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A comparison between peripheral iridectomy with thermal sclerostomy and trabeculectomy: a controlled study

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SUMMARY In 15 patients with primary open-angle glaucoma who required surgery in both eyes because of progressive glaucomatous disease a peripheral iridectomy with thermal sclerostomy was performed in one eye and a trabeculectomy in the other eye, the choice of procedure being determined randomly. In all 15 cases at one year and 13 cases at 5 years after operation the immediate complication rate was higher in patients receiving peripheral iridectomy with thermal sclerostomy. The average final level of intraocular pressure (on no treatment) was 16 mmHg in patients receiving peripheral iridectomy with thermal sclerostomy and 22 mmHg in those in whom a trabeculectomy was performed. The control of disease was the same in both groups, there being an improvement in the visual field in approximately one-third of all cases and stability of the visual field in all other cases except for one. However, twice as many patients after trabeculectomy required additional medical therapy to maintain the intraocular pressure in a range that was considered satisfactory. Stability of intraocular pressure was virtually the same in both groups. The mechanism of control of intraocular pressure in patients receiving peripheral iridectomy with thermal sclerostomy appeared to be gross filtration in all cases, whereas such gross filtration was observed in only 2 eyes in which a trabeculectomy had been performed.

The purpose of this report is twofold: (1) to review the long-term results of 2 different procedures performed for primary open-angle glaucoma, specifically peripheral iridectomy with thermal sclerostomy and trabeculectomy; and (2) to compare and contrast the results of these 2 operations in 15 patients entered into a prospective, controlled study of 5 years' duration. Information of this nature is at present virtually unavailable.

Materials and methods

Fifteen patients with primary open-angle glaucoma were selected for the study. All were under the care of the senior author, had surgery performed by him, and were followed up by him. Examination techniques included Goldmann applanation tonometry, gonioscopy with the Zeiss 4-mirror gonioprism, examination of the optic disc with direct ophthalmoscopy and the Hruby lens, and perimetry with the Goldmann perimeter using the Armaly-Drance method. All patients required surgery in both eyes to control bilateral glaucomatous disease. The indication for surgery was progressive cupping of the optic nerve and/or progressive visual field loss considered due to excessively elevated intraocular pressure. In all patients a peripheral iridectomy with thermal sclerostomy was performed in one eye and a 'trabeculectomy' in the other, the choice of procedure being decided solely on a random basis. Surgery was performed in both eyes within a period of 3 months, the eye with the more advanced disease being operated upon first.

The surgical technique for all eyes was the same, with the exception of the scleral portion of the procedure. A flap of conjunctiva and Tenon's capsule was developed, the incision being made high in the cul-de-sac just inferior to the insertion of the superior rectus muscle. This was reflected to the limbus and the episclera incised and similarly reflected to the

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Table 1 *Clinical and operative details of patients*

Patient number	*Patient 1*		*Patient 2*		*Patient 3*		*Patient 4*		*Patient 5*		*Patient 6*		*Patient 7*	
Procedure	*T*	*S*	*T*	*S*	*T*	*S*	*T*	*S*	*T*	*S*	*T*	*S*	*T*	*S*
Eye	*OD*	*OS*	*OD*	*OS*	*OD*	*OS*	*OD*	*OS*	*OD*	*OS*	*OD*	*OS*	*OD*	*OS*
Age, race, sex	46 W, M		66, W, M		80, W, F		69, W, F		73, W, M		30, W, M		40, W, F	
Diagnosis	POA		POA		POA		POA		POA+NA		POA		POA	
Intraocular pressure														
Initial	21	25	30	65	26	24	36	36	50	53	38	40	26	22
One year postoperatively	14	10	18	11	18	6	11	12	13	13	10	5–7	18	12
Most recent off treatment (& on treatment)	17	18	40 (18)	23 (19)	28 (12)	35 (16)			22 (20)	25 (14)	26	14	18 (16)	10
Visual field	W	NC	B	B	NC	NC			NC	NC	B	B	NC	NC
Nature of the bleb														
At 1 year	FLP	HT	O	HC	F	HCL	FL	HCL	FC	HCL	HCL	HCL	FP	CL
At 5 years	O	HCL	O	FC	O	FC			C	C	O	LC	O	HCL
Visual acuity														
Initial	20/20	20/50	20/20	20/20	15/80	20/30	20/60	20/200	20/70	20/70	20/20	$20/30^{-2}$	20/20	20/20
One year postoperatively	20/30	20/80	20/20	20/20	20/100	20/40	20/200	HM	20/100	20/70	$20/20^{-1}$	$20/40^{-2}$	20/20	20/20
Most recent	20/30	20/100	20/30	20/15	20/100	20/70			20/200	20/200	20/20	20/40	20/20	20/20
Change between initial & most recent	−1	−4	−1	0	−5	−5			−3	−1	0	−1	0	0
Cataract														
Present preoperatively	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	No
Change?	NC	NC	W	NC	CE	CE	W	W	NC	NC	NC	NC	NC	NC
Operative complications														
Hyphaema	2+	2+		1+	1+		1+		2+	2+		2+	1+	
Depth of anterior chamber		2+		1+				1+		2+		1+		1+
Disease controlled														
5 years after surgery?	Q	Y,	YR	YR	QR	QR			QR	YR	Y	Y	YR	Y

Code: T=Trabeculectomy. S=Peripheral iridectomy—thermal sclerostomy (Scheie). POA=Primary open-angle glaucoma. B=Better. NC=No change. W=Worse. CE=Cataract extraction. Q=Disease questionably controlled on no treatment. Y=Disease controlled on no treatment. QR=Disease questionably controlled on treatment. YR=Disease controlled on treatment.

Abbreviations: F=Flat. C=Cystic. L=Limbal. H=High. T=Thick. P=Posterior.

Ocular complications code: Hyphaema 2+ refers to a hyphaema of greater than 2 mm in thickness. Hyphaema 1+ refers to a hyphaema smaller than 2 mm. 3+ flattening of the anterior chamber indicates contact between the iris and the corneal endothelium extending from the periphery almost all the way to the pupillary margin. 2+ indicates contact limited to the periphery. 1+ signifies that the chamber was shallower postoperatively than preoperatively, but no iris-corneal contact was present.

limbus, leaving bare sclera from the superior rectus insertion to the corneoscleral sulcus. Light cautery was applied to bleeding vessels where necessary, except over the area where the scleral flap was to be developed in patients who would be treated with trabeculectomy. In peripheral iridectomy with thermal sclerostomy light cautery was applied 1 mm posterior to the limbus followed by a shallow incision 4 mm long; cautery was then placed in the incision spreading the edges.[1] The procedure was repeated until the anterior chamber was entered with a blade. In trabeculectomy a scleral flap 5×5 mm and approximately one-third the thickness of the sclera was fashioned and dissected anteriorly to its hinged attachment at the limbus.[2] A block of tissue 3×3 mm including sclera, trabecular meshwork, and cornea was excised in a fashion similar to that described by Watson.[3] (The author at present does not employ this same method, but rather makes the posterior incision more anteriorly, so that less or none of the ciliary body is unroofed.) The scleral flap was sutured with four 8–0 virgin silk sutures. In both types of procedures entry into the anterior chamber was at the 12 o'clock position on the globe. In all cases a peripheral iridectomy was performed; this was invariably larger in patients having trabeculectomy than in those treated with peripheral iridectomy with thermal sclerostomy. In all cases the following procedures were employed: an effort was made to have the anterior chamber well formed at the conclusion of the surgery; atropine 1% was instilled throughout the procedure so that the pupil was dilated at the conclusion; Tenon's capsule was closed separately with 8–0 locked, running chromic catgut sutures; and the conjunctiva was closed with multiple, closely-spaced, running 8–0 chromic catgut sutures.

Postoperative care was essentially the same for all eyes, and consisted of topical atropine 1%, dexamethasone 0·1%, and antibiotics, all 4 times daily until discharge and then in rapidly decreasing amounts thereafter. Intraocular pressure was determined and biomicroscopic examination performed twice daily while the patient was in hospital, which was customarily 5 days. Postoperative outpatient examinations, including measurement of visual acuity, intraocular pressure, biomicroscopic, and ophthalmoscopic examinations were performed 1, 2, and 4 weeks after discharge, and at least 6-month intervals after that. Visual field examinations were repeated at 6-month intervals or more often if indicated. External

Patient 8		*Patient 9*		*Patient 10*		*Patient 11*		*Patient 12*		*Patient 13*		*Patient 14*		*Patient 15*	
T	*S*	*T*	*S*	*T*	*S*	*T*	*S*	*T*	*S*	*T*	*S*	*T*	*S*	*T*	*S*
OD	*OS*	*OD*	*OS*	*OD*	*OS*	*OD*	*OS*	*OD*	*OS*	*OD*	*OS*	*OD*	*OS*	*OD*	*OS*
68, W, F		53, W, F		41, W, F		18, W, M		55, W, M		63, W, M		77, W, F		38, W, M	
POA		POA		POA		POA		POA+NA		POA		POA		POA	
27	30	22	20	23	35	43	40	24	18	23	33				
20	12	5	8	15	17	24	10	16	8	20	8	36	34	55	48
20 (18)	16	14	10	15	12	33 (20)	24 (20)	18 (4)	6	20 (15)	6	14	8	17	15
NC	B	B	B	NC	NC	NC	NC	NC	NC	NC	NC			17	15
														B	B
F	LC	F	FLC	F	HC	O	TC	O	FLC	O	HC	F	LC	F	LC
O	TC	O	HCL	C	LC	F	O	O	HC	F	HC			F	LC
20/20	20/20	20/20	20/20	20/30	LP	20/70	20/70	20/25	20/25	20/20	20/20	20/200	20/40	20/70	20/30
20/30	20/30	20/20+	20/25	20/20	NLP	20/70	20/70	CF	20/25	20/20	20/20	20/200	20/40	20/30	20/20
20/30	20/30	20/20	20/30	20/20	NLP	20/70	20/70	20/25	20/30	20/20	20/20			20/30	20/20
−2	−2	0	−1	0	−1	0	0	−8	−1	0	0			+2	+1
No	No	No	No	No	No	No	No	Yes	Yes	No	No	Yes	Yes	No	No
NC	NC	NC	NC	NC	NC	NC	NC	CE	W	NC	NC	W	W	NC	NC
			1+											1+	
			2+		3+		1+						1+		1+
YR	Y	Y	Y	Y	Y	YR	YR	YR	Y	YR	Y			Y	Y

photographs were taken at 1 year and 5 years after the operation. Tonography with a Mueller electron tonometer was performed at the 5-year evaluation.

All patients entered into the study were available for re-evaluation at 1 and 5 years with the exception of 1 individual who was lost to follow-up 2 years after operation, and 1 who died 3 years after operation (patients no. 4 and 14). At the time of final preparation of the paper the shortest duration of follow-up was 5 years and the longest 8 years.

Results

The results are shown in Table 1. Table 2 lists a comparison of the differences between the results of trabeculectomy and peripheral iridectomy with thermal sclerostomy, considered 5 years after the operation.

Discussion

For over a century the basic aim of most surgeons performing most procedures for open-angle glaucoma was to establish a fistula between the anterior chamber and the subconjunctival space, permitting

Table 2 *Summary of data of cases followed up 5 to 8 years: 13 white patients, aged 15–80 years, 5 females, 8 males*

	Trabeculectomy	*Peripheral iridectomy with thermal sclerostomy*
Intraocular pressure (mmHg)*		
Initial	31·4±11·4	34·9±14·7
Five years postoperatively		
On no treatment	22·2±7·6	16·5±8·4
On treatment	17·1±3·6	13·5±4·5
Complications		
Iris-cornea contact	0	4
Hyphaema greater than 2 mm	2	3
Progression of cataract†	6 (2)	5 (1)
Total complications	6	15
Change in visual field		
Better	4	5
No Change	8	8
Worse	1	0
Control of disease		
On no treatment	4	9
On treatment	7	3
Questionable on no treatment	1	0
Questionable on treatment	1	1
Nature of bleb		
'Better' at 5 years than at 1 year	1	0
'Worse' at 5 years than at 1 year	0	2
Coefficient of aqueous outflow‡		
Initial	0·10 (0·03–0·18)	0·07 (0·02–0·14)
Postoperative	0·16 (0·13–0·27)	0·25 (0·10–0·35)

*Mean±standard deviation.
†Number requiring cataract extraction shown in parentheses.
‡Mean (μl/min/mmHg) and range.

the aqueous humour to pass from the eye with less resistance than before the operation.[4,5] The surgeon used techniques to ensure that the incision remained patent, so that bulk flow of aqueous would result. A wide variety of different procedures was developed, but the principle behind them was the same. A quite different concept holds that it is possible to lower intraocular pressure by improving outflow without developing a gross fistula leading to bulk flow.[6,7]

Recently, with the development of the operating microscope, this new concept has been implemented.[8–10] Various procedures have been developed to implement it, the most popular of which is 'trabeculectomy.' However, trabeculectomy is itself a generic term used to describe quite different procedures.[11–19] Some surgeons remove a block of tissue that contains only the trabecular meshwork. Others remove tissue solely anterior to the trabecular meshwork. Still others excise tissue that includes cornea, the trabecular meshwork, and sclera. In some reports it is advised that the block of tissue be removed with a 1 mm trephine, while in others a specimen 10 or even 20 times as large is excised. Some surgeons cauterise the tissues heavily, whereas others recommend minimal cautery. The scleral flap may be fashioned so as to be so thin that it is translucent, or so thick that it occupies the bulk of the thickness of the sclera; some flaps are sutured meticulously tightly, others are not sutured at all.

The major conceptual difference that underlies these procedural differences is the goal of the operation: should there be a gross fistula with bulk flow of aqueous, or should there not? The present study, however, was not designed to determine the best way to perform a 'trabeculectomy.' It was designed to see if an operative procedure specifically designed to lower intraocular pressure *without* producing a gross fistulising bleb had significant clinical advantages over a procedure designed specifically to produce such a bleb.

Many studies attest to: (1) the effectiveness of both peripheral iridectomy with thermal sclerostomy and 'trabeculectomy' in lowering intraocular pressure; (2) a decreased incidence of postoperative complications with trabeculectomy in comparison with peripheral iridectomy with thermal sclerostomy, sclerostomy, or corneoscleral trephining.[20–31] Prospective studies comparing the different types of procedures are rare.[32–35] Drance and Vargas, comparing trabeculectomy with thermosclerectomy found no significant difference between the percentage of patients controlled by the 2 different techniques.[33] However, 36% of patients treated with thermosclerectomy showed a reduction of vision greater than 2 Snellen lines, whereas only 11% in patients in whom trabeculectomy had been performed showed a similar loss. Spaeth *et al.*[2] noted that the intraocular pressure 3 years after trabeculectomy in patients with primary open-angle glaucoma was 12·3±6 in comparison with 16·6±7 mmHg for eyes treated with trabeculectomy. There was no apparent difference in the visual ability after 3 years, though in the immediate postoperative period the trabeculectomy was associated with less visual loss. Watkins and Brubaker[34] found a mean intraocular pressure of 15±5·9 mmHg in patients treated with trephination (a full-thickness procedure) in comparison with a pressure of 17±3·8 mmHg in similar cases undergoing a 'partial-thickness filtering procedure' (trabeculectomy). The review of the cases was made one year after operation. However, in cases followed up for 3 years the mean intraocular pressure was 13 mmHg in patients treated with trephination in comparison with 18 mmHg in the trabeculectomy group. Complications were slightly higher in the group having the full-thickness procedure, though the development of cataract was the same in both groups. A bleb infection occurred in one patient following trephination.

The author was unable to find any controlled studies in which surgical procedures of this nature were compared.

The only 2 patients who did not complete the full 5 years of the present study were deleted for reasons other than complications: one disappeared and the other died. There were so few serious complications in the present study that evaluation of the clinical significance of such complications is fairly difficult. There were more eyes with 'flat anterior chambers' in the group receiving peripheral iridectomy with thermal sclerostomy, but even in this group there was only one eye which had moderately extensive contact between the iris and the cornea, and 2 eyes with minimal contact. In no case was corneal decompensation noted; in no case was reformation of the anterior chamber by surgical means necessary. Thus no conclusions can be drawn about the possible long-term effects of the more extensive or more persistent 'flat anterior chamber' which is well established to be a frequent complication of the standard filtering procedures and which is unquestionably less frequent in patients treated with trabeculectomy.[34,35] But the striking conclusion that must be drawn from this study is that mild or even moderate shallowing of the anterior chamber (where there is actual contact between the iris and the endothelium, but which has spontaneously cleared within one week) does not appear to be associated with a higher incidence of late problems in the eye.

What can be said about the factors that appear to predispose to the late development of cataract?[36–39] The most important factor was the presence of a cataract before the surgical procedure itself. In only

one instance, patient no. 2, did a clinically significant cataract develop after operation when there was not such a cataract before the surgery. In contrast, in the 9 eyes in which a cataract was present to the extent that it interfered with vision preoperatively, all 9 cases showed a clinically significant worsening of their cataract. Though the importance of the presence of a pre-existing cataract as an indicator of subsequent progression of cataract should be noted, the initiation of a cataract in an eye in which no such change was observed before operation should also be kept clearly in mind.

The primary purpose of the surgery in all cases was of course to control the glaucomatous disease.[40] Presumably eyes with a low intraocular pressure postoperatively should be less likely to have progressive deterioration of the visual field.[41,42] However, the tolerable level of pressure clearly varies from eye to eye. There is at present no evidence to suggest that an eye in which there is no progressive glaucomatous disease at a level of pressure of x mmHg is healthier at a level of $x-5$ mmHg. In contrast, to achieve a lower level of intraocular pressure demands performing a procedure designed to produce bulk flow of aqueous humour and a cystic conjunctival bleb in most instances. In the present study the degree of control was slightly better in eyes receiving a peripheral iridectomy with thermal sclerostomy: 9 of such eyes were controlled without treatment, whereas only 4 eyes in which a trabeculectomy had been performed were controlled without medical therapy after the operation. Furthermore, the only eye showing a clinically significant worsening of the visual field was one in which intraocular pressure had been judged to be controlled by trabeculectomy (postoperative intraocular pressure 14–17 mmHg) and no medical treatment had been employed. In no eye receiving a peripheral iridectomy with thermal sclerostomy was there progressive visual field loss.

In one-third of the patients in both groups a clinically significant improvement in the visual field following surgery was observed. Increase in the size of the pupil can result in an apparent improvement of the visual fields; the change for the better described here, however, was not thought to be a result of such a change in pupil size.

The stability of the surgical result appeared to be highly similar in both groups. One year after trabeculectomy 2 patients had cystic conjunctival blebs, 3 had low diffuse blebs, and 8 had virtually no detectable bleb. In 3 cases there was an enlargement of the conjunctival bleb at 5 years in comparison with 1 year; in one case this was quite extensive. In the eyes receiving peripheral iridectomy with thermal sclerostomy all cases initially showed cystic blebs. Five years later 2 eyes showed a definite diminution of the size of the bleb; in one case the fistula apparently closed completely with total elimination of filtration. In 2 other cases the conjunctiva covering the bleb became increasingly thin; there was concern that in the future the tissue would become excessively thin.

The mechanism by which trabeculectomy works has not been established with complete certainty. However, the fact that pressure control can be achieved without clinically apparent filtration suggests strongly that the mechanism is not solely that of bulk flow of aqueous through a fistula. Rich and McPherson demonstrated in monkeys that trabeculectomy lowered intraocular pressure without producing demonstrable filtration.[43] Furthermore, the cut sclera appeared to absorb the aqueous rapidly, suggesting that aqueous humour crossed directly through the sclera itself. Furthermore. Benedikt has shown by means of injection of fluorescein into the anterior chamber that some eyes after trabeculectomy will show a gross leak, as is characteristic of patients after successful filtering procedures, whereas those in whom the traditional cystic bleb is not present will not show such bulk flow.[44,45] In addition it is possible to inspect trabeculectomy sites in patients who, after successful trabeculectomy, have required cataract extraction. In 10 cases without apparent bleb formation, though with a marked improvement in intraocular pressure after trabeculectomy, we have examined the trabeculectomy site using fluorescein; no gross leakage of aqueous through the sclera was demonstrable. There is also some evidence that aqueous leaves the cut edges of Schlemm's canal. One year after successful trabeculectomy blood has been seen to reflex from the cut edges of Schlemm's canal back into the anterior chamber. On the other hand Spencer has shown that successful control of intraocular pressure can be achieved in cases in which trabecular meshwork is not removed.[46]

The mechanism by which topical steroids cause an increase in intraocular pressure has also not been fully established. However, there appears to be a tendency for eyes treated with trabeculectomy to show a rise of pressure in response to topical corticosteroids, a phenomenon which may be partly responsible for the high intraocular pressure which is not uncommon in these eyes in the first month postoperatively.[47,48] In contrast, no such rise in pressure is characteristic of eyes receiving full-thickness sclerectomies. To test this observation further, topical dexamethasone 0·1% was instilled 4 times daily for a period of 3 weeks. The results are shown in Table 3. There was an inverse correlation between the amount of pressure rise induced by topical steroids and the amount of clinically apparent gross filtration. Furthermore, there was a greater pressure rise in response to topical steroids in individuals who had a lower coefficient of

Table 3 *Effect of topical dexamethasone 0/1% 4 times daily for 3 weeks on 12 cases*

	Eye with trabeculectomy	*Eye with peripheral iridectomy—thermal sclerostomy*
Mean change in intraocular pressure	+3·5 mmHg	−0·1 mmHg
Range of change in intraocular pressure	−2 to +8 mmHg	−2 to +1 mmHg

aqueous outflows. The significance of this observation is uncertain, since the coefficient of aqueous outflow was lower in patients having trabeculectomy than in those treated with peripheral iridectomy with thermal sclerostomy.

This paper compares one type of trabeculectomy with one type of peripheral iridectomy with thermal sclerostomy. Conclusions thus cannot necessarily be generalised to other modifications of these 2 procedures.

In the past retrospective or uncontrolled studies of surgical procedures have been performed in an effort to gain information on specific techniques and how they compared with each other.[33–35 49–51] But if more valid information is to be gained about surgical procedures, more controlled studies need to be conducted.[52]

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