Trabeculectomy: a retrospective long-term follow-up of 444 cases

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SUMMARY   The results of the surgical procedure of trabeculectomy, as performed by the staff of the Manchester Royal Eye Hospital from 1974 to 1979 inclusive on 356 patients (444 eyes) are presented, with particular emphasis not only on intraocular pressure control but on operative and postoperative long-term complications. Its position in the surgical treatment of glaucoma is confirmed, but the attendant surgical and long-term side effects associated with trabeculectomy appear to be more widespread and problematical than previous reports would suggest.

Trabeculectomy, introduced by Cairns[1] and modified by Watson,[2] has become the favoured procedure for the surgical management of various types of glaucoma. Its success in controlling the intraocular pressure without many of the serious operative and postoperative complications associated with previous drainage procedures has been well demonstrated by many authors.[3-8] Although the surgical technique was originally designed to work by allowing aqueous to gain access to the cut ends of Schlemm's canal, several authors have shown that it appears to be effective by simple fistulisation to a subconjunctival drainage bleb.[3 9 10]

As a consequence of many encouraging reports trabeculectomy is assuming increasing importance in the management of glaucoma. It is often no longer considered as a second-line treatment for use when medical treatment fails to control the glaucomatous process, but rather as a serious contender for use as the initial management of the disease. It is with this development in mind that a retrospective study of 444 eyes undergoing trabeculectomy was undertaken. Particular emphasis is placed not only on the control of intraocular pressure but also on the accompanying short and long-term drawbacks of this procedure.

Materials and methods

All patients undergoing trabeculectomy at the Manchester Royal Eye Hospital from 1974 to 1979 inclusive, and who were available for follow-up, were studied. A total of 356 patients (444 eyes) were

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included in the study. They were divided into various glaucomatous groups based on the preoperative clinical and gonioscopic appearance (Table 1). Four groups accounted for 90% of cases (Table 1): chronic simple open angle, acute closed angle, compound (narrow angle and chronic angle-closure), and combined (trabeculectomy and cataract extraction).

TECHNIQUE

The surgical procedure is based on that described by Watson.[2] Most of the operations were performed by the consultant staff and senior registrars of the above hospital. A small percentage were carried out by the junior staff of registrar status.

Most of the surgery was performed with the help of magnification. The variations in technique that occurred were mainly twofold. Firstly, the conjunctival incision was usually made well posteriorly to the limbus near the superior rectus insertion; occasionally it was made more anteriorly. Secondly, the number of virgin-silk sutures applied to the scleral

Table 1   *Breakdown of 444 eyes into glaucoma groups as described in text*

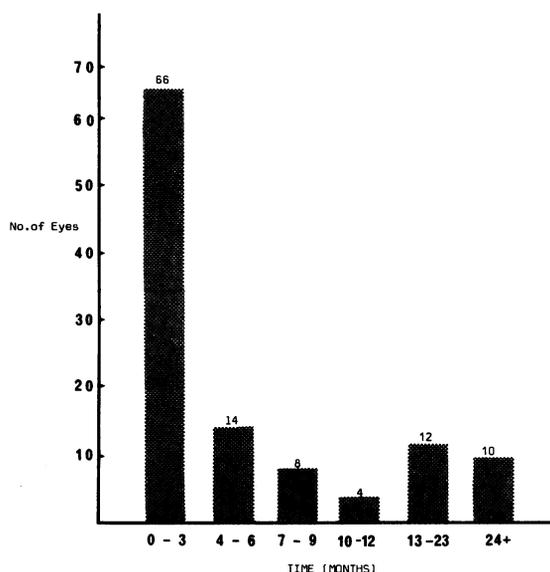| Glaucoma type	Patient nos.	Eyes	% of total	F	M	Mean age (years)
Chronic simple	154	220	49·7	55	99	67·2
Acute closed angle	78	81	18·3	53	25	65·8
Compound	56	66	14·9	32	25	66·5
Combined procedure	27	34	7·4	17	10	74·6
Secondary	15	16	3·6	4	11	37·4
Open angle with pseudoexfoliation	14	14	3·2	6	8	67·4
Rubeotic	7	8	1·8	3	4	52·1
Aphakic	5	5	1·1	4	1	61·8

Fig. 1 *Histogram showing number of eyes requiring postoperative medication and the time postoperatively when this began (from a total of 415 eyes)*

flap varied with different surgeons from 2 to 4. A minority of eyes received post-surgical subconjunctival antibiotics (either gentamicin or soframycin).

Results

Table 2 gives analysis of the success of the procedure in terms of control of intraocular pressure (defined as an IOP <21 mmHg), with or without additional medication and for each glaucoma type. The intraocular pressure reading used for this analysis is that recorded at the latest clinic attendance.

Eyes requiring postoperative medication in an attempt to normalise intraocular pressure, with the

Table 2 *Percentage of eyes controlled with or without treatment, or uncontrolled: control is taken as an IOP <21 mmHg*

Glaucoma type	Control without	Control with	Control without and with	Uncontrolled
Chronic simple	73·4	13·5	86·9	13·1
Acute closed angle	74·1	16·1	90·2	9·8
Compound	68·2	18·2	86·4	13·6
Combined procedure	47·2	38·9	86·1	13·9
Secondary	37·5	12·5	50	50
Open angle with pseudoexfoliation	64·2	7·1	71·3	28·6
Rubeotic	12·5	0	12·5	87·5
Aphakic	50	25	75	25

Table 3 *Distribution of IOP (taken at latest clinic attendance) for chronic, acute closed-angle, compound, combined, and pseudoexfoliative glaucoma (total 415 eyes)*

	IOP reading mmHg					
	<10	11–15	16–20	21–25	26–30	>30
Number of eyes	41	122	195	32	11	14
% of total	9·9	29·4	47·0	7·7	2·7	3·4

time at which this was first instituted, are shown in the histogram in Fig. 1 (from a total of 415 eyes). Rubeotic, aphakic, and secondary glaucomas are omitted from this evaluation because their numbers are too small to be meaningful (rubeotic and aphakic) or they represent an ad hoc mixture of uncommon glaucomas (secondary). 124 eyes required additional medication (30·0%) at a mean onset of 8·3 months postoperatively. Only 35 eyes required treatment after a postoperative time of 6 months or more. Hence 89 eyes (71·8% of the total requiring medication) required the antiglaucoma medication in the first 6 months (mean 1·9 months postoperatively).

The distribution of IOP readings taken at the latest clinic attendance for all eyes excluding rubeotic, aphakic, and secondary (total 415), whether controlled with treatment or without, or uncontrolled, is shown in Table 3 and expressed diagramatically in Fig. 2.
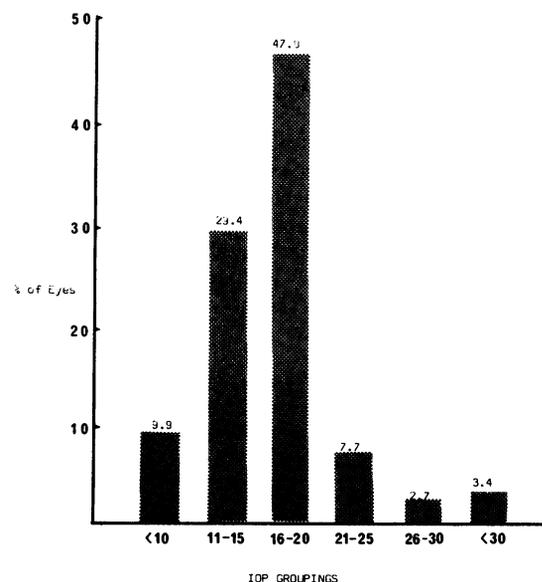
The relationship between IOP and time of follow-

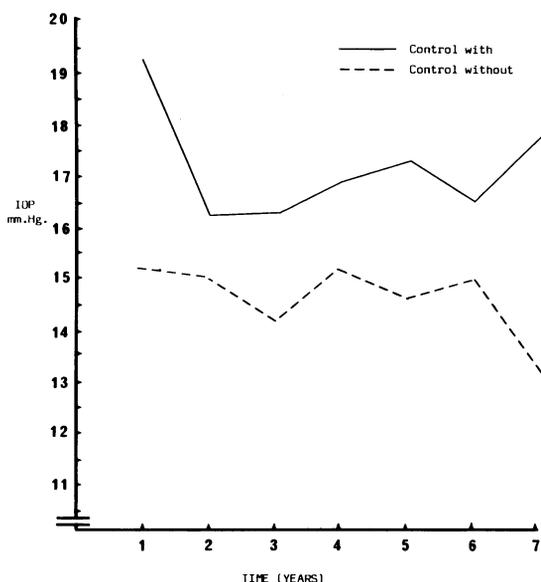Fig. 2 *Histogram showing distribution of IOPs. Figures used are taken from total column in Table 3*

Fig. 3 *The intraocular pressure levels with lapse of time for eyes controlled with and without medication in chronic, acute closed-angle, and compound glaucoma (367 eyes)*

up is shown graphically in Fig. 3. The figures are taken from Table 4, which shows the duration of follow-up and mean IOP readings, with or without treatment, for chronic, acute closed-angle, and compound glaucoma (total 367 eyes).

Table 5 gives a full list of short- and long-term complications of this procedure in 435 eyes. Hyphaemas lasting less than 5 days are excluded. Loss of visual acuity is included if this was more than 2 Snellen lines with correction. Further surgery includes either a further trabeculectomy (or drainage procedure) or surgery necessitated as a direct consequence of the trabeculectomy (i.e., for malignant glaucoma or the removal of a rapidly swollen lens). Later removal of a cataract is not included.

The percentage of eyes with and without short- or long-term complications (as shown in Table 5) for the

Table 5 *A comprehensive list of short- and long-term complications of trabeculectomy in 435 eyes (rubeotic glaucoma excluded)*

Complication	No. (%)	Complication	No. (%)
Hyphaema 5/7	30 (6·9)	Retinal detachment	1 (0·2)
Shallow or flat AC	57 (13·1)	Severe uveitis	4 (0·8)
Resuturing conjunctiva	7 (1·6)	Decrease visual acuity >2 lines	66 (15·2)
Reformation of AC	7 (1·6)	Endophthalmitis	2 (0·5)
Uveal prolapse	2 (0·5)	Herpetic keratitis	1 (0·2)
Choroidal detachment	23 (5·3)	Enucleation	1 (0·2)
Malignant glaucoma	3 (0·7)	Further surgery	27 (6·2)

AC=anterior chamber.

4 numerically largest groups of glaucoma is shown in Table 6. 59·9% of eyes controlled with or without treatment are thus free of such complications. 6·2% of eyes are uncontrolled but have no complications. The percentage of eyes, therefore, showing one or more complications as shown in Table 5 is 33·9%.

Table 6 *Percentage of eyes with chronic, acute, compound combined glaucoma (401 eyes) subjected to one or more complications shown in Table 5.*

No complications				Complications			
Control without	Control with	Uncontrolled	Total	Control without	Control with	Uncontrolled	Total
48·1	11·8	6·2	66·1	21·9	7·0	5·0	33·9

Table 7 shows the number of eyes having *surgical* problems (as shown in Table 5), for the major glaucoma groups, with particular reference to the control of intraocular pressure postoperatively.

Table 8 shows the severity of visual loss secondary to cataract formation with regard to time elapsed postoperatively in eyes with chronic, compound, pseudoexfoliative, and acute closed-angle glaucoma (381 eyes). 45·2% of 62 eyes so affected showed serious visual loss within the first 6 months postoperatively. Of these 28 eyes 17 (60·7%) were associated with shallow/flat anterior chamber post-

Table 4 *Number of eyes at yearly follow-up (for those controlled without and with medication) with corresponding mean IOPs (mmHg) for chronic, acute closed-angle, and compound glaucoma (total 367 eyes)*

Follow-up (years)		1·0	2·0	3·0	4·0	5·0	6·0	7·0
Controlled without	No.	34	44	49	55	44	28	10
	IOP mmHg	15·4	15·1	14·4	15·3	15·1	15·2	13·3
Controlled with	No.	2	9	11	13	15	5	2
	IOP mmHg	18·5	16·2	16·2	17·0	17·0	16·5	17·5

Table 7 *Number of eyes (percentage in brackets) for the glaucoma groups shown having surgical problems (as described in Table 5) in relation to the control of postoperative intraocular pressure*

Glaucoma type	Control without	Control with	Uncontrolled
Open angle	40 (24·8)	11 (38·0)	9 (31)
Acute closed angle	16 (26·7)	1 (7·7)	4 (66·7)
Compound	12 (26·7)	2 (16·7)	2 (22·2)
Combined	3 (18·8)	1 (5·9)	2 (100)
Total	71 (25·3)	15 (20)	15 (35·6)

Table 8 *Severity of visual loss secondary formation in 62 eyes (from total of 381 eyes)*

Loss of acuity	Postoperative follow-up				
	<6/12	6/12-12/12	13/12-24/12	25/12-36/12	37/12-48/12
−0·3	9	2	2	3	2
−0·4	8	1	3	0	0
−0·5	2	2	1	2	1
−0·6	4	3	4	1	1
−0·7	3	0	2	1	0
−0·8	1	0	0	1	0
>−0·8	1	1	0	0	1

operatively, 2 required resuturing of conjunctival wound, and 2 had the anterior chamber reformed. Thirty-four eyes developed cataracts after 6 months postoperatively. Fifteen of these eyes (44·1%) had shallow/flat anterior chambers (one requiring surgical reformation), and a further 6 (17·6%) had postoperative hypotony (persisting IOP <10 mmHg).

Table 9 gives a breakdown of the glaucoma types included in the secondary group with their post-surgical control. The eye with aniridia has undergone previous filtration surgery, including cyclodialysis. The post-trabeculectomy IOP remained uncontrolled despite maximum therapy. One eye with traumatic angle damage required repeat trabeculectomy 2 years later, which failed to normalise the IOP. Trabeculectomy failed to normalise the IOP in a second eye with traumatic angle damage, and retrobulbar alcohol was administered 3 months postoperatively for a painful blind eye.

In the eight eyes with rubeotic glaucoma the condition was secondary to diabetic eye disease in 3 cases and to central retinal vein occlusion in 5. The intraocular pressure was normalised in only one case (but the visual acuity decreased from counting fingers to no perception of light). Four of the remaining 7 eyes required further procedures to relieve pain (in 2 retrobulbar alcohol injection, 1 cyclocryotherapy, and in the fourth enucleation). The IOP remained elevated in the remaining 3 eyes despite topical and systemic therapy.

Three of the 5 eyes with aphakic glaucoma maintained a normal IOP after trabeculectomy with no

complications. One such eye had had previous glaucoma surgery (cyclodialysis). Of the other eyes with aphakic glaucoma both had previous glaucoma surgery (cyclodialysis). In one the IOP remained uncontrolled after trabeculectomy, and the visual acuity with aphakic correction decreased from 6/18 to perception of light (with terminal disc cupping). The other eye maintained a normal IOP after trabeculectomy but became phthisical (visual acuity, no perception of light) within 3 months.

For glaucoma secondary to uveitis the pressure was normalised in 83·0% of post-trabeculectomy eyes (including those eyes requiring additional topical medication).

Three eyes with juvenile glaucoma failed to achieve a normal IOP postoperatively despite heavy antiglaucoma medication introduced within 2 weeks of operation in all 3 cases.

Discussion

The intraocular pressure was normalised in 71·9% of eyes with adult primary glaucoma (i.e., chronic, compound, and acute closed-angle) without the addition of any therapy. 87·8% of eyes with adult primary glaucoma showed a normalised intraocular pressure if those receiving antiglaucoma medication are included in the analysis. These results are consistent with those reported by many previous authors[4 8 9 11 12] and are rather higher than those reported by others.[13] In this series 47·2% of 34 eyes undergoing the combined procedure had a normalised IOP without additional therapy. A high proportion (38·9%) required additional medication to achieve IOP control. The percentage uncontrolled (13·9%) compares favourably with that in other series (11·7% in Jerndal and Lundström[6]). The latter authors reported 82·4% of 17 eyes undergoing the combined procedure to be controlled without additional medication (but 50% of eyes had pseudoexfoliative glaucoma, which might explain the better IOP control postoperatively).

The lack of success of this procedure in rubeotic and to a less extent secondary glaucoma (apart from glaucoma secondary to uveitis) has been demonstrated[4] and is confirmed in this study.

71·8% of 114 eyes requiring additional medication in an attempt to normalise the intraocular pressure do so within the first 6 months of surgery (57·9% within the first 3 months). Only 19·3% of such eyes (5·3% of total number of eyes in survey) require the institution of such medication after the duration of one year. Thus, once the early postoperative period has passed, the chance of failure becomes quite small. This has also been commented upon by other authors.[4]

Irrespective of the presurgical intraocular pressure the majority of eyes (76·4%) return to the physio-

Table 9 *Results of trabeculectomy in secondary glaucoma*

Type	No.	Control without	Control with	Not controlled
Uveitis with 2° glaucoma	6	3	2	1
Juvenile	5	2	0	3
Angle recession	3	1	0	2
Aniridia	1	0	0	1
Penetrating keratoplasty	1	0	0	1

logical range after surgery. It is worthy of note that 9·9% of 415 eyes undergoing surgery have a sustained hypotony (<10 mmHg for >1 year), which is at variance with previously reported figures.[4 9 12]

The intraocular pressure would appear to remain relatively stable with extended follow-up, and in particular, there would appear to be no long-term 'drift or escape.' It is of interest to note that the intraocular pressures in eyes requiring medication, though normalised (<21 mmHg), run at a consistently higher level than in eyes controlled without medication (Fig. 3). In eyes requiring medication for control postoperatively the intraocular pressure is lower than when receiving similar medication before operation. This could be due to incomplete or sclerosing fistulisation (as many such eyes have drainage blebs) or represent a more thorough penetration of the ocular medication through the trabeculectomy site.

The incidence of hyphaema of more than 5 days' duration is 6·9% in this series (excluding rubeotic glaucoma). Only 4 eyes had a persistent hyphaema (>3 weeks). It is difficult to make meaningful comparisons with other authors as most include all hyphaemas when evaluating results. Ridgway[4] reported a 15·9% incidence for chronic simple glaucoma, Portney[14] 30%, and Zaidi[8] 53%, but all 3 included all hyphaemas in their calculation. Persistent hyphaema is uncommon.

The incidence of cataract after classic fistulising procedures has been calaculated at between 35 and 40%.[15] The incidence of cataract in this series producing a decrease in visual acuity of more than 2 Snellen lines is 15·2%, which, while confirming that it is a less harmful procedure to the lens than the classic procedures, nevertheless represents a serious problem. This is higher than reported in some communications (Ridgway[4] reported 8·7% incidence of cataract after trabeculectomy in chronic simple glaucoma) but less than others (D'Ermo et al.[7] reported an incidence of cataract of 35·6%). As shown by the latter authors, this may either be an acceleration of pre-existing lens opacities or opacification in previously clear lenses. In 28 eyes (45·2% of eyes which developed cataract) the change occurred in the first 6 months postoperatively. Seventeen of these eyes (60·7%) had a shallow or flat anterior chamber (with reformation of anterior chamber in 2 and resuturing of conjunctival wound in a further 2), and 13 eyes (46·4%) had ocular hypotony, confirming the observation of D'Ermo et al.[7] that ocular hypotony may play an important part in the cataract formation. In the 34 eyes in which the cataract developed after 6 months 15 (44·1%) had shallow or flat anterior chambers and 6 (17·6%) had ocular hypotony. These results imply that shallowing or abolition of the anterior chamber (with or without ocular hypotony) may disturb lens metabolism

sufficiently for opacification to occur. In addition direct trauma to the lens at the time of surgery cannot be excluded as a causative factor.

Clinically one frequently faces a dilemma in the management of cataract developing in a trabeculectomised eye, particularly if unilateral. Removal may convert a stable into an unstable situation with regard to intraocular pressure (with the additional problems encountered in the treatment of aphakic glaucoma). Conventional correction of the aphakia with glasses is not indicated if the fellow eye has normal phakic vision and peripheral field may have been lost due to the glaucomatous process, so benefit may not be derived from this viewpoint. Correction with intraocular implant would be deemed undesirable by most surgeons and contact lens fitment may be difficult because of such things as bleb size, disturbance of pre-corneal tear film, aphakic astigmatism, or lack of dexterity. So, although the trabeculectomy may be successful from the primary consideration of arresting the glaucomatous process, one may produce a non-seeing eye due to advancing cataract (secondary to the procedure) for which treatment from a visual point of view is imperfect. This point has rarely been mentioned in previous communications but represents a fairly frequent problem to the clinician.

The incidence of shallow (9·2%) or flat (3·9%) anterior chamber (total 13·1%) in this series is higher than reported by many authors but is similar to that reported by McPherson et al.[11] (shallow anterior chamber 11·6%, flat anterior chamber 4·5%). However, it is significantly less than reported for classical fistulising procedures. For example, Scheie[16] reported a 41% incidence of flat chamber lasting more than 3 days in a series of thermal sclerotomies.

Uveal prolapse is a rare complication reported in this series. One eye with a ciliary body prolapse was enucleated because of the risk of sympathetic ophthalmitis. Endophthalmitis after trabeculectomy has not been previously reported in the English ophthalmic literature and case reports with discussion appear in an accompanying communication.

One in 3 eyes (33·9%) will be affected by one or more of the complications as shown in Table 5. The analysis in Table 7 shows that there is no clear correlation between the incidence of operative and postoperative complications and the control of the intraocular pressure. This finding is rather unexpected.

In summary, it appears from this retrospective survey that, although trabeculectomy represents an important surgical advance (from previous fistulising procedures) in the treatment of glaucoma, it remains a procedure with significant and serious complications. It does, therefore, in the author's opinion, have a doubtful role in the primary management of glaucoma.

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