

NEW CONCEPTS REGARDING ANTERIOR DRAINAGE OF THE EYE *

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THE drainage system of the eye must play an important part in the aetiology of glaucoma. Little has been added, however, to the conceptions of Leber (1903) and Maggiore (1917), accepted for thirty years or more, until Ascher (1942) described the presence of aqueous veins in 27 per cent. of normal eyes. Goldmann (1946, etc.), working independently, discovered clear or striated veins in 75 per cent. of cases. Such vessels have been described or figured by Graves (1934), Loewenstein (1940), Thomassen (1947), Berliner (1948) and Davson (1949), and photographed by Gartner (1944)

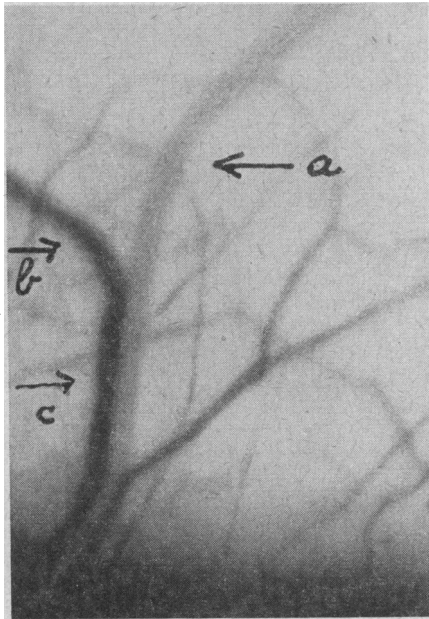


FIG. 1.—*a*, Vena aqueosa. *b*, V. recipiens. *c*, V. laminaris.

and de Vries (1947). The photographs reproduced for this paper were taken in my ward at the Ophthalmic Department of the Jewish Hospital, Budapest, in collaboration with my assistant, Dr. Forgács.

Fig. 1 shows an aqueous vein which runs an extended course to join an episcleral vein (v. recipiens) and proceeds as a laminary

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vein (*v. laminaris*) containing aqueous humour and blood in stratified layers. At first sight the laminary vein looks like two separate vessels, but if compressed, the entire vessel fills with

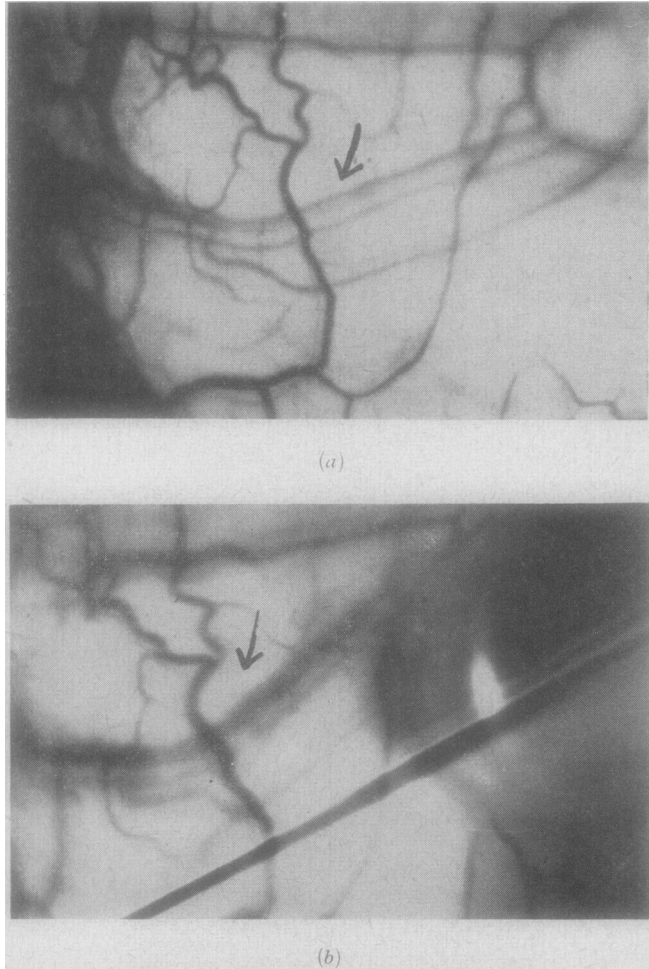


FIG. 2.—Negative glass-rod phenomenon or blood influx phenomenon. (a) *V. laminaris*. (b) Blood influx phenomenon after glass rod compression.

blood (Ascher's negative glass-rod phenomenon or blood influx phenomenon) as shown in Fig. 2. Our investigations suggest that aqueous veins eventually join the jugular, as compression of the latter produces the immediate appearance of blood, entering the aqueous vein in retrograde fashion (Fig. 3). If at the same

time the angle at the anterior chamber is examined gonioscopically, Schlemm's canal is also seen to fill with blood. The two systems are therefore in close communication.

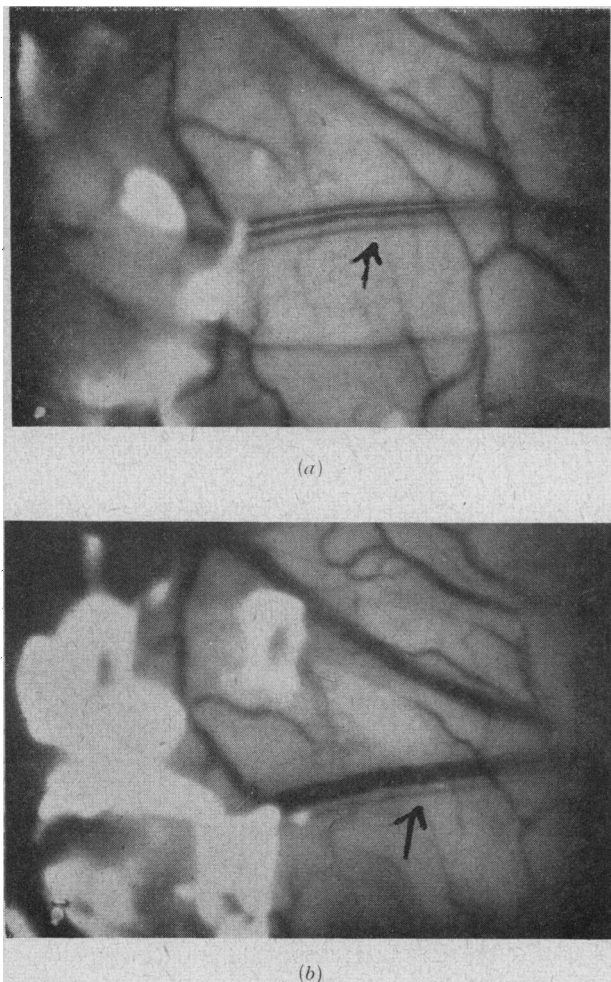


FIG. 3.—(a) *V. laminaris*. (b) Blood influx after jugularis compression (Weinstein).

Ascher and Goldmann have called attention to the behaviour of aqueous veins in glaucoma. The result of the glass-rod test of Ascher and the apparent outflow pressure of Goldmann suggest that there is an obstruction situated somewhere in the region of Schlemm's canal. Our observations with the glass-rod test in the normal eye show that on removal of the obstruction from the

striated vein it quickly regains its former appearance but the process is delayed in cases of simple glaucoma because of the increased pressure in the efferent vein.

Visible pulsation of aqueous veins, which is comparatively common in normal eyes, signifies an uninhibited transmission to the efferent system of the undulations of the intra-ocular tension synchronous with the cardiac cycle, and the phenomenon is absent in glaucoma. We believe that when adrenalin decreases the ocular tension of glaucomatous eyes it does so by altering the diameter of the efferent vessels and thus reduces secretion but it does not

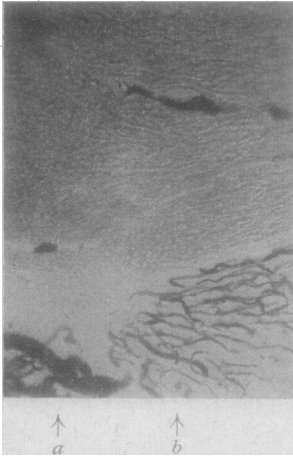


FIG. 4 (after Kiss).—*a*, Proc. ciliaris. *b*, Plexus ciliaris sec. (Kiss).

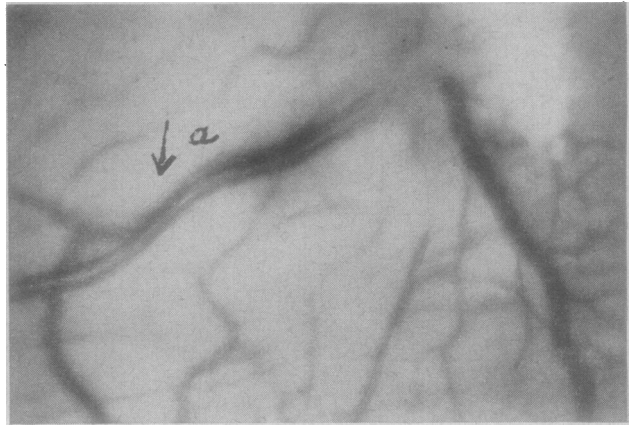


FIG. 5.—*a*, V. laminaris from limbus.

influence the calibre of the aqueous veins so that the outflow channels are relatively increased.

Francis Kiss, Professor of Anatomy at Budapest University, discovered in 1943 another efferent system. This consists of a thin plexus (plexus ciliaris sec. Kiss; see Fig. 4) adjacent to the within the region of the ciliary muscle. From it thin T-shaped veins and a few thick acutely-angled emissary veins branch off towards the episclera. Schlemm's canal normally contains aqueous humour only and so must aqueous veins at their origin. Those aqueous veins which appear at the limbus as laminary vessels (Fig. 5) are probably continuations of the thin veins of the ciliary plexus where the blood and aqueous must have mixed together. Fig. 6 demonstrates a thick emissary vein which was shown by serial section to arise in the ciliary plexus. We have discovered the episcleral continuation of such vessels, and Fig. 7

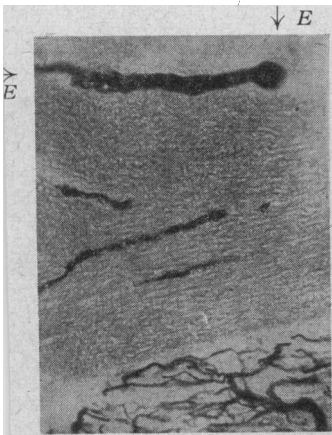


FIG. 6 (after Kiss) —E, V. emissarii.

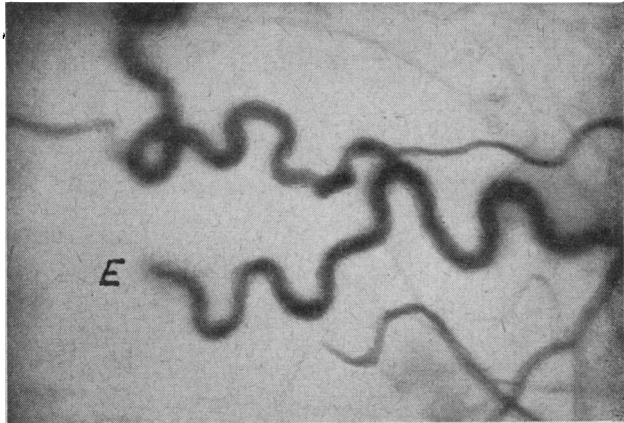


FIG. 7 (after Weinstein).—E, V. emissarii.

clearly shows such veins apparently arising from the sclera itself. Pressure with a glass rod showed that the direction of flow was away from the eye (Kaminskaya, 1948).

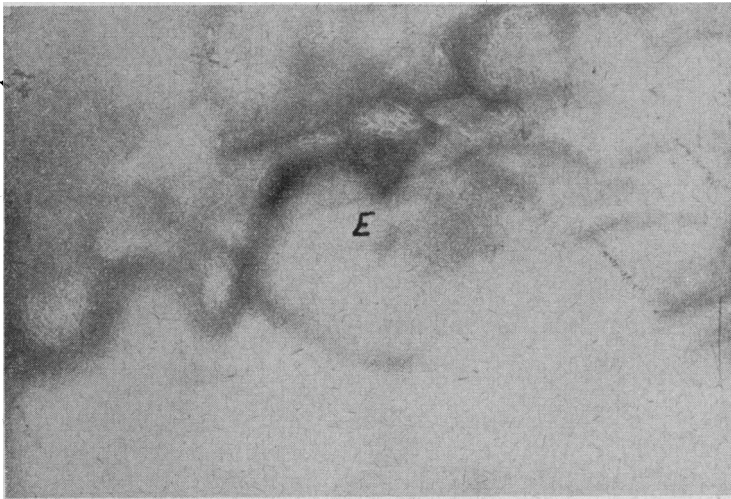


FIG. 8.—E, Emissarium in hydrophthalmos.

Busacca (1948) was unable to find aqueous veins in cases of hydrophthalmos and we had a similar experience in our own cases. But we discovered typical thick emissary veins with dilatations at the points of their emergence from the sclera (Fig. 8). It is well known that in cases of congenital hydrophthalmos, Schlemm's

canal is absent or replaced by tissue hyperplasia but yet the tension stabilizes at a moderate height. This suggests that a discharge system other than that of Schlemm's canal plus aqueous veins must exist.

The experiments of Seidel (1937) and later of Schulte (1948) and Kiss (1949) showed that some efferent veins were filled with indian ink while others remained unaffected. This work together

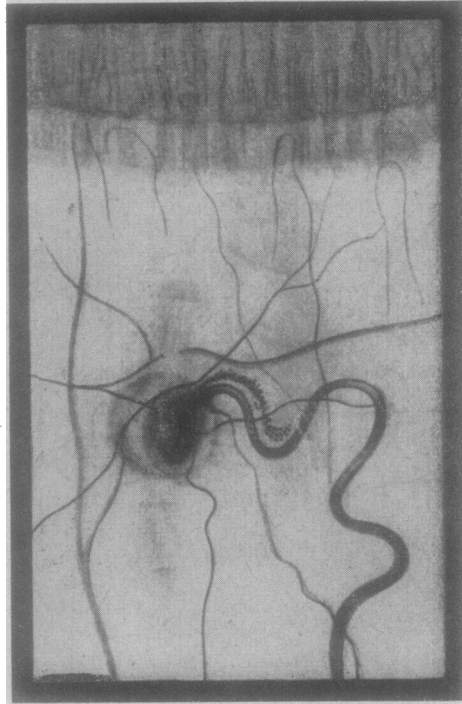


FIG. 9.—Emissarium cysticum (after Thiel).

with that of Schenk (1949) make the hypothesis of a second drainage system highly probable.

Dilated emissaries were described as early as 1928 by Thiel (Fig. 9), who believed along with Koeppe that emissary vessels were arteries. He emphasized that in cases of glaucoma with raised intra-ocular tension bulbous protuberances formed, containing aqueous humour and surrounded by pigmentation, at the place of emergence of the emissary vessels. Kaplan described conjunctival oedema around the dilated emissary vessels. We were able to confirm Thiel's findings and we frequently found in cases

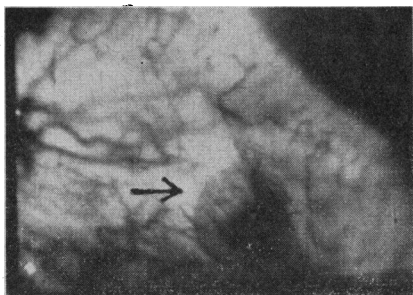


FIG. 10.—Emissarium cysticum without vessel (after Weinstein).

of glaucoma an emissarium from which no vessels arose, and lying superficial to it a conjunctival cystic protuberance (Fig. 10). In normal eyes we frequently discovered dehiscences and foramina

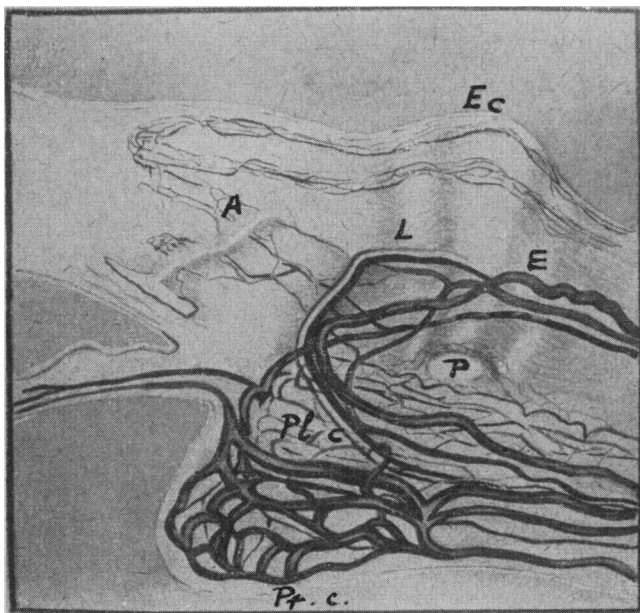


FIG. 11.—Combined schema of the figures of Leber, Maggiore, Ascher and Kiss. *A*, *V. aqueosa*. *L*, *V. laminaris*. *E*, *V. emissarii*. *P*, preformed emissarium. *Ec*, emissarium cysticum. *Pr. c.*, processes ciliaris. *Pl. c.*, plexus ciliaris (Kiss). See Weinstein, 1949.

in the sclera from which no vessels emerged but which might act as preformed exit channels in cases of increased ocular tension.

Fig. 11 shows, concisely, the anterior discharge system of the

eye modified from Leber and Maggiore. Physico-chemical investigations of the aqueous humour suggest a considerable flow of intra-ocular fluid through the eye. Under these conditions, the Schlemm canal-aqueous vein system does not seem to be a sufficient means of egress. The venous system of the uvea as described above may be of greater importance and it may perhaps serve as a basis for future work on the aetiology and therapy of glaucoma.

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