Abstract:
Point of care sonography is a useful tool in the evaluation of both medical and traumatic ocular conditions. Traditional ocular evaluation including fundoscopy, computed tomography and magnetic resonance imaging involves significant patient cooperation, radiation exposure, and/or transfer of sometimes critically ill patients. Sonography is safe, does not utilize radiation and is done at the patient's bedside. Imaging is done through the closed eyelids which permit sonographic ocular examination even with significant eyelid edema and limited patient cooperation. The nature of the fluid filled eye allows for assessment of the anterior and posterior chambers, and even behind the eye itself to assess for increased intracranial pressure.

Keywords:
Pediatrics; emergency medicine; ultrasound; ocular trauma; optic nerve sheath diameter; Increased intracranial pressure

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Ocular Ultrasound—Point of Care Imaging of the Eye

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A 9-year-old boy is brought to the emergency department (ED) with complaint of right eye pain for one day. He denies trauma, fever or eye discharge. On physical exam he refuses to open his right eyelids. There is no overlying edema, erythema or lid tenderness. Despite your best attempts, he refuses to open his eye. A point of care ocular ultrasound (POCUS) reveals an intra-ocular foreign body. After the diagnosis is made he admits to playing with his father's grinding wheel in the garage yesterday and feeling a foreign body sensation in his eye. Ophthalmology is emergently consulted, he is brought to the operating room and the piece of metal is removed without incident. He ultimately suffered no visual loss.

A 14-year-old girl with a history of migraines presents with a 10/10 headache for one to two days and photosensitivity. She has had migraines for "years" and reports migraine headaches once or twice weekly over the past month. She denies trauma, fever, or neck pain. Despite the standard migraine cocktail of intravenous fluids, toradol, metoclopramide and diphenhydramine, she has no improvement in her headache. Ocular ultrasound reveals an increased optic nerve sheath diameter of 0.65 mm in the right eye and 0.67 mm in the left eye. A computed tomography (CT) scan shows no mass lesion. Lumbar puncture is done with an opening pressure greater than 35 cm H_2O. Twenty milliliters of cerebrospinal fluid (CSF) is removed and her headache resolves. The diagnosis of pseudotumor cerebri is made; she is started on acetazolamide and has been headache free ever since.

The eye is the perfect structure to visualize with ultrasound (US)—superficial, fluid filled, and without overlying obstructions. Direct visualization with fundoscopy is the traditional approach

for ocular examination. However, findings are limited by practitioners' skill set and the cooperation of the patient. Fundoscopic exam of the nondilated eye provides limited information given the narrow field of view. While it may be indicated to have a pediatric ophthalmologist examine all children with suspected ocular injuries and diseases, this practice is simply not feasible. With a keen understanding of normal and abnormal ocular sonoanatomy, the emergency physician is further equipped to perform an in depth examination of the eye. Ocular US can add to the information gained from the general eye exam and help determine the need for ophthalmologic referral. Even with limited training, practitioners can acquire the skills with which to perform accurate point of care ocular US examinations for specific indications.[1–3] The five clinical indications for ocular US include: orbital trauma; loss or change in vision; eye pain; intraocular foreign body; and increased intracranial pressure

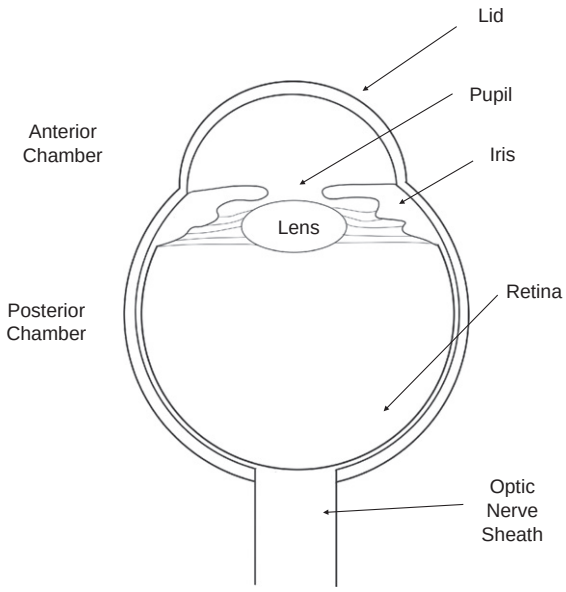

Figure 1. Artist drawing of transverse slice through orbit—courtesy of Rod Roxas, MD, RDMS.

IMAGE ACQUISITION

Imaging is performed with a high-frequency (12-7 MHz) linear probe placed in both the transverse and sagittal planes over closed lids. The patient is usually in the supine or semi-upright position. An adequate amount of gel is placed directly over closed lids and the probe is placed within the gel. An alternative technique is to place a clear adhesive dressing over the lids; gel is placed over the dressing.[4] When imaging is complete the dressing is removed along with the overlying gel minimizing clean up. With either technique, the sonographer should brace the imaging hand on the patient's nose, cheek, or surrounding orbital ridge for stability and to minimize pressure on the eye. Pressure on the globe is uncomfortable and may result in decreased heart rate secondary to vagal stimulation. Absolute care must be maintained in the setting of globe injury to avoid prolapse of intraocular contents. When performing ocular US, the standard convention for US probe orientation is utilized (marker to the patient's right for transverse imaging and toward the top of the patient's head for sagittal imaging). Scan through the entire orbit for a complete examination. The anatomy of the eye and its structures is shown in Figures 1 and 2. Adjust the depth to visualize the entire orbit and optic nerve sheath. Cooperative patients may assist with the examination by shifting their gaze. Eye movement may unmask subtle pathology and help distinguish pathology from artifacts. Sonographic artifacts will often remain fixed on the screen with eye movement whereas true pathology (eg, vitreous hemorrhage) will move with the eye.[5]

The US machine should be set to the ophthalmic or ocular preset; this minimizes the power output that is sent to the ocular tissues. Although no evidence exists that standard ocular US causes ocular damage, the correct setting should be used to avoid any theoretical complications.

Lens dislocation is usually the result of trauma. It may also occur in metabolic and connective tissue disorders (eg, Ehler's Danlos syndrome and Marfan syndrome) in which it may be present bilaterally. The hyperechoic lens will be irregularly oriented and displaced posteriorly. Traumatic lens

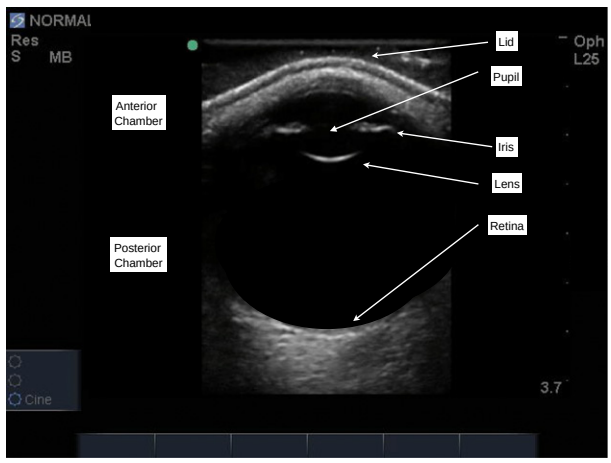

Figure 2. Sonographic image of orbit with structures identified.