adults
GCS 15. 8 patients had CT findings which correlated with increased ICP
Sensitivity of US to detect:100% , 63% specific
Intracranial Pressure (Optic Nerve Sheath)

“Use of the sonographic diameter of optic nerve sheath to estimate intracranial pressure”

*American Journal Emergency Medicine*

Prospective study
50 non traumatized patients
Patients with EVD or Intraparenchymal ICP monitors
US done -> LP
ONSD > 5.5mm Sensitivity / Specificity of 100%

“Optic nerve sheath diameter and lumbar puncture opening pressure in nontrauma patients suspected of elevated intracranial pressure”

*American Journal Emergency Medicine*

Prospective, observational
51 patients
US Done -> CT -> LP
ONSD > 5mm Sensitivity 75% / Specificity of 44%
Final Thoughts

Scan contralateral anatomy for comparison*

Use a lot of gel and avoid pressure on the eye

Use ultrasound in conjunction with clinical scenario
THANK YOU

chris.bryczkowski@rutgers.edu