

# Bedside Ocular Ultrasound

Pedro J. Roque, MD<sup>a,\*</sup>, Nicholas Hatch, MD<sup>a</sup>, Laurel Barr, MD<sup>a</sup>,  
Teresa S. Wu, MD<sup>b</sup>

## KEYWORDS

- Ocular ultrasound • Eye ultrasound • Bedside eye ultrasound
- Bedside ocular ultrasound • Retinal detachment • Globe rupture • Lens dislocation
- Vitreous hemorrhage

## KEY POINTS

- Perform an ocular ultrasound on any patient suspected of having ocular trauma, visual changes, eye pain, or a suspected foreign body.
- Use the examination function for nerve, small parts, or ocular settings and increase the gain to evaluate for subtle posterior chamber findings.
- Dynamic extraocular movements during the ocular ultrasound may help unveil subtle pathology, such as a small retinal tear or vitreous hemorrhage, and should be included in the ultrasound examination if possible.

## INTRODUCTION

The eye is a fluid-filled structure that lies superficially within the orbit, making it one of the easiest objects to visualize with ultrasound examination. Although CT and MRI are invaluable to the diagnosis of many orbital pathologies, they lack the immediacy and the simplicity of ultrasound and cannot provide real-time images. Ultrasound is, therefore, more effective at the diagnosis of various tissue diagnoses, such as retinal detachment and vitreous hemorrhage, both of which are difficult to visualize with conventional static images of CT or MRI.<sup>1</sup> Furthermore, ultrasound allows practitioners to evaluate the structures of the globe in a dynamic fashion at the bedside, even in situations where orbital swelling, trauma, and patient cooperation inhibit direct visualization of the eye for a traditional ocular examination.

## EYE AND ORBIT ANATOMY

In order to interpret the images of a pathologic eye, it is vital to understand the anatomy and the points of firm attachment of the vitreous, retina, and choroid in a normal

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<sup>a</sup> Department of Emergency Medicine, Maricopa Medical Center, 2601 East Roosevelt Street, Phoenix, AZ 85008, USA; <sup>b</sup> Department of Emergency Medicine, Maricopa Medical Center, University of Arizona, School of Medicine-Phoenix, 2601 East Roosevelt Street, Phoenix, AZ 85008, USA

\* Corresponding author.

E-mail address: [pjroquemd@gmail.com](mailto:pjroquemd@gmail.com)

eye (**Box 1, Fig. 1**). The eyeball lies surrounded by fat but separated from it by a membranous sac, termed Tenon capsule. Its attachments include the corneoscleral junction and the optic nerve. This sac is in turn pierced by the extraocular muscle tendons. On ultrasound evaluation, the surrounding facial bones appear as bright reflectors with deep posterior shadowing.<sup>2,3</sup> The eyeball contains 2 major fluid-filled compartments called the anterior chamber and the posterior chamber (see **Fig. 1**).<sup>1</sup> Echolucent aqueous humor fills the anterior chamber, and vitreous humor fills the posterior chamber. The normal anterior and posterior chambers of the eye should be completely anechoic (see **Fig. 1**).<sup>1</sup>

### ***Sclera and Cornea***

The outer wall of the eyeball consists of 3 layers. The outermost layer is tough and fibrous and contains the sclera and the cornea, both of which are mostly avascular. **Fig. 1** illustrates the cuplike extension of the sclera as it extends from the dural sheath of the optic nerve. The sclera bulges forward anteriorly, thereby forming the cornea, which overlies the entire anterior chamber (see **Fig. 1**). The cornea appears as a thin hyperechoic structure attached to the sclera at the periphery.<sup>1</sup> The corneoscleral junction contains 2 sinuses called the canal of Schlemm at the periphery of the anterior chamber. This canal is responsible for the drainage of aqueous humor, which then communicates with the anterior scleral veins.

### ***Choroid, Ciliary Body, and Iris***

The choroid, ciliary body, and iris (like the sclera) are cuplike extensions of the arachnoid and pia mater layers of the optic nerve posteriorly (see **Fig. 1**). The choroid layer begins as the optic nerve meets the posterior chamber and travels anteriorly toward the anterior chamber. It turns into the ciliary bodies bilaterally at the junction of the anterior/posterior chambers and the vitreous, which are responsible for pupil dilation and constriction. The choroid is firmly attached to the sclera throughout, with the firmest points of attachment the scleral spur and the exit foramina of the vortex veins (see **Fig. 1**).<sup>1</sup> The choroid is an avascular layer that is of lower reflectivity than the retina or the sclera on ultrasound. The iris is the last segment of the choroid anteriorly acting as a contractile diaphragm situated directly anterior to the lens. It is

#### **Box 1**

#### **Review of the important anatomic considerations, including the key firm attachment points of the eye critical to understanding ocular pathology**

The inner wall of the orbit consists of the retina, choroid, and the sclera (anteriorly to posteriorly).

The firm attachment points of the various layers of the inner orbit are critical to the understanding of ocular detachments.

The posterior layers of the eye consist of the retina and the choroid, bound by the sclera.

The 2 most important attachments of the choroid are the scleral spur and the exit foramina of the vortex veins.

The 2 most important attachments of the retina are the optic nerve head and the ora serrata.

The 2 most important attachments of the vitreous are the pars plana and optic disc.

Elevated optic nerve sheath diameter is associated with an elevation of intracranial pressure. A normal optic nerve sheath diameter is <5 mm (adults), <4.5 mm (children 1–15 years old), and <4.0 mm (infants <1 years old).

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