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Using point-of-care ultrasound in ocular emergencies: A mini review

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ABSTRACT

As a diagnostic aid in emergency services, ultrasound has expanded considerably in recent years. Among its applications, ocular ultrasonography allows for a better evaluation of patients with ophthalmological emergencies. In addition, it provides a simple and easy technique to obtain clinical information that may not be easily accessible either through the clinical examination or by using the ophthalmoscope. Ocular ultrasonography can help to diagnose hemorrhage and retinal detachment and/or vitreous, eye infections, foreign bodies, retrobulbar hematomas, papilledema, and eye trauma. By measuring the diameter of the optic nerve sheath, intracranial hypertension could be screened. This article reviewed the approach to eye exam by ultrasound and common ophthalmic pathologies diagnosed with ultrasound in the emergency department.

KEYWORDS: Point of care ultrasound; Optic nerve sheath; Retinal detachment

1. Introduction

The use of ocular ultrasonography in the emergency department provides many advantages to primary care physicians. As an important diagnosis approach to ocular emergencies, ocular ultrasonography is easy to learn[1] and quick to perform, especially when lesions are located in places where are hard to access, such as subconjunctival hemorrhage, cataract or eyelid edema, which make the clinical evaluation difficult[2-4].

Ocular ultrasonography makes it possible to diagnose periorbital or intraocular foreign bodies, retinal and/or vitreous detachment with or without hemorrhage, luxation or subluxation of the lens; evaluate the eye trauma, papilledema; and screen the increased intracranial pressure[2,5,6]. This article reviewed the approach to the eye exam by ultrasound and described some frequent pathologies in our emergency department.

2. Application method

Ocular ultrasonography is performed in B mode (brightness) with linear transduce. It works ideally in the highest frequency setting, and the echosonogram is in real-time pattern. Initially, patient is placed in a decubitus supine position with eyes closed, and then abundant gel is applied over the closed eyes to avoid contact of skin with the transducer skin and against increased intraocular pressure caused by the transducer[7-10].

To visualize the eye structures, the transducer must be placed longitudinally and transversally, and the patient is requested to move their eyeballs quickly in all directions (right and left, up and down) in order to visualize the displacement of the vitreous humor and so to discard intraocular injuries[11].

3. Normal findings in ocular ultrasound

The eyeball is round with delimited walls and anechoic content due to its liquid condition. The retina, choroid, and sclera are visualized as the same single echoic and curved line because ultrasonography usually cannot differentiate among them[8].

The anterior and posterior lens capsules are identified as curvilinear echoes, whose interior is anechoic in the healthy eye (Figure 1). A study measured both eyeballs from the cornea to the retina, and the normal range of the healthy eye is 23-25 mm[4][8].

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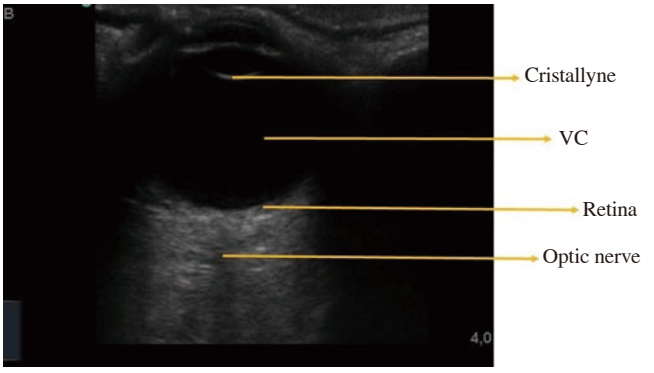

Figure 1. Normal eye. VC: Vitreous chamber.

The osseous walls appear as hyperechoic bands with posterior acoustic shade on both sides. Retrobulbar fat is identified as a homogeneous hyperechoic area behind the eyeball. Extraocular muscles have a fusiform and hypoechoic configuration. The optic nerve located at the back of the eyeball is visualized as a hypoechoic tubular structure[11].

4. Pathology

4.1. Vitreous hemorrhage

Vitreous hemorrhage is defined as the presence of extravasated blood within the space among the internal limiting membrane of the retina, the non-pigmented epithelium of the ciliary body, and the lens posterior capsule. Bleeding is caused by a disruption of the retinal veins, abnormal angiogenesis, or hemorrhage crossing the retina from other sources, usually spontaneously or caused by eye traumas[12,13]. Diabetes mellitus, cerebrovascular disease, systemic hypertension, and hematological pathologies such as hemophilia, polycythemia, multiple myeloma, thrombocytopenic purpura, and anemia of sickle cell anemia are the risk factors. Vitreous hemorrhage is also associated with disorders such as multiple sclerosis and eye pathologies including intermediate uveitis, complications of ophthalmic surgical procedures, detachment of the posterior vitreous and retinal detachment, in addition to an eye trauma where the presence of a foreign body increases the risk of vitreous hemorrhage[14].

Clinically, vitreous hemorrhage is presented with an unexpected, painless marked decrease of the unilateral visual acuity. Besides, the patient would complain of photopsia. Vitreous hemorrhage can be identified under ophthalmoscopy. Although it is not an emergency, it is recommended as prior ophthalmological assessment for monitoring[13,15].

Ultrasonography shows hyperechoic-like material within the vitreous with a semi-mobile appearance as the eye movements, and typically, it would show an undulated posterior movement (Figure 2)[12].

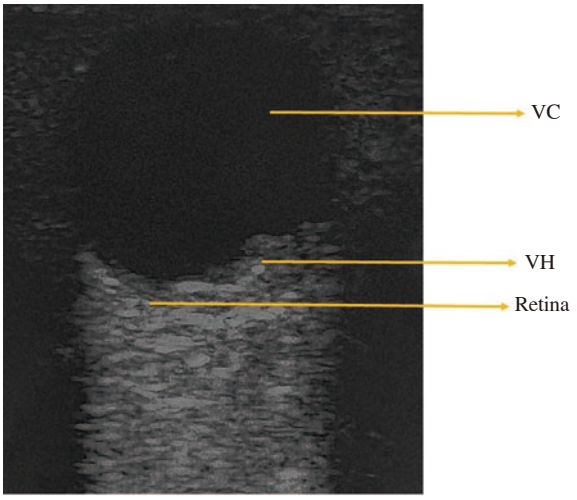

Figure 2. Vitreous hemorrhage. VC: Vitreous chamber; VH: Vitreous hemorraghe.

4.2. Retinal detachment

Retinal detachment refers to the separation of the neurosensory retinal from the pigmentary epithelium because of the passage of the liquid from the vitreous cavity into the subretinal space through a tear or retinal disinsertion, and its prevalence is higher in men between 50 and 70 years old[16].

Usually, there is a history of blunt traumas, major physical efforts, or previous surgical interventions. It is usually a consequence of previous structural alterations in the vitreous and retina[17].

Clinically, it is presented along with a decrease of the visual acuity and patients would see a black cloud with loss of light perception and photopsia. Dark and tortuous vessels are evidenced under ophthalmoscopy. There is decreased luminous reflex and the choroids are observed in retinal areas. Its main sequel is vision loss[18,19]. Treatment is determined by ophthalmological diagnosis, so an early assessment is recommended[20].

Ultrasonography shows a kind of a brilliant white membrane (hyperechoic) in the posterior chamber and may have a mobile appearance when the patient moves his/her eye (Figure 3).

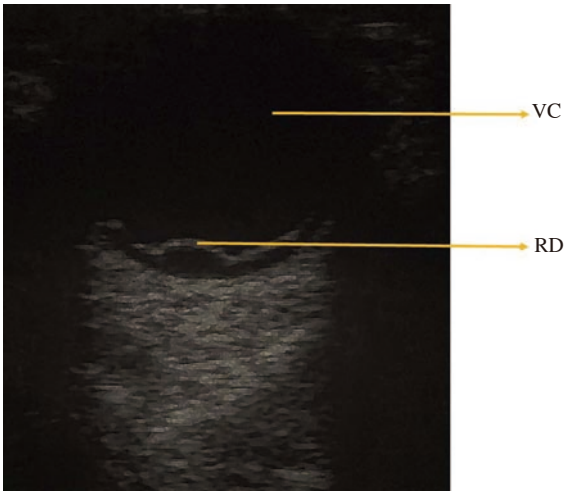

Figure 3. Retinal detachment. VC: Vitreous chamber; RD: Retinal detachment.

Depending on the age of injury, the retinal detachment can be freely mobile when it is acute, or more rigid when it is chronic. A full retinal detachment is seen as a "v" shape with the vertex joined to the optic disk[21]. Its main differential diagnosis is the posterior vitreous detachment. To differentiate them, the optic nerve must be found. The retinal detachment will usually remain tied to the optic disc and therefore, usually it will not cross the midline of the posterior chamber, while a posterior vitreous detachment will cross the midline[20,21].

4.3. Papilledema

Papilledema or optic nerve edema is usually caused by high intracranial preassure (ICP). The increased ICP may be secondary to pathologies like intracerebral tumors, brain hemorrhage, skull trauma, meningitis, hydrocephalus, spinal cord, drainage dysfunction of the cerebral sinuses, skull abnormalities, and idiopathic intracranial hypertension[22]. It is believed that increased ICP goes from the subarachnoid space to the optic nerve where the interruption of the metabolic processes leads to edema, ischemia, and gradual loss of vision[23]. Patients may experience loss of visual field and temporary attenuations, diplopia, tinnitus, headache, nausea, and emesis. Ophthalmoscopy shows dilated veins, hemorrhages covering the disc, disc hyperemia, and peripapillary folds[24].

Tackling the cause of increased ICP is the main treatment[22-24]. Ultrasonography shows elevated optic disc and increased thickness of the optic nerve (Figure 4)[25,26]. The sensitivity of elevated optic disc by a 0.6 mm height can be 91% and the specificity can be 75% for the diagnosis of papilledema[27]. The disc height is obtained by measuring the distance between the anterior peak and the disc and its intersection with the posterior surface of the eyeball[26,28]. The measurements of the optic nerve sheath diameter by ultrasonography is also a simple and sensitive indicator of increased intracranial pressure. A diameter of the optic nerve sheath greater than 5 mm, 3 mm behind the orbit, may be a sensitive (88%) and specific (93%) marker of increased ICP (Figure 5)[29-31].

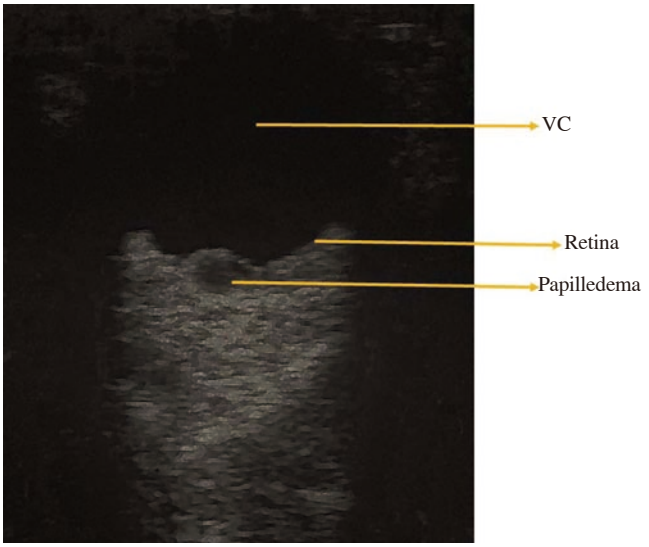

Figure 4. Papilledema. VC: Vitreous chamber.

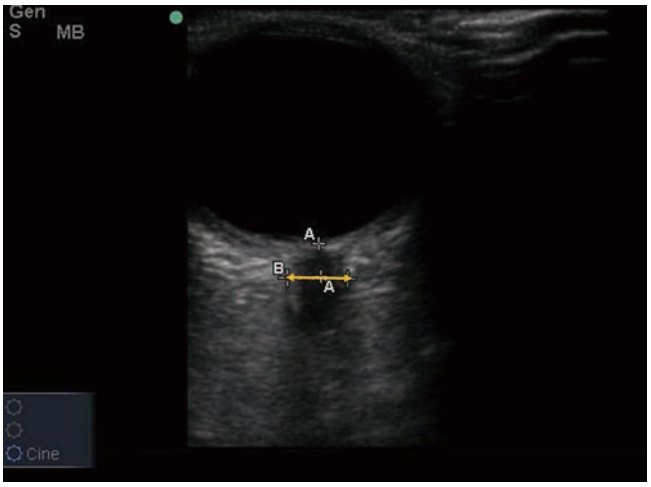

Figure 5. Increased thickness of the optic nerve. A: 0.30 cm; B: 0.55 cm.

4.4. Other eye diseases

Ultrasound helps to find other ocular diseases as periorbital and intraocular foreign bodies[32-34], luxation, and subluxation of the crystalline lens[13], posterior vitreous detachment[22], retinal hemorrhage (it is seen as a hyperechoic image under the retina[22-23]), choroid detachment[35], vascular pathologies[36], and eye infections[22].

5. Conclusion

Diagnosis of eye emergencies with ultrasonography is validated in many kinds of literature. Ultrasonography is an excellent complement to physical examination during the initial care of patients with eye disease. In addition, it has many benefits compared with other imaging methods, for example, it is rapid, non-invasive and cost-saving. The eye can be easily evaluated by using a high-frequency linear transducer since it is an organ that transmits sound waves very well, leading to visualize good images with little effort. With appropriate training, physicians of the emergency department can easily master the application of ultrasonography to accelerate the diagnosis and treatment, as well as to prioritize patients requiring a faster ophthalmological assessment.

Conflict of interest statement

The authors report no conflict of interest.

Authors' contributions

Bibliographic search and writing of the initial manuscript: S.V.B. and V.G.G. Review and complement of both the manuscript and the initial bibliography: A.C.O. Following corrections, complements and final review: S.V.B., V.G.G. and A.C.O.

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