ULTRASONOGRAPHY FOR ORTHOPTISTS

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Abstract

A general look at ultrasonography as used in diagnosis and management of certain eye conditions, namely cataract, foreign bodies, intraocular and intraorbital tumours and diseases and squint. The basic principles are described as is the equipment used. General methods of operation are outlined and artefacts discussed briefly. Attention is drawn to the possible use of ultrasonography in determining before surgery the amount of recession/resection necessary in the squinting eye.

Key words: *A-scan, B-scan, transducer, cataract, intraocular lens, squint surgery.*

About eighteen months ago I was confronted with a new piece of electronic equipment and told to get busy measuring eyeballs for intraocular lens implantations. Up until then, I had thought that the intraocular lens was the idiosyncracy of a few ophthalmologists and the only ultrasound I had heard of was used in performing antenatal checks. Therefore I felt that a brief discourse on basic ocular ultrasonography might aid someone else in the same position.

Ultrasonography works on the same principle as radar. The transducer sends out an ultra sonic beam which is reflected off any radio-opaque surface the resulting echo being picked up by the transducer again. Thus the distance of any object can be readily measured by the time taken. Excellent for submarines and night-flying aircraft, ultrasonography also provides a goldmine of information about the human body without recourse to invasive techniques such as X-rays and surgery.

Most ultrasonographic set-ups consist of a hand-piece containing the transducer which generates ultrasonographic waves when a voltage is applied to it; a recording device such as an oscilloscope with a vernier scale, and a permanent recorder, usually a polaroid camera which takes instantaneous black-and-white photographs. Often attached is a mini-computer for various calculations required in intraocular lens implantations.

The ultrasonic beam has a frequency between 5 and 20 MHz which is too low to cause any damage to the auditory system, yet high enough to be inaudible. This is the only difference between an ultrasonic and a sonic wave.

In its ocular application, the ultrasonic beam is delivered by means of two different transducers, one known as the A-mode transducer which gives a single continuous beam, while the other, known as the B-mode transducer gives a series of beams through an arc of about 75°, the resultant picture being fan-shaped. The beams produce echoes from the ocular structures at which they are directed, the resulting echoes being received by the transducer again and passed back to the oscilloscope for visual display.

The A-mode transducer is applied to the well-anaesthetized cornea in the same fashion as an applanating tonometer, and held there

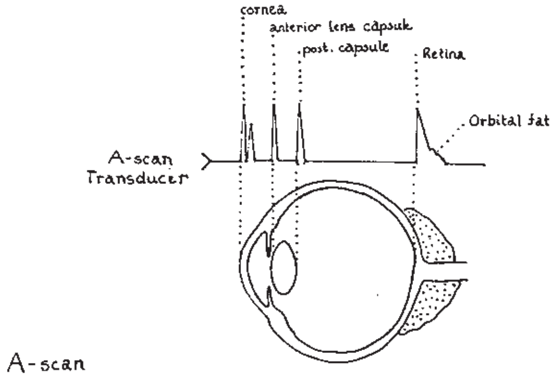

Figure 1a: A-scan correlation with eyeball structures.

Figure 1b: Application of A-scan transducer.

until a steady reading is obtained from the oscilloscope. The A-mode can be used for measuring the axial length of the eyeball, this being a critical measurement when intraocular lenses are being considered. The average strength of an intraocular lens is about +21 DS, so very small increments can make a very large impact on the patient's ultimate refractive error. As we now have the technology to determine the correct lens strength for each eye, it is important that we use it.

Axial length is of importance in squint surgery also. Given some thought it would seem unreasonable to perform the same amount of recession/resection on an eye with a diameter of 26 mm and on an eye with a diameter of 20 mm. It has been found[2] that a smaller eye requires a lesser amount of recess/resect than does a larger eye. Perhaps A-mode measurements will make squint surgery a little more predictable in its outcome.

The B-mode is the mode most frequently used at the present moment. This is a series of beams radiating in an arc from the transducer giving a 2D picture of the object in view. The transducer used for B-mode is different to that used for the A-mode, being much larger and hand-held. The B-mode transducer is placed on the well-lubricated closed eyelid and gently moved around to obtain the best possible view of the object. Most often the B-mode is used to "see" the posterior pole of the eye when the ocular media are opaque. Cataractous eyes are noted for vitreous and retinal detachments and unnecessary surgery can be eliminated. A better prognosis can also be made. The basic B-mode picture can be enhanced by clever electronics to produce a 3D picture on the oscilloscope, allowing demonstration of certain pathological features not obvious by other means.

B-mode is also used in the following conditions:

- intraocular and intraorbital tumours and diseases;
- intraocular foreign bodies, particularly glass which is not detectable by other means, but is radio-opaque;
- retinal diseases and other abnormalities, including staphylomata and vitreous haemorrhage.

Ultrasonography is not difficult to perform; in fact, anyone who can perform applanation or indentation tonometry will have very few problems. As in all diagnostic testing however, the difficulty lies in the interpretation of results. Ultrasonography is subject to the same problems, sources of error and artefacts as any other form of electrodiagnostic equipment—that is, interference from other power sources. Once the basic principles of ultrasonography and electricity are understood, the various

Figure 2b: Application of B-scan transducer, oscilloscope in background.

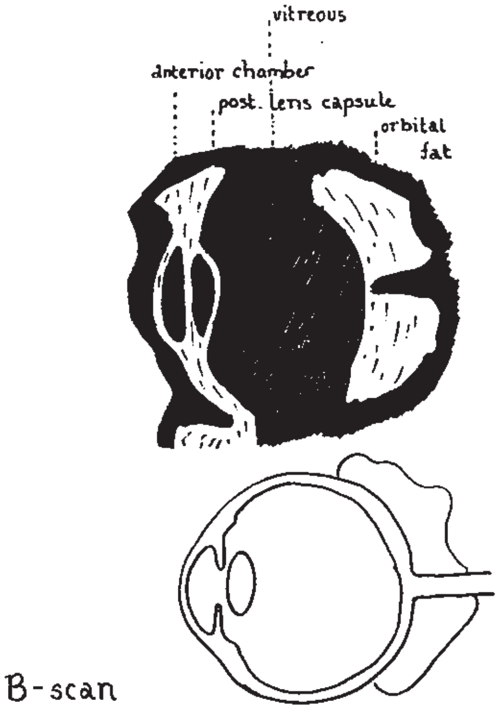

Figure 2a: B-scan correlations.

artefacts become less of a problem. Some of these artefacts are:

snow—produced by background electrical noise—the same as that on T.V. sets.

grass—the same as snow but only prod on the linear A-scan.

reduplication echoes—which occur when the transducer is perpendicular to a surface which will then reflect the beam back into the transducer and it will be reproduced. This causes a very fuzzy picture of little diagnostic value.

These are just a few of the artefacts produced and it is necessary to be able to recognise them and their significance. There are a number of others which are too complex to be discussed here.

Ultrasonography is a very important diagnostic tool and will play a larger and larger role in the diagnostic ophthalmic field. Orthoptists have already proved their value in many non-traditional areas and the use of ultrasonography is well within their scope.

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References

1. Coleman DJ, Lizzi FL, Jack RL. Ultrasonography of the eye and orbit. Philadelphia: Lea & Febiger. 1977.
2. Gillies WE, McIndoe A. Measurement of strabismus with A scan ultrasonography. Aust J Ophthalmol Aug 1981, Vol 9, No. 3.