AQUEOUS VEINS IN RABBITS*

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IN the course of investigations into the effect of cervical sympathetic stimulation on the ocular vessels of experimental animals, it was noticed that aqueous veins were a regular feature of the limbal circulation in the rabbit. Experiments were therefore designed to demonstrate the function of these vessels.

A search of the literature revealed that although Ascher (1942) had failed to find aqueous veins in the monkey, dog, and rabbit, Schmerl (1947) described laminated veins in the rabbit, and a recent paper by Weekers and Prijot (1950), described the presence of aqueous veins in the rabbit and guinea-pig. Our investigations, begun independently, confirm this finding of Weekers and Prijot.

ANATOMY.—In the rabbit the limbal vessels are mainly concentrated in two regions—at the upper and lower poles associated with the superior and inferior rectus muscle insertions. Joining these two regions there are smaller vessels concentric with the limbus, which receive blood from the marginal plexus of the cornea and from a few deeper vessels. The concentric vessels are continued in front of the insertions of the rectus muscles, and receive tributaries which can be seen to emerge through openings in the sclera. Some of these vessels, particularly in the upper nasal quadrant, contain a clear fluid, presumably aqueous. There are also superficial veins draining the conjunctiva towards the limbus.

From the main concentric vessels arise episcleral veins running over the insertions of the rectus muscles and disappearing beneath the conjunctiva of the fornix.

The vessels so far considered are all venous channels. The superficial arterial supply to the limbal region is obtained from a series of small vessels running towards the limbus from the rectus muscles. The origin of the scleral perforating veins and aqueous veins is as yet uncertain, but they appear to come from the region of the angle of the anterior chamber and the ciliary body. Fig. 1 (overleaf) shows the general arrangement of the limbal vessels.

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FIG. 1.—Limbal region of rabbit's eye showing normal vascular pattern.

METHODS

The animals were anaesthetized with Nembutal gr. 1 per 5 lb. body weight, intravenously. The aqueous veins were then identified in each eye using a Haag-Streit slit-lamp microscope. In eight experiments the cervical sympathetic nerve was next dissected out on one side, and a needle inserted into the anterior chamber, and connected to a manometer similar to that described by Davson and Purvis (1950) to record the intra-ocular pressure. The animal was supported in such a position that observations and photographs of the vessels could be taken. The photographs were taken with an Exacta V.P.K. camera with a long extension tube attached. An electronic flash-tube provided adequate illumination for photography at an aperture of f.22.

EXPERIMENTAL FINDINGS

Pressure on the Globe.—This caused a marked increase in the flow of clear fluid in the aqueous veins. When the pressure was released, the veins filled up with blood until an equilibrium had been reached and they returned to their normal condition (Figs 2a and b).

Artificial Raising of the Intra-Ocular Pressure.—A needle was inserted into the anterior chamber and connected to a manometer containing saline. An interval was allowed to enable the pressure to become stable. It was then noticed that on raising the pressure by 10 cm. saline, the aqueous flow was increased within a few seconds. A further rise in pressure up to 40 cm. caused a further increase in the flow of aqueous, which continued until the intra-ocular pressure returned to a level near the normal range.

Injection of Indian Ink and Evans Blue Dye into the Anterior Chamber.—Weekers and Prijot claimed that Indian ink, when injected into the anterior chamber, appeared in the aqueous veins. This finding we have been unable to confirm in nine experiments.

Our final method was to inject Indian ink, maintaining by means of a second needle connected to a manometer a compensated intra-ocular pressure of 25 cm. saline. Care was taken to put the needle through the cornea clear of the limbal region. We also injected

FIG. 2(a).—Limbal vessels before pressure.

FIG. 2(b).—Same region as shown in 2(a) during pressure on globe. Vessels indicated by arrows are now seen to be clear.

similarly a suspension of black water-paint, and this also failed to appear in the aqueous veins. In both instances the particle size of the pigment was slightly under 1μ .

Evans blue, a non-particulate dye, injected by the same means, appeared rapidly in the aqueous vein under observation, and also disclosed many channels deep in the episclera in areas previously thought to be lacking in vessels.

These experiments suggest that if there is a direct connection between the anterior chamber and the aqueous veins, it does not allow the passage of particles of size approximately 1μ .

Stimulation of the Iris.—When the iris of a rabbit is scratched with a needle, a rise in intra-ocular pressure and contraction of the pupil follow (Duke-Elder, 1931). If the aqueous veins are watched at the same time it can be seen that the flow of aqueous increases greatly while the intra-ocular pressure is rising, in spite of the appearance of exudate in the anterior chamber. It would appear that irritation of the iris produces an increase in the volume of aqueous, which presumably follows hyperaemia of the anterior half of the uveal tract.

Sympathetic Stimulation.—Stimulation of the cervical sympathetic nerve causes a drop in the intra-ocular pressure in the rabbit. This drop may be due to a decrease in the blood volume of the eye, to a

FIG. 3(a).—Normal limbal region.

FIG. 3(b).—Same region as shown in 3(a) during stimulation of ipsilateral cervical sympathetic nerve.

FIG. 3(c).—Same region one minute after cessation of stimulation.

FIG. 3(d).—Same region five minutes after cessation of stimulation.

decrease in the formation of aqueous, to an increase in its elimination, or to a combination of any of these factors.

If a stimulation of 5 volts for one minute is applied, and the aqueous veins observed, it is noted that at first there is an apparent increase in the flow of aqueous, but after a little time contraction of

all the limbal vessels occurs and the whole region appears avascular. A smaller stimulation (3 volts) produces an increase in the flow of aqueous with a less marked effect on the recipient episcleral vessels (Figs 3a, b, c, and d).

SUMMARY

- (1) The presence of aqueous veins in rabbits is described.
- (2) Their anatomical arrangement is illustrated.
- (3) Their response to increased pressure on the globe, to artificial raising of the intra-ocular pressure, iris stroking, and stimulation of the cervical sympathetic nerve are detailed.
- (4) Indian ink injected into the anterior chamber did not appear in the aqueous veins but Evans blue dye did so.
- (5) The communication of the aqueous veins with the anterior chamber is discussed.

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