

We see therefore that the buphthalmic eye with the average measurements chosen above would have to be 31 mm. long in order that it might be emmetropic. It is interesting to note that the *normal abhakkic eye*, i.e., the aphakic eye with normal corneal curvature, must also be 31 mm. long in order that parallel incident rays may be focussed upon the retina. Such an eye, before the lens is removed, would have a myopia of $(31-23) \times 3 = 24$ D.

E. L. Gros.—Étude sur l'hydrophtalmie ou glaucome infantile.
Ferraris' Dioptric Instruments—H.M. Stationery Office, 1919.

AN IMPROVED IRIS PROLAPSE OPERATION FOR GLAUCOMA

BY

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THIS paper is supplementary to the somewhat cursory description of work done in India, published in the *Trans. Ophthal. Soc. U.K.*, Vol. XXXIX (1919), p. 218. To make the subject fully intelligible to those who do not see the *Transactions*, an outline of salient facts is included here.

The facts and arguments collected below form a reasoned plea for a fairly general utilization of the prolapse operation in this country. The appeal is timely, since many surgeons have been driven back to iridectomy by late infections following sclerectomies. This is surely a retrograde step, an unwarranted confession of failure in the professed filtration methods as a whole. Extremely valuable though iridectomy has been, it is for ever discredited as a satisfying future treatment by the fact that it fails most often (1) when most perfectly performed, and (2) where least is asked of it, in the more chronic simple glaucomas. One can never again rest content to ignore the urgent call for clinical and pathological research to explain these iridectomy results fully, and to explore the possibilities contained in them.

Method.—A purely subconjunctival sclero-corneal incision, about 6 mm. long, is made above, close to the limbus, with 1 mm. Graefe knife. The only conjunctival puncture is 3 mm. away from the limbus; from this point the conjunctiva is slid on the point of the knife. The puncture is enlarged a little when withdrawing the knife. It is quite easy to avoid wounding the conjunctiva at the counter-puncture, by beginning short sawing movements as soon as the point of the knife is seen perforating the sclera. Through this section a wide fold of iris is drawn up under the conjunctiva (see later), where it is transfixed and incised by the same narrow

knife cutting upwards. Atropin is instilled at once, two or three times, and repeated several times daily, mainly to prevent displacement of the pupil upwards.

Result.—In chronic glaucomas, however advanced, in which the rise of tension has been moderate, this has commonly been the whole treatment; the tension has remained low, and the prolapsed iris has remained flat or nearly so. The visible iris has become changed into white fibrous tissue, evidently remaining as impervious to aqueous as normal iris tissue, and forming a protective plate beneath the unchanged conjunctiva. Filtration of aqueous has developed evidently at the margin of the prolapse where the iris was incised.

It would have done so sufficiently early in most cases to prevent a return of tension, even if the iris had not been cut. The cutting has been done more particularly to prevent bulging of the prolapse.

Drawbacks.—The enlargement of the pupil is less, but the astigmatism produced generally greater than in classical iridectomy. These disadvantages are sufficient to bar the application of the method in fairly mild and early glaucomas with unimpaired central vision, which are likely to yield fully to such operations as my small flap sclerotomy (*Trans. Ophthalm. Soc. U.K.*, Vol. XXX [1910] p. 199), which leave a normal pupil.

Two special drawbacks have been in evidence, particularly in the more severe advanced untreated chronic glaucomas. There has been (1) a recurrence of plus tension in three weeks or less, resisting the use of eserine and massage. Though there is reason to believe this rise of tension would have come to an end spontaneously sometime within three months, obviously we could not afford to wait for this ending. In order to preserve sight, the tension had to be kept low during this period by repeating the sub-conjunctival marginal incision of the prolapse, perhaps two or three times. The tension has then finally remained low. In somewhat earlier cases, the eyes being not so hard, there have been some slight and very transient returns of tension subsiding without supplementary incision. (2) Before, with, and after these rises of tension came more or less unsightly bulging of the prolapse. Where, as not infrequently happened, only the base of the iris had come into the wound, the elevation was correspondingly less than when the whole width of iris was included.

There was no opportunity of determining whether or in what degree some of the prominences may have remained permanently, but the tendency was to slow subsidence. In a few of my earlier cases no incision of the displaced iris was made till ten days or a fortnight after the primary operation. The early bulging was then possibly greatest in the lower grade glaucomas. Fig. 20 on p. 224 of the *Trans. Ophthalm. Soc.* 1919, shows the late result of such a

case. Before the iris was cut it stretched to form a prominent sausage-shaped swelling covering the incision, and this excessive stretching may account for the imperfect sclerosis seen at the outer part of the prolapse. But the collapse brought about by one incision was complete and permanent. There was no stiffening from fibrinous deposit, such as took place apparently in the advanced higher grade glaucomas. The selection of this method may become most imperative precisely in the desperate cases in which the drawbacks are most likely to be pronounced and prolonged. But where one is struggling to preserve the little sight remaining, perhaps in one eye only, these troubles are very minor considerations.

Advantages.—If the promise shown hitherto is fulfilled later, the method has the inestimable advantage of combining certainty with safety in advanced chronic glaucoma, in a measure not hitherto approached.

(1) According to present observation, while *lasting hypotony is never produced*, complete removal of abnormal tension is assured by these wide iris-inclusions in all primary glaucoma with any vision still remaining. (I have almost no experience of it in absolute glaucoma, and do not intend to enlarge that experience.)

In the question of *permanence*, my very long negative Indian experience may count, though it relates mainly to much smaller prolapses. In 1903 (*Trans. Ophthal. Soc.* Vol. XXXIII, p. 324) I reported on 130 iris-prolapse operations of various kinds, and since then have returned to them repeatedly in all intervals between attempts at the formation of satisfactory iris-free cicatrices. I only remember one late return of tension in the whole list of cases. In this instance the iris was particularly rigid and narrow from chronic glaucomatous changes, and the prolapse was correspondingly small.

The spontaneous ending of the recurrent tension seen, after the present operation, as also of the period of tendency to such tension where the actual return of tension is mostly prevented by treatment, is strongly suggestive of permanency.

(2) Possibly there is no absolute security from the risk of disaster of vascular origin in operating in advanced chronic glaucoma. [See my two cases recorded in the *Ophthalmoscope*, Vol. XII. (1914) pp. 5-6.] But as yet the invariable absence, in these purely sub-conjunctival operations, of the serious accidents so much in evidence among my early Bombay iridectomies is most encouraging. Though the fields of vision were never taken, many of the eyes operated upon evidently had extremely small fields; but they did not suffer on that account.

(3) *Safety from infection, early and late.*—This crucial question must be met squarely and honestly. The time has come, and is long overdue, for discrimination among the widely varying types

and results of iris prolapse and incarceration. The old general condemnation of all alike must be rejected.

I believe that many of my Indian results were absolutely safe from ectogenous infection of all kinds. And yet these prolapses differed only in detail—all-important detail—from Bader's, found wanting in 1882 (*Trans. Ophthalm. Soc. U.K.*, Vol. II, p. 127).

Taking early infections to include all such as might have taken place within the periods of continued observation practicable in our Indian hospital treatment, my extensive experience is certainly of value. This experience of prolapse both in glaucoma and cataract work, purposeful and accidental, showed clearly that early infection could be excluded by (1) effective conjunctival antiseptics before operation,* and by (2) securing a complete conjunctival covering for the prolapsed iris [see *Trans. Ophthalm. Soc., U.K.*, Vol. XXIII (1903), 325 and 327; also my books on cataract extraction].

In the matter of *later* infection negative observation is of little value, particularly in India. But of recent years valuable positive knowledge of infected scars has accumulated. I have myself seen late destructive inflammation which had gained entrance through prolapsed iris, both covered and uncovered by conjunctiva. The conjunctival covering was either vesicular or defective through the formation of stomata.

In the wide prolapses now dealt with great reliance must be placed on (1) the absence of any clinically recognizable changes in the overlying conjunctiva, and on (2) the white fibrous change which takes place in the visible iris tissue. The progressive loss of colour is very striking and easily estimated in the deeply pigmented Indian iris. I have seen the whole iris surface uniformly dull grey within three months, uveal pigment being visible only at the margin, lying mostly free in the conjunctiva. Later, this grey surface becomes quite white. In this country the change may excite little notice unless steps are taken to see the final result.

In the perfect result this fibrosis is uniform and complete. The causes of irregularity in the change seem now tolerably clear, though doubtless there may be more yet to be learnt in this respect. So far as present indications go, little difficulty is likely to be experienced in securing the desired condition, except perhaps where recurrent tension is most prolonged and troublesome.

Particular care should be taken to avoid injuring this portion of iris in operating [see *Trans. Ophthalm. Soc. U.K.*, (1919), p. 223]. And the formation of a *wide* prolapse is perhaps especially indicated where the tension is highest, to diffuse the filtration as much as possible. Apparently any considerable subsequent stretching of the prolapse is to be avoided [see above, p. 4, lines 14-15, and below, p. 12,

* This conjunctival antiseptics was not found commonly necessary in my latest Indian glaucoma work, and the same applies in this country.

lines 11-14]. That is to say, incision of the iris if omitted at the primary operation, should not be deferred longer than about ten days and it should be repeated afterwards immediately there is rise of tension not fully controlled by eserine and massage.

It is possible that some adhesion of the conjunctiva to the sclera, a result of former operation, may occasionally tend to produce unevenness in the elevation of the prolapse. But this should be preventable by incision of the subconjunctival tissue (see below).

When the fibrotic change in the iris is complete we have, in place of vulnerable uveal tissue, an impervious shield throughout the neighbourhood of the limbus, conducting the leaking aqueous beneath it to a wide area where the conjunctiva is free and movable, and where the only change is a diffuse oedema.

It is a complete reversal of our attitude to prolapse in general now to regard changed subconjunctival uveal tissue as an efficient safeguard against late infection, instead of as a permanent grave menace to both eyes, an unjustifiable infliction.

The prolapsed iris has been found noticeably thickened and rigid at supplementary cuttings in one or two severe glaucomas (see below, lines 9-10). Though troublesome in delaying the establishment of filtration, this thickening has perhaps a compensating advantage in affording increased protection against the penetration of surface organisms, in the very advanced cases in which this protection appears most needed, *i.e.*, where the factitious leakage needs to be greatest.

Recent utilization of the method in this country.—The first operation was performed last July in a case of severe haemorrhagic glaucoma, with considerable vitreous opacity, the result of retinal venous thrombosis. It was selected as the supreme test of the safety and efficiency of sub-conjunctival operation, presumably a more severe test than would be furnished by any primary glaucoma.

After the incision had been made nothing more could be done owing to the bleeding which took place, freer than any I have seen in primary glaucoma. Being at least partly intraocular in origin the blood carried the base of the iris into the wound. Afterwards the blood was quickly absorbed.

The first cutting of the iris was done just three weeks later, as soon as the first elevation of tension was detected; and the second incision five weeks later still. Thickening and toughening of the prolapse tissue was then very distinctly noticeable. But after another month the tension felt normal, and the vision had improved from finger counting at a few inches to the same at four feet. The case then looked most promising.

However, in view of the well recognized tendency to extension of the retinal condition, one had no right to expect such a simple ending of the case. Four and a half months after the original operation the Schiötz tension was 6 mm. higher than in the fellow eye; and the fundus, now easily seen, showed a good deal of bright red blood, with some dark blood and white patches. The patient had been working on the land, bending down.

A third sub-conjunctival incision, then made, apparently added to the trouble. Hypphaema appeared and persisted in varying amount, being evidently added to repeatedly. It was in two layers, bright above, dark below. Haemolysis appeared to be responsible for a good deal of inflammatory reaction; there was a broad band of

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bright ciliary injection. The tension was slightly up again in three weeks, and in a little over six weeks it rose to + 2, with considerable pain. A small sub-conjunctival tapping of the prolapse fortunately then gave almost immediate relief. Ciliary congestion, blood, pain, and tension all quickly disappeared. When last seen, two months later, eight months from the beginning of the treatment, the eye was quiet and the tension felt normal; but there was no sight left.

The experience has been distinctly encouraging in its bearing on the treatment of primary glaucoma by this method. It seems highly probable that with an open wound of the same size, the haemorrhage at the primary operation would have been expulsive; but it was restrained sufficiently by the conjunctiva and sub-conjunctival tissue, already infiltrated by aqueous. The reduction of tension after the second cutting of the prolapse, and again, finally, was satisfactory. The incarcerated iris remained almost flat for a long time, possibly stiffened by fibrin, but it stretched and became somewhat prominent as the later tension became pronounced. The stretching was a little uneven, producing temporary unevenness in the fibrosis, but afterwards the only uveal colour visible was quite at the ends of the prolapse.

I have since performed sixteen more of these operations, and attempted the same in three additional cases, but failed to get a satisfactory iris inclusion. These operations have served to emphasize some technical points.

Some points of technique.—Whereas all my Indian operations were first operations, of these the majority had already been treated by small flap sclerotomy. Hence the conjunctiva was somewhat adherent about the middle of the new incision, though not sufficiently so to necessitate preliminary subconjunctival injection of fluid.

This moderate adhesion of the conjunctiva interfered with the drawing of the iris up through the wound. It had never hitherto been found necessary to cut up under the conjunctiva before drawing up the iris, but this was now frequently done while enlarging the conjunctival puncture.

(2) Where only a quarter per cent. eserine solution has been used in preliminary treatment, the miosis usually gives way readily to adrenalin and cocaine instillation. But even where 1 per cent. eserine may have been used beforehand, it is well not to use atropin until after moderate instillation of adrenalin and cocaine. The reason for this is that it is better to operate when the pupil is not widely dilated. In order to widen the prolapse it is often better not to cut the iris at all until a week or ten days after the primary operation. To keep the conjunctiva healthy for this delayed incision the eye is kept open under a shield after the first day.

(3) The iris should be well drawn up under the conjunctiva before it is incised. Otherwise it is likely to fall back into the anterior chamber after it has been cut. This tendency is increased by failure to free an adherent conjunctiva, and by rigidity of the pupil. Thus occurred the failure mentioned above. The iris returned almost entirely into the chamber, mostly after the application of the bandage. Lately, I have used very fine straight forceps for drawing up the iris. The iris is seized near its base. Punctures or tears are permissible only towards the base of the iris, lest the formation of an effective subconjunctival plate be made impossible. To facilitate the introduction of the iris forceps, the conjunctival puncture is now made in a line drawn horizontally outwards from the scleral puncture.

(4) At any subsequent sub-conjunctival incision of a bulging prolapse, the same sliding of the conjunctiva is practised as at the primary operation. The cutting is made as close to the sclerotic as possible. Where the swelling is particularly prominent and rigid, the incision may sometimes be doubled in part, keeping still close to the sclerotic. Isolating a purely marginal narrow strip of the prolapse tissue thus appears unobjectionable, and may aid in the development of permanent leakage.

Preliminary Miotic Treatment

Consideration of the essentially temporary rise of tension seen after these prolapse operations* permits, of a practical deduction, likely to prove of value in the general operative treatment of glaucoma. Three points claim attention :

(1) The rise is evidently largely proportionate to the suddenness, and extent of the drop in tension, and to the previous duration of the plus tension. It was most marked and lasted longest in eyes which were distinctly hard until a few days before operation, and which had been so for a considerable time, as shown by the very small remnant of sight left. Eyes with moderate or minimal elevation of tension were nearly or entirely exempt from recurrence.

(2) There was no other clinical feature to distinguish some of the eyes which provided protracted return of tension. Before operation eserine contracted the pupil fully, with complete reduction of tension, demonstrating the absence of iritic changes and of firm closure of the filtration angle.

(3) The relatively great drop from the higher degrees of chronic tension is perhaps an ample explanation, both of the subsequent rise and of its limited duration. Two assumptions seem warranted in these cases: (a) The aqueous after operation must be more highly albuminous (Treacher Collins, *Trans. Ophthalm. Soc. U. K.*, 1917 and 1918) than in mild and early glaucomas; and (b) the aqueous may not become quite normal again for two months or more, where the vascular changes from the previous prolonged high tension are most profound.

The obvious deduction is that in these eyes in which eserine acted well before operation, much or all of the subsequent high tension might have been avoided by keeping the eyes normally soft for a considerable time beforehand.†

And what is true of these prolapse operations should apply more or less to other filtration operations, including to some extent iridectomy. That is to say, in the attempt to form iris-free filtering cicatrices, any measure which tends to lessen the albumen content of the aqueous, and to restrict the deposit of fibrin throughout the healing period, must aid in the desired object of preventing firm healing. And since a return of tension, indicating firm healing after these operations is essentially permanent, its prevention is much more important than after the prolapse procedure.

Hence there seems reason to lay down the rule tentatively in chronic primary glaucomas, that no eye with continuous plus

* Noted long ago, see *Trans. Ophthalm. Soc. U. K.*, Vol. XXIII (1903), p. 327.

†Note the shortened period of recurrent tension in the case of the second eye reported on p. 225, *Trans. Ophthalm. Soc. U. K.*, 1919, perhaps attributable in part to moderate preliminary eserine treatment.

tension which can be relieved fully by eserine, should ordinarily be operated upon without preliminary miotic treatment lasting for a period proportionate to the degree and probable duration of the tension. A period of two to three months would be the maximum, as far as it can be judged from the recurrences after operation.

Selection of Operation

The above division of chronically glaucomatous eyes into two groups, according to completeness or incompleteness of response to miotics, may be of service in indicating the type of operation suitable to individual cases.

The one group may possibly contain all the cases in which such a simple measure as flap sclerotomy may be expected to succeed. Does it include only these? Pending further development of my thread sclerotomy (*Trans. Ophthal. Soc. U. K.*, 1919), should not some very advanced mild glaucomas, with damaged central vision, be subjected rather to the wide prolapse treatment, even though the tension may give way quite readily to eserine?

The prolapse operation may be perhaps at present the soundest treatment for all primary glaucomas not fully reducible by eserine, and not already operated upon by wide iridectomy. Certainly, the application of the method promises to be much wider than was suggested in the *Transactions* (1919), p. 218.

For use in India I think it is the best routine general operation, suited to the capacity of the average civil surgeon.

The existence of a wide coloboma, while barring the prolapse operation, renders an eye particularly suited to thread sclerotomy. In this operation the only real difficulty lies in preventing adhesion of iris to the wound.

These three operations cover nearly the whole field of primary glaucoma, combining safety with efficiency. Together they go far towards the final solution of the main glaucoma question, which has not proved to be so simple as it once seemed to be.

THE TREATMENT OF PROLAPSE OF THE IRIS FOLLOWING ACCIDENTAL PERFORATING WOUNDS, WITH A NOTE ON THE REMOVAL OF NON-MAGNETIC FOREIGN BODIES FROM THE ANTERIOR CHAMBER *

BY

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PROLAPSE of the iris in connection with accidental wounds of the eye is a fairly frequent occurrence. Many cases are not difficult to

* Read in the Section of Ophthalmology of the Royal Society of Medicine on March 3rd, 1920.