PERIPHERAL IRIDECTOMY IN ANGLE-CLOSURE GLAUCOMA*† A COMMON COMPLICATION

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ALTHOUGH prophylactic peripheral iridectomy is probably one of the most satisfactory operations in the whole of surgery if carefully performed on carefully selected cases, we have the clinical impression that posterior synechiae in the part of the pupil related to the iridectomy can be a common complication. Posterior synechiae following peripheral iridectomy were mentioned by Lowe (1962). The present investigation was made in an attempt to elucidate the causes, sequelae, and method of prevention of this complication.

Material and Methods

Patients who had peripheral iridectomy between 1958 and 1962 (majority), or early in 1965, were recalled between January and March, 1966, and 63 patients (63 eyes) were selected for statistical analysis.§ Often only one eye was relevant, for example if the other had had a drainage operation, but when two eyes were available, only one was chosen for inclusion in this investigation; inclusion of two eyes from one patient would mean that each individual observation is not as independent as possible of all the others, since two eyes in the same patient probably tend to behave in the same way. The right eye was selected if the patient's glaucoma clinic number was even, and the left if it was odd.

In 55 cases the operation had been done because of intermittent subacute attacks of angle-closure glaucoma, or an acute attack which had resolved on miotics; in eight cases it had been done because of a positive mydriatic test. All the patients had been given topical atropine 1 per cent. daily post-operatively for 1 or 2 weeks, except for two who had received homatropine 1 per cent. Only two had subsequently required pilocarpine for control of ocular tension.

In each case a photograph of each eye was taken before and after mydriasis with phenylephrine 10 per cent. An Ilford Sportsman camera was used with a supplementary 10 dioptré lens fitted to the standard vario 2.8f/45 mm. lens so that a larger magnification and a smaller field could be obtained. An attachment was used to achieve and maintain a fixed distance between the cornea and the anterior pole of the standard vario lens; this measured 10 cm. in length from the graduated scale, which appeared on all the photographs. The film was left as a roll and projected on to white paper so that the cornea was enclosed in a black ring of diameter 10 cm. drawn on the paper. The outline of pupil and iridectomy was then drawn in with a fibre pen. Readings detailed in this communication were measured on these tracings with a scale prepared by reference to the graticule on the foot-piece of the camera. It is realized that all the figures are "apparent", not real, because no correction has been made for magnification by the cornea or its variations.

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§ Included in another paper (Phillips, 1966) is a short account of some of the results of this investigation, for which a total of 64 cases was analysed. For the present paper a fresh analysis was made, but one patient could not be traced, hence a small discrepancy.

Results

Of the 63 eyes, the surprisingly high number of 21 (33 per cent.) had posterior synechiae. Five had synechiae in all four sectors of the pupil, *i.e.* the sector related to the iridectomy and all three others. In eleven only one sector was affected, and in the remainder two or three. These observations are recorded in Table I, and compared with the distribution expected from the application of the null hypothesis. Since there are 63×4 quadrants and 44 synechiae (*i.e.*, from Table, $4 \times 5 + 3 \times 3 + 2 \times 2 + 1 \times 11 = 44$), the probability that any particular segment will be affected is $\frac{44}{63 \times 4} = \frac{11}{63}$. If the null hypothesis be applied, *i.e.* that any synechia affected a quadrant independently of any other synechia in any other quadrant, then the number of eyes with 4, 3, 2, 1, 0 quadrants affected would be given by the terms of the binomial expansion $63 \left(\frac{11}{63} \times \frac{5}{6} \right)^4$ as shown in Table I.

TABLE I
QUADRANTS AFFECTED IN 63 EYES

No. of Quadrants Affected	No. of Eyes	
	Observed	Expected
4	5	0.0585
3	3	1.1072
2	2	7.8509
1	11	24.7424
0	42	29.2410
Total	63	63

A χ^2 test ($n = 4$) confirmed that the distribution of synechiae was not random ($P < 0.001$). A larger than expected number of eyes suffer no synechiae at all, but also a disproportionately large number suffer synechiae in all four quadrants.

If only the 21 eyes with synechiae are considered, leaving out the 42 eyes with none, is the distribution of synechiae random? Application of a Cochran Q test resulted in a Q value of 15.72, $\chi^2 = 11.34$ ($n = 3$) and therefore a P value of < 0.01 , indicating rejection of the null hypothesis in this case, the distribution is not random.

The situation is statistically simplified if eyes with only one sector affected are considered. In eleven such eyes, the sector related to the iridectomy was involved in nine. If the synechiae had been distributed at random, then $11 \div 4$ synechiae would have been present in each sector. These considerations are summarized in Table II.

TABLE II
QUADRANT AFFECTED IN 11 EYES

Quadrant Affected	Iridectomy	Other
Observed	9	2
Expected	2.75	8.25

A binomial test gave a significant P value at < 0.01 .

Does a broad, as opposed to a narrow, peripheral iridectomy tend to predispose to synechiae in the iridectomy-sector of the pupil? When the breadths of the iridectomy, measured with pupils undilated, in the 42 eyes without pupillary

synechiae were compared with those in the nine eyes which had synechiae in the iridectomy quadrant, the median results in mm. of peripheral iridectomy were 1.75 in the former and 2.35 in the latter. A one-tailed χ^2 test (median test) gave a significant P value of < 0.03 . The Figure (opposite) shows a typical example of the effects of a large "peripheral" iridectomy, with a posterior synechia in the iridectomy quadrant.

Does the presence of posterior synechiae have a deleterious effect on vision? The best corrected visual acuity before and after operation was noted for groups without synechiae and with synechiae. The average fall in visual acuity of the former was one line on Snellen's test chart, and that of the latter 2.05 lines. This change was not significant to a Mann-Whitney U test. However, the variances of the two groups did differ significantly (P of <0.01) as found by a Fisher's F test. Lens opacification seems to be the likeliest explanation for the fall in visual

acuity, but it was not possible clinically to identify this with certainty—at least, localized lens opacities were not seen. An implication here is that, in iridocyclitis, complicated cataract may be partly due to posterior synechiae and that strong efforts should be made to prevent or minimize them.

Clinically, the pupil often appears D-shaped after peripheral iridectomy. As a measure of this, it was decided to use the ratio of (*a*) distance from centre of pupil to its edge at iridectomy-sector to (*b*) distance from centre of pupil to its edge at next adjacent quadrant. The centre of the pupil was taken as the centre of a line across the pupil at right angles to a line through the centre of the peripheral iridectomy and the centre of the pupil. This was easily done on the tracings made. The smaller the above-described ratio, the greater the "D" tendency; the larger the ratio, the less the "D" tendency. (It was assumed that the normal pupil is circular.) As would be expected, when eyes which had peripheral iridectomy (without posterior synechiae) were examined, the ratio deviated significantly from unity ($t = 3.246$; $n = 30$; $0.01 > P > 0.001$), *i.e.* a D tendency is demonstrable.

Similarly, when the pupil was dilated with phenylephrine 10 per cent. a D tendency was demonstrable ($t = 4.5$; $n = 30$; $0.01 > P > 0.001$). When homatropine 2 per cent. was used in a small number of patients, a D tendency was present ($t = 3.750$; $n = 8$; $0.01 > P > 0.001$). In the small series examined, a comparison between the D tendency produced by phenylephrine 10 per cent. and homatropine 2 per cent. showed no significant difference. When the undilated pupils were compared with the pupils dilated with phenylephrine 10 per cent., an alteration in the D ratio was frequently noted, but the number showing an increase was almost equal to the number showing a decrease, *i.e.* mydriasis with topical phenylephrine 10 per cent. had no consistent effect in decreasing or increasing the D tendency.

It would be expected that the D tendency would be the greater, the broader the peripheral iridectomy. No correlation, however, was found between these two, with the pupil either undilated or dilated. Nor was there any statistical correlation

FIGURE.—Effect of a large peripheral iridectomy. Note immobility of iridectomy quadrant in dilated pupil. There is a posterior pupillary synechia in the iridectomy quadrant.

between the breadth of the iridectomy and the change in the D tendency with pupil dilatation.

Discussion

If it be assumed that in a normal eye there is no tendency for posterior pupillary synechiae to develop, the operation of peripheral iridectomy and/or related circumstances must play an important part in causing 33 per cent. of eyes to develop posterior synechiae. Presumably, their appearance depends on a number of factors:

- (1) Variable pre- and post-operative (inflammatory) reaction;
- (2) Variable response of pupil to mydriatics;
- (3) Iris applied quite firmly to lens because of the shallow anterior chamber characteristic of eyes with closed-angle glaucoma;
- (4) No flow of aqueous through the pupil,
and therefore
- (5) Wide area of iris in contact with lens;
- (6) Immobility of pupil in sector related to peripheral iridectomy (especially if iridectomy is broad).
- (7) Localized inflammation in ? necrotic area of iris between pupil and iridectomy.

Some of these considerations may apply to the peripheral iridectomy in cataract extractions.

A part of our statistical observations suggests that the sixth factor is important, which is not surprising. A further point may be worth mentioning. When the breadth of the iridectomy in the group *without* posterior synechiae is compared with a group which had posterior synechiae *not* involving the iridectomy sector, inspection of the figures suggested no significant difference (*cf.* significant difference when the former group was compared with the group which *had* posterior synechiae in the iridectomy sector as described under "Results" above). In this group with synechiae which did *not* involve the iridectomy sector, a severe post-operative inflammatory response and/or a poor response to mydriatics were probably important—whereas, if the breadth of the peripheral iridectomy is large, a relatively mild inflammatory response will probably produce posterior synechiae in the iridectomy sector only.

Should the iridectomy be small in all dimensions and not merely narrow? We did not carry out statistical tests on the radial size or area of the iridectomy in relation to synechiae. Nor do we know if there is complete denervation or atrophy of the muscle in the residue of iris between the pupil and the iridectomy. An attempt was made to elucidate this question by comparing the distance between pupil and iridectomy on the one hand and pupil and base of iris in an adjacent sector on the other hand. In the majority of cases the shortening of iris in the intact sector was greater (proportionately) than in the iridectomy sector, but it must be admitted that shortening in the latter might have been merely passively induced from the neighbouring intact iris. Graphs showed no correlation between the shortening of the iris tissue in response to mydriatics and the radial length of the iris tissue available before mydriasis.

Summary and Conclusions

Of 63 eyes which had prophylactic peripheral iridectomy, 21 (33 per cent.) developed posterior pupillary synechiae. They had been treated post-operatively with gutt. atropine 1 per cent. or (in two cases) with homatropine 1 per cent. The sector

of the pupil related to the iridectomy quadrant was affected more often than chance would suggest, but all four quadrants were also affected in a rather high proportion of cases. The breadth of the peripheral iridectomy was significantly greater in eyes which developed synechiae in the iridectomy quadrant alone than in eyes which failed to develop synechiae. The pupil had a D shape in the undilated and the dilated state. The average fall in the best corrected visual acuity of the eyes which did not develop synechiae was 1 line on Snellen's test chart, whereas that of eyes which did develop synechiae was 2.05 lines; although this difference was not statistically significant, the variances of the two groups did differ significantly.

The causes suggested, in order of importance, are:

- (a) Ineffectiveness of atropine as a preventer of synechiae;
- (b) Relative unresponsiveness to atropine of the iridectomy quadrant, especially when
- (c) The peripheral iridectomy is broad;
- (d) Unresponsiveness to atropine of the whole iris (especially in eyes with all four quadrants affected by pupillary synechiae), either because of an inherent property common in elderly patients or because of a marked inflammatory reaction.

Other factors are:

- (e) Absence of a flow of aqueous through the pupil because of the peripheral iridectomy;
- (f) A wide area of iris in contact with the lens for the same reason, and also probably
- (g) Firm application of the iris to the lens because of the shallow anterior chamber.
- (h) Localized inflammation in ? necrotic area of iris between pupil and iridectomy.

For clinical purposes, in order to minimize the danger of posterior synechiae, we aim to do a peripheral iridectomy which is small in all dimensions (although the particular measurements we actually made justify a narrow rather than a broad one), we prescribe gutt. phenylephrine 10 per cent. twice daily (recommending that the pupil should be seen to dilate in all sectors on this treatment), and also topical corticosteroids which should minimize traumatic iridocyclitis.

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ADDENDUM

Since this paper was written it has been possible to examine a series of patients who have had a purely prophylactic peripheral iridectomy, *i.e.* none has had acute or sub-acute attacks of angle-closure glaucoma; in the vast majority the operation was done on a "fellow eye" which had an open though narrow angle, with or without a positive mydriatic test. Post-operative treatment was usually gutt. homatropine 1 per cent., often with phenylephrine 10 per cent.; very few cases had cortisone and a few had atropine 1 per cent. Of 37 eyes (37 patients) examined, seven showed posterior synechiae (18.9 per cent.). This probably represents an underestimate, because in some cases classified as having no synechiae

pigment blobs were noted on the lens capsule when the pupil was dilated, usually in the iridectomy quadrant; these blobs may well represent minimal adhesions of iris to lens at some time which could be broken down by mydriatics. This observation had also been made in the series analysed in detail in the main results.

In all of the seven eyes with posterior synechiae, the iridectomy quadrant was involved; in three out of the seven it was the only quadrant affected. This distribution tends to confirm the observations on the 63 eyes described above. The reduced incidence of synechiae, 18.9 instead of 33 per cent., may be due to treatment with transiently acting mydriatics—nevertheless, the risk is substantial. Topical cortisone may reduce it further.

The average area and breadth of the peripheral iridectomy in the group without synechiae was 0.167 sq. cm. and 0.15 cm. The averages in the group of three with synechiae in the iridectomy quadrant were 0.150 sq. cm. and 0.140 cm.; in the group of four with synechiae in other quadrants as well, the averages were 0.165 sq. cm. and 0.145 cm. These figures do not support the observations recorded alongside Table II in "Results" above. No detailed statistical analysis of these latest figures has been done but, on general grounds, the principle of doing a small iridectomy with as little surgical trauma as possible seems to be worth applying.