

THE TRABECULA IN CHRONIC SIMPLE GLAUCOMA,
WITH SPECIAL REFERENCE TO THE GONIOSCOPIC
APPEARANCE OF BLOOD IN THE CANAL OF
SCHLEMM*

BY

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GONIOSCOPIC observations of the iridocorneal angle in glaucoma have attracted increasing attention as the technique has developed and become more widely used. Attempts have been made to correlate certain clinical features with details of the gonioscopic picture and to classify types of the glaucoma symptom-complex according to these appearances (Sugar, 1941). The well established association between congestive attacks and a shallow anterior chamber has thus been illustrated by observations of the narrowness of the angle in a very large proportion of cases, and the demonstration *in vivo* of anterior peripheral synechiae after the attacks has confirmed the association of these with embarrassment of the aqueous outflow.

In chronic simple glaucoma the appearance of the trabecula, especially that part of it which overlies the canal of Schlemm, has been studied, and variations of the texture and pigmentation of its surface have been noted; these have been considered by some observers to signify the essential lesion in this type of glaucoma. Koeppe (1918), in early studies of the angle, first distinguished an appearance of pigmentation of the trabecula to which he attributed pathological significance in the genesis of glaucoma; and his observation, if not his conclusions, was later confirmed by others, *e.g.*, Trantas, 1928. Pigment dispersal within the anterior chamber, however, was found to be a normal concomitant of age (Vogt, 1921), and trabecular pigmentation has since been considered to be so on the evidence of gonioscopic examination (Sugar, 1940; Busacca, 1945; François, 1948; Troncoso, 1947); but the appearances, more especially when the canal of Schlemm itself has been noted to be outlined by pigment in glaucoma, have continued to provoke speculation as to their possible role in the production of the disease. Thus Barkan and

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others (1936) consider that a stoppage of the trabecular pores with pigment, allied with sclerosis of the trabecula itself, which they believe to be distinguishable gonioscopically by a porcelain appearance of the surface, is responsible for the great majority of cases of glaucoma simplex. Bangerter and Goldmann (1941) also find evidence of trabecular abnormality in glaucoma, either as a felted appearance of the surface or as pigmentation. They recognize such appearances with certainty in 55 per cent. of their forty cases of glaucoma simplex, and find similar, but less conclusive, changes in a further 30 per cent., only 15 per cent. appearing normal.

The fact that most observers have been able to see Schlemm's canal fill with blood during gonioscopy in a large proportion of normal eyes, but in only a very small proportion of eyes with simple glaucoma, has appeared to strengthen the case for a mechanical block at the angle of the anterior chamber. François (1948), for example, who finds no other gonioscopic sign pathognomonic, considers that the permanent and constant absence of blood from the canal in chronic simple glaucoma is the sole certain fact to be elicited from the examination; and Trantas (1928) finds this absence to be so constant that by the observation of blood he excludes the condition.

In normal eyes a red line at the site of Schlemm's canal, interpreted as blood, has been seen in a moderately large proportion of cases, either during observation with a contact gonioscope (Trantas, Salzmann, Busacca, François, etc.), or during hypotony induced by paracentesis, or after the use of a special form of dynamometer (Kronfeld and others, 1942; van Beuningen, 1949).

Personal Observations

Routine gonioscopic examination of patients attending the Glaucoma Clinic at the Institute of Ophthalmology has been performed with Goldmann's gonioprism and the Haag-Streit slit-lamp microscope, employing a minimum magnification of x 20. Forty patients with established chronic simple glaucoma provide the material for this analysis, and it may be of interest to record the findings in so far as they relate to the appearance of the trabecula. It has not been possible during these examinations to identify a difference in surface texture which appeared with any constancy among the cases in which the trabecula could be seen, but considerable differences in pigmentation have been noted; the cases include some in which little or none was present ("not marked"), some showing a moderate degree ("moderate"), some described as well-marked or with a good deal of pigment ("marked"), and

others in which the region of Schlemm's canal was clearly demarcated by a separate zone of pigment ("pigmented Schlemm").

Comparisons of the severity of the disease, as judged by the degree of cupping and extent of visual field changes, with the degree of pigmentation fail to show any association between marked trabecular changes and severe ocular lesions such as might have been expected if the latter were attributable to the former. Marked pigmentation was found with early clinical disease in several instances, and advanced clinical changes were present without remarkable pigmentation in others. These findings are summarized in the Table.

TABLE
Trabecular Pigmentation in Chronic Simple Glaucoma

"Not Marked"		"Moderate"		"Marked"		"Pigmented Schlemm"	
Case No.	Degree of Severity	Case No.	Degree of Severity	Case No.	Degree of Severity	Case No.	Degree of Severity
0003	great	0063	slight	0013	moderate	0066	slight
0044	moderate	0021	great	0020	great	0105	great
0089	great	0028	great	0023	slight	0126	slight
0107	great	0084	slight	0034	slight	0025	great
0037	moderate	0132	slight	0045	great	0085	great
0011	great			0068	moderate	0118	slight
0047	slight			0040	great	0056	slight
0071	moderate			0060	great	0134	moderate
0092	great			0128	slight	0018	moderate
0093	moderate					0008	great
0101	great						
0043	moderate						
0035	slight						
0123	moderate						
0125	moderate						
0135	slight						

It was noted that in four of the cases included in the Table, blood appeared in Schlemm's canal during gonioscopy, and no valid reason for this finding could be discovered so far as the state of the glaucoma was concerned. In view, however, of the pronounced differences noted in the fit of the gonioprism, pressure upon the post-limbal veins seemed likely to be greater in eyes in which the fit was scleral than in those in which the contact was primarily corneal. That this was likely to be a factor responsible for the appearance or non-appearance of the phenomenon was suggested

also by the fact that one of the cases in which blood was seen was a myope. It was felt, therefore, that the use of a gonioprism in which the fit could be said to be more certainly scleral in all cases might result in a greater proportion of cases showing the phenomenon, if post-limbal venous occlusion were a factor in producing the influx of blood into the canal. A simple modifica-

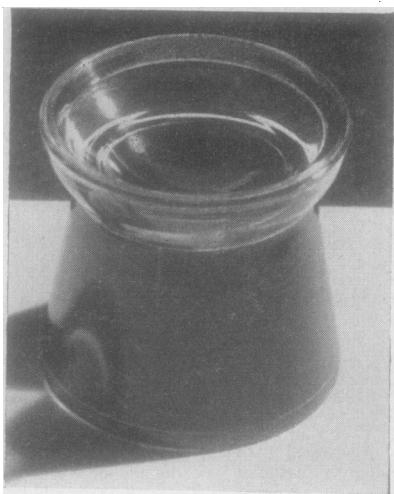


FIG. 1.—Modified gonioprism.

tion of the Goldmann gonioprism was therefore made by adding to the scleral surface of its posterior lip a narrow rim, 0.75 mm. thick and 1.0 mm. broad, as shown in Fig. 1.

Examination of the normal eye with this device showed the canal to fill with blood (Fig. 2), the appearance being most readily apparent when the gonioprism was first applied with light pressure. When this was maintained for a few minutes the depth of colour increased and, in one or two cases, minute streams of blood were seen to issue from the canal into the anterior chamber. Firm pressure usually caused these to cease and the canal to blanch, an effect which could also be produced by gently withdrawing the gonioprism from the eye against the suction with which it adheres to the globe. Congestion of the episcleral vessels is apparent from the ring of oedematous conjunctiva seen on removing the instrument, and this is found to subside within a period of some 10 to 20 minutes. Further evidence of a rapid return to normality could be seen, in suitable cases, by the re-stratification of previously noted aqueous veins. It was felt, therefore, that the possibility of producing congestion dangerous to glaucomatous eyes was slight, and tonometry before and after examination supported this supposition, a maximal rise of 6 mm. Schiötz being seen in one patient only, and the majority showing an alteration, plus or minus, of less than 2 mm. Schiötz.

Examination in this way, of twelve normal individuals, whose ages ranged from 25 to 67 years, has shown blood in the canal in every case, either in its whole extent (7) or in sectors (5); and in two of this small number leakage of blood into the anterior chamber was seen.

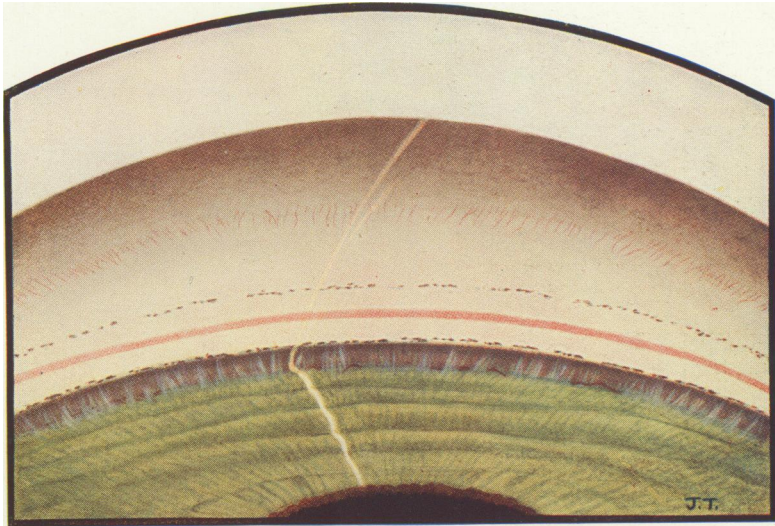


FIG. 2.—Appearance of blood-filled canal of Schlemm (initial magnification $\times 20$).

In the 26 glaucomatous patients subsequently examined by this method, pigmentation of the trabecula was encountered in varying degree, associated in three instances with the definite appearance of blood in non-pigmented sectors, in four with a change of hue suggestive of blood, and in five others, more densely pigmented, with no such change. The findings in this respect may be summarized as follows:—

BLOOD FILLING THE CANAL	8
BLOOD FILLING SECTORS	8
APPEARANCES SUGGESTIVE OF BLOOD	5
BLOOD NOT SEEN	5

In three of these cases the minute leakages of blood noted in normal cases were seen to appear.

Discussion

The variations in the appearance of the trabecula are considerable and the difficulty, under the magnifications possible in gonioscopic examination, of recognizing an appearance characteristic of an insidious condition such as sclerosis must evidently be great. Nevertheless, since the cases examined included a number in which the condition was of long standing, it was to be expected that some of these, at least, would have shown a distinct variation from the normal and also from early cases of glaucoma. The failure to observe such an appearance would seem to provide reasonable evidence against its existence as an important factor in chronic simple glaucoma, as Sugar, Busacca, François, and others believe. Moreover, pigmentation of the trabecula does not appear to be a necessary concomitant of simple glaucoma, since it was absent in advanced cases, and marked in some with only early signs.

The number of cases of chronic glaucoma in which blood has been seen to enter the canal of Schlemm represents a sufficiently high proportion to cast doubt upon the contention, based upon gonioscopic evidence (Trantas, Barkan and others, Kronfeld and others, Bangerter and Goldmann), that obstruction at the canal of Schlemm plays an important part in the pathogenesis of the condition. In so far as transparency of the trabecula is necessary to the observation, it suggests that the opacification of the trabecula which would reasonably be expected to accompany sclerosis, and which has been put forward as an alternative reason for the non-appearance of blood in the canal, cannot be an important factor in many of the cases here reported. Busacca's finding, that in chronic simple glaucoma the trabecula preserves its normal transparency, through which he also has reported the appearance of blood, is thus confirmed.

Summary

- (1) The gonioscopic appearance of the trabecula in forty cases of chronic simple glaucoma is reported. Among them the degree of pigmentation differed greatly, and no characteristic variation from the normal could be found, either in this respect or in the surface texture.
- (2) There was no correlation between the degree of pigmentation and the severity of the disease; pigmentation was frequently found to be minimal in advanced glaucoma and it was marked in many cases in an early stage of the disease.
- (3) A blood reflux into Schlemm's canal, seen with greater constancy when the gonioprism is modified to produce uniform scleral pressure, was noted in a high percentage of cases of chronic simple glaucoma.
- (4) It is suggested that gonioscopic examination provides no conclusive evidence of the pathogenesis of simple glaucoma, and, in particular, that it fails to confirm the existence of a mechanical block at the angle of the anterior chamber by demonstrating either surface changes or the absence of blood reflux into the canal of Schlemm.

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