Ultrasound of the eye

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Abstract

Ultrasound of the eye is not an examination that most sonographers are commonly asked to perform, however it may be requested from time to time, particularly in regional or rural areas. This paper hopes to assist the sonographer to gain an understanding of the anatomical and sonographic anatomy of the eye in order to diagnose several common pathologies.

Fig. 1: Normal anatomy of the eye.¹

Anatomy

From a practical ultrasound perspective it is best to describe the anatomy of the eye (Fig.1) in terms of two discrete chambers. The anterior chamber defined by structures superficial to the iris and the posterior chamber defined as structures deep to the iris.

On the sonogram (Fig. 2) the cornea is the most superficial thin convex membrane, followed by the anechoic fluid of the anterior chamber. The iris is represented by echogenic linear bands that originate from the edge of the eye. Deep to these bands, in the posterior chamber is the convex membrane of the lens, followed by the anechoic space of the vitreous body. The thick echogenic round outer membrane of the eye consists of three layers. The inner layer is the retina. The middle layer is the choroid, and the outer layer is the sclera. The three layers are difficult to differentiate in a normal sonogram. Posteriorly, there is a hypoechoic shadow representing the optic disc behind which lies the optic nerve.

The most important anatomical information for the sonographer is that the retina is strongly attached to the optic disc posteriorly and the ora serrata anteriorly, and that the retina and choroid have their own blood supply (Fig. 1). The retina is supplied by the central retinal artery which enters through the optic nerve while the choroid is perfused by the short and long posterior ciliary arteries.

The vitreous body is a jelly-like substance that presses

Fig. 2: Normal sonographic appearance of the eye.

firmly against the retina ensuring it remains in contact with the choroid and sclera. As the eye ages the vitreous liquefies and starts to separate from the retina. This normal process usually occurs between the ages of 40 and 70. As the vitreous separates – posterior vitreous detachment (PVD) – it can pull on the retina rupturing tiny blood vessels which results in vitreous haemorrhage (VH). For the most part the vitreous and retina form a loose attachment, however if the vitreous is abnormally adherent or the retina weak small tears can occur in the retina as the vitreous separates, allowing the vitreous liquid to pour through the break and detach the retina – retinal detachment (RD)².

Scanning technique

The patient is asked to lie supine on the examination table and close their eyes. Sterile gel is placed on the high frequency linear transducer and light pressure is used to place the probe on the eyelid. The eye is sequentially scanned in sagittal and transverse planes. During the examination the patient is asked to move their eye from right to left, up and down resulting in a dynamic examination. It is important to vary the gain throughout and the use of deliberately over gained images will ensure visualisation of thin membranes and low-level echoes.

Fig. 3: The normal lens is not visualised. In this patient a thickened ovoid echogenic mass is seen (C) at the superficial border of the posterior chamber, representing a mature cataract.

Fig. 4: Sonogram demonstrating mildly thickened membranes attached at the level of the OS and OD.

Fig. 5: Vascularity on colour Doppler confirming a large acute bilateral RD.³

Indications

The two most common reasons for sonographic evaluation of the eye in adults are:

- 1 Non visualisation of the back to the eye with the ophthalmoscope. This may be due to either cataract (the opaque lens inhibits direct visualisation of the retina, Fig. 3) or haemorrhage occurring spontaneously or because of trauma, Fig. 12, and;
- 2 A mass has been visualised on the ophthalmoscope examination, Fig. 18.

The sonographer needs to assess the status of the posterior chamber for the presence of PVD, VH, RD or masses.

Pathology

Retinal detachment

Retinal detachment appears as a thin or mildly thickened pliable membrane that is anchored to the optical disc (OD) and ora serrata (OS). On dynamic imaging the membrane can often be seen to flutter with movement. Using colour Doppler, blood flow should be demonstrated in the membrane. In cases of chronic retinal detachment, the membrane becomes thickened and ridged forming a V shape from its

Fig. 6 Mature cataract.³

attachments at the OD and OS and demonstrates reduced or no colour Doppler flow.

In Figs. 4 and 5, the patient presented with mature cataract prior to surgery. The sonogram demonstrates mildly thickened membranes attached at the level of the OS and OD with vascularity on colour Doppler confirming a large acute bilateral RD. At the time of cataract surgery the retina was also reattached.

In Figs. 6, 7 and 8, the patient presented with mature cataract (C). The sonogram demonstrates a mildly thickened membrane attached at the level of the OD extending towards the OS with vascularity on colour Doppler, confirming an acute unilateral RD. A moderate overlying VH is also present. At the time of cataract surgery the patient also underwent vitrectomy and retinal reattachment.

Vitreous Detachment

If a membrane is seen to cross over the OD or OS then it must be either a PVD or VH. PVD can occur at any position along the wall of the eye. It is seen as a thin non vascular membrane. On dynamic imaging the membrane demonstrates little or no movement. VH is seen as an echogenic highly mobile collection with thick margins that demonstrate no vascularity.

Fig. 7: Mature cataract.

Fig. 8: Mature cataract.

Fig. 9: Patient presenting with mature cataract.

Fig. 10: Patient presenting with mature cataract.

Fig. 11: An asymptomatic eye demonstrating progression in the aging process.

The amount of PVD and VH can vary dramatically. In an asymptomatic eye over the age of 40, a small PVD with tiny echogenic foci in the vitreous body representing VH (called

floaters) may be present. In the symptomatic eye (sudden loss of vision) the sonographer may encounter an extensive PVD with gross VH.

Figs. 9 and 10 are of a patient who presented with mature cataract. The sonogram demonstrates a tiny PVD with a small amount of VH consistent with normal ageing. This patient underwent cataract surgery.

Fig. 11 is of an asymptomatic eye that demonstrates progression in the aging process with more VH and larger PVD.

Figs. 12 and 13, patient presented with sudden loss of vision and no history of trauma. A thin membrane is seen crossing over the OD and past the level of the OS with no vascularity on colour Doppler confirming PVD. There is a large irregular, mobile, echogenic mass with no vascularity between the PVD and lens confirming VH. Tiny echogenic foci can be seen in the VH consistent with asteroid hyalosis. Low-level echogenic debris from haemorrhage can often be seen between the retina and the vitreous membrane in the acute presentation. This patient had a vitrectomy.

Figs. 14 and 15, patient presented with loss of vision following recent direct trauma to the eye. There is a thickened membrane seen crossing over the OD and past the level of the OS with no vascularity on colour Doppler. The inside of the membrane is filled with echogenic debris which swirls

Fig. 12: Patient presenting with sudden loss of vision and no history of trauma.

Fig. 13: Patient presenting with sudden loss of vision and no history of trauma.

Fig. 14: Patient presenting with loss of vision following recent direct trauma to the eye.

Fig. 15: Patient presenting with loss of vision following recent direct trauma to the eye.

Fig. 16: Diagram showing the both retinal and vitreal detachment.²

around on dynamic imaging confirming VH. The retina is intact and as a result the patient was instructed to rest to allow the VH to reabsorb. If this does not occur then vitrectomy is performed to restore vision.

Choroidal detachment

Choroidal detachment (CD) is a rare condition that most commonly occurs due to trauma or infection. The potential space between the sclera and choroid becomes filled with exudate or blood, increasing the transmural pressure due to either transudation of serum or accumulation of blood from the rupture of choroidal vessels. It can be a complication of cataract surgery.

CD appears as a bilateral smooth dome-shaped membrane of scalloped appearance in the mid body of the eye that does not spread to the optic disc. Figs. 16 and 17, the patient presented with an eye infection following trauma. The scalloped membrane is highly vascular on colour Doppler imaging with VH also demonstrated. The CD often resolves as the infection clears. If this does not occur saline is injected into the anterior chamber increasing pressure in the posterior chamber and thus reducing the CD by allowing the exudate to exit via a small slit made in the anterior sclera. After reduction an RD may be revealed.

Masses

The most common eye masses encountered by ultrasound are benign naevi or melanoma. Other eye masses may occur,

Fig. 17: Patient presenting with an eye infection following trauma.

Fig. 18: A mass on the posterior wall in an asymptomatic eye.

Fig. 19: Mass located at the OD with an AP diameter of 2.4 mm.

Fig. 20: Sonogram demonstrating a mass close to the OD with AP thickness 5.3 mm.

however they are extremely rare.

In Fig. 18, an ophthalmoscope examination revealed a mass on the posterior wall in an asymptomatic eye. The sonogram demonstrates a 1.6 mm homogeneous mass situated next to the OD. Eye masses of less than 3 mm are generally considered benign naevi or small melanoma and regularly checked for progression⁴.

Clinical and sonographic characteristics of a suspicious choroidal naevus/melanoma are:

- S Symptoms (flashes, blurred vision)
- P Proximity of the mass to the optic nerve
- O Orange pigment (on ophthalmoscope examination)
- T Thickness, the AP dimension of the mass
- US Echolucency within the mass on ultrasound⁴.

Fig. 19 demonstrates a mass located at the OD with an AP diameter of 2.4 mm. The mass also displays some internal echolucency. The treatment of this patient would have included early intervention with brachytherapy. The isotopes used are iodine 125 and ruthenium.

In Figs. 20 and 21, the patient complained of a long standing history of blurred vision that progressed to recent partial loss of vision. The sonogram demonstrates a mass

close to the OD with AP thickness 5.3 mm. It has a length of 9.3 mm with an associated RD. Lesions greater than 3 mm with increased risk factors are considered to be melanoma and are generally treated with brachytherapy⁴.

Fig. 22 demonstrates a mass involving the OD with AP thickness 9.5 mm and length 12.4 mm. When lesions of greater than 6 to 8 mm are present with a large base treatment is often enucleation⁴.

Summary

While ultrasound of the eye is not a common examination I believe that by understanding the anatomy and common pathology outlined in this paper all sonographers can perform the examination with confidence.

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Fig. 21: Sonogram demonstrating a mass close to the OD with AP thickness 5.3 mm.

Fig. 22: Sonogram indicating a mass involving the OD with AP thickness 9.5 mm and length 12.4 mm.

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