British Journal of Ophthalmology, 1980, **64**, 432–435

Characteristics of reduction of intraocular pressure after trabeculectomy

JEFFREY L. JAY AND STEPHEN B. MURRAY
From the Tennent Institute of Ophthalmology, University of Glasgow

SUMMARY The change in intraocular pressure achieved after 98 trabeculectomy operations performed on 70 patients with primary open-angle glaucoma was analysed. The reduction was proportional to the untreated preoperative pressure, and the results indicated that a first trabeculectomy reduced the intraocular pressure to between 16 and 20 mmHg irrespective of its initial level. Cases which required medical therapy for final pressure control after surgery showed a distribution of initial intraocular pressure similar to those not requiring such therapy. In addition, these cases were reduced to a level of pressure only slightly above the arbitrary figure of 20 mmHg before medical therapy was added, and were therefore considered almost to have reached the normal physiological range. Cases submitted to a second trabeculectomy are discussed, including 2 cases with unexplained acute open-angle glaucoma some months after the first operation.

Trabeculectomy has gained worldwide acceptance as perhaps the safest and most effective drainage operation for glaucoma. While the pressure reducing effect is comparable to that of other drainage procedures, it has been shown to have a lower risk of delayed reformation of the anterior chamber, cataract, and ruptured or infected drainage bleb.[1–7] None of these authors has, however, determined whether or not the eyes with the highest pressure before treatment are the most likely to require supplementary treatment after trabeculectomy. In 1975 Watson and Barnett[8] did state that another operation produced the same absolute reduction in intraocular pressure as the first operation, but Watson (personal communication) has recently revised this opinion.

This paper examines the characteristics of the intraocular pressure reduction following trabeculectomy in primary open-angle glaucoma to determine whether or not it is possible to predict the level of pressure after surgery.

Material and methods

A retrospective analysis of the reduction of intraocular pressure achieved by trabeculectomy was performed on 98 eyes (70 patients). All cases were first operations for primary open-angle glaucoma, including pseudoexfoliation (3 eyes), developmental (10 eyes), pigmentary (2 eyes), and low-tension glaucoma (2 eyes). Cases of angle closure or secondary glaucoma were excluded to avoid the possibility of distortion of the level of preoperative intraocular pressure by transient factors. Similarly we excluded cases of uncertain diagnosis and those with unreliable applanation recordings.

Operative technique followed the description by Watson,[9 10] and the procedures were carried out by various members of the junior and senior surgical staff. Eyes with postoperative hyphaema or shallow anterior chamber were included, but 1 case with iris incarcerated in the trabeculectomy fistula was rejected.

Applanation pressures (Goldmann) were recorded at the time of initial diagnosis or in the immediate preoperative period if the patient was not then using medical therapy to reduce the intraocular pressure. Most cases required operation within 1 year of diagnosis, but cases with no record of untreated pressure in the 2 years prior to surgery were excluded. After operation pressures in those eyes not requiring medical therapy were recorded at 1 and 3 months after surgery and at the time of latest follow-up, which ranged from 9 months to 5½ years. Where several applanation recordings were available for 1 assessment period, the highest was used for analysis. Similarly the highest peaks of intraocular pressure fluctuation were used when assessing the need for additional therapy after operation.

Regression equations were determined for the relationship of initial pressure to pressure reduction

Correspondence to Dr J. L. Jay, Tennent Institute of Ophthalmology, 38 Church Street, Glasgow G11 6NT.

at both 3 months and final follow-up. The statistical probability of these being straight-line relationships was assessed by calculation of the regression coefficient (r), and the difference between the two graphs was tested by Fisher's transformation. The results were calculated for every eye in the series but were also checked by using only one eye selected at random from those patients having operations on both eyes.

Eyes which required further medical or surgical measures to maintain the intraocular pressure below 20 mmHg after operation were studied separately to determine whether or not their exclusion from the main analysis might significantly alter the results, and to this end their initial pressures were compared with those of the whole group. Eight of these eyes underwent a second trabeculectomy within the time of follow-up, and the effect of this subsequent procedure on the intraocular pressure was noted.

Results

EFFECT OF A FIRST TRABECULECTOMY

The reduction of intraocular pressure after a first trabeculectomy was plotted against the initial or untreated pressure for each eye, and the results at 3 months after operation are displayed in Fig. 1. For initial pressures between 16 and 60 mmHg the drop in pressure was found to be directly proportional to the initial level, and the relationship could be expressed by the equation $y=0{\cdot}87x + 20{\cdot}0$ ($n=91$, $r=0{\cdot}92$). The level of significance, $P<0{\cdot}001$, is high enough to confirm that the results represent a true straight-line correlation. Fig. 2 shows the same analysis using the drop in pressure at the time of latest follow-up and is a straight line of similar significance, $y=0{\cdot}86x + 19{\cdot}9$ ($n=76$, $r=0{\cdot}91$, $P<0{\cdot}001$). In both figures the line cuts the ordinate between 16 and 20 mmHg. The results were identical when only 1 eye from each patient was used in the analysis.

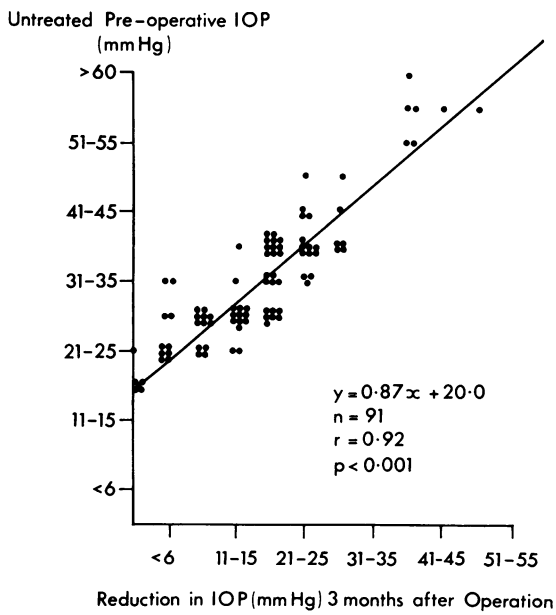

Fig. 1 *The effect of a first trabeculectomy on the intraocular pressure (IOP) 3 months after operation in primary open-angle glaucoma. The reduction in pressure is proportionate to the initial pressure and is likely to restore the pressure to the physiological range (n=number of eyes, r=regression coefficient).*

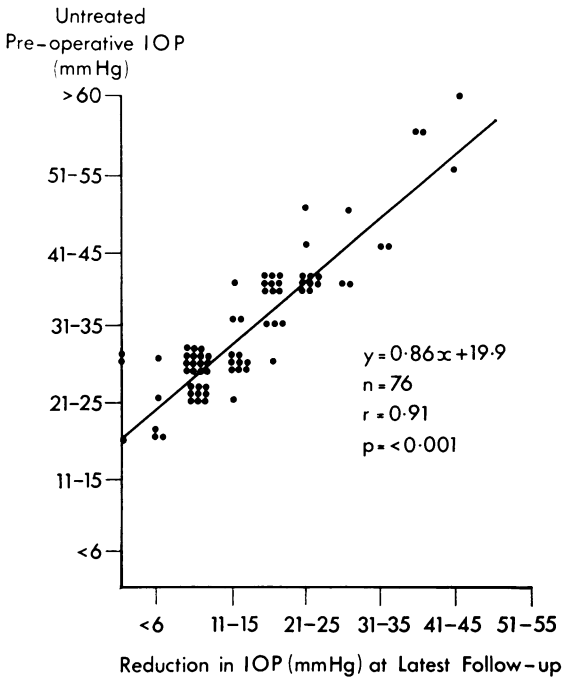

Fig. 2 *The effect of a first trabeculectomy on the intraocular pressure at latest follow-up, minimum 9 months, maximum 5½ years. The relationship is similar to that in Fig. 1 (Fisher's transformation).*

Fig. 3 is a histogram comparing the distribution of initial pressures of eyes requiring further medical or surgical treatment to the distribution of initial pressures of the population displayed in Figs. 1 and 2. As there were only 6 such cases at the 3-month assessment, the histogram shows the total number of 22 cases on supplementary treatment at final follow-up. Inspection indicates that these eyes are evenly distributed throughout the whole series and

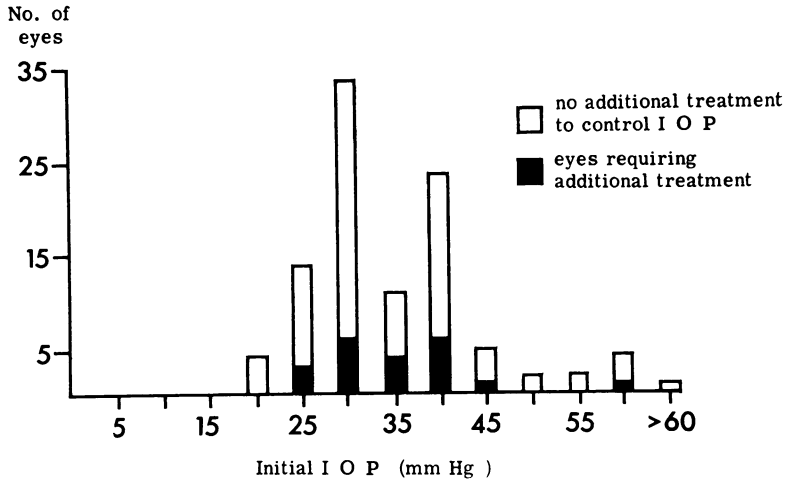

Fig. 3 *Histogram showing the similar distribution of initial pressures of eyes requiring supplementary therapy after trabeculectomy (shaded), compared with the distribution in eyes controlled below 20 mmHg without supplementary medical therapy (unshaded).*

do not come from a separate group with high initial pressures. The mean pressure at which supplementary postoperative therapy was introduced for various clinical reasons was 25 mmHg (range 21–32 mmHg).

EFFECT OF REPEAT TRABECULECTOMY

Eight eyes (6 patients) had a second trabeculectomy carried out within the period of the study. One of these eyes had pigmentary glaucoma and is described below, but the others had primary open-angle glaucoma without pseudoexfoliation or developmental anomaly. In 6 eyes there had been immediate residual hypertension not controlled to a level below 20 mmHg with medical agents, and in these cases the additional hypotensive effect of the second operation was small, all still requiring supplementary medical therapy. In the other 2 cases there had been good control for several months after the first operation, followed by sudden inexplicable extreme rise of pressure. Both these cases were stabilised by a second operation, and as they seem to have behaved similarly in producing delayed acute glaucoma with open angles they will be described in detail.

Case 1. A 58-year-old woman had uncomplicated trabeculectomy operations on each eye because of pigmentary glaucoma not controlled on maximum medical therapy. The initial pressure was 38 mmHg right eye, 42 mmHg left eye. There was deep cupping of the left optic disc and early arcuate scotomata in the fields of both eyes. Postoperative applanation pressures were, approximately, 12 mmHg right eye, 8 mmHg left eye on numerous occasions up to 6 months after surgery. The patient presented 9 months after operation with blurring of vision in the left eye of 24 hours' duration followed by haloes, severe frontal headache, and vomiting. There was acute congestion of the globe with corneal oedema. The pressure was approximately 80 mmHg by applanation but the anterior chamber was of normal depth and the pupil was reactive. Gonioscopy after clearing the cornea with glycerol revealed an open angle with pigmentation as before, a patent peripheral iridectomy, and a trabeculectomy site with diffuse drainage bleb. There was no aqueous flare, cells, or pigment particles. A further trabeculectomy was performed a few days later with control between 10 and 15 mmHg over the following 3½ years. The right eye has had an uneventful course, with pressure between 10 and 14 mmHg over 4 years.

Case 2. A 53-year-old woman with primary open-angle glaucoma with early optic disc cupping and early visual field defects had uncomplicated trabeculectomies in both eyes because of intolerance of medical treatments. The untreated initial intraocular pressures were 26 mmHg right eye, 25 mmHg left eye. After surgery the pressures were controlled at approximately 15 mmHg right eye, and 5 mmHg left eye for 10 weeks, but 1 week later she reported with a history of 48 hours of severe pain and blurring of vision in the left eye, which showed typical signs of acute glaucoma but with a deep and quiet anterior chamber and a normally reactive pupil. The intraocular pressure was over 60 mmHg. Gonioscopy confirmed a wide open drainage angle and patent peripheral iridectomy with unobstructed trabeculectomy site and undisturbed drainage bleb. Trabeculectomy was repeated adjacent to the site of the first operation, and for the succeeding 2 years the pressure has been between 6 and 18 mmHg without additional therapy. The pressure in the right eye has remained between 10 and 15 mmHg without supplementary therapy since the first operation.

Discussion

This study is of a group of cases with specified type and duration of glaucoma selected to allow clear assessment of the pressure changes achieved by trabeculectomy and to avoid sources of error such as drug therapy or transient increases in preoperative pressures. As eyes with a postoperative pressure of over 20 mmHg were excluded from Figs. 1 and 2 because of the introduction of supplementary medical therapy, it is essential to demonstrate that this group does not differ from the overall population and that its exclusion from the results does not introduce an unacceptable error. These cases represent only 6·2% at 3 months and 22·5% at final follow-up, and it has been shown in Fig. 3 that they have a distribution of initial pressures similar to the eyes included in the graphs in Figs. 1 and 2. Thus they do not form a separate group with initial pressures higher or lower than the more successful cases. It is also useful to consider the level of intraocular pressure at which supplementary medical treatment was introduced, and the mean of 25 mmHg confirms that most of the eyes excluded from Figs. 1 and 2 achieved a valuable reduction of pressure to near normal values. The straight line demonstrated may therefore be accepted as the expression of pressure reduction after a first trabeculectomy in primary open-angle glaucoma.

The slope of the line in both Figures cuts the ordinate at 16–20 mmHg, indicating that for values of preoperative intraocular pressure from 16 to 60 mmHg the effect of a first operation is to reduce the pressure to within the range of physiological normal. The slight difference between the straight lines in Figs. 1 and 2 is not significant (Fisher's transformation).

Consideration of those few cases submitted to repeat trabeculectomy suggested that, if there had been no technical reason for failure, little extra hypotensive effect was gained unless there had been a recurrence of hypertension after a period of satisfactory control. The cause of the acute rise in intraocular pressure in the 2 cases described remains unexplained.

It is interesting to speculate on why the operation seems to restore the intraocular pressure to the physiological range despite a wide variation in initial pressure. This phenomenon might be used to gain an understanding of the control mechanism regulating the intraocular pressure, but we have not been able to form a hypothesis, partly because of uncertainty about the cross-sectional area and resistance of the fistula in a series of cases operated upon by several surgeons, whose operations may have slightly differing dimensions. Nevertheless the apparent constant effect of a single fistula merits further study.

These results should not be considered evidence for rejecting trabeculectomy in the management of low-tension glaucoma. The number of cases in this study with initial intraocular pressure below 20 mmHg is very small and does not allow accurate extrapolation of the graph into the low-tension range. Moreover we know little of the role of transient and undetected pressure elevations in the loss of visual field in this condition.

We thank Mr Harry Moseley for assistance with the mathematical expressions, and Professor W. S. Foulds, Dr J. S. Cant, Dr Anna J. Kesson, and Dr J. Dudgeon for permission to study their patients.

References

[1]Cairns JE. Trabeculectomy. *Am J Ophthalmol* 1968; **66:** 673–9.
[2]Chatterjee S, Ansari MW. Microsurgical trabeculectomy in Ghana. *Br J Ophthalmol* 1972; **56:** 783–7.
[3]D'Ermo F, Bonomi L. Trabeculectomy. Results in treatment of glaucoma. *Ophthalmologica* 1973; **166:** 311–20.
[4]Jerndaal T, Kriisa V. Results of trabeculectomy for pseudoexfoliative glaucoma. *Br J Ophthalmol* 1974; **58:** 927–30.
[5]Ridgeway AEA. Trabeculectomy, a follow up study. *Br J Ophthalmol* 1974; **58:** 680–6.
[6]Schwartz AL, Anderson DR. Trabecular surgery. *Arch Ophthalmol* 1974; **92:** 134–8.
[7]Vancea PP, Schwartzenberg T. Treatment of glaucoma by trabeculectomy, early and late clinical results. *Ann Oculistique* 1974; **207:** 563–579.
[8]Watson PG, Barnett F. Effectiveness of trabeculectomy in glaucoma. *Am J Ophthalmol* 1975; **79:** 831–45.
[9]Watson PG. Discussion. *Trans Ophthalmol Soc UK* 1969; **89:** 523–8.
[10]Watson PG. Trabeculectomy. A modified ab-externo technique. *Ann Ophthalmol* 1970; **2:** 199–205.