A NEW TECHNIQUE FOR OPENING THE CANAL OF SCHLEMM*

PRELIMINARY REPORT

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THERE are many reasons for supposing that a perfect goniotomy would be a successful operation for several types of glaucoma, and Barkan (1936) tried it in some cases of chronic simple glaucoma. Apparently his results were not satisfactory, since he gave up this technique for this type of case, and recent histological evidence presented by Maumenee (1959) suggests that goniotomy in practice is not quite the same as goniotomy in theory. The ciliary body and scleral spur are probably maximally affected and it is doubtful whether the trabecular meshwork is efficiently divided.

If this could be done, especially if it could be effected without bleeding, and if the obstruction to outflow of the aqueous humour did lie in the trabecular meshwork (a point about which there is still no certainty), then a new and hopeful type of glaucoma surgery would have been initiated.

Prompted by earlier experience of the injection of the canal of Schlemm in the Department of Pathology at the Institute of Ophthalmology, a series of experiments has recently been carried out at the Western Ophthalmic Hospital, London (St. Mary's Hospital). Using cadaver human eyes, a technique has been devised by means of which access is gained to the canal of Schlemm by an *ab externo* approach, and the canal is then opened into the anterior chamber over a wide area, almost half the circumference of the limbus.

Following the experiments on cadaver eyes a similar operation was performed on a living subject immediately before removal of the eye for malignant melanoma of the choroid, and it is this operation which is now described.

Procedure

General anaesthesia was employed because an enucleation was to follow but a local anaesthetic would probably be satisfactory for the trabeculotomy. An operating microscope was used (Beck's Lomag) giving a magnification of $\times 6.5$.

A superficial incision across the limbus and about 3mm. long was made at 12 o'clock. This was gradually deepened under microscope control, pushing the corneal and scleral fibres sideways with the knife to effect slight widening, until the

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FIG. 1.—First incision. The canal appears as two small black dots on each side of the incision as it is widened by pushing the corneal and scleral fibres sideways; Descemet's membrane and the deepest scleral layer are not penetrated. The trabecular meshwork can be seen between the black dots; it appears as a narrow band of circumferential fibres at the corneo-scleral junction.
FIG. 2.—Nylon thread inserted into the canal.

FIG. 3.—Second incision. Nylon thread found in the canal is pulled out and the free end is inserted into the next sector of the canal.

FIG. 4.—Third incision. Nylon thread pulled out and free end is secured by a knot and clamp.

FIG. 5.—The nylon is pulled firmly from the first point of entry and appears in the anterior chamber like a bowstring, having burst through the antero-internal wall of the canal of Schlemm.

canal was entered from its outer aspect. This was recognized by the appearance of a narrow band of circumferentially directed fibres at the corneo-scleral junction in the depths of the incision and a small black dot in each side wall (Fig. 1). There was no loss of the anterior chamber but a trickle of bloodstained fluid could be seen welling up from the canal into the incision.

A fine nylon suture was then pushed into the canal and along it until it would go no further (Fig. 2). From previous experience with the cadaver eyes, it was known that the nylon traversed just less than a quarter of the circumference; a similar incision was therefore made at the 2 o'clock position and the nylon was found in the canal and drawn out. The free end was then reintroduced into the canal and pushed along the next sector, being pulled out again through a third incision (Figs 3 and 4). The anterior chamber was still present. The lower end of the nylon was then secured by knotting, and, for further safety, by clamping. The end emerging through the upper incision was then gripped with forceps. The position at this stage, therefore, was that there were three small, non-perforating limbal incisions, through the upper and lower of which the ends of the nylon thread emerged, the nylon between these points lying in the canal of Schlemm.

The upper end of the nylon was then firmly pulled and the suture appeared, like a bowstring, in the anterior chamber, having burst through the antero-medial wall of the canal of Schlemm. The nylon thread was then withdrawn from the eye by pulling it gently out through the lower incision. There was still no loss of the anterior chamber and no hyphaema, although a very faint puff of blood could be seen to enter the chamber just as the nylon burst through the canal wall (Fig. 5).

Histological Appearances

In the operated area the canal of Schlemm was put into direct communication with the anterior chamber. In the cadaver eyes the anterior wall of the canal was fractured and the peripheral part of Descemet's membrane separated from the substantia propria, the nylon finally appearing to have entered the anterior chamber by fracturing Descemet's membrane a short distance anterior to Schwalbe's line. The resulting trabecular-Descemet flap tended to fall towards the anterior surface of the iris, causing the canal to gape widely into the anterior chamber (Figs 6, 7, 8, 9).

FIG. 6.—Dissection showing nylon thread in canal.

FIG. 7.—Cadaver eye. The nylon has burst through the anterior wall of the canal and stripped off Descemet's membrane for a short distance, so that the trabecular-Descemet flap falls on to the anterior surface of the iris.

The appearances were much the same in the eye in which the procedure was carried out *in vivo*, except that less of Descemet's membrane was stripped off, so that almost a purely trabecular flap was obtained.

Clinical Implications

The procedure may be of some use in cases of glaucoma due to trabecular block, provided that the healing process does not re-establish an obstruction. This would not seem to be very likely, since the cut edge of Descemet's membrane and the corneal endothelium would presumably only grow back

FIG. 8.—The eye in which the operation was carried out *in vivo* before enucleation for choroidal melanoma. The unoperated side shows a normal (blood-filled) canal of Schlemm.

FIG. 9.—Same eye as Fig. 8. Operated side, showing Descemet's membrane fractured only just anterior to the limit of the trabecular meshwork which tends to fall towards the iris thus widely opening the canal of Schlemm which gapes into the anterior chamber. Note that there is no blood in the opened part of the canal.

until the outer cut edge of the endothelium of the canal was reached. At the apex of the trabecular-Descemet flap, the endothelia should heal rapidly, and there is no reason to suppose that the flap would fall back towards the cornea. In fact, in cases in which there were goniosynechiae, the pull of the iris would tend to pull the flap away and cause the canal to gape even more widely.

In addition to offering hope of benefit in cases of glaucoma due to trabecular obstruction, this procedure might go some way towards solving the problem of the site of obstruction to the outflow of aqueous humour in chronic simple glaucoma.

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