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COMMUNICATIONS

THE PRODUCTION OF A FILTERING CICATRIX IN GLAUCOMA*

BY

SIR RICHARD CRUISE

LONDON

At long last I have obtained for microscopic examination an eye on which I had performed a successful hinged flap sclerotomy 12 years previously. Mr. Eugene Wolff has cut sections which substantiate the theory on which I have operated for the last 25 years.

The theory was that it was possible to establish permanent drainage from the anterior chamber by means of incisions alone, without excision of any tissue.

This drainage was arrived at by enlisting the assistance of the endothelial cells in the formation of a filtering cicatrix (Fig. 6):

1. The technique consists in dissecting a conjunctival flap up to the limbus as in trephining.
2. A triangular flap of corneo-scleral tissue is cut with its blunt apex attached at the limbus.
3. The conjunctival flap is replaced but *not* sutured.
4. Primary union of the corneo-scleral flap is prevented by massaging aqueous through the incision under the conjunctiva,

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which causes the corneo-scleral flap to ride up and delay approximation of its edges.

5. This massage must be done before 24 hours have elapsed, and continued for a week or ten days, otherwise there will be a tendency to premature union.

6. Primary union is delayed deliberately to enable endothelial cells to proliferate and insinuate themselves between the cut margins at the expense of the normal C.T. cells and form a permeable track through the periphery of the anterior chamber (Fig. 6). It follows then that the greater the length of incision through endothelial lined tissue, compatible with safety from iris prolapse, the more consistent will be the result. My experience is that incisions amounting in linear measurement to 9 mm., formed by a blunt apexed triangle with a 5 mm. base and lateral cuts 2 mm. give the best results.

In the *Trans. Ophthal. Soc. U.K.*, 1940, I described the operation I performed for many years, using a keratome and angled knife for the lateral cuts (Figs. 2 and 3). There was frequently some difficulty in making the lateral cuts owing to the mobility of the small amount of tissue involved and other manipulations, and, in fact, a colleague admitted to me that though appreciative of the results obtained, he did not adopt my method because it was *too difficult*.

As difficulty in the performance of an operation is a serious handicap to its popularity, I have evolved the following technique, which demands the minimum of digital dexterity or risk (Figs. 4 and 5):

1. A flap of conjunctival and subconjunctival tissue is dissected down to the limbus, splitting the cornea for $\frac{1}{2}$ mm.

2. A special hook with a very sharp point is inserted into the corneo-sclera just above the limbus, so as to get a firm hold of the eyeball.

3. The anterior chamber is entered by dissecting through the sclera $1\frac{1}{2}$ mm. from the limbus with a scalpel or Graefe knife for a distance of 5 mm. If the aqueous is permitted to escape slowly the iris does not prolapse. If it does, it can be replaced with a repositor and there will be no tendency for iris protusion when the posterior chamber is empty.

4. While the corneo-scleral lip of the incision is held by the hook, with a pair of sharp-pointed scissors two lateral cuts of 2 mm. are made, one at each end of the incision, and sloped towards each other, so as to make a blunt angled hinge, with the apex towards the cornea.

5. The conjunctiva is replaced but not sutured. If the conjunctival flap is thick, as it is in some cases where there is plenty of subconjunctival tissue, a suture that merely keeps the flap from flopping forward may be inserted, but never pulled tight, as this

would tend to hasten healing. By this means an incision of 9 mm. has been made in endothelial lined tissue, and my experience is that this is adequate to produce an endothelial paved cicatrix with minimal risk of prolapse of the iris.

The late Colonel Herbert in 1907 introduced his operation of flap sclerotomy, whereby he obtained in a certain percentage of cases a filtering scar and permanent reduction of tension. Unfortunately, there was a larger percentage in which no filtration took place, and on account of the unreliability of the results, Colonel Herbert gave it up, and in 1921 substituted a form of iris inclusion with a cystoid scar.

Colonel Herbert explained the results he had obtained in flap sclerotomy as due to a shrinking of the tissue between his incisions, and persevered with what he described as "wedge isolation" for the purpose of obtaining consistent shrinking. The wedge, he stated, "may be likened to a disconnected graft of fibrous tissue . . . and like any completely separated graft, may be confidently expected to shrink in bulk. The shrinkage should provide for filtration." Herbert's operation with its incisions, which were varied with much ingenuity, was unsuccessful because the basic principle, "shrinkage of tissue," was incorrect.

Figs. 1, 2, 3. Blocks kindly lent by the Council of the Ophthalmological Society of the United Kingdom.

The question of endothelial cells being responsible for the filtration was never considered, and as far as I am aware endothelial activity has never before been taken into account and deliberately utilised.

Some years later, after an interlude of enthusiastic trephining for glaucoma, my satisfaction with that operation was shaken by two cases of late infection in my private practice. I therefore tried Herbert's operation, without arriving at any consistency in results, while aiming at shrinkage of the isolated wedge of tissue. However, in one case on which I had performed a flap sclerotomy, and which had firmly healed at the first dressing, I opened up the incision subconjunctivally with a repositor, and repeated the performance on two succeeding days. I found that the oedematous area over the incision remained boggy, and was undoubtedly permitting leakage of aqueous. It was obvious that prevention of union and delay in healing was the key to the situation. The only explanation that seemed feasible was, that there must be outgrowth of endothelial cells that would allow aqueous to percolate through the incisions and form a filtering cicatrix (Fig. 6). Later on, in the *Trans. Ophthalm. Soc. U.K.*, 1940, before I obtained microscopical proof, I submitted that it was a race between the endothelial and connective tissue cells, and the type of scar, filtering or impermeable, depended on which type of cell predominated in its formation.

I was impressed by a paper by Thomson Henderson, in the "Ophthalmoscope," 1907, on "So-called filtering cicatrices in the treatment of glaucoma." He poured scorn on the possibility of such an occurrence, stating that "the endothelium seals the inner margin of the incision and that it is this endothelium that precludes all possibility of a permanent filtering cicatrix following any operative incision, however devised." This statement was histologically correct for *normal* healing.

However, accompanying his paper is a very instructive illustration of the normal healing of a limbal incision taken from a case that died suddenly 8 days after operation. This shows the endothelium growing forward into the irregular posterior margin of the corneal incision to meet the fibrinous plug that was forming primary union. It occurred to me that if this fibrinous plug could be prevented from consolidating and interference with normal healing deliberately achieved, enterprising endothelial cells, unable to bridge a gap, would tend to grow into, and line, the gap. My aim has been to prevent normal healing by deliberately keeping the incisions apart; this is achieved by massage, which expresses the aqueous under the conjunctival flap, and thereby raises the hinge flap of corneo-scleral tissue with its endothelial lining. This gives time for the endothelial cells to proliferate and line the margins of

the incisions, and instead of " sealing " off the incisions, renders them permanently permeable.

Now that there has been histological verification of my clinical hypothesis, I feel I am justified in strongly advocating the hinge flap sclerotomy as the operation of choice in cases of chronic glaucoma.

FIG. 4.

FIG. 5.

FIG. 6.

Scheme as suggested to R.C. to indicate method by which sclerotomy produces permanent drainage. Note endothelial lined track.

For 25 years I have aimed at utilising the endothelium of the anterior chamber as my accomplice in committing an offence against nature, that is, the prevention of the normal healing by primary union of every incision into the anterior chamber, without excision of any tissue.

The evidence supplied by the regular periodic visits of cases in one's private practice where alone accurate tonometric observation

FIG. 7.

Low power view of the area of drainage, with a portion of the track leading from it.

FIG. 8.

Portion of Fig. 7 under higher power.

can be maintained over periods varying from 6 months to 25 years, fortifies me in my conviction that the "offence" has been justified.

I have to thank my late House Surgeon, Mr. Dermot Pierse, for his excellent drawings of the operation, and for his comment, "I hope your paper will have the desired effect of changing the views of the many die-hard trephine enthusiasts. I am very satisfied with the results I obtain from the operation."

Mr. Boxill, another House Surgeon, is not less enthusiastic. Evidence from successive generations of House Surgeons, with

their varied experience of various surgeons, and their ill-concealed intolerance of any misadventures by their seniors, is not a negligible criterion.

The eye which is the subject of histological investigation by Mr. Eugene Wolff, was obtained by a most fortuitous chain of circumstances within 3 hours of the death of the patient. It was noted at the time of the removal of the eye that aqueous could be expressed from the anterior chamber into the subconjunctival tissues. The eye was fixed in Zenker and serial sections cut in celloidin. The sections were stained with haematoxylin and eosin, van Gieson, Mallory's triple stain, Mallory's phosphotungstic acid haematoxylin and Verhoeff's elastic tissue stain.

The boggy area of filtration is covered by thinned conjunctival epithelium containing two to four layers of nuclei (Figs. 7 and 8). It is limited above by a characteristic papillary-like thickening of the epithelium. The drainage area itself is largely filled with a very delicate spongework of connective tissue with here and there some fine fibres which stained like Descemet's membrane.

The actual track in the corneo-sclera also was not empty as might be thought from haematoxylin and eosin stained sections. But sections stained with Mallory's triple stain show it to be filled

FIG. 9.

Drawing of a portion of the track to show endothelial lined and bare areas.

FIG. 10.

Microphotograph of portion of the track to show endothelial lining.

with the same spongework of very delicate connective tissue as the drainage area. Here and there also are some spots of pigment.

The walls of the track are in part lined by very definite endothelium (Figs. 9 and 10), while in others the sclera is bare, and it is a very remarkable feature that where the sclera is bare it has apparently undergone no change since the day the incision was made some twelve years ago.

In many of the sections a portion of Descemet's membrane is seen (Fig. 9). This is no doubt due to the fact that Descemet's membrane tends to curl forwards when cut.

Comment

An endothelial lining to filtering scars is usually denied but there can be no doubt of its presence here. The fact that the sclera has shown no signs of healing appears to bear out Thomson Henderson's theory that tissues bathed by the aqueous are not stimulated to show the usual signs of repair.

THE FLAP SCLEROTOMY IN THE TREATMENT OF GLAUCOMA*

BY

W. M. DE C. BOXILL

LATE R.M.O., ROYAL WESTMINSTER
OPHTHALMIC HOSPITAL

SINCE the introduction of a similar operation by the late Colonel Herbert in 1907, but based on an erroneous hypothesis, the technique of the flap-sclerotomy appears to have been considerably varied by those few who, in the past, have used it in the treatment of chronic primary glaucoma. The technique, which will later be described, has arisen through the work of Sir Richard Cruise at the Royal Westminster Ophthalmic Hospital during his long and successful association with that hospital, and it is through the efforts of this great master of the simple extraction operation for cataract that an even simpler method of permanent decompression of the hypertensive eye has been evolved.

In the past this operation has mostly been confined to cases of chronic glaucoma particularly the primary ones. Recently it has been performed with success on acute congestive hypertensive eyes which did not respond to medical treatment. The technique in both

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