B-scan ultrasonography in the evaluation of retinal detachment

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The use of B-scan ultrasonography was first reported by Baum and Greenwood (1958), who described their results as equivalent to the first x rays. As they predicted, improvement in equipment and technique has led to increased resolution of ocular structure being obtained by B-scan ultrasonography. The clinical application of the B-scan has been described by Coleman and Jack (1973) and the reliability of diagnosis of retinal detachment placed at 100 per cent. (Coleman, 1972). Previous fears of ocular hazards and difficulties in technique (Ballantyne and Michaelson, 1970) have so far proved groundless.

The purpose of this communication is two-fold:

(a) To present the results of B-scan examination of the eye, using a standard ultrasonic machine, which has been designed primarily for abdominal and obstetric use and which should be available in most general hospitals;

(b) To illustrate the usefulness of B-scan echography as an additional approach to the assessment of retinal detachment as a confirmatory or diagnostic aid.

Material and methods

(1) Apparatus (Fig. 1)
The Nuclear Enterprises Diasonograph 4102 is currently in use at this hospital for abdominal, cardiac, and ophthalmic echography. The image of the orbit presented on the B-scan oscilloscope has been increased by a simple modification by the makers to twice life size, resulting in a substantial improvement in the resolution of the system.

(2) Preparation of the patient
Acoustic coupling between the transducer and the eye is achieved by a direct water bath. The patient lies supine on the examining couch, and the periorbital skin is cleaned with Hibitane solution and dried thoroughly. A small piece of steri-tape is applied to the eyebrow (this minimizes discomfort on removal) and an ophthalmic steri-drape (3M Ltd.) is made to adhere to the periorbital skin. Two drops of amethocaine 1 per cent. are instilled into the lower fornix, and a Barraquer speculum is used to retract the eyelids. The edges of the plastic steri-drape are then drawn up through a 6" diameter metal ring to which the sheet is secured. Ringer lactate (pre-warmed to 37°C.) provides the coupling medium for transmission of the sound waves from the ultrasonic transducer to the eye. The examination is completed in 10 to 15 minutes, and is well tolerated by the patient. To date no ocular mishap has occurred in over 100 examinations. Several patients have had echographs of both eyes taken consecutively without demur.
(3) Scanning technique
The compound linear-sector scan (Coleman, 1972) is used and acoustic "tomograms" are taken at
intervals of approximately 2 mm. above and below the horizontal equator of the globe with the eye
in the primary position. In this way a three-dimensional concept of the eye and its contents can be
built up. Secondary positions of the globe can be used to allow more effective examination of the
pars plana. All scans are made with a 5 MHz transducer and recorded on Polaroid film.

(4) Patients studied (Table)
33 cases of retinal detachment have been studied. Of the two cases with inflammatory eye disease,
one was due to retinal vasculitis, and the other severe posterior uveitis. Histological confirmation
of melanoma has been obtained in one of the cases of neoplastic detachment; the other is still
under observation.

Table 1 Diagnosis in 33 cases of detachment

<table>
<thead>
<tr>
<th>Type</th>
<th>Number</th>
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<tbody>
<tr>
<td>Primary</td>
<td></td>
</tr>
<tr>
<td>Neoplastic</td>
<td>13</td>
</tr>
<tr>
<td>Vitreous haemorrhage</td>
<td>6</td>
</tr>
<tr>
<td>Trauma</td>
<td>6</td>
</tr>
<tr>
<td>Inflammatory eye disease</td>
<td>2</td>
</tr>
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<td>Aphakia</td>
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33
Results

NORMAL OCULAR APPEARANCES (Fig. 2)
Echoes are received from anterior and posterior surfaces of cornea, lens, and iris. The aqueous and vitreous are transonic areas and appear black. The retina, choroid, sclera, and retro-orbital fat appear as a single mass of echoes (white area) at the posterior wall of the globe. The position of the optic nerve is seen as an acoustically clearer “indentation” of the retro-orbital fat. The vitreous chamber gives no echoes, and presents a smooth concave surface from the ora serrata posteriorly.

FIG. 2 Normal ocular appearances. Position of optic nerve shown by arrows
FIG. 3 Total retinal detachment. Attachment of retina to optic nerve head shown by arrow

PRIMARY RETINAL DETACHMENT

(1) Total retinal detachment (Fig. 3)
A total primary retinal detachment appears as a thin continuous line of echoes from the ora serrata to the optic nerve and back again. The subretinal fluid is transonic.

(2) Partial retinal detachment (Fig. 4)
A small flat retinal detachment is seen in Fig. 4, where a 2-mm. separation of the retina is seen to extend to the optic nerve on the temporal side only. As with any detachment, its full vertical extent is estimated by making serial scans.

FIG. 4 Detached retina (1) and optic nerve (2)
(3) Complex retinal detachment (Fig. 5)
Fig. 5 shows a detached retina as a complication of vitreous traction with extensive fibrous proliferation. Retinal tissue can be traced posteriorly to the optic nerve and the remaining echoes are presumed to be dense fibrous bands.

FIG. 5 Detached retina (1) and fibrous band (2)

FIG. 6 Margins of anteriorly placed tumour outlined by arrows

SECONDARY RETINAL DETACHMENT (Fig. 6)

(1) Neoplastic
A ballooned retinal detachment is seen to be widely separated from a choroidal tumour by a transonic area, which is probably fluid in nature—most likely serous transudate from the tumour area.

(2) Vitreous haemorrhage (Fig. 7)
Of thirteen cases of vitreous haemorrhage, only one has shown evidence of echoes on ultrasonic examination (Fig. 7). Three of these cases were found to be complicated by retinal detachment.

FIG. 7 Using minimum attenuation of sound waves, echoes received (arrow) from vitreous haemorrhage

(3) Traumatic retinal detachment (Fig. 8)
A post-traumatic retinal detachment is shown in Fig. 8. Stronger than normal echoes were received from the apex of the detachment in the equatorial plane, indicating the position of an intraocular foreign body, just anterior to the detachment.
POSTOPERATIVE ASSESSMENT (Fig. 9)

Fig. 9 is a postoperative record of Fig. 4. The position of a scleral plomb is indicated by strong reverberating echoes lateral to the scleral surface. Only partial reapposition of the retina has been achieved, as an area of retinal separation can be seen at the posterior pole for about 4 mm.

Discussion

In the preoperative evaluation of retinal detachment, several factors are taken into account, including the nature of the detachment, i.e., whether it is primary or secondary, the localization and extent of the detachment, the presence of retinal holes and tears, and the state of the vitreous. Lack of clarity in the optical media may confuse the issue in direct and indirect ophthalmoscopy and in fluorescein angiography in cases of suspected solid tumours. B-scan ultrasonography circumvents this problem by providing information as to the presence, locality, and extent of detachment in cases in which the media are opaque and also in which the detachment is anteriorly placed (as in Fig. 6). In this case fluorescein angiography was unhelpful, despite the clear media, because of the anterior position of the tumour and the considerable separation of the retina from the tumour site. Although the neoplastic nature of the detachment was suspected on the clinical basis of the neovascularization on the retinal surface, a definitive diagnosis of a tumour was made only from the B-scan appearances. A histological diagnosis of amelanotic melanoma was made after enucleation.

In the management of retinal detachment where the optical media are obscured, e.g., by corneal nebula, early cataract, or vitreous clouding, B-scan ultrasonography can be of value in deciding the extent and type of surgical intervention. The exact localization and extent of the detachment is demonstrated and the optimum positioning of a scleral plomb may be determined (Fig. 4). The decision whether or not to drain subretinal fluid at the time of operation may be influenced by the magnitude of the subretinal space as recorded on B-scan (Fig. 2). The postoperative B-scan examination will show the amount of reapposition of the retina to the pigment epithelium which has been achieved (Fig. 9).

Cases of vitreous haemorrhage are currently under assessment in this department for possible treatment with intravitreal injections of urokinase (Forrester and Williamson, 1973). Those cases in which the intraocular haemorrhage is complicated by retinal de-
attachment and/or dense vitreous fibrous bands are at present excluded, since a visual result is unlikely to be obtained. B-scan ultrasonography gives an immediate diagnosis as to the presence of such conditions. Fig. 5 is the B-scan of the right eye of a young diabetic woman with bilateral vitreous haemorrhages, in whom the presence of a retinal detachment was suspected, but the definitive diagnosis came only from B-scan.

As has been stated above, using the standard model Nuclear Enterprises Diasonograph 4102, in thirteen cases of vitreous haemorrhage we have so far detected the presence of blood in only one case (Fig. 7). This is in contrast to the findings of Coleman (1972) who has recorded various echoes from vitreous haemorrhages. His percentage reliability in the diagnosis of vitreous haemorrhage per se has not been stated, but he has hinted that a number of cases are transonic. There are two possible explanations in this situation: either the sensitivity of the diasonograph is inadequate to detect the weak echoes arising from the vitreous blood or, as Oksala (1960) has noted with A-scan ultrasonography, vitreous haemorrhages will not give rise to echoes when the haemorrhage is old and spread diffusely. Our one case of positive echogram was a fresh, resolving vitreous haemorrhage.

In the case of a retinal detachment secondary to an intraocular foreign body (Fig. 8), the proximity of the foreign body to the detachment suggests that it may be embedded in retinal and/or pre-retinal fibrovascular tissue. This information is valuable to the surgeon as it gives him a guide to the difficulties he is likely to meet in the extraction of such a foreign body. Also the prospects for reattachment of this retina are poor.

The diagnostic criteria for retinal detachment using B-scan ultrasonography have been fully described by Coleman (1972) and our initial experiences with this technique confirm them. Using standard equipment, designed for abdominal or obstetric examination, satisfactory echograms can be obtained, giving useful information on the nature of retinal detachments. The test is simple, rapid and non-invasive, causing little discomfort to the patient and in our experience no ocular mishap has occurred. In patients with opaque media and suspected secondary neoplastic detachment it is the diagnostic method of choice.

Summary
The ophthalmic application of the standard model Nuclear Enterprises Diasonograph 4102 which is widely used for abdominal and cardiac ultrasonography is described. It is a simple, rapid method of examination and provides information on the ocular and orbital structures which might not be available by other means. In particular, its role in the evaluation and management of retinal detachment is discussed. In cases of opaque media or suspected solid tumours it is recommended as the diagnostic method of choice.

I wish to acknowledge the much appreciated guidance of Dr. John Williamson, consultant ophthalmologist at the Southern General Hospital, Glasgow.

References

COLEMAN, D. J. (1972) Amer. J. Ophthal., 73, 501
— and jack, R. L. (1973) Arch. Ophthal. (Chicago), 90, 29
FORRESTER, J. V., and WILLIAMSON, J. (1973) Lancet, 2, 179