Intraocular surgery in advanced glaucoma

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It has been found that 40 per cent of glaucomatous patients registered blind or partially sighted, are registrable when they first present for ophthalmic supervision. In addition, lens opacity contributes significantly to visual disability in registered glaucomatous patients (Miller and Karseras, 1974). Drainage procedures, and/or lens extraction, may therefore have to be considered in eyes in which visual reserves are grossly reduced from glaucomatous field loss.

There is an established view that intraocular

surgery may result in obliteration of the central visual field subserving macular function when this is threatened by preoperative glaucomatous field loss. Lichter and Ravin (1974) have summarized the historical development of this view.

The present study attempts to define the incidence of postoperative loss of central vision, consequent upon modern drainage procedures and/or cataract extractions.

Material and method

A review of the case histories of glaucomatous patients who have had drainage procedures or cataract extraction was undertaken. Those patients whose preoperative

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Table I *Quadrantic nasal field loss $\pm$ arcuate scotoma*

Preoperative status						Postoperative status (after 6 months)			
Patient	Visual acuity	Intraocular pressure (mmHg)	Visual field	Lens opacity	Operation	Corrected visual acuity	Intraocular pressure (mmHg)	Macular function	Lens opacity
1	6/9	30	Upper nasal quadrantanopia	-	Iridencleisis	6/9	22	No change	-
2	6/9	32	Lower arcuate defect	-	Scheie	Counting fingers corrected to 6/9 (see comment)	35	No change (see comment)	+
3	6/18	34	Lower nasal quadrantanopia	+	Trabeculectomy	6/18	10	No change	+
4	6/6	28	Upper nasal quadrantanopia	-	Scheie	6/6	15	No change	-
5	6/6	50	Lower nasal quadrantanopia	-	Trabeculectomy	6/6	15	No change	-
6	6/6	28	Upper nasal quadrantanopia	-	Trabeculectomy	6/6	18	No change	-
7	6/6	30	Upper nasal quadrantanopia	-	Trabeculectomy	6/6	21	No change	-
8	6/18	30	Lower nasal quadrantanopia	+	Trabeculectomy	6/18	29	No change	+
9	6/9	40	Lower nasal quadrantanopia	-	Trabeculectomy	6/9	13	No change	+
10	6/9	28	Upper and lower quadrantanopia (nasal hemianopia)	+	Trabeculectomy	6/9	14	No change	+
11	6/9	60	Upper nasal quadrantanopia	-	Scheie	6/9	8	No change	-
12	6/9	30	Upper and lower quadrantanopia (nasal hemianopia)	-	Trabeculectomy	6/9	14	No change	-
13	6/6	38	Upper nasal quadrantanopia	-	Trabeculectomy	6/6	14	No change	-
14	6/24	40	Upper hemianopic defect (nasal and temporal)	-	Trabeculectomy	6/36	14	No change	-
15	6/9	48	Upper and lower quadrantanopia (nasal hemianopia)	-	Iridencleisis	6/9	14	No change	-
16	6/6	22	Upper nasal quadrantanopia	-	Iridencleisis	6/6	15	No change	-
17	6/9	28	Upper nasal quadrantanopia	-	Trabeculectomy	6/9	14	No change	-
18	6/12	32	Upper nasal quadrantanopia	-	Trabeculectomy	6/12	20	No change	-
19	6/18	32	Upper nasal quadrantanopia	++	Trabeculectomy	6/18	9	No change	+
20	6/60	40	Upper and lower quadrantanopia (nasal hemianopia)	++	Trabeculectomy	<6/60	16	No apparent change	+
21	6/6	22	Upper nasal quadrantanopia with lower arcuate	-	Trabeculectomy	6/6	15	No change	-
22	6/36	30	Upper nasal quadrantanopia	++	Trabeculectomy	6/36	20	No change	+

field loss encroached on central fixation were selected for this study. They were divided into two groups:

1. 24 eyes with a residual central island, with or without a temporal island of vision
2. 22 eyes in which an arcuate scotoma not only approached to within 5° of central fixation but had extended to the peripheral field to cause a nasal quadrantic defect.

An additional arcuate scotoma was occasionally present. Five patients from Group 1 and three from Group 2 subsequently had cataract extractions. Five eyes in three patients who presented with coincidental cataract and late glaucoma also underwent cataract extraction. An analysis of the results of these 13 cataract extractions was undertaken.

Preoperative and postoperative data recorded in both groups included visual acuity, intraocular pressure, Goldmann perimetry, an assessment of lens opacity, and the drainage procedure undertaken.

Postoperative data from both groups were recorded 6 months from the day of surgery. Loss of fixation after such an interval was not considered attributable to the drainage procedure. The present status of each patient was ascertained and any change of status after 6 months was recorded.

The postoperative status of the cataract group (Table III) was assessed 2 months after extraction when the eyes were free from postoperative inflammation. Loss of

fixation directly attributable to the operation was therefore recorded but possible medium or long-term postoperative maculopathy was not excluded in some instances (Table III). The visual acuity of each patient at the final review was recorded.

Preoperative field analysis in the cataract extraction group (Table III), Patients 1 to 8, was carried out several months, and in some instances years, before extraction, when the visual acuity and amount of lens opacity allowed accurate Goldmann perimetry. Patients 9–13, because of gross cataract and glaucoma at presentation, did not have perimetry. Visual fields were assessed by confrontation to hand movement and perception of light.

The difficulty in assessing macular function in the presence of cataract and a glaucomatous nasal quadrantic or hemianopic field defect is discussed later.

Results

Table I shows that drainage operations on eyes with quadrantic field loss did not lead to any further loss of visual field involving macular fixation.

In Patient 2 the visual acuity fell from 6/9 to counting fingers immediately postoperatively. This was found to be due to lenticular myopia which, when corrected, restored the visual acuity to its preoperative level. Nuclear sclerosis developed after 6 months, but cataract extraction at 1 yr, although complicated by vitreous loss, restored the visual acuity to 6/9 (Table III, Patient 7).

The only instance in which the preoperative visual acuity of 6/18–6/24 could not be explained by any condition other than glaucomatous field loss was that of Patient 14. The sequence of field loss in this patient was also unusual, in that temporal field loss, giving an altitudinal hemianopia, succeeded a nasal quadrantanopia instead of the more usual development of a nasal hemianopia.

Table II illustrates that drainage operations on eyes with central islands of vision did not cause an obliteration of macular function from extension of visual field loss. There is a higher morbidity affecting visual acuity than in the quadrantic field loss group, and losses in visual acuity therefore occurred in nine out of 24 eyes immediately postoperatively. In Patients 5, 12, and 22 the cause was first attributed to loss of central field, but later to the presence of a correctable lenticular myopia. When cataract became apparent, subsequent extraction restored the visual acuity to the pre-drainage level (Table III: Patients 4, 2, and 5).

Patient 15 was considered to belong to this group but refused operation. It was first thought that Patient 17 had lost central fixation, but the study revealed a divergent squint with a facultative suppression of the preoperative vision. Three weeks' postoperative occlusion (for shallow an-

al review

ie)	Visual acuity (operated eye*)	Comments
'12	Counting fingers 6/9*	Left cataract extraction at 15/12
	6/12* 6/6	Postoperative loss wrongly attributed to loss of visual field Right cataract extraction at 1 yr (vitreous loss)
	6/18* 6/18	Bilateral lens opacities
2	6/6* 6/6	Patient died at 6/12
	6/6* 6/6	—
'12	6/6* 6/6	—
'12	6/6 6/6*	—
'12	6/9 6/24*	Slight increase in cataract
	6/5 6/24*	Development of cataract
2	6/36 6/9*	Left corrected lenticular myopia
'12	6/9* 6/9	—
3/12	6/12 6/9*	—
3/12	6/6 6/6*	—
'12	6/36* 6/4	Atypical field loss and visual acuity preoperatively
'12	6/9* 6/9	—
	Hand movements 6/18*	Lens opacity developing
'12	6/9* Counting fingers	—
	6/12* 6/6	Branch vein occlusion (right)
'12	6/12 6/36*	Increasing cataract
'12	Hand movements*	Macular function could not be assessed as patient refused lens extraction
	No perception of light	—
2	6/6 6/6*	—
	6/12 6/60*	Preoperative lens opacity increasing

Table II *Residual central island $\pm$ temporal island*

Preoperative status						Postoperative status (after 6 months)				
Patient	Visual acuity	Intraocular pressure (mmHg)	Visual field	Lens opacity	Operation	Visual acuity	Intraocular pressure (mmHg)	Macular function	Lens opacity	
1	6/18	44	Central island	+	Trabeculectomy	6/18	18	No change	+	
2	6/36	32	Central island	++	Trabeculectomy	6/36	9	No change	++	
3	6/6	42	Central island and temporal island	-	Scheie	6/6	50	No change	-	
4	6/12	44	Central island	-	Scheie	6/18	18	No change	+	
5	6/9	29	Central island	-	Scheie	Counting fingers	25	No change (see comment)	+	
6	6/6	60	Central island and temporal island	-	1. Stallard 2. Scheie	Counting fingers	20	Lost central island	-	
7	6/18	42	Central island and temporal island	+	Iridencleisis	6/18	9	No change	+	
8	6/12	48	Central island	-	Iridencleisis	<6/60	8	Gross reduction in macular function	-	
9	6/12	30	Central island	+	Scheie	6/60	18	Gross reduction in macular function	+	
10	6/6	70	Central island	-	Iridencleisis	6/6	13	No change	-	
11	6/24	24	Central island	+	Trabeculectomy	6/24	17	No change	+	
12	6/6	31	Central island	-	Scheie	6/24	17	No change (see comment)	+	
13	6/18	28	Central island	+	Trabeculectomy	6/24	18	No change	+	
14	6/9	44	Central island	-	Iridencleisis	6/9	18	No change	+	
15	6/9	42	Central island and temporal island	-	Stallard	6/18	18	No change	+	
16	6/9	50	Central island and temporal island	-	Scheie	Hand movements	18	Reduction of macular function	+	
17	6/9	44	Central island	-	Scheie	6/9	20	No change	-	
18	6/24	62	Central island and temporal island	+	Trabeculectomy	6/24	15	No change	+	
19	6/18	24	Central island	+	Trabeculectomy	6/18	14	No change	+	
20	6/9	28	Central island	-	Trabeculectomy	6/9	14	No change	-	
21	6/6	46	Central island	-	Trabeculectomy	6/6	18	No change	+	
22	6/9	34	Central island	-	Scheie	6/60	21	See comment	-	
23	6/6	44	Central island and temporal island	-	Trabeculectomy	6/6	26	No change	-	
24	6/9	40	Central island and temporal island	-	Iridencleisis	6/12	23	No change	+	

terior chamber), a lack of binocular field available for fusion, and a possible pre-existent exophoria may have contributed to this status.

In three instances there was an irreversible loss of visual acuity – due to a postoperative maculopathy (Patient 16), exacerbation of a preoperative maculopathy (Patient 8), and a maculopathy which developed coincidentally with a cataract postoperatively, or subsequent to an eventual cataract extraction (Patient 9, Table II; Patient 1, Table III).

After two unsuccessful drainage procedures with very raised intraocular pressures Patient 6 lost central fixation, and it is not certain whether the surgery or the uncontrolled pressure was the cause.

Patient 7 lost central vision 2 years after the drainage procedure.

Table III shows that cataract extraction did not

lead to worsening of central vision. Three patients out of the 13 did not obtain an improved visual acuity. In Patients 1 and 9 this was due to maculopathy and in Patient 12 to absence of macular function. Maculopathy also restricted visual improvement to 6/18 in Patient 8.

Of the five eyes (1 to 5) with an isolated central visual field, four (2 to 5) survived a drainage procedure and a cataract extraction allowing visual acuities of 6/9. In Patient 1 a coincidental maculopathy restricted vision to the preoperative level of perception of light.

The three (Patients 6–8) with charted pre-extraction quadrantic defects did not lose central fixation after a cataract extraction or a preceding drainage operation.

The five eyes (9 to 13) belonged to three patients

review

	Visual acuity (operated eye*)	Comments
	6/9 6/18*	—
2	6/12* 6/36 (lens opacity and quadrantic loss of visual field)	Cataract extraction at 1 yr Prefers to function with aphakic central island
	6/6* 6/5	Stallard procedure 3/12 before Scheie
at		Preoperative maculopathy
2	6/18* 6/9	Cataract extraction at 1 yr Bilateral aphakia, loss of fixation originally diagnosed
2	Hand movements* 6/9	5 wk between the 2 operations with intraocular pressure 50 mmHg Flat anterior chamber and choroidal detachment after Scheie
2	Hand movements* 6/5	Central vision loss at 2 yr Gradual deterioration
2	Counting fingers counting fingers*	Progressive maculopathy in both eyes Pathological myopia
	Perception of light*	Cataract extraction at 2½ yr showed gross maculopathy
	6/36	—
	6/6* 6/9	—
	6/18 6/60*	Increase in cataract
2	6/9* counting fingers	Cataract extraction at 1 yr Patient functioning with aphakic central island
2	6/60* 6/36	Bilateral lens opacities
	6/6 6/9*	—
2	6/36* hand movements	Increasing lens opacities
2	6/36 hand movements*	Postoperative exudative maculopathy
	6/9* 6/9	Divergent squint with suppression Difficulty in locating test type
2	6/9 counting fingers*	Progressive lens opacities
	6/18* 6/60	—
	6/12 6/9*	—
	6/12* 6/9	—
	6/9* 6/12 (aphakic)	Cataract extraction at 1 2/12 yr
	6/6* 6/9	—
	Counting fingers*	Progressive cataract both eyes
	6/6 (aphakic)	Cataract extraction at 3 yr

who presented with both advanced glaucoma and cataracts. Intraocular pressures were controlled medically before extraction in three eyes (Patients 9, 10, and 11) and by peripheral iridectomy and medical treatment in two (Patients 12, 13).

Considerable improvement in visual acuity resulted in eyes 10, 11, and 13. The postoperative development of maculopathy in Patient 9 allowed only the preoperative vision of 6/60.

Patient 12 was the only example in the present series in which macular function was lost before the development of a nasal hemianopia. This patient had chronic angle-closure glaucoma with intraocular pressures of 60 mmHg at presentation. Central fixation was absent postoperatively. In Patients 8 to 12 macular function could not be demonstrated preoperatively.

DRAINAGE OPERATIONS AND CATARACT FORMATION
IN ADVANCED GLAUCOMA

Within 6 months, in the 'central island' group of 24 patients, postoperative lens opacities significantly reduced vision in five patients (Table II, Patients 5, 9, 12, 15, and 22). After the period of final review cataracts had progressed in a further five patients (Patients 2, 11, 13, 18, and 24). Preoperative lens opacities were present in four of those 10 patients (Patients 2, 11, 13, and 18). In the four Scheie operations the cataracts developed within 6 months and were not associated with preoperative lens opacities. In the four trabeculectomies there were preoperative lens opacities and these progressed significantly after the 6-month interval.

Within 6 months, in the 'quadrantic loss' group of 22 patients, postoperative lens opacities significantly reduced vision in one patient (Table I, Patient 2) and this was corrected to 6/9. After the period of final review cataracts had progressed in a further eight eyes (Patients 1, 8, 9, 10, 16, 19, 20, and 22). Preoperative lens opacities were present in five of these eyes.

Consideration of both groups (Tables I and II) shows that 10 out of 25 trabeculectomies resulted in the progression of lens opacities, but that preoperative opacities were present in nine of these.

Five out of 12 Scheie operations were associated with progressive postoperative cataract and preoperative lens opacity was present in one instance. Inequality of follow-up does not allow valid comparison between the Scheie and trabeculectomy procedures, but at the 6-month level, trabeculectomy would appear to induce less deterioration of visual acuity of lenticular origin.

Discussion

Lichter and Ravin (1974) correctly stated that many of the opinions regarding loss of central vision in late glaucoma after intraocular surgery are the result of clinical impression rather than of the study of a series of patients. It is of interest to analyse the relatively few series which have led to a reluctance to undertake intraocular surgery in advanced glaucoma.

Bloomfield and Kellerman (1949) compared the results of surgery in 19 patients with those of medical treatment in 22 patients. All had residual central islands and after an average follow-up period of 2 years and 4 months it was found that vision was better maintained in the unoperated group. The cause of reduction in visual acuity was not determined so that reversibility of the condition was not excluded.

The present study showed that postoperative

Table III *Cataract extraction group*

<i>Preoperative status</i>				<i>Postoperative status (2 months)</i>		
<i>Patient</i>	<i>Corrected visual acuity</i>	<i>Intraocular pressure (mmHg)</i>	<i>Visual field</i>	<i>Corrected visual acuity</i>	<i>Intraocular pressure (mmHg)</i>	<i>Macular function</i>
1	Perception of light	8	Central island with temporal island	Perception of light	18	See comment
2	6/36	17	Central island	6/9	16	Maintained
3	Hand movements	5	Central island	6/9	16	Maintained
4	Counting fingers	25	Central island	6/9	18	Maintained
5	Counting fingers	21	Central island	6/9	15	Maintained
6	6/36	22	Upper nasal quadrantanopic loss with lower arcuate defect	6/6	24	Maintained
7	Counting fingers	30	Lower nasal quadrantanopic defect	6/9	8	Maintained
8	6/60	18	Upper nasal quadrantanopic defect	6/18	21	Partially maintained
9	6/60	17	Lower nasal quadrantic defect	6/60	16	See comment
10	Hand movements	20	Upper and lower quadrantic defects (nasal hemianopia)	6/12	20	Maintained
11	Counting fingers	24	Nasal hemianopia	6/12	20	Maintained
12	Counting fingers	21	Upper nasal quadrantic defect	Counting fingers	20	Absent (? lost from extraction)
13	6/60	32	Upper nasal quadrantic defect	6/9	15	Maintained

refractive error and cataract formation accounted for the loss of visual acuity postoperatively in four out of 10 patients (Table II). Only five out of the total of the 24 central island group had significant irreversible reduction of vision, up to the time of the final review (Table II, Patients 6 to 9, 16).

The trephine operations and the acknowledged inexperience of some surgeons would have increased the reversible postoperative loss of acuity in Bloomfield and Kellerman's series. The amount of irreversible macular loss in uncontrolled medically-treated patients would also increase with a follow-up longer than the 2 years averaged.

Nemetz and Papapanos (1959) found that visual acuity was the most significant factor influencing

the results of surgery. Thus only 6 per cent of 212 eyes with a preoperative vision of more than 6/60 'turned blind' after operation and 64 eyes with a preoperative vision of 6/60 or less had an incidence of 64 per cent blindness. All patients had a 'contraction of the visual field as low as 5° in one quadrant'.

Glaucomatous field loss does not significantly reduce the visual acuity unless it extends to inside the 5° isoptre (see below). In the series of Nemetz and Papapanos it is likely that macular fixation was involved preoperatively in most of the 64 eyes or that there was a non-glaucomatous cause for the preoperative vision of 6/60 or less. These eyes therefore cannot be said to have lost central

I review

	Visual acuity (operated eye*)	Comments
	6/6 Perception of light* (aphakic)	Large white scar at macula observed postextraction Drainage procedure 2½ yr before extraction
2	6/9 counting fingers	Drainage procedure 1 yr before extraction Functioning well with aphakic central island
	6/12* 6/36 (phakic)	Drainage procedure 1½ yr before extraction Patient prefers to function with aphakic central island
	6/18* 6/9	Drainage procedure 1 yr before extraction Bilateral aphakia
	6/9* 6/12 (phakic)	Drainage procedure 1 2/12 yr before extraction Difficulty in locating test chart but eye is unused, being held in reserve
	6/9* counting fingers	Drainage procedure 1 3/12 yr before extraction Functioning well with aphakic eye
	6/12* 6/6 (phakic)	Drainage procedure 1 yr before extraction Operated eye held in reserve Vitreous loss
	6/18* counting fingers	Maculopathy evident postoperatively Patient died at 9/12
2	6/18 6/60*	Progressive maculopathy reduced visual acuity of 6/24 to 6/60
2	6/12* 6/24	Cyclodialysis 3/12 postoperatively Bilateral aphakia
2	6/12 6/24*	Slight membrane over pupil Visual acuity transiently 6/12 Macula function not thought to be present preoperatively but patient insisted on extraction in view of result of first operation (Patient 10)
	6/12-6/18 counting fingers*	Normal visual functioning Iridectomy before extraction (sub- acute angle closure) Macular function could not be demonstrated in early stages of cataract
2	6/12-6/18* counting fingers	Iridectomy 1 yr before extraction (subacute angle closure) Visual functioning much improved

fixation as it is unlikely to have been present preoperatively.

Fanta and Herold (1966) undertook static perimetry before and after operation on 10 eyes in which the macular fixation was approximated by glaucomatous field loss. They demonstrated a fall in the profile of sensitivity to static perimetry and a reduction of the functioning field in all instances. However, fixation was maintained in eight of their cases. Of the two who lost fixation, one was a high myope (Case 10). In the other (Case 8), the inferior scotoma, almost splitting fixation preoperatively, was questionably glaucomatous as it was atypical in shape and crossed the horizontal meridian nasally. Fanta and Herold suggested that operation

was justified only if the limits of the visual field did not encroach more than 5° from fixation and that loss of fixation was probable if the encroachment was 3° or less.

This supposition is not borne out by the recent results of Lichter and Ravin (1974) or those of the present series. We found that the patients' response to perimetry inside the 5° isoptre is usually inconstant and that the actual visual acuity is the best method of determining macular involvement in glaucomatous field loss in these circumstances. We found that acuity fluctuated at different examinations, usually between 6/9 and 6/18 and, exceptionally, 6/24 (Patient 14, Table II).

Careful refraction and time for the patients' concentration and orientation of visual direction were the most important factors in eliciting the maximum visual acuity. When fixation is involved the acuity is invariably less than 6/60 and when the condition is due to glaucomatous field loss the decline to this level is dramatic unless other factors such as cataract have already lowered the acuity to between 6/24 and 6/60.

Lichter and Ravin (1974) attempted to classify late glaucoma in terms of visual acuity and field loss. They did not give a full description of the visual fields but in 23 eyes in which visual field loss 'involved fixation' (as shown by a reduced visual acuity), and in nine eyes in which field loss extended to within 5° of fixation, drainage procedures did not influence macular function. Loss of acuity was attributed to cataract and this caused a similar loss of acuity postoperatively in glaucomatous eyes in which fixation was not threatened.

The present investigation has also revealed that postoperative cataracts reduce the visual acuity. They occurred earlier, and with a greater effect on vision, in the central island group than in the nasal field defect group. This may mean that the more severe the glaucomatous damage, the more vulnerable are the eyes to postdrainage cataract formation. Alternatively, the 'tunnel' vision of these eyes may be more vulnerable to minor lens opacities. The number of trabeculectomies carried out was also much lower in the central island group, and this operation appears to be much less likely to cause postoperative lens opacity, at the 6-months level of follow-up.

Lichter and Ravin's series was remarkable because of the absence of any postoperative maculopathy. In the central island group (Table II) in the present series maculopathy reduced vision postoperatively in three out of 24 eyes (12.5 per cent). Postoperatively maculopathy was not seen in the nasal field defect group. It appears from this series that the central island group is more vulnerable not only to postoperative cataract

formation, but also to postoperative maculopathy. Of a total of 46 drainage procedures (Tables I and II), however, maculopathy developed in three eyes (7 per cent).

Lawrence (1969) found a similar postoperative morbidity regarding cataract and maculopathy. In 19 eyes with residual central islands, central fixation was not lost but visual acuity was reduced as a result of cataract in six eyes and maculopathy in one. In 24 eyes with 'quadrantic' field loss, central fixation was maintained but vision was reduced by cataract in seven eyes and by macular degeneration in eight. All were eyes which had been trephined and this operation would appear to cause a greater postoperative morbidity.

Kronfeld and McGarry (1948) found that, in 18 eyes with field defects extending to within 5° of fixation (mainly central islands), 95 per cent retained fixation for 5 years postoperatively. Immediate postoperative loss of fixation was not recorded. Twelve eyes with similar field defects, uncontrolled medically, were not operated upon and nine (75 per cent) retained fixation during 5 years. Although their study supports the view that surgery does not significantly affect fixation, it does call into question the wisdom of surgery in elderly patients with advanced glaucoma in whom pressures are not greatly raised or have been reduced significantly by medical therapy.

The present series has shown that the risk of reoperation for cataract in the 'quadrantic loss' and the central island groups is in the order of 30 per cent within the periods of final review. The risk of a maculopathy for the residual central island group is in the region of 12.5 per cent within 6 months (Tables I and II).

If the 5-year survival of macular function is improved only from 75 to 83 per cent by drainage surgery (Kronfeld and McGarry, 1948), these sequelae of surgery would not be justified. However, Kronfeld and McGarry did not describe the amount of lowering of intraocular pressure achieved medically in their unoperated group and this may have more significance regarding survival of the visual field than 24-hour control under the arbitrary pressure of 21 mmHg (Miller and Karsenas, 1974). In cases in which medical therapy has little therapeutic effect on high intraocular pressures and reasonable longevity is assumed, the risks of surgery may be considered to be justified in patients with advanced glaucoma.

The results of cataract extraction show that 10 of 13 patients had an improved visual acuity, maculopathy being responsible for postoperative morbidity in three patients.

Lawrence (1969) carried out eight cataract extractions in eyes with macular function and this was retained in six patients (three central islands

and three quadrantic loss). Maculopathy restricted visual improvement in two eyes with quadrantic field loss.

These findings suggest that cataract extraction in eyes with advanced glaucoma will usually incur benefit to the patient and that the risk of removing the small amount of sight the patient may have, is small (reduction or loss of visual acuity was not recorded in the present series or in Lawrence's eight cases). Failure to improve the vision may occur in 24 per cent of patients (five out of 21 extractions, combining data of Lawrence and present series), mainly due to an increased incidence of maculopathy. Sixteen of these eyes were subjected to drainage operations before cataract extraction. Both series show the development of a postdrainage maculopathy in some of these patients with late glaucoma, so that the culpability of the cataract extraction itself may be less.

In the monitoring of glaucoma simplex a gradual progressive loss of visual acuity is frequently observed. This gradual loss is not due to glaucomatous field loss (despite apparent changes in perimetric field analysis), but often to progressive lens opacity. We have found that, as in retinitis pigmentosa with residual macular function, minor lens opacities severely affect visual acuity in late glaucoma. When loss of visual acuity is severe enough lens extraction will improve the sight in over 75 per cent of patients. Six of the 11 patients who underwent cataract extraction experienced a great improvement in visual function (Table III; Patients 2, 3, 6, 8, 10, and 13). Two aphakic eyes (4, 11) are contributing to binocularity, and two (5, 7) are held in potentially useful reserve.

When cataracts develop in patients with glaucoma simplex who are under ophthalmic care their management is easier. The history of the visual acuity and the visual fields will usually indicate if macular function is likely to be present, as discussed already.

When patients present with advanced cataracts and late glaucoma (Patients 9 to 13, Table III) it may be impossible to determine the status of macular function. Thus in four of these five patients, pinhole vision, Maddox rod testing, entoptic imagery, and testing the perception of two approximated coloured lights did not indicate the presence of macular function. Perimetric field analysis is too refined a technique to determine the visual fields. If vision is capable of registering hand movements this visual stimulus to confrontation in the four quadrants has been found to be the most useful in determining the extent of glaucomatous field loss. If visual fields are full to confrontation macular function is invariably present despite possible central Bjerrum scotoma. It is rare for central vision to be lost subsequent to a quadrantic

defect (Patient 12, Table III) and it is often retained in the presence of a nasal hemianopic defect (Table III, Patients 10 and 11). Such glaucomatous field defects, when associated with advanced cataract, do not preclude potential macular function. This was attained in three out of five eyes in these circumstances (Table III, Patients 10, 11, 13). It is rare to make such patients' vision worse, so that reversibility of visual loss may be excluded by cataract extraction when the patient's binocular visual status and life situation merit it.

Summary

Loss of visual field subserving macular function has been found to be rare after intraocular surgery in advanced glaucoma. Abrupt changes in refractive error, lens opacity, and suppression must be carefully excluded before macular fixation is deemed lost.

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Out of 69 intraocular procedures (46 drainage operations, 13 cataract extractions) two patients lost central visual field subserving macular fixation possibly as a result of surgery.

There is an increased incidence of postoperative maculopathy in late glaucoma. Three drainage operations out of 46 and four cataract extractions out of 13 had this complication.

Altogether 30 per cent of drainage procedures induced deterioration of visual acuity of lenticular origin to a level normally requiring cataract extraction. Trabeculectomy was found to be less likely to cause this sequela than the Scheie procedure at the 6 month postoperative stage. However, 77 per cent of patients with advanced glaucoma and cataract obtained a satisfactory improvement in visual status after cataract extraction.

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