

COMMUNICATIONS

VARIATIONS IN THE EPISCLERAL VENOUS PRESSURE IN RELATION TO GLAUCOMA*

BY

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THOMASSEN (1947, 1948, 1949) was the first to try to relate variations in the episcleral venous pressure to the phasic variations of intra-ocular pressure in the human eye. In view of the fundamental importance of his observations it was decided to confirm and perhaps to extend them.

Method

A perspex chamber having a thin rubber diaphragm opposite an observation window was constructed (Fig. 1*a*). This chamber was connected with a seamless metal bellows which altered the pressure in the chamber by means of a screw thread. The bellows was also connected with a U-shaped water manometer calibrated in centimetres (Fig. 1*b*). The screw thread actuating the bellows was of such a pitch as to allow of minute variations in the pressure in the system. The chamber and bellows were filled with air.

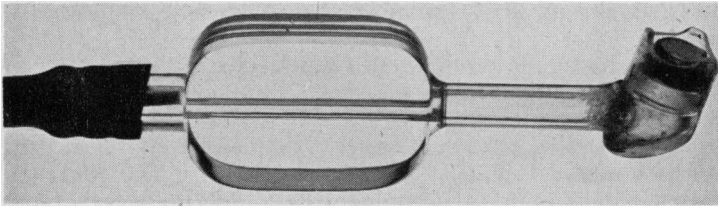


FIG. 1 (a).—
Pressure chamber.

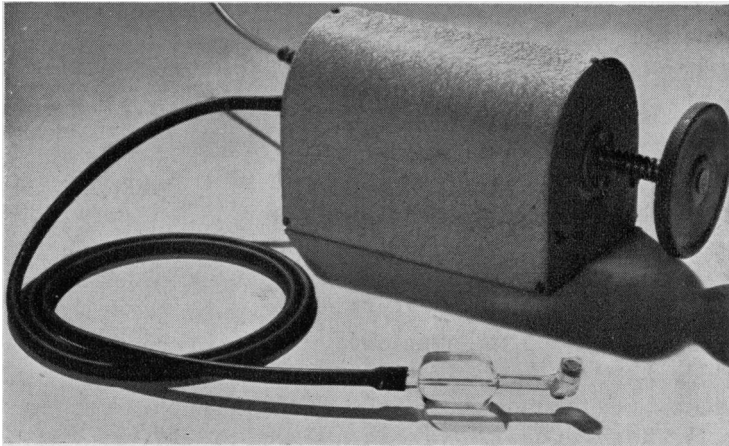


FIG. 1 (b).—
Pump and pressure chamber.

The end of the chamber carrying the diaphragm was supported by three small legs, which rested on the globe and formed a steady base from which the vein under observation

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was compressed. It was found that the fine rubber diaphragm, dry on one side and wet with tear fluid on the other, was perfectly transparent.

In selecting veins for observation, it was found that those lateral to the cornea were the most convenient; the chamber, though small, is bulky enough to make other parts of the sclera less accessible. At first veins were sought which could be seen to emerge from the depths of the sclera, and observations were made as far as possible before they branched. In the course of the investigation, however, it was found that this was less important than at first thought, and that variations in pressure could be detected in most of the episcleral veins near the limbus. Serial observations were confined to the same site on the same vein in all cases.

The method has several limitations. First, while some patients tolerated repeated observations very well, a few complained of, and showed signs of, local conjunctival irritation. Second, some subjects showed no suitable vein for taking readings, either because there were few veins in the convenient area mentioned above, or because those available showed variations of low tension so small that they were impossible to record. Presumably in such cases there had been so much branching in the scleral plexus that pressure variations had been ironed out before the vein came into the field of observation.

It was found in some cases that the point of obliteration of a vein did not always coincide with the point of re-filling. Thus, on increasing the pressure in the chamber, a vein might empty at a certain pressure-level, but on lowering the pressure slightly it was found that the vein did not always re-fill with blood at the level at which it had emptied. Therefore in all cases the end-point was taken to be the level of pressure that just allowed the first fine thread of blood to pass along the vein. This was found to be constant in the same eye within 2 cm. of water pressure for consecutive readings.

In all, forty patients out of some sixty examined were found to have suitable veins in the most convenient site.

The readings of venous pressure in centimetres of water are recorded on the graphs that follow. It should be emphasized that these readings are not absolute pressures; the three legs on the end of the pressure chamber hold the rubber diaphragm a fraction of a millimetre away from the eye, so that a small degree of the pressure within the chamber is used up in bringing the rubber diaphragm into contact with the surface of the globe. The amount of pressure required to do this naturally varies with the curvature of the sclera, and with the site chosen for the observations.

In general it will be noted that the readings are of the order of venous pressure recorded by other observers, except that the highest ones are lower than Thomassen's highest readings.

Normal Findings

(1) *Phasic Variations.*—Fig. 2 shows superimposed venous pressure and intra-ocular pressure curves in a normal eye. The curves of the intra-ocular pressure were found, in general, to follow the curves of the venous pressure, and the changes in the latter to precede those in the former. This is in accordance with Thomassen's findings, and in this series was a feature common to both congestive and simple glaucoma.

Figs 3 and 4 show the superimposed curves of intra-ocular and venous pressure in the right eye of two cases of simple glaucoma. Fig. 5 shows clearly the same feature; here in addition, the curves for both eyes have been superimposed and it will be noticed that the venous pressure shows almost the same variation for the two eyes. The intra-ocular pressure of the right eye reaches a markedly greater height than that of the left. In this case, clinically,

the tension of the right eye was barely controlled by miotics and the field to 2/2000 mm. white was reduced to 10°. The left eye had a full field to 2/2000 mm. white, but a strongly positive water-drinking test; it was symptom-free.

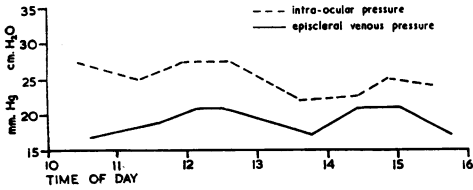


FIG. 2.—Normal.

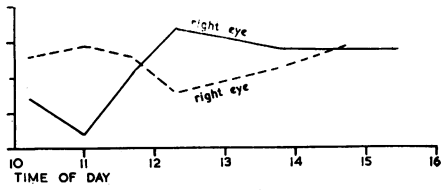


FIG. 3.—Simple glaucoma.

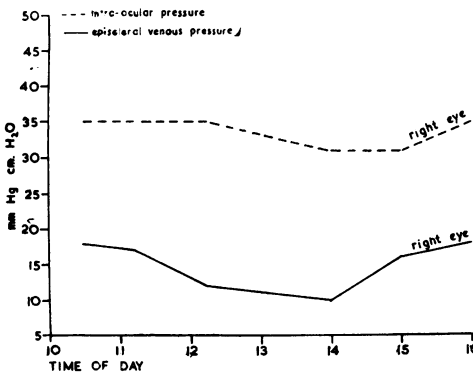


FIG. 4.—Simple glaucoma.

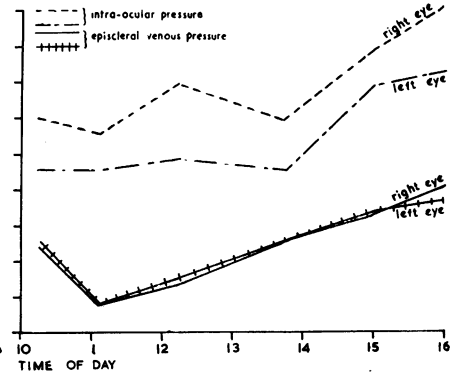


FIG. 5.—Simple glaucoma, both eyes.

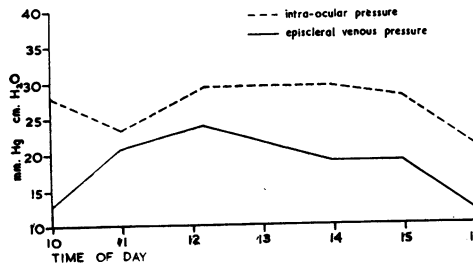


FIG. 6.—Congestive glaucoma.

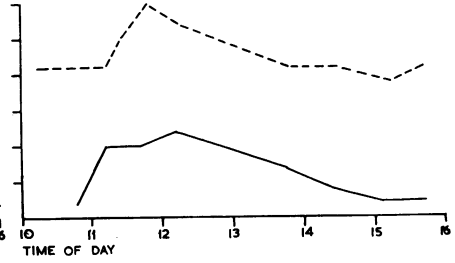


FIG. 7.—Congestive glaucoma.

Figs 6 and 7 show the relationship between episcleral venous pressure and intra-ocular pressure in two subjects with congestive glaucoma.

In addition to this time-relationship for individual eyes it was found that the curves for the episcleral venous pressure of each eye of the same subject showed the same features, provided that veins could be found in each eye which were similar in size, and which could be observed at a similar distance from their exit from the sclera. In the case shown in Fig. 5 both eyes were glaucomatous, the right eye much more advanced than the left as described above. Fig. 8 (overleaf) shows a case of early congestive glaucoma in the left

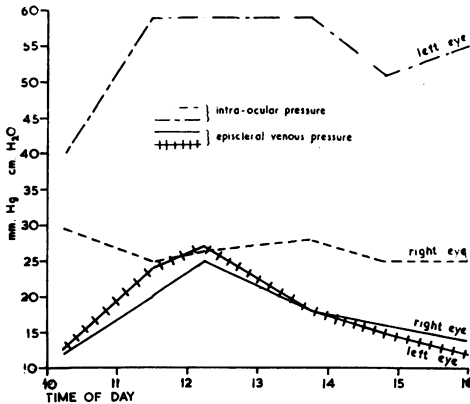


FIG. 8.—Early congestive glaucoma, both eyes.

eye. There was no cupping of either optic disc and the visual fields were full. The dark-room test was positive in the left eye, and there was a history of haloes and misty vision. Gonioscopy showed that both anterior chambers had narrow angles, but that the angle in the left eye was obscured by peripheral anterior synechiae round one quarter of the circumference, the overall width being markedly less than that of the right eye. Whereas the curves of the episcleral venous pressure followed each other closely, those of the intra-ocular pressure diverged widely. The curve taken from the eye with the narrower angle and with marked formation of peripheral anterior synechiae rose to 59 mm. Hg, whereas that of the normal eye remained within normal limits. Furthermore, in the left eye, despite the fall in episcleral venous pressure the ocular tension remained above 50 mm. Hg and had to be reduced by miotics. Presumably this eye has such a defective filtration system (*i.e.* its angle becomes so readily blocked) that lowering the episcleral venous pressure can no longer lower the ocular tension.

(2) *Effect of Miotics.*—In patients with either simple or congestive glaucoma the instillation of a miotic into the affected eye was found to reduce the episcleral venous pressure in the first place, and the intra-ocular pressure at a later stage.

The changes in the venous pressure were more marked and more immediate after eserine than after pilocarpine.

In Fig. 9 this point is clearly illustrated in a case of congestive glaucoma with instillation of eserine. In Fig. 10 more attention was paid to the time-relationships on taking the readings, and it will be seen that whereas the venous pressure was affected within 5 min., the intra-ocular pressure did not show any demonstrable fall for 15 to 20 min.

Fig. 11 shows the curves in a case of absolute glaucoma; here, as might be expected, the eye showed complete peripheral anterior synechiae, and although there was a significant fall in episcleral venous pressure on exhibiting eserine, the intra-ocular pressure was unaffected. Again, as in the case shown in Fig. 8, abnormalities of structure caused a departure from the basic physiology.

The instillation of pilocarpine showed similar results; a typical curve for an early case of congestive glaucoma is shown in Fig. 12, and one for a more

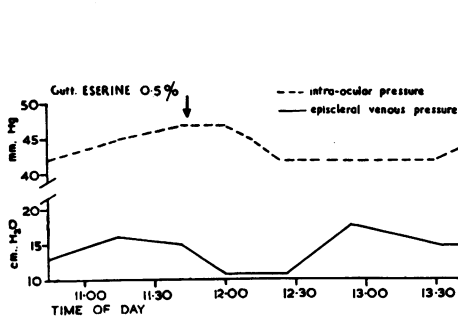


FIG. 9.—Congestive glaucoma.

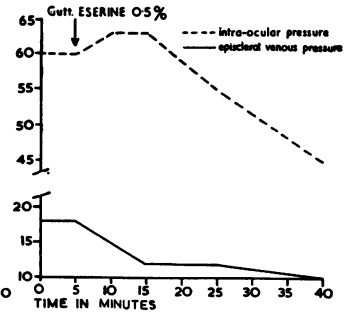


FIG. 10.—Congestive glaucoma.

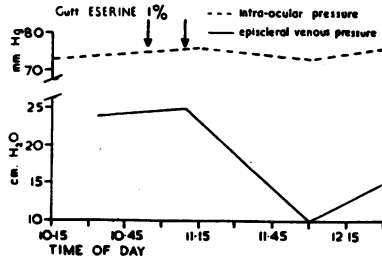


FIG. 11.—Absolute glaucoma.

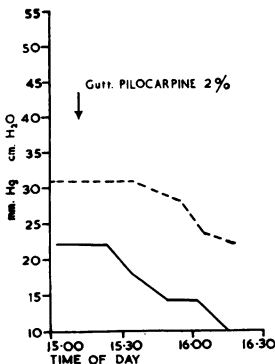


FIG. 12.—Early congestive glaucoma.

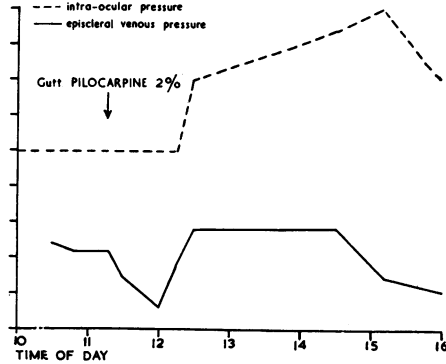


FIG. 13.—Advanced congestive glaucoma.

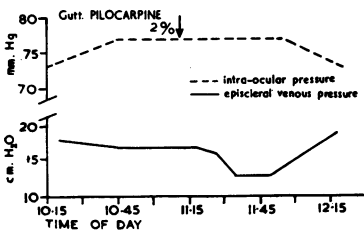


FIG. 14.—Absolute glaucoma.

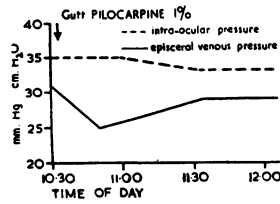


FIG. 15.—Thrombotic glaucoma.

advanced case in Fig. 13. In the latter there was a rise in venous pressure within 40 minutes of instilling pilocarpine; there was no fall in intra-ocular pressure; soon after the venous pressure began to rise the intra-ocular pressure followed; 40 minutes after the venous pressure began to fall again (following, presumably, its phasic pattern), the intra-ocular pressure began to fall also.

Figs 14 and 15 show the effects of pilocarpine in cases of absolute congestive glaucoma and thrombotic glaucoma. It can be seen that the miotic lowers the venous pressure without markedly affecting the ocular tension.

Discussion

Two points seem to emerge from this investigation:

(1) Measurable changes occur in the pressure in the episcleral veins and these can be shown to precede changes in the intra-ocular pressure, whether these are due to the diurnal rhythm of the patient or to drugs.

(2) In comparable veins in the two eyes of one subject variations in the pressure follow a very similar pattern. This agrees with the findings of Dobree (1953), who studied the variations in calibre of the episcleral veins photographically, and stated that the same changes in calibre take place in the veins of each eye.

The recorded variations of venous pressure in this series are not large, but it must be borne in mind that they are taken from the episcleral veins after their emergence from the sclera. As a result, the pressures will tend to be low and the pressure variations to be damped down, and it is reasonable to suppose that these variations reflect greater changes within the ciliary venous plexus.

The facts that changes in the venous pressure occur bilaterally, and are the same in a normal eye as in its glaucomatous fellow, seem to indicate that changes in the venous pressure do not of themselves cause pathological rises in the ocular tension. However, in eyes with an already defective drainage mechanism, these changes in venous pressure may serve as a trigger mechanism, setting off an irreversible rise in tension. This is well seen in the cases of congestive glaucoma illustrated above, where the chamber angle is partly obstructed by peripheral anterior synechiae.

In simple glaucoma, rises and falls of ocular tension are preceded by similar changes in the venous pressure, and if we accept the classical concept of a trabecular sclerosis hindering drainage, a stage may be reached when even quite small rises in the episcleral venous pressure serve as the "last straw" which precipitates a pathological rise in tension.

Summary

(1) The relationship between the episcleral venous pressure and the intra-ocular pressure has been studied.

(2) Changes in the episcleral venous pressure generally seem to precede changes in the intra-ocular pressure, and to occur bilaterally.

(3) It is suggested that changes in the episcleral venous pressure in eyes with defective structure (*e.g.* peripheral anterior synechiae) may set off pathological rises in tension.

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