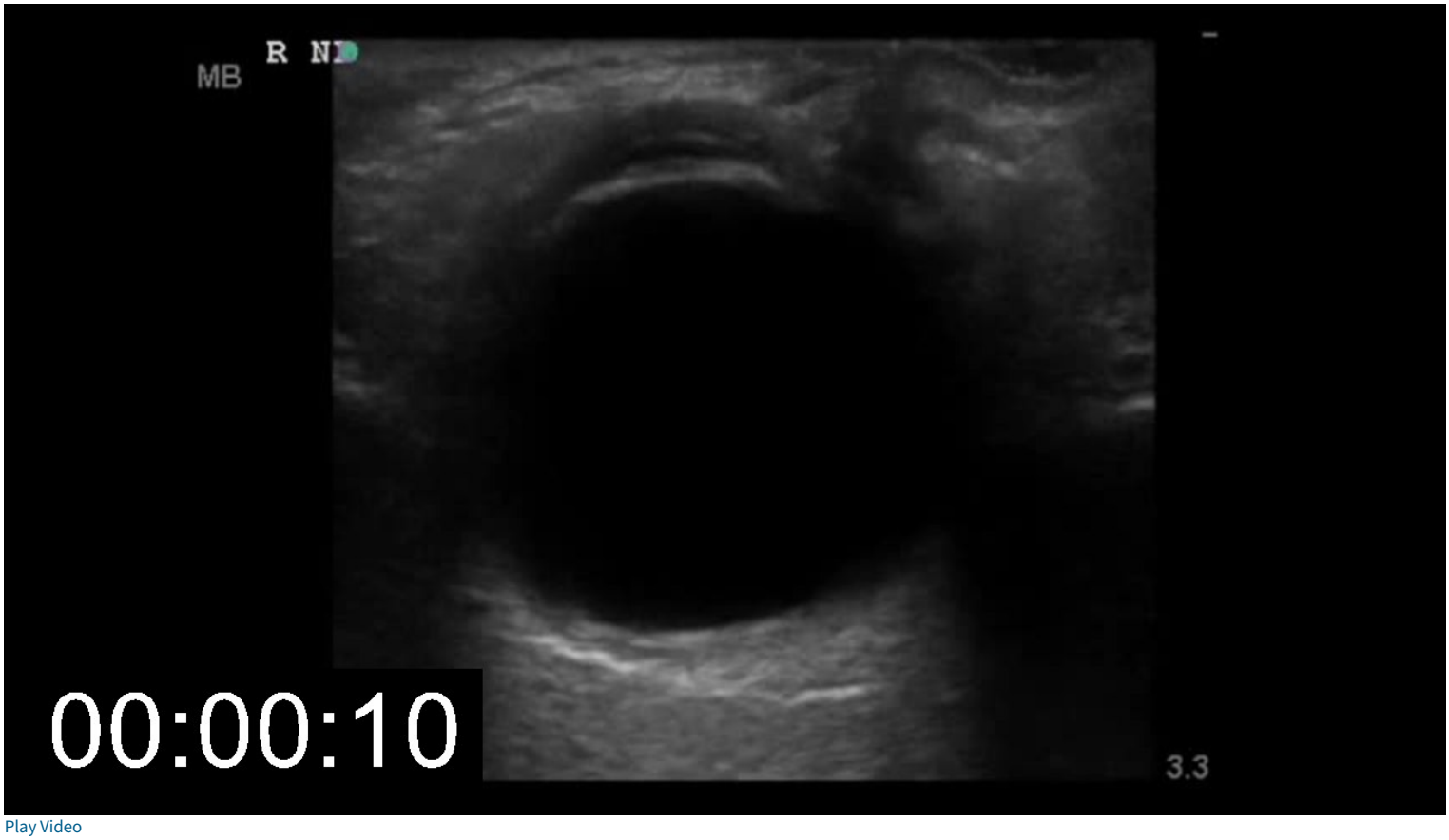
Chapter 14: Ocular Ultrasound

KEY IMAGES

Ocular anatomy

Video 14-01: Ocular anatomy

The ocular anatomy can be identified in this video. Notice the soft tissue at the top of screen shows no sign of compression, and there is even a small pocket of uncompressed gel at the top right side of the screen. This is important to not put pressure on the eye. The lens can be seen anteriorly, followed by the anechoic vitrea. At the bottom of the screen, the retina is bright due to posterior acoustic enhancement, but the dark shadow of the optic nerve sheath can be seen as the operator fans through the eye.



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Hand positioning

Ask patient to look straight ahead; stabilize hand on patient's nose, malar bone, or forehead (if scanning from head of bed) to avoid pressure on globe.

Figure 14-1

Ergonomics

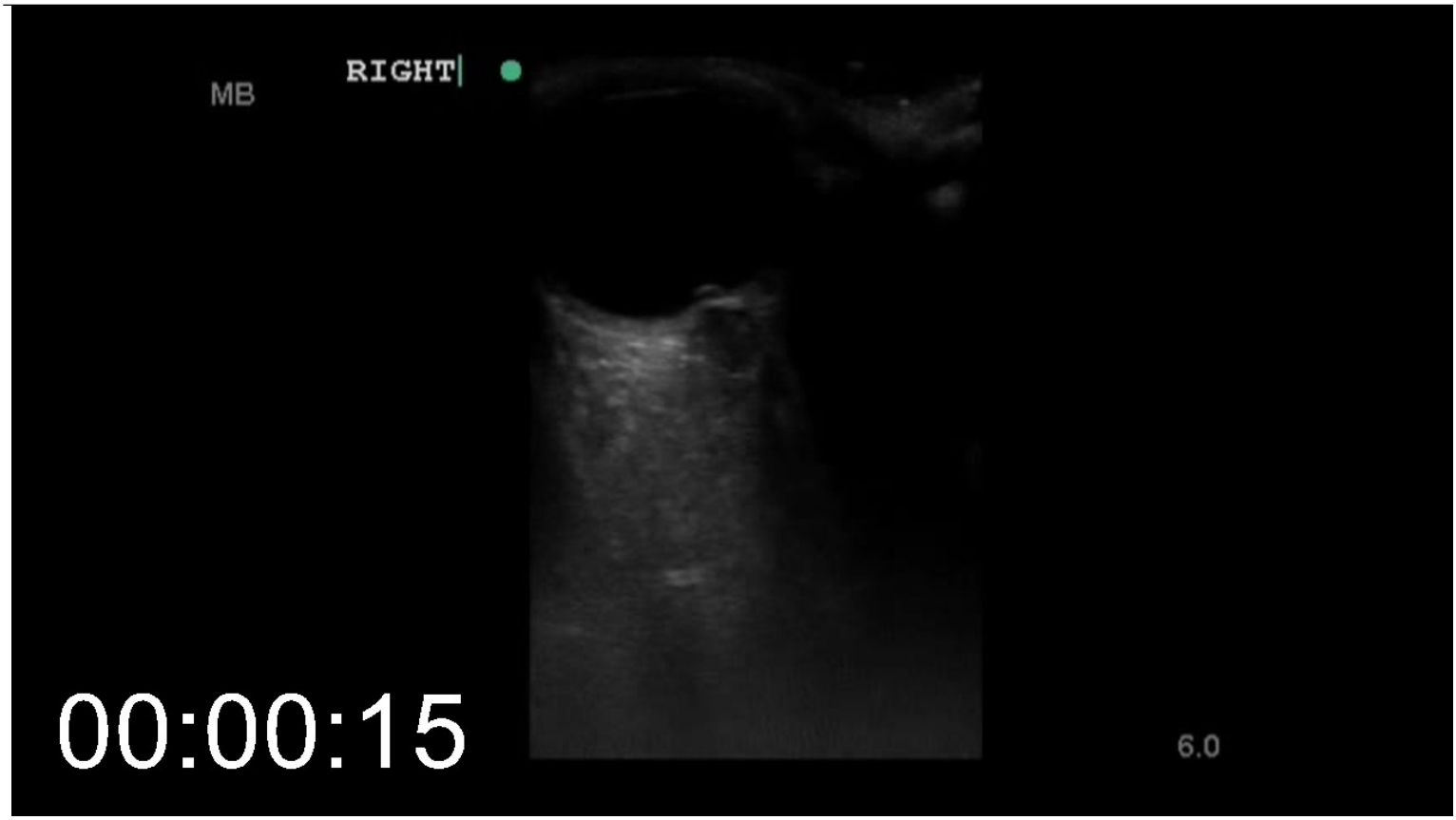
Figure 14-2

Measurement of optic-nerve sheath diameter (ONSD)

Measure the ONSD 3 mm posterior to the globe; normal diameter, <5.0 mm.

Video 14-02: Increased optic nerve sheath diameter (ONSD)

In this video, good low pressure technique is again demonstrated. The optic nerve sheath is larger, however, than in the previous video. Using the freeze frame and caliper functions on the machine are essential to make the precise measurements of the optic nerve sheath diameter.



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ACQUISITION TIPS

- Indications for exam: ocular trauma, sudden vision changes, concern for increased intracranial pressure or foreign-body.
- Probe selection: high-frequency linear probe.
- Use the ocular setting if available. In addition to image optimization, this preset reduces power to 50% to minimize the risk of retinal damage.
- When prepping the patient for the exam, a clear plastic adhesive dressing may be used. Gel placed on the outside of the dressing decreases the likelihood of gel entering the eye. We do not recommend this technique because air bubbles may be trapped under the dressing, there is a greater likelihood of applying pressure to the globe, and there may be eyelid or eyelash trauma with removal of the adhesive dressing.
- Apply gel generously so that images are obtained without actual contact with the skin. The footprint of the probe and curved surface of the globe can make maintaining contact without applying excessive pressure challenging.
- Stabilize hand on a boney structure: nose, forehead, or malar bone of cheek.
- Image in both transverse and sagittal planes.
- Ask patient to look right and left as well as up and down if concerned for hemorrhage or foreign body.
- The optic nerve is a dark, well-demarcated tubular structure that arises from the posterior chamber. The sheath outside the optic nerve may or may not be clearly discernable.
- Measure ONSD 3 mm posterior to the globe, normal <5.0 mm diameter (think 3-by-5 index card)
- When evaluating for papilledema, make sure that the focus is set to the posterior globe. Turn down the gain if posterior acoustic enhancement is too bright.
- Avoid putting any pressure on the eye with the ultrasound, especially if there is concern for globe rupture.

INTERPRETATION AND PITFALLS

Normal Eye

- Round, smooth-walled, hypoechoic structure with the lens located symmetrically behind the iris, anechoic vitreous within the globe, and hypoechoic optic nerve located posterior to the

globe.

Optic Nerve

- The ONSD is measured 3 mm posterior to the globe.
- Increased ONSD is suggestive of increased intracranial pressure, as the nerve sheath is in continuity with the subarachnoid space of the brain.
- ONSD >5.0 mm are increasingly specific for increased intracranial pressure, but diameters of 5–7 mm can be normal, especially in younger patients.
- Calcifications within the optic-nerve shadow can indicate central retinal artery occlusion.

Papilledema

- Just anterior to the optic nerve, papilledema can be visualized as an echogenic membranous structure separated from the globe. Mild elevation can be seen in normal cases, but any separation from the underlying globe is noteworthy.
- Optic nerve drusen are intensely echogenic, not membranous, and usually display reverberation artifact and/or shadowing.

Detachments and Hemorrhage

- Note: the following descriptions serve as guidelines, but if there is any concern for retinal detachment, urgent consultation with an ophthalmologist may be prudent.
- Retinal detachment (RD) appears as a hyperechoic, irregular membranous structure that is tethered to the optic nerve.
  - Mac on/off: Determination of whether the detached retina remains attached at the macula (“mac on”) versus not (“mac off”).
  - The macula is about 4 mm lateral and slightly superior to the optic-nerve sheath.
  - A “mac **ON**” detachment requires emergent, rather than urgent, ophthalmology consultation in the hope that it can be arrested before it involves the macula.
- Vitreal detachment also appears as a hyperechoic membranous structure within the globe, but it extends across the optic nerve without any attachment.
- Vitreal hemorrhage appears as echogenic material in the globe that is non-membranous. Eye movement may reveal a swirling motion. Vitreal hemorrhage may be associated with vitreal detachment and shares expectant management, so distinguishing them may not be critical. Both must be distinguished from retinal detachment, which has urgent or emergent management.

Foreign Body

- Hyperechoic area within the eye that may display shadowing or reverberation (“ring-down” artifact).

Lens Dislocation

- The ovoid, hyperechoic lens may be found displaced from its usual location in the anterior globe posterior to the iris.

Globe Rupture

- No pressure should be applied to the eye if there is any possibility of globe rupture.
- Rupture is suggested when an abnormally shaped, irregular globe is identified. There may be internal hemorrhage.

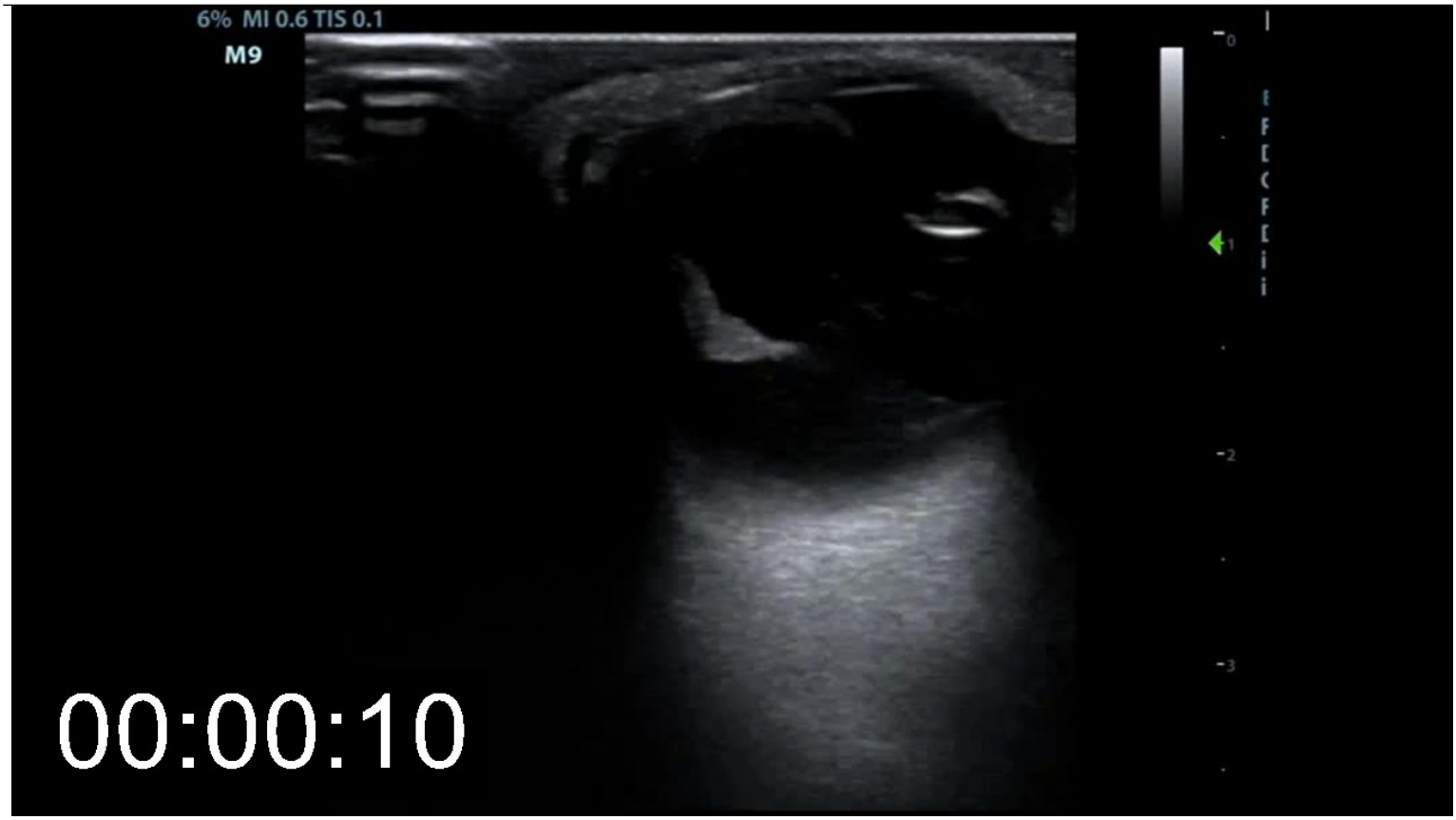
Retro-orbital Hemorrhage

- This diagnosis cannot reliably be made by ultrasound, since hemorrhage appears indistinguishable from retro-orbital fat.

EXAMPLES OF PATHOLOGY

Video 14-03: Vitreous hemorrhage

The usually anechoic vitrea can be seen to have a layering echoic component deep to it in this video. That layering is blood following a trauma in this patient.



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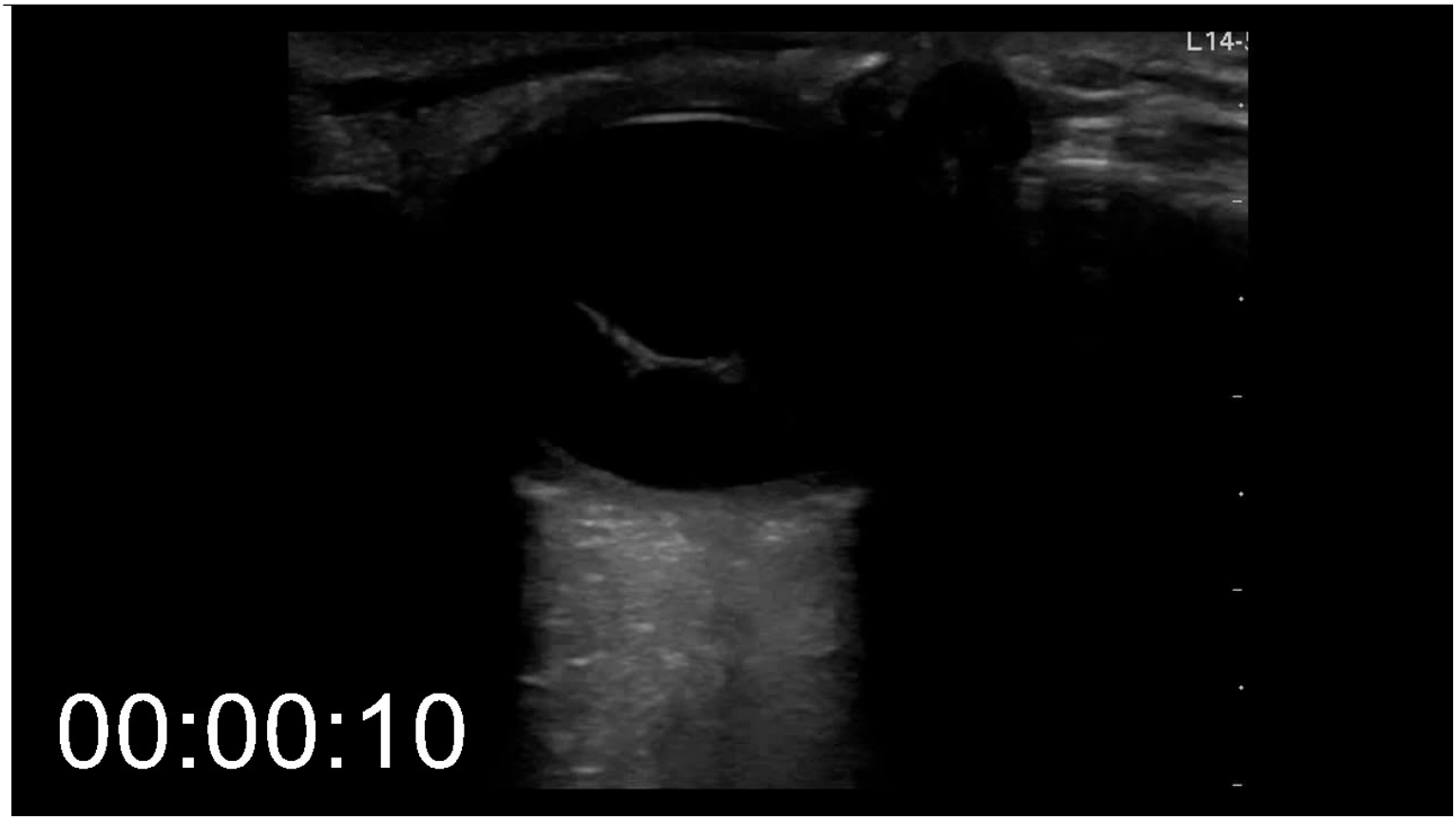
Video 14-04: Retinal detachment with macula on

This video demonstrates a linear structure in the eye. Instead of floating freely, however, it can be seen to be anchored just on either side of the optic nerve. This is referred to as macula on, and requires emergency evaluation by an ophthalmologist for potential salvage of remaining vision. As a contrast, if the macula is freely floating, salvage is not possible.



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Video 14-05: Central retinal artery occlusion

This patient presented with painful loss of vision in the left eye. Ultrasound demonstrates a hyperechoic finding that does not densely shadow in the optic nerve sheath. This is an embolus that had lodged in the central retinal artery.

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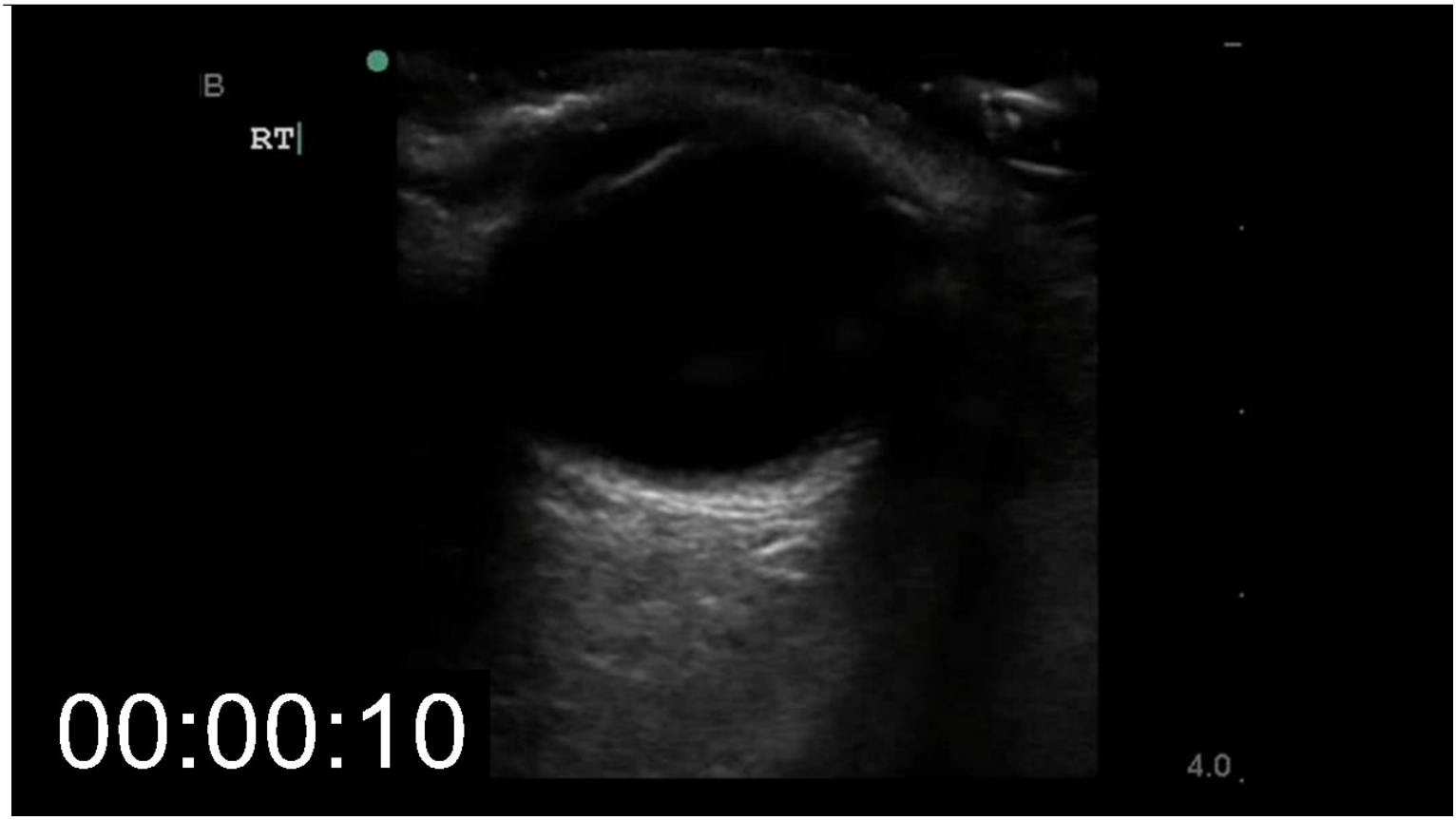
Video 14-06: Papilledema

In addition to an enlarged optic nerve sheath, the retina can be seen to have a thin hyperechoic dome over where the optic nerve meets the eye. This is an ultrasound representation of papilledema, without requiring the operator to find or remember how to effectively use an ophthalmoscope.



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Lens dislocation

Figure 14-3

Arrowhead: anticipated location of the lens.

Arrow: dislocated lens.