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Editorial: Ultrasonic investigation

The eye is a small superficial organ which readily lends itself to ultrasonic investigation. Such examination is indicated when opaque media prevent visualisation of the posterior segment of the globe or if orbital pathology is suspected. Standard 'pulse-echo' techniques are used. Pulses of sound are transmitted into the eye from a transducer, and in the time interval between pulses, echoes are received by the same transducer and recorded. Although a variety of techniques has been employed (Coleman *et al.*, 1969; Coleman and Weininger, 1969; Ossoinig, 1974; Restori and Wright, 1977; Restori, 1978) only A- and B-scan techniques are in routine use. Ultrasonic frequencies suitable for ophthalmology range between 5 and 20 MHz.

First reports of the A-scan technique appeared in the 1950s (Mundt and Hughes, 1956; Oksala, 1958). The transducer is generally coupled directly to the anaesthetised eye by means of methyl cellulose. The echoes are recorded as spikes on a cathode ray tube; the height of the spike indicates the amplitude of the echo, and the position of the spike along the horizontal axis is a measure of the arrival time of the echo at the transducer. The normal A-scan appearances are well known, and diagnosis is made on the basis of the position, the extent, the amplitude, and the movement of abnormal echoes together with the sound-attenuating properties of the abnormality. Some workers place great stress on accurate measurement of abnormal echo amplitudes (Ossoinig, 1974); however, the amplitudes of echoes from large interfaces, such as membranes, are highly dependent on inclination, making quantification tedious.

The use of the B-scan technique in ophthalmology was first described by Baum and Greenwood (1958). The sound is coupled to the eye either by a saline bath or by means of a gel applied to the closed eyelid. The echoes are displayed as spots, the brightness of which indicate the echo amplitude. The transducer is moved to many positions across the eye, and a whole series of intensity registrations are recorded. The resulting B-scan displays a cross-sectional image through the eye and orbit as illustrated by McLeod and Restori on page 533 of this issue.

The transducer may be moved across the eye in a straight line to produce a *linear* B-scan or it may be rocked through an angle to produce a *sector* B-scan. Many of the commercially available B-scanners are of the sector type. Linear and sector B-scans present only partial outlines of the globe, so the eye must be examined in many directions of gaze. Alternatively, a more complete outline of the globe may be achieved by combining the linear and sector transducer movements (*compound* B-scan). B-scans are generally taken in the horizontal plane at regular intervals.

The transducer may be moved manually or mechanically to produce a B-scan. Alternatively, an array of transducers or transducer elements may be fired electronically in sequence to simulate a linear-moving transducer (linear array) or a sector-moving transducer (phased array) respectively. Rapid B-scanning (Bronson, 1974; McLeod and others, 1977) permits dynamic studies of abnormalities in 2 dimensions and thus greatly enhances the recognition and interpretation of such structures. A full lateral deviation of the eye takes approximately 0·1 second, while aftermovements of abnormalities, for example of a detached vitreous gel, are considerably slower (of the order of 1 second). Thus, B-scanners with frame rates in the region of 8 B-scans per second have sufficient time resolution to resolve any such aftermovements. Improving the time resolution on the B-scan by faster scanning, however, has the advantage of reducing flicker on the display and permits easy recording on to standard cine or video systems.

Diagnosis with B-scanning depends on the qualitative recognition of patterns, based on the location, the distribution, the number, the amplitude, and the movement in 2 dimensions of the abnormal echoes. In addition, the sound-attenuating properties, determined by changes in appearance of deeper structures, may aid in the identification of a lesion. Many workers are still using the A-scan technique as a sole means of examination. Others combine the B-scan and A-scan techniques, using the B-scan to provide topographical information and the A-scan to quantify the amplitudes of abnormal echoes. This need for A-scan reflects the unsatisfactory grey scale on most commercially available B-scanners. In the near future as many of the technical problems associated with arrays are overcome it is expected that a selection of high-quality grey-scale, rapid ophthalmic B-scanners will become available.

Much research is now being directed into rigorous analysis of scattered echoes (Lizzi *et al.*, 1976), and the use of computers in this field is expanding. Computers are also being used to generate acoustic images from pulse-echo data. Both of these techniques may improve the accuracy of ultrasonic diagnosis in ophthalmology.

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