Ultrasound Biomicroscopy in Anterior Ocular Trauma

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BACKGROUND AND OBJECTIVE: The authors investigated the role of ultrasound biomicroscopy after ocular trauma.

PATIENTS AND METHODS: Ultrasound biomicroscopy was performed in six eyes of six patients at the New York Eye and Ear Infirmary after a variety of traumatic ocular injuries.

RESULTS: Eyes with angle recession, iridodialysis, cyclodialysis, hyphema, an intraocular foreign body, scleral laceration, and subluxed crystalline lens were imaged without complication. Ultrasound biomicroscopy aided in the diagnosis when visualization was limited by media opacities or distorted anterior segment anatomy.

CONCLUSION: Ultrasound biomicroscopy is a safe and effective adjunctive tool for the clinical assessment and management of ocular trauma, especially when visualization is limited and multiple traumatic injuries are involved.


INTRODUCTION

Injury to the eye is a leading cause of visual impairment in the United States, with approximately 2.4 million eye injuries reported each year. The New York Eye and Ear Infirmary is a designated national eye trauma center that evaluates and treats more than 1000 trauma-related eye injuries each year. The initial evaluation of ocular trauma is crucial in localizing the site of injury and planning therapeutic strategies. Conventional eye examination is often limited by injury-related media opacities. Ultrasound biomicroscopy uses a high-frequency transducer that images the anterior segment of the eye with high resolution. Ultrasound biomicroscopy has been used extensively to study the anterior chamber angle, cornea, iris, and ciliary body, and has led to a better understanding of glaucomas, iris tumors, scleral diseases, and uveitis. In the presence of media opacities, ultrasound biomicroscopy facilitates the examination of ocular structures that otherwise could not be visualized. We describe 6 patients with traumatic eye injuries. In these cases, ultrasound biomicroscopy provided clinically relevant information that could not be obtained with standard examination techniques.

PATIENTS AND METHODS

Six eyes of 6 patients with traumatic ocular injuries underwent complete ophthalmic examination and ultrasound biomicroscopy. The time course of
imaging after injury was variable and depended on the type of injury. Ultrasound biomicroscopy (Zeiss-Humphrey, San Leandro, CA) has been described elsewhere. At our institution, the transducer functions at 50 MHz and attains a resolution of approximately 50 µm, with a tissue penetration of 5 mm. The probe is suspended from an articulated arm to diminish motion artifact. Scanning is achieved with standard room lighting conditions while the patient is supine. A fixation target is used for the nonaffected eye. After topical anesthesia is achieved, a 20-mm eye cup is gently placed on the globe and filled with balanced salt solution as a coupling medium. The scanner probe is carefully placed in the balanced salt solution, approximately 2 to 3 mm from the ocular surface, and manually moved to selected areas. Multiple cross-sectional images are taken over a range of 360° in each eye and projected onto a video monitor.

CASE REPORTS

Case 1
A 54-year-old man had sudden visual loss in his left eye after a bungee cord injury. The best-corrected visual acuity was 20/40 in the right eye and hand motion in the left eye. Examination of the left eye showed a nonreactive and corectopic pupil. There was an iridodialysis inferiorly, and the lens was displaced posteriorly (Fig. 1). The anterior chamber was formed with a large amount of fibrinous and cellular material. The intraocular pressure (IOP) was 34 mm Hg in the left eye. B-scan ultrasonography showed an attached retina. Ultrasound biomicroscopy showed an inferior iridodialysis (Fig. 2A) of approximately 180° in addition to an angle recession injury of 360° (Fig. 2B). IOP was controlled with aqueous suppressants, and the patient underwent pars plana vitrectomy, pars plana lensectomy, and repair of the iridodialysis.

Case 2
A 29-year-old man had sudden loss of vision after an exploding firecracker struck his left eye. Visual acuity was 20/20 in the right eye and hand motion in the
Figure 3. Cycloidalysis cleft (arrow). C = ciliary body; A = anterior chamber; S = suprachoroidal space; arrowhead = scleral spur.

Figure 4. Spontaneous closure of the posterior aspect of the cleft (*). An area of suprachoroidal fluid remains (arrow). C = ciliary body; A = anterior chamber.

Figure 5. Goniophotograph of the chamber angle showing a large cycloidalysis cleft opening (arrows), with posterior displacement of the iris.

left eye. Examination of the left eye showed a formed anterior chamber with a 2.5-mm hyphema. The cornea was noticeably edematous, with a paracentral epithelial defect. IOP was 11 mm Hg in the right eye and 9 mm Hg in the left eye. Fundus examination showed an attached retina and clear vitreous. The patient was given prednisolone acetate 1%, ciprofloxacin hydrochloride 0.3%, and atropine sulfate 1% eye drops. Six days later, the visual acuity was 20/150 and the IOP was 5 mm Hg. Gonioscopy was limited by poor visibility secondary to the residual hyphema and corneal edema. Fundus findings were unchanged. Ultrasound biomicroscopy of the anterior segment showed a cycloidalysis cleft (Fig. 3). The cleft was 2.5 clock hours in circumference and was accompanied by a 360° shallow serous detachment of the ciliary body. Four days later, the patient came to the emergency room with severe ocular pain and nausea. IOP was 50 mm Hg. The remaining examination findings were unchanged. Repeat ultrasound biomicroscopy showed apposition of the posterior ciliary body to the sclera, with resolution of the choroidal detachment (Fig. 4). The patient was treated with timolol maleate 0.5% and dorzolamide hydrochloride 2%. IOP decreased to 20 mm Hg. Over the next 2 months, all topical medications were tapered, and the IOP was 17 mm Hg at the most recent examination.

Case 3

A 33-year-old woman sought a second opinion about poor vision in the left eye after a gunshot wound to the left orbit 3 months earlier. Visual acuity was 20/25 in the right eye and counts fingers in the left eye. The left eye had 4 mm of enophthalmos with restriction on movement. The pupil was nonreactive, with an afferent pupillary defect. Slit lamp examination showed vitreous in the anterior chamber and temporal displacement of the lens. IOP was 14 mm Hg in the right eye and 3 mm Hg in the left eye. Gonioscopy showed a cycloidalysis approximately 150° temporally (Fig. 5). Examination of the fundus showed preretinal gliosis over the macula, with a tractional retinal detachment. Ultrasound biomicroscopy showed a large cycloidalysis cleft approximately 180° temporally (Fig. 6). The patient was treated with cycloplegics and...
underwent pars plana lensectomy, pars plana vitrectomy, air–fluid exchange, endolaser, and membrane peel of the left eye. Postoperatively, the cyclodialysis remained unchanged, with IOP of 1 mm Hg despite proper positioning from the air–fluid exchange. The patient underwent argon laser photocoagulation to the base of the cleft. The procedure successfully closed the cyclodialysis and increased IOP to 10 mm Hg. Repeat ultrasound biomicroscopy showed that the posterior portion of the cleft was apposed to the sclera temporally (Fig. 7A) and the iris was adherent to the sclera inferotemporally (Fig. 7B).

Case 4

A 32-year-old man was struck in the left eye with a piece of shattered glass. Visual acuity was 20/20 in both eyes. Both pupils were round and reactive, with no afferent pupillary defect. Examination of the left eye showed a conjunctival laceration 3 mm superior to the limbus at the 1-o’clock position, with underlying hemorrhage. The sclera appeared grossly intact and showed a negative reaction to the Seidel test. The cornea was clear, and the anterior chamber had a mild cellular reaction. IOP was 10 mm Hg in both eyes. Dilated examination showed a clear lens and vitreous. Indirect ophthalmoscopy showed a localized area of retinal hemorrhage in the superotemporal peripheral retina. Orbital x-rays showed no foreign bodies. Ultrasound biomicroscopy was performed and showed a full-thickness scleral laceration (Fig. 8). The patient underwent exploratory surgery, repair of the scleral laceration, and cryotherapy.

Case 5

A 65-year-old man had trauma to the right eye caused by a piece of metal 30 years earlier. The best-corrected visual acuity was 20/70 in the right eye. Slit lamp examination showed an oval, inferiorly drawn pupil; an old superior cornea scar; and senile cataract. The iris had a 1.0 × 1.5-mm pigmented mass in the inferior chamber angle. Gonioscopy showed synechiæ formation at the site of the mass, with no extension...
Figure 8. Composite of the peripheral retina showing a scleral laceration (arrow). Note the overlying edematous conjunctiva (C). a = anterior chamber.

Figure 9. Goniophotograph showing an elevated iris lesion in the inferior chamber angle.

cornea, and vitreous was seen in the anterior chamber around the lens (Fig. 11B).

DISCUSSION

Anterior segment trauma can lead to significant damage and distortion of ocular tissues. During blunt trauma, axial compression and rapid compensatory equatorial expansion cause stretching and tearing of ocular tissues. Campbell described seven rings of tissue anterior to the equator that are prone to injury after blunt trauma: the sphincter pupillae, iris, anterior ciliary body, ciliary body attachment, trabecular meshwork, zonule, and retinal attachment to the ora serrata.

An iridodialysis is a tear in the iris at its junction with the anterior ciliary body. Ultrasound biomicroscopy in case 1 showed a tear in the iris root, with a narrow band of iris peripheral to the tear remaining attached to the ciliary body. The potential severity of ocular injury from bungee cord accidents has been well described. At the initial evaluation, the magnitude of injury was not evident because of the severe cellular reaction and distorted anatomy. Ultrasound biomicroscopy imaged the iridodialysis and showed the extent of the injury. The surgeon used this information to prepare the surgical plan.

A cyclodialysis cleft results from a disinsertion of the ciliary body from the scleral spur, allowing direct communication between the anterior chamber and the suprachoroidal space. Visualization of the cleft and anterior chamber angle by gonioscopy can be limited by hemorrhage or corneal edema. In case 2, spontaneous closure of the cleft was associated with an acute elevation in IOP. Ultrasound biomicroscopy confirmed the anatomic closure of a cleft, despite the
Figure 11. (A) Subluxed lens (L) displaced posteriorly and superiorly. The zonules (arrows) are disinserted from the ciliary body (C) inferiorly, and the iris is in apposition (*). (B) Area of clotted hyphema and vitreous (arrows) adherent to the appositional iris (I) and displaced lens (L).

unchanged gonioscopic appearance of the angle in this area. By differentiating a spontaneous closure, ultrasound biomicroscopy was useful in excluding other possible causes of post-traumatic IOP elevation, such as angle contusion injury, inflammation, or topical steroid use. Ultrasound biomicroscopy has been shown to be useful in delineating the location and size of a traumatic cleft. 11

The treatment of a cyclodialysis cleft involves reattaching the ciliary body to the sclera. Therapeutic options include medical management (case 2), argon laser cyclocoagulation, and surgical reattachment. Case 3 shows closure of a cyclodialysis cleft after argon laser photocoagulation and pneumatic cyclocoagulation. In some areas, the posterior portion of the ciliary body became reattached to the sclera, with the anterior portion of the cleft remaining patent. In other areas, the iris became adherent posterior to the scleral spur. Ormerod et al. 19 found that all patients who were successfully treated with argon laser photocoagulation still had open cleft apertures. Ultrasound biomicroscopy permits imaging of a cyclodialysis cleft along its entire longitudinal and circumferential extent, 11,20 with an accurate assessment of its location and size, regardless of gonioscopic visibility or patent cleft aperture. 11 Although ultrasound biomicroscopy did not alter the planned treatment, it did help to confirm the diagnosis of a cleft.

Angle recession results from a traumatic tear in the anterior ciliary body, often between the circular and longitudinal muscle layers. In case 1, ultrasound biomicroscopy imaged a distinct tear within the ciliary body, with posterior displacement of the ciliary body and iris. Angle recession could not be viewed gonioscopically because of hemorrhage and anterior chamber debris.

A full-thickness scleral laceration was imaged in case 4. Although a ruptured globe was suspected clinically, the diagnosis of laceration was assessed before surgical exploration. Ultrasound biomicroscopy can assist in the diagnosis of a penetrating injury. The technician must carefully prepare the eye for the treatment of these injuries. The eye cup is placed so that minimal pressure is placed on the globe while the cup is filled with a sterile coupling medium. The patient must not move during the scanning. We do not recommend ultrasonography when there is strong clinical suspicion of a penetrating ocular injury, when surgical exploration has been definitively planned, or when the patient cannot tolerate the testing. When a penetrating injury is less likely, ultrasound biomicroscopy can assist in determining the need for surgical intervention. Ultrasound biomicroscopy in these cases should be performed by a highly skilled and experienced technician.

Identification and accurate localization of intraocular foreign bodies is limited by poor visualization in patients with opacified media or distorted anatomy. In these cases, radiography or ultrasonography is needed for localization and to rule out multiple foreign bodies. In case 8, ultrasound biomicroscopy confirmed the
presence of a metallic foreign body within a fibrous capsule in the anterior chamber angle and showed no other evidence of structural damage, except for a corneal scar.

A hyphema usually results from disruption of the greater arterial circle of the iris. Associated anterior segment changes, such as angle recession, cyclodialysis, and iridodialysis, are usually present. Ultrasound biomicroscopy in case 6 imaged a formed clot against presenting vitreous.

Lens subluxation secondary to zonular disruption may occur after blunt trauma. Gross displacement of the lens, or more subtle signs, such as phacodonesis, iridodonesis, or anterior chamber depth asymmetry, may be seen, depending on the extent of subluxation. In case 6, visualization of the lens was limited because of the hyphema. Ultrasound biomicroscopy showed the displacement of the lens superiorly, with disrupted zonules inferiorly. Ultrasound biomicroscopy also ruled out other anterior segment injuries that could alter the management of these cases.

Ultrasound biomicroscopy is a noninvasive, safe method for diagnosing injuries in the presence of anterior segment trauma and can potentially aid in the surgical management of these cases. It is especially useful in patients with multiple traumas, media opacities, or abnormal anterior segment anatomy.

REFERENCES