Section of Ophthalmology

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Glaucoma

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Effect of Intravenous Acetazolamide on Relative Arcuate Scotomas and Visual Field in Glaucoma Simplex

The effect of increased intraocular pressure on the visual field has been investigated by several workers (Drance 1962, Tsamparlakis 1964) who have shown that transient elevation can cause a transient arcuate scotoma. The reverse effect of acutely induced intraocular hypotension has received less attention and this study was undertaken to learn more about such an effect. Interest in this subject has been stimulated by recent work on the peripapillary capillaries. This network, described by Michaelson (1954), supplies the superficial nerve fibre layers and thus subserves the pericentral field of vision. Henkind & Alterman (1968) have shown by indian ink perfusion experiments that these capillaries, which are longer and straighter than those in other networks, are particularly susceptible to changes in intraocular pressure, as shown by early filling defects under conditions of increased pressure. So it would seem possible that for normal visual function a state of critical equilibrium exists between the retinal vascular bed and intraocular pressure, and in some cases if this is altered functional changes in the visual field can ensue. In this investigation intravenous acetazolamide was used to bring about this alteration.

Method

The Goldmann projection perimeter was used for all the visual field examinations. This instrument has a standardized background illumination of 31·5 apostilb and a projected stimulus which is calibrated against a luxmeter. Thus the exact conditions of examination can be accurately reproduced each time. The target size selected was 0·25 mm² and the intensity 100 apostilb. This stimulus was used in the first instance to investigate the central fields of all patients and will be designated I-2, I referring to surface area and 2 to intensity. The intensity was increased to 1,000 apostilb for examination of the peripheral field giving stimulus value I-4; if necessary the target surface area was subsequently increased in size to give more information.

A correcting lens was used for all examinations of the central field when indicated. This consisted of the distance correction of the patient plus the correction for age recommended by Goldmann. This correction was removed for peripheral field examination.

The minimum pupil size acceptable was 3 mm to eliminate the adverse effect of miosis on the visual field. Any patients on miotic drops were asked to discontinue them for the twenty-four hours preceding the test; none was already on acetazolamide.

All patients had been examined on the Goldmann perimeter at least twice, and often more frequently, to eliminate the possibility of a learning effect. Only subjects with good co-operation were selected. On the day of the test the patient attended for examination of the visual field on the Goldmann perimeter. The intraocular pressures were then measured with the applanation tonometer. An injection of 500 mg acetazolamide was then administered intravenously and the fields re-examined after half an hour. At the end of this time the pressures were measured again.

The sample investigated falls into four groups: (1) Relative arcuate scotoma. (2) Glaucoma

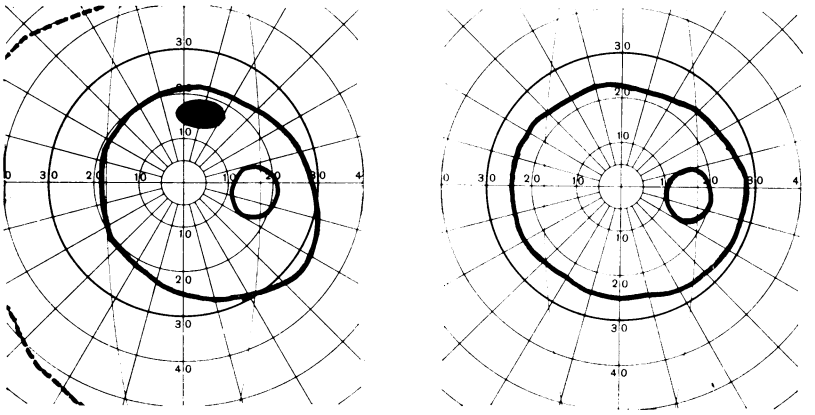

Fig 1 *Woman aged 55, relative arcuate scotoma, before (left) and after (right) acetazolamide.*
$\triangle P = 5$ *mm (17→12).* $VA = \frac{6}{6}$. *Correction* $= +3{\cdot}00$. *Pupil diameter = 3 mm.*
- - - - I_4, ——— I_2

simplex. (3) Low-tension glaucoma. (4) Early glaucoma simplex.

All patients were drawn from the glaucoma clinic of the High Holborn branch of Moorfields Eye Hospital, where they are attending for treatment or observation either in the glaucoma clinic or the family screening clinic. Other causes of field defect were eliminated as far as possible.

Relative scotoma: Into this group fall patients with an applanation pressure of 19 mmHg or less showing a definite, relative arcuate scotoma in the field of vision. Relative scotomas are very interesting phenomena. They are a manifestation of areas of depressed retinal sensitivity due either to a reduction in intensity of the light stimulus by factors in the ocular media or to retinal damage. They are therefore affected by several factors in addition to the intraocular pressure level.

These include refraction, opacities in the ocular media, and pupil size; they were eliminated as far as possible for the purpose of this investigation. The importance of using a correcting lens has already been stressed. If a relative scotoma is found with a certain correction it is necessary to change the lenses to see if it can be diminished in size or eliminated. All the scotomas under investigation in this study were tested with lenses half and one dioptre above and below the calculated correction and the correction giving the smallest lesion was selected for all subsequent visual field examinations.

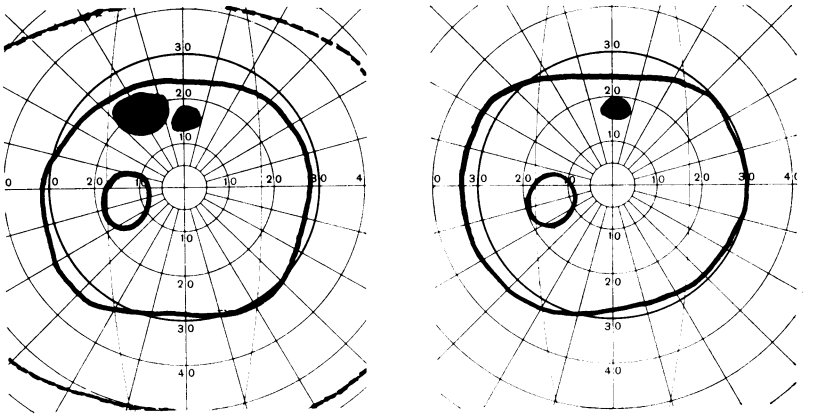

Fig 2 *Man aged 52, early glaucoma simplex, before (left) and after (right) acetazolamide.*
$\triangle P = 3$ *mm (20→17).* $VA = \frac{6}{6}$. *Correction* $= +2{\cdot}25$. *Pupil diameter = 4 mm.*
- - - - I_4, ——— I_2

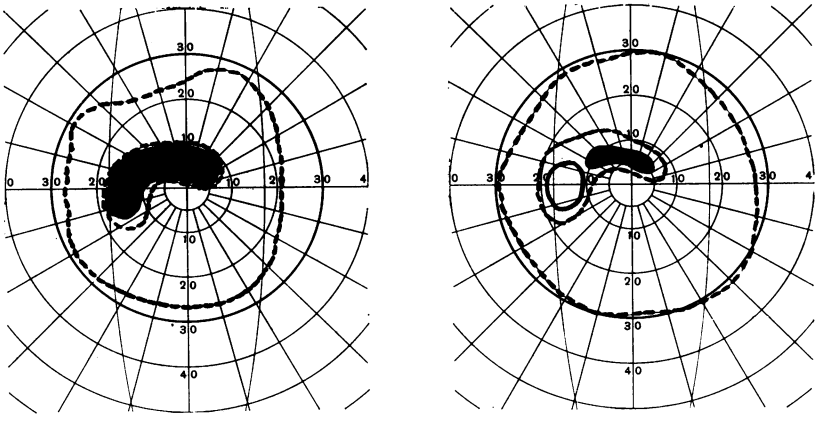

Fig 3 *Man aged 52, low-tension glaucoma, before (left) and after (right) acetazolamide.* $\triangle P = 4$ *mm (18→14).* $VA = \frac{6}{6}$. *Correction* $= +1{\cdot}00$. *Pupil diameter* $= 4$ *mm.* ---- I_2, ——— V_4

All the relative scotomas in this group had a minimum diameter of 5 degrees and all were confirmed on more than one occasion before the test was performed.

There was no specific disc pattern in this group of patients, most of whom were found on family screening.

Early glaucoma simplex: This comprised patients with minimum applanation pressures of 20 mmHg, relative scotomas, but no specific disc pattern. The intraocular pressure level is the parameter dividing this group from the preceding one and the same remarks about the relative scotomas apply.

Low-tension glaucoma: This group consisted of patients with an applanation pressure of 19 mmHg or less, cupped discs and severe field defects, often absolute. An absolute scotoma is a manifestation of gross retinal damage such that the neurones cease to function and no stimulus, however bright, is perceived.

Glaucoma simplex: This group contained patients with a minimum applanation pressure of 20 mmHg, cupped discs and severe field defects.

Results

There are four ways in which a visual field may vary: (1) Blind spot. (2) Isopters. (3) Area of scotomas. (4) Density of scotomas. To consider all four in each of the cases studied would take too much space. In the relative scotoma and early glaucoma simplex groups I have concentrated on the change in area of the scotomas as measured in degree scale units along the circumferential axis of the scotoma. One degree scale unit = 5 degrees.

There was no constant pattern of field defect in the remaining two groups so the individual cases have been considered.

Relative scotoma: There were 10 patients, 6 male and 4 female, and 13 eyes were studied. The age range was from 23 to 67 years with an average of 52. The average base-line pressure was 16·2 mmHg and the average drop in pressure after the acetazolamide was 5·3 mmHg. The mean improvement in the area of the scotomas was 11·23 degree scale units. Fig 1 shows the results in one case.

Early glaucoma simplex: There were 14 patients, 12 male and 2 female, and a total of 16 eyes were studied. The age range was from 30 to 69 years

Table 1

Results in relative scotoma and early glaucoma simplex groups

	Relative scotomas	*Early glaucoma simplex*
Average pressure	16·2∓1·5	21·8∓2·2
Average △P	5·3∓1·5	6·2∓2·5
Average improvement (degree scale units)	11·23∓8·5	7·6∓6·30
Average age (years)	52∓12·5	58∓8·5

1 degree scale unit = 5°

Table 2

Results in individual eyes in relative scotoma and early glaucoma simplex groups

Improvement	*Early glaucoma simplex*	*Relative scotoma*
None	6	2
1–5°	3	2
6–10°	3	3
10–20°	3	5
>20	1	1
	16	13

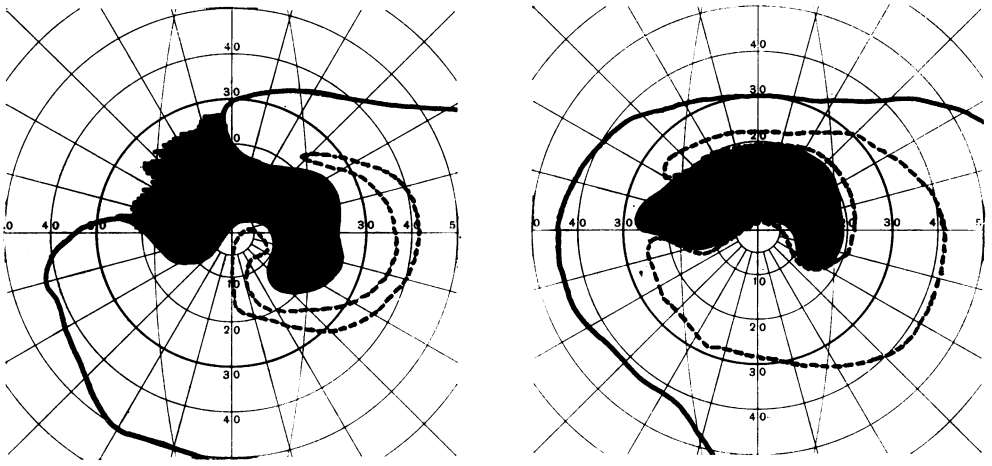

Fig 4 *Man aged 54, glaucoma simplex, before (left) and after (right) acetazolamide.* $\triangle P = 12$ *mm (23→11).* $VA = \frac{6}{4}\ \frac{-0{\cdot}50}{+1{\cdot}25}\ 15°$. *Correction* $= +3{\cdot}00$. *Pupil diameter = 4 mm.* - - - - I_2, ——— V_4

with an average of 58. The average base-line pressure was 21·8 mmHg and the average drop in pressure after the injection was 6·2 mmHg. The mean improvement in the area of the scotomas was 7·6 degree scale units. Fig 2 shows the results in one case.

Tables 1 and 2 summarize the results in these two groups. Improvement was greater in the first group where the base-line pressures were lower and the average age of the patients below that in the second group.

Low-tension glaucoma: There were 7 patients, 4 female and 3 male, with an average age of 56 years. Before injection the mean pressure in this group was 17·1 mmHg with an average drop of 4·9 mmHg afterwards. There was little or no improvement in 5 eyes and a reduction in density of the scotomas in 2 eyes studied. Fig 3 shows the fields of a man with a dense absolute upper arcuate scotoma continuous with the blind spot before administration of acetazolamide, with considerable reduction in the absolute area afterwards.

Glaucoma simplex: There were 10 patients, 3 female and 7 male, with an average age of 57 years. The mean base-line pressure was 27·5 mmHg with an average fall in pressure of 8·7 mmHg after acetazolamide. Four eyes showed no improvement. One eye showed a reduction in the scotomatous area to the I-4 target. The remaining eyes showed great improvement in the isopters

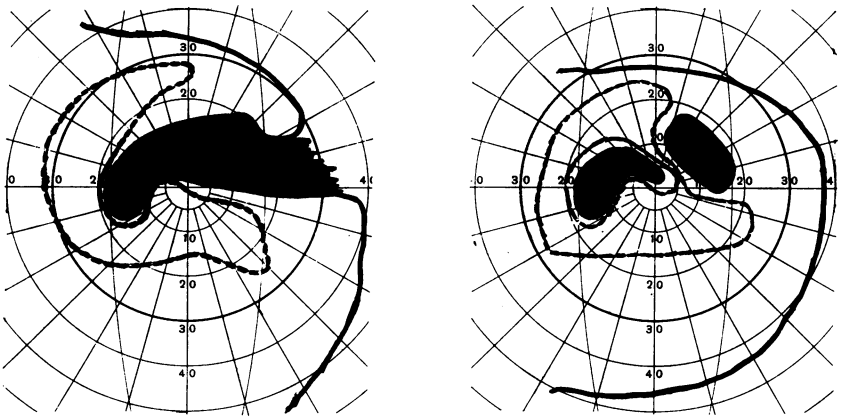

Fig 5 *Woman aged 56, glaucoma simplex, before (left) and after (right) acetazolamide.* $\triangle P = 6$ *mm (20→14).* $VA = \frac{6}{4} + 0{\cdot}50$. *Correction* $= +3{\cdot}00$. *Pupil diameter = 4 mm.* - - - - I_2, ——— I_4

including the pulling out of nasal steps in 4 cases with associated reduction in the scotomatous area. Examples of improvement are shown in Figs 4 and 5.

All patients who improved as a result of the test were treated, and the improvement gained has been maintained. In the young patients, seen on the family screening programme, the single injection of acetazolamide effected a cure and three of them have been followed for more than a year.

Conclusions

There were much greater changes in the relative arcuate scotoma and early glaucoma simplex groups, suggesting that the early relative scotomas are more easily reversed than the more advanced denser ones. The younger patients responded to a greater extent, as one might expect. The lack of response among the low-tension glaucoma patients is interesting and stresses the need for careful examination and full investigation before reaching that diagnosis. Marked individual variability in response leads one to think that other factors besides the level of the intraocular pressure and the state of the vascular bed may be involved. If the neurones are deprived as a result of a systemic metabolic or endocrine disturbance, then they would be more susceptible to a reduction in blood supply than normal healthy nerve cells and would need a relatively greater increase in blood supply to show recovery of function. Of interest in this respect is the work of Armaly (1969). He followed a population of 3,936 subjects for ten years, at the end of which time 4 had developed relative arcuate scotomas with minimum pressure levels of 22 mmHg. These 4 subjects were further investigated and it was found that all had abnormal glucose tolerance tests, 2 had thyroid dysfunction and 3 had acute peptic ulcers. The simultaneous occurrence of the field defects and defective carbohydrate metabolism could surely not be due to chance alone.

There is no doubt, however, that some scotomas are pressure-dependent. It is extremely important to search carefully for early lesions in all glaucoma work and to treat such lesions vigorously with hypotensive therapy when they are found to be present.

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Glaucoma: A Fourteen-year Retrospective Study of Scheie and Flap Sclerotomies

The purpose of this paper is to show the results of a retrospective study on the patients operated on by members of the glaucoma clinic of the High Holborn branch of Moorfields Eye Hospital, to see whether the results of flap sclerotomy differ from those of Scheie's operation. A total of 170 patients have been examined. The duration of follow up varies between fourteen and two years, with an average of seven years.

The operation technique was as follows: flap sclerotomy standard procedure with iridecleisis; Scheie 4·5 mm limbal incision and cautery to anterior lip; subconjunctival betamethasone after both operations.

In assessing the effects of operation, the following parameters were considered: visual acuity, visual fields and intraocular pressure, and the successes were divided into three grades: Grade I – visual fields maintained with no deterioration; intraocular pressure below 20 mmHg; visual acuity showing no fall of more than two lines of Snellen's chart. Grade II – as Grade I, but with drops needed to maintain normal intraocular pressure. Grade III – normal intraocular pressure, with fall of visual acuity more than two lines but not requiring drops.

Method of Research

The notes of all patients operated on by Scheie's procedure or flap sclerotomy by the glaucoma unit over the last fifteen years were collected and those patients who were available for re-examination were included in the study. There were three men operated on for every two women.

The re-examination consisted of field study on the Goldmann perimeter, visual acuity and intraocular pressure by applanation. Enquiry was also made as to how much, if any, interference with the patient's occupation had occurred.

The results were then compared with the patients' condition at the time of operation. The patients were grouped according to type of glaucoma, age and sex. This paper deals only with those patients suffering from chronic simple glaucoma.

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