

THE DARK-ROOM TEST*

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ONE of the provocative tests used to reveal the instability of ocular tension characteristic of glaucoma is the dark-room test. It has been known for over 40 years that darkness can increase the intra-ocular pressure, slightly in normal eyes and markedly in some cases of glaucoma, but there is still lack of agreement about how this occurs. This is not surprising in that it reflects our ignorance of many of the fundamental processes of glaucoma.

Grönholm (1910), who first described a case that showed this reaction considered that the pupillary dilatation reduced the drainage capacity of the iris, and Seidel (1922) attributed the change to obstruction of the angle of the anterior chamber by the periphery of the iris. Other authors deny the effect of angle block and implicate a neuro-vascular disturbance, which may be within the eye (Feigenbaum, 1931) or of a more widespread character, possibly involving the hypothalamic region (Magitot, 1948; Weinstein, 1953).

Primary glaucoma may be divided into two main groups, simple and congestive, the clinical features of which are well known. Anatomical differences between these groups were first noticed by Priestley Smith (1887), who found the shallow anterior chamber to be a typical sign of the acute congestive form. Numerous observers, starting with Barkan (1936), found that eyes subject to attacks of acute glaucoma always had narrow chamber angles. Eyes of patients with chronic simple glaucoma may have angles of any width and in this respect do not differ from non-glaucomatous eyes of similar age group.

Sugar (1941), investigating the mydriatic test, found that a marked rise of tension occurred only in eyes that had a narrow angle and that the angle was closed by the mydriasis. Kronfeld (1949) stated that the dark-room test is applicable only to such eyes, but no series of cases has been reported to confirm this. Bloomfield and Kellerman (1947), comparing several provocative tests in eyes with chronic simple glaucoma, found the dark-room test to be of little value.

This paper presents information obtained from about 400 dark-room tests, which were performed as part of the routine investigation of patients attending the glaucoma clinic of the Institute of Ophthalmology. The problem was two-fold: to find out in what type of glaucoma (if any) the test would be of clinical value; and to study the mechanism of the rise of ocular tension.

Method

All tensions were recorded with the same Schiötz X tonometer and by the same observer,

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two drops of 1 per cent. amethocaine being used as a surface analgesic. Four readings were taken of the tension of each eye. The first reading was taken on the patient's arrival, and the second half an hour later, the intervening period being used to examine the angles of the anterior chambers, using the Goldmann contact glass and the Haag-Streit slit-lamp. Some eyes showed evidence of a spontaneous rise of tension, in that the second reading was higher than the first, and these were excluded from the series. The patient then sat in a completely dark room for an hour, and was instructed not to go to sleep. At the end of this period the tension was measured again, using the minimum of light, and in some cases gonioscopy was then repeated. The light was then turned on and a final tension reading was taken after a further half hour had elapsed.

Results

The three accompanying scattergrams correlate the tension immediately before going into the dark-room with the change which occurred during the next hour, each dot representing the reaction of one eye. All these eyes were unoperated and miotics had been withheld for at least 24 hours.

Fig. 1 shows the results in 117 normal eyes. There was an apparent tendency for the tension to rise, the mean being +2.1 mm. Hg, the range from -4 to +9 mm. Hg. 91 eyes with chronic simple glaucoma behaved similarly (Fig. 2). There was again a mean rise of 2.1 mm. Hg, but the scatter was greater, ranging from -7 to +14 mm. Hg. This is not surprising in view of the diversity of the initial tensions. Fig. 3 shows the very different behaviour of 122 eyes with congestive glaucoma; the mean change of tension was +16.2 mm. Hg (range 0 to +64).

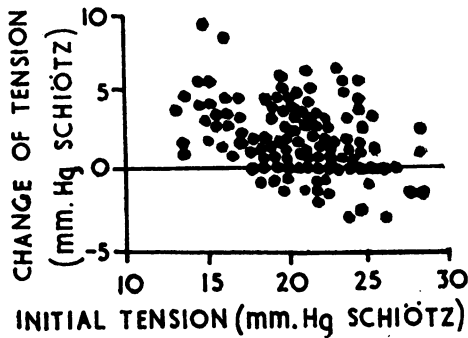


FIG. 1.—Results of dark-room test on 117 normal eyes.

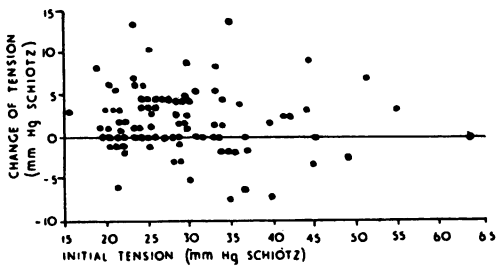


FIG. 2.—Results of dark-room test on 91 eyes with chronic simple glaucoma.

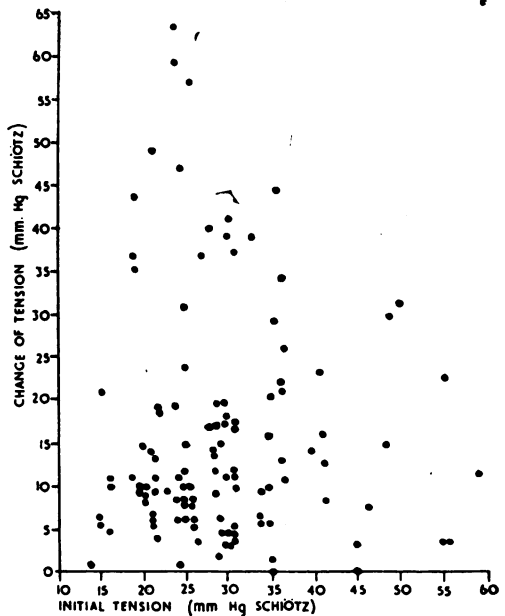


FIG. 3.—Results of dark-room test on 122 eyes with congestive glaucoma.

It is at once obvious that the dark-room test is of clinical value only in cases of congestive glaucoma. It seems that a test should not be considered positive unless the tension rises more than 9 mm. Hg or reaches a level above 31 mm. Hg. Adopting these criteria, of 86 eyes with congestive glaucoma the tensions of which were all below 32 mm. Hg, before the test, positive results were obtained in 67, that is, in more than three-quarters of the total. Repeated tests on the same eye showed the response to be variable, a great rise one day being often followed by an insignificant one on another day.

Bangerter and Goldmann (1941) and Sugar (1941) report gonioscopic observations of eyes suffering from congestive glaucoma in which the angles were found to be open during a phase of low tension, but closed when the tension was raised. Ross (1953) made similar observations in two cases in which the rise of tension was provoked by darkness. Weinstein (1953), however, could detect no change in the angle in one case after a strongly positive dark-room test.

In the present series 39 eyes were examined both before the dark-room test and after a large rise of tension had been caused by one hour in the dark. The second gonioscopy was done immediately after the tension had been recorded, the contact lens being inserted using as little light as possible.

It is not easy to tell whether these narrow angles are open or closed; often the relevant region is entirely obscured by a convex iris; in others only a little anterior trabecula can be seen. Some eyes do permit a good view into an obviously open narrow slit, but this is exceptional. In 21 of these 39 eyes the angles were not well enough seen to assess their patency. The appearances were unchanged after the tension had risen.

Two angles which were definitely open below before the test, the upper part not being visible, were found to be closed on the second examination.

The remaining sixteen eyes were seen to be open all around at first. Two of these were still open after a positive dark-room test, seven were open below but closed above, and the other seven were closed all round.

Whilst watching these angles in the dark, it was noticed that the light of the slit lamp caused a marked variation in the width of the angle according to whether it shone into the pupil or not. A greater change was seen as the light was switched off and then on again after about 2 seconds; momentarily the iris root seemed to be in contact with the cornea, then, as the pupil contracted, the base of the iris became less convex and the angle opened. This movement of the iris base was not noticed until late in the investigation, but it seems to be present in nearly all cases to some degree, although it is not always great enough to close the angle completely. It is seen clearly only when the angle is not obscured by a convex iris, is present in some normal eyes with angles of medium width, and is abolished by miotics.

One case was particularly instructive in this respect. The angle of the patient's right eye was narrow but readily visible, and had a segment from 6.30 to 8.30 o'clock which was much wider than the rest where ciliary body could be seen. When the ocular tension was 27 mm. Hg, the angle was

open all round, but the narrow five-sixths appeared to close by forward movement of the iris root when the light was off. The wider segment narrowed but still remained open. An hour in the dark raised the tension to 70 mm. Hg and closed the angle, even when the pupil was illuminated by the slit-lamp beam, except for the segment from 6.30 to 8.30. Switching the light off and on left no doubt that this region also was closed in the dark. A drop of eserine brought the tension down to 25 mm. Hg, opened the angle all round, and abolished movement of the iris root. The patient was seen again on another day when the iris root was less mobile and did not appear to close fully when the light was off. After an hour in the dark the tension rose by only 4 mm. Hg and the angle remained open.

Miotics tend to abolish the rise in tension which occurs in the dark, or at least to reduce it towards the normal range; 27 eyes that showed an average rise of tension of 24 mm. Hg when miotics were withheld, showed an average rise of only 6 mm. Hg when they were used.

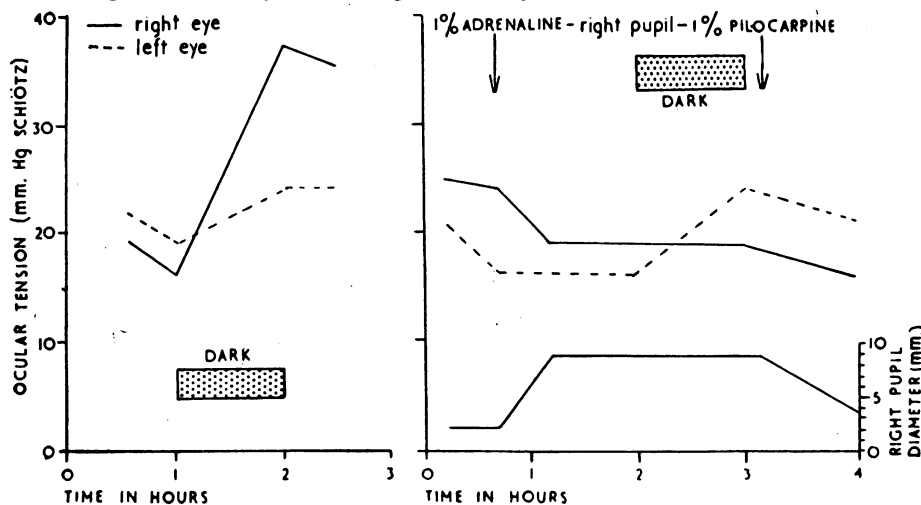


FIG. 4 (a).—Graphic record of a dark-room test in a case of congestive glaucoma.

FIG. 4 (b).—Dark-room test repeated in the same patient as Fig. 4 (a) after the right pupil had been dilated with 1 per cent. adrenaline.

The effect of mydriasis upon the test is of interest. Fig. 4(a) shows the change in tension of a patient kept in the dark for an hour. He was one of the seven patients whose angle could be seen to close completely as the tension rose. Fig. 4(b) shows the same test repeated after the right pupil had been fully dilated with a drop of 1 per cent. adrenaline; this failed to provoke a rise of tension. The angle of the right eye was opened wider by the mydriasis so that posterior trabeculae could be seen all round. The tension remained unchanged after a stay in the dark and the angle remained open. This was confirmed by another practically identical case.

In most instances surgery prevented the characteristic dark reaction but there were several interesting exceptions. Fig. 5 (overleaf) shows the results

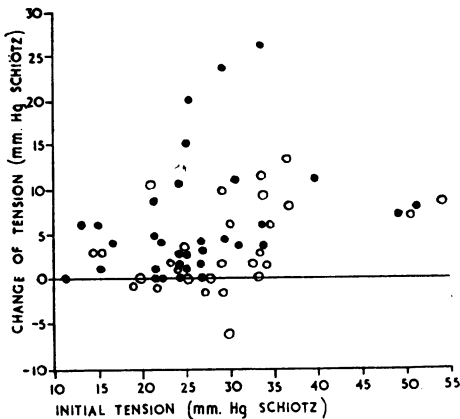


FIG. 5.—Results of dark-room test in cases of congestive glaucoma, 33 eyes which had been trephined (solid dots), and 28 eyes which had undergone broad iridectomy (circles).

in 33 eyes which had been trephined and in 28 eyes which had undergone broad iridectomy. Five of the latter had a rise of more than 9 mm. Hg, the highest being 14 mm. Hg. Of the trephined eyes, four had a large rise (15, 20, 23 and 26 mm. Hg respectively); each had a peripheral iridectomy, extensive but not total peripheral anterior synechiae, and showed no sign of drainage. Gonioscopy disclosed no difference in the angle after a stay in the dark.

Feigenbaum (1931) stated that this characteristic rise of tension occurred in aniridia. Three such cases were tested, two with glaucoma, and a third with normal tension. In none of these six eyes did the tension change during an hour in the dark.

Comment

There appear to be two distinct mechanisms involved in the dark-room test; one which causes the slight rise of tension in normal eyes, in chronic simple glaucoma, and in cases of congestive glaucoma when using miotics; and another quite different, which precipitates the dramatic changes of tension in congestive glaucoma without miotics. Obstruction of the angle of the anterior chamber can play no part in the former, the angle being of all widths with only a minority narrow. A neuro-vascular change seems to be the most likely explanation. The Table shows the distribution of angle width.

TABLE
WIDTH OF ANGLE OF ANTERIOR CHAMBER

Angle	Wide	Medium	Narrow	Total
Normal	52	53	12	117
Eyes Chronic simple glaucoma	39	42	10	91
Congestive glaucoma	0	0	122	122

Slight pupillary dilatation is accompanied by narrowing of the angle. Although this is normally of no significance to the eye, when the angle is narrow it may be occluded. There seems little doubt that this is how the dark-room test works in congestive glaucoma.

Although a narrow angle can often be seen to open and shut by varying the light, this movement becomes less as the tension rises, and the angle may

remain completely closed in spite of the bright beam of the slit-lamp. The 122 eyes which showed a mean rise of 16·2 mm. Hg in the dark showed a considerably smaller subsequent fall after a further half hour in ordinary room lighting; this averaged 6·5 mm. Hg (varying between a rise of 5 and a fall of 26 mm. Hg). Many eyes become quite refractory, the tension remaining high until relieved by sleep or miotics.

Whether the obstruction of the angle by iris root is due to the relative pupillary block causing a peripheral iris bombé, as suggested by Curran (1920) and more recently by Chandler (1952), is not clear. The bowing forward of the iris root seen when the light intensity is reduced could be interpreted as a bulging due to the greater pressure in the posterior chamber, the iris being more relaxed when the pupil is semi-dilated than when the sphincter is taut. The effect of maximal pupillary dilatation in the response to darkness also provides confirmatory evidence. A peripheral iridectomy, according to this theory, should stabilize the tension by providing free communication between anterior and posterior chambers. This it failed to do in the four trephined eyes in which tension rose in the dark. It seems likely that relative pupillary block is of importance in early congestive glaucoma, but that extensive peripheral anterior synechiae alter the mechanical conditions so that the remaining open segments of the angle can be closed by some mechanism other than peripheral iris bombé.

Summary

(1) The dark-room test is of clinical value only in cases of congestive glaucoma wherein it is positive in some 78 per cent. of cases. It should be considered positive if the tension rises more than 9 mm. Hg or reaches a ceiling above 31 mm. Hg.

(2) The test is of value to assess the control of the tension by miotics which abolish the rise of tension in the dark.

(3) The cause of the increased tension is obstruction of the angle of the anterior chamber by the root of the iris.

(4) In two cases which showed a marked positive reaction, mydriasis by adrenaline led to no increase in tension.

(5) A peripheral or even a broad iridectomy does not necessarily abolish the rise in tension.

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