Ocular US
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Objectives

• Learn to image a number of trauma-related ocular lesions that can impair vision.

• Learn to identify two related ocular diseases that can cause acute vision loss.
Technique

- Fill the orbit with gel
- “Float” the high frequency linear array transducer on the gel, not on the eye
- Stabilize hand on nasal bridge, orbit, or zygomatic arch
- Probe marker toward top of head or patient’s right side
- Patient may move eye to aid examination
Ocular US Technique

- adjust depth so that the image of the eye fills the screen
- adjust the focus as required
- turn up the gain to achieve acceptable imaging (to assess the vitreous chamber the eye should be examined at both 'moderate' and 'high' gain settings).
anatomy

- **cornea** — thin hyperechoic layer parallel to the eyelid.

- **anterior chamber** — filled with anechoic fluid and is bordered by the cornea, iris and anterior reflection of the lens capsule.

- **iris and ciliary body** — echogenic linear structures extending from the peripheral globe towards lens. Pupillary response can be assessed by shining a light in the fellow eye.

- **lens** — anechoic.
anatomy

- *vitreous chamber* — filled with anechoic fluid in the young healthy eye.

- *retina* — cannot be differentiated from the other choroidal layers.

- *retrobulbar area* includes optic nerve, extraocular muscles and bony orbit

- *optic nerve* is visible posteriorly as a hypoechoic linear region radiating away from globe

- *central retinal artery* — can be assessed with Doppler
Case 1 “Minding My Own Business”

- Lid laceration
- Corneal abrasion
- Anterior hyphema
- Blowout fracture
- Retrobulbar hematoma
- Lens subluxation/dislocation
- Globe perforation
- Vitreous hemorrhage
- Retinal detachment
- Intraocular foreign body
Traumatic Hyphema
Globe Rupture

- decrease in the size of the globe
- anterior chamber collapse
- buckling of the sclera
- vitreous hemorrhage
Anterior Chamber Collapse with Normal
Vitreous hemorrhage

- Fresh mild hemorrhages: small dots or linear areas of areas of low reflective mobile vitreous opacities
- More severe and older hemorrhages: blood organizes and forms membranes.
Vitreous hemorrhage

- Vitreous hemorrhages may also layer inferiorly due to gravitational forces.
Vitreous hemorrhage

The ocular ultrasound demonstrates the ‘washing machine’ sign. Blood (granular echogenicities) swirl with eye movement and settle when the eye is still.
Dislocated Lens

- the lens is displaced from its normal position, either anteriorly or posteriorly.

- this may be a result of trauma or occur in conditions like Marfan’s syndrome.

- other evidence of trauma, such as vitreous hemorrhage, globe rupture or retinal detachment may also be present.
Retrobulbar hematoma
Retinal detachment

- A thick hyperechoic undulating membrane in the posterior/lateral globe
- In total retinal detachments the folded surface attaches to the ora-serrata anteriorly and the optic nerve posteriorly.
Periorbital emphysema
Intraocular Foreign Body

- Seidel’s test is used to detect aqueous humor leaking from a corneal wound.
- Fluorescein dye is applied to the region of the suspected laceration. The test is positive when a stream of fluorescent dye emanating from the site is visualised on slit-lamp examination.
- A negative test does not rule out a full thickness corneal laceration
Intraocular Foreign Body

- bright echogenic acoustic profile of the foreign body
- shadowing or reverberation artifacts may be seen
- decrease in diameter of globe or depth of the anterior chamber
Raised intracranial pressure

- Optic nerve sheath diameter (ONSD) correlates closely with ICP and can be measured using ocular ultrasound.

- The normal optic nerve sheath is up to 5 mm in diameter. ONSD is higher in the presence of a raised ICP (>20 mmHg).
Measuring the optic nerve

- take the measurement 3 mm posterior to the globe for both eyes (ultrasound contrast is high at this point and measurements are more reproducible)
- average two measurements
- suspect raised ICP if the average ONSD is >5 mm
The Evidence

- ONSD > 5 mm predicts IOP > 20 mmHg with a sensitivity of 100% (95% confidence interval [CI] 68% to 100%) and specificity was 63% (95% CI 50% to 76%). Tayal et al. Ann Emerg Med. 2007 Apr; 49(4):508-14

- ONSD > 5 mm detects ICP > 20 cm H2O with a sensitivity of 88% (95% CI = 47% to 99%) and specificity of 93% (95% CI = 78% to 99%). Kimberley et al. Acad Emerg Med. 2008 Feb;15(2):201-4

- ONSD threshold of 5.2 mm as a predictor of ICP >20 mm Hg had sensitivity and specificity of 94% and 76%, respectively. Moretti et al. J Neurosurg Anesthesiol. 2009 Jan; 21(1):16-20

- Optimal ONSD for detection of ICP > 20 mmHg was ≥0.48 cm with sensitivity 96% (95% CI 91-99%); specificity 94% (92-96%). Rajajee et al. Critical Care 2012, 16:R79
A 50 year-old man presents with loss of vision.

He describes a curtain coming down across his vision. It was preceded by ‘flashes and floaters’.
Retinal detachment

The detached retina is visible as a free floating echogenic membrane separated from the globe posteriorly.

It moves with eye movement and is attached at the optic disc.
Evidence

- 61 subjects with ocular complaints or trauma at a suburban academic ED. The prevalence of retinal detachment was 15%. The sensitivity and specificity were 1.00 (95% CI, 0.66 to 1.00) and 1.00 (95% CI, 0.93 to 1.00), respectively. Blaivas M., Theodoro D., and Sierzenski P.R.: A study of bedside ocular ultrasonography in the emergency department. Acad Emerg Med 2002; 9: pp. 791-799

- 92 subjects in a large urban academic ED, with complaints concerning for retinal detachment. The prevalence of retinal detachment was 32%. Sensitivity and specificity were 0.97 (95% CI, 0.82 to 1.00) and 0.92 (95% CI, 0.82 to 0.97), respectively. Shinar Z., Chan L., and Orlinsky M.: Use of ocular ultrasound for the evaluation of retinal detachment. J Emerg Med 2011; 40: pp. 53-57
• 48 subjects at an urban academic ED who presented with acute (<48 hours’ duration) vision change. The prevalence of retinal detachment was 38%. Sensitivity and specificity were 1.00 (95% CI, 0.81 to 1.00) and 0.83 (95% CI, 0.65 to 0.94), respectively.

Case 2

- A 65 year-old comes into the ED saying that he thinks ‘the jelly’ in his eye has ‘peeled off again’.

- He says he been seeing flashes of light as well as blobs and cobwebs floating in front of his right eye. He experienced the same thing about a year ago in his other eye.

- His visual acuity is similar in both eyes.

DDx

- posterior vitreous detachment
- vitreous haemorrhage
- retinal break
- retinal detachment
- retinal hemorrhage
Posterior Vitreous Detachment

- Ultrasound shows fine linear and granular echogenicities in the posterior segment of the eye, which swirl around as the eye moves.
- There is no tethering to the optic disc. This is consistent with vitreous debris seen in posterior vitreous detachment.
A symptomatic PVD carries a 10% risk of retinal tear with half of these tears leading to retinal detachment.