

SUPERFICIAL PERILIMBAL VESSELS IN THE NORMAL AND CONGESTED EYE*

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ON examining the normal white eye with a 20x or 40x power of the slit-lamp microscope, the vascular pattern of the superficial vessels of the corneo-scleral junction is not readily made out. The vessels of the perilimbal conjunctiva are in the form of straight, slender, radially directed channels in which the flow may be either towards or away from the cornea. The vessels forming the marginal corneal loops present even greater difficulty, since well over half of the available channels are completely empty of blood and the remainder have an extremely fine column in which the flow may vary in direction as neighbouring capillaries open up or contract.

If, however, the eye is examined when in the congested state, especially if in the deep or ciliary type, the anatomy of the superficial vessels can be much more clearly seen. It will be apparent later why the superficial vessels should be involved in a deep congestion, but for the moment it is sufficient to state that when the globe is congested all the blood channels are filled, and the distinction between even the smallest arterioles and venules is made clear by the differences in their form and blood flow.

There is a close similarity in the anatomical plan of the vessels of the perilimbal conjunctiva and of the marginal corneal loops. The arterioles of both groups originate from arteries which lie deeply in the episcleral tissues within a millimetre of the limbus, and the veins of both groups drain deeply into the episcleral veins in the same region.

The arterioles of the perilimbal conjunctiva turn sharply forwards from their deep origins, and run outwards towards the fornices in all sectors, for a distance of 3 to 6 mm. The veins which drain the corresponding area flow, in most cases, towards the cornea, and just before the limbus they loop deeply to empty into the episcleral veins. Similarly the arterial limbs of the marginal loops are formed by twigs of the episcleral arteries and run towards the cornea. Blood is returned by collecting veins, which pass deep to the conjunctiva to drain into the veins of the episclera.

* Received for publication May 8, 1950.

The bulbar conjunctiva which lies more than 5 mm. from the limbus gets its blood supply from vessels lying in the region of the fornices. There is therefore a neutral ring of bulbar conjunctiva lying between the two systems.

Graves (1934), in studies on the white eye, demonstrated this arrangement of the perilimbal circulation in localized sectors. He also described the vascular connections of another, rather inconstant, series of minute vessels, the "palisade" vessels of Vogt. When present, these are best marked in the lower limbus and consist of a series of minute arterio-venous loops, some one millimetre in length, which are connected to the bases of the marginal corneal loops and run outwards for a short distance on the bulbar conjunctiva.

By observing and photographing the superficial vessels in congested globes and watching their changes during resolution, the anatomy of the vessels in the whole of the perilimbal area is further clarified. In addition, the close anatomical relationship which exists between the superficial and deep vessels has been found to have important consequences in pathological states. In deep ciliary congestions for example the dilatation of the episcleral arteries and the engorgement of the veins produce similar changes in the conjunctival vessels and corneal loops which originate from and drain into them. Moreover, alterations in the blood flow in the deeper vessels, such as active hyperaemia, venous engorgement, and partial or complete venous stasis, are usually associated with similar secondary changes in the superficial system.

The anatomy of the superficial perilimbal vessels will now be set out. The accompanying photographs show patients suffering from iritis of moderate severity, in which the congestion of the superficial vessels was secondary to the deep congestion and could not be attributed to conjunctival infection or irritation.

Arteries of the Perilimbal Conjunctiva

There are some 15 to 25 main arterioles which run in a radial direction towards the fornices from the limbal area for some 3 to 6 mm. before breaking up into their terminal capillaries.

The largest arterioles are found running from the upper part of the limbus and frequently do not have an accompanying vein (vessels A and B in Fig. 1 *a*, vessels B and C in Fig. 2). Smaller arterioles situated in the lower part of the limbal area are often associated with a vein, and it may be possible to trace the blood flow from the arterioles to the venules through the capillaries. A characteristic feature of these arterial vessels is

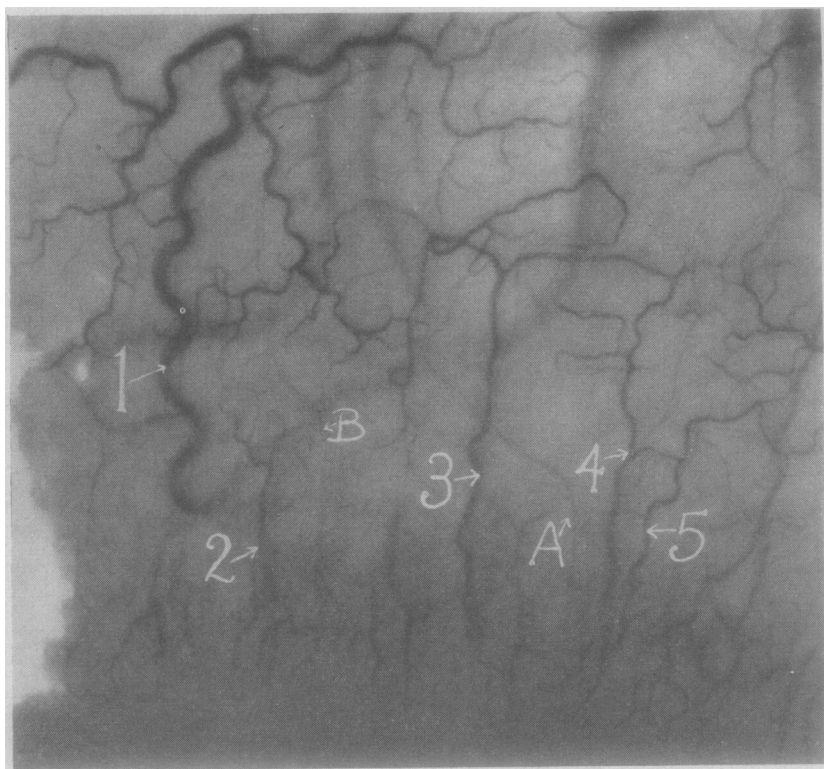


FIG. 1(a).—Acute iritis of moderate severity. Upper nasal limbus. 1, 2, 3, 4, 5, perilimbal conjunctival veins. A, B, perilimbal conjunctival arteries.

that they are usually only a quarter to one-third of the diameter of the corresponding veins.

As stated above, the vessels of origin of the arterioles lie deeply in the episcleral tissues immediately adjacent to the limbus, and probably in all cases derive directly from branches of the anterior ciliary arteries. In some instances it is possible to trace these branches from parent twigs, given off from the anterior ciliaries just before they penetrate the sclera and running towards the limbus in the episcleral tissues almost to the cornea, before giving off the conjunctival branch which loops sharply forward to run a recurrent course on the conjunctiva. Most of the superficial vessels, however, are given off by branches of the anterior ciliary arteries which lie more deeply in the episclera and cannot be traced back to their parent vessels.

The course of the arterioles is straight or slightly curved, and they tend to branch at acute angles. The blood flow is extremely

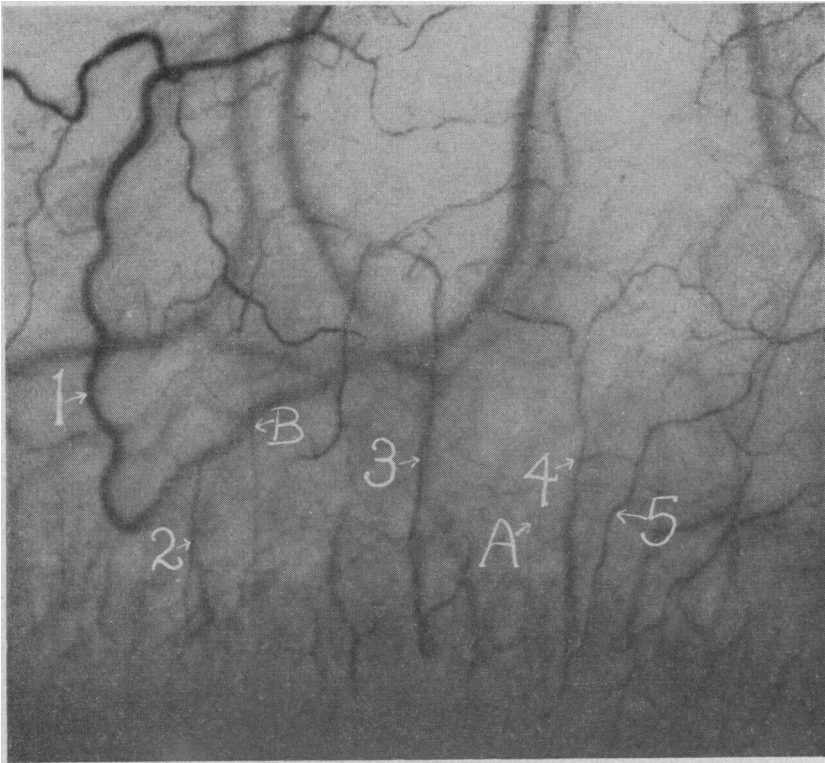


FIG. 1(b).—The same as Fig. 1(a) after resolution. Vessels numbered as in Fig. 1(a).

rapid and often “ spurting ” in character; it is easier to see in the smaller branches than in the main stems.

When the globe is in a state of ciliary congestion photographs show that the anterior ciliary arteries (and especially their branches) are greatly dilated. It has been shown by serial photographs taken from onset to resolution that even the most minute branches show no tortuosity and pursue exactly their original courses. Since in these conditions the veins undergo enormous dilatation and tortuosity, the identification of arterioles and veins is further simplified.

Veins of the Perilimbal Conjunctiva

The veins are rather more numerous than the arteries, and are the more conspicuous on account of their larger size and deeper colour. Those of the upper part of the perilimbal conjunctiva are larger than elsewhere, and can often be seen with the naked

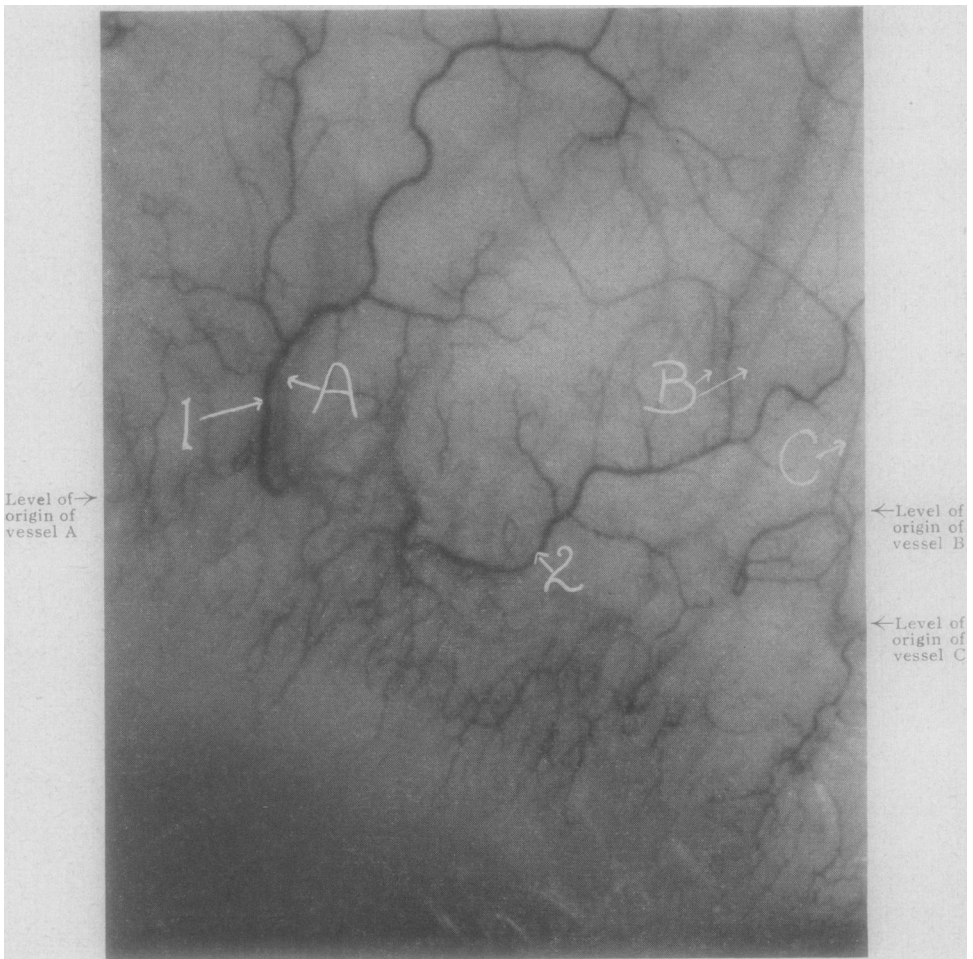


FIG. 2.—Resolving iritis. Upper nasal limbus. 1, 2, perilimbal conjunctival veins. A, B, C, perilimbal conjunctival arteries.

eye. They drain regions supplied by the corresponding arteries towards the cornea.

The individual veins are formed by a number of tributaries joining an elongated trunk which takes a slightly wavy course to the limbus. At a distance of about one millimetre away from the limbus they loop sharply backwards to empty into the episcleral veins. Some of the largest (vessel 1, Fig. 1*b*) give rise to quite sizeable episcleral veins.

In normal cases, 80 to 90 per cent. of the conjunctival veins

drain towards the limbus, but isolated sectors of perilimbal conjunctiva drain directly towards the fornices; this occurs most frequently in the lower temporal and the nasal areas.

When the eye is examined in a state of deep ciliary congestion (whether due to iritis, keratitis, or glaucoma), remarkable changes are found in the conjunctival veins. Even in slight congestions they increase greatly in calibre and tortuosity (compare Figs 1*a* and 1*b*), and in severe congestions the stems may be cork-screwed or even coiled. Fresh channels are opened up and the anastomoses between the perilimbal and peripheral groups of veins are easily seen. If the congestion is severe, the flow in some of the tributaries or even in the main stems may be reversed towards the fornices through these anastomotic channels.

Not only do these veins share in the venous engorgement when this is present in the deeper vessels, but if either partial or complete venous stasis exists there, similar changes are usually found in the conjunctival vessels. That these changes are not purely a reflex hyperaemia is shown by the behaviour of the perilimbal veins in other conditions. In chronic thrombotic glaucoma for instance, where the episcleral venous plexus is engorged by veins bringing blood at considerable pressure from the interior of the globe, this obstruction to their outflow causes a dilatation of the conjunctival veins.

Marginal Corneal Loops

The study of these loops is greatly facilitated when the minute vessels are congested and all the channels are opened up. The venous elements become apparent by their gross dilatation and sluggish blood flow, whereas the arterial limbs retain their fine calibre.

There are wide variations in the form of the loops. The simplest type, commonly found in the lower part of the limbus, consists of a thread-like arterial limb which forms a loop and then immediately dilates to become the venous limb (Fig. 1*a*). More complicated forms are often found in the upper limbus where the arterial twigs may form several loops at varying distances into the cornea. Some loops do not dilate in even the most severe congestions until a considerable way down the returning limb, and until dilatation occurs they are probably arterial.

The arterial limbs are derived from the episcleral arteries and, like those of the conjunctiva, can sometimes be traced from branches of the anterior ciliary arteries. The main vessels which supply the limbs often run along the line of the limbus, giving off their minute branches at right angles as they go. The arterial

limbs tend to lie deeper than the venous limbs, and it is usual to find several of the latter converging to form a collecting venule, which lies astride the limbus and then passes deep to the conjunctiva to empty into the episcleral veins (Fig. 1*a*).

In some sectors the loops empty into a superficial collecting vein which runs along the line of the limbus for several millimetres and then turns sharply away from the cornea to pass sometimes onto the surface of the conjunctiva and sometimes deep to it.

A rapid spurting flow can often be made out in the arterial channels. In the venous limbs the flow is much slower and frequently "granular", an appearance associated with a slow rate of flow (Knisely and others, 1947), which can easily be observed from the initial dilatation to the point where the collecting channels disappear under the conjunctiva.

Summary

A detailed account of the vascular arrangements of the perilimbal conjunctiva and of the marginal corneal loops has been made by observing and photographing the perilimbal region with the globe in a congested state.

The changes in form and blood flow in the superficial vessels is shown to be closely related to the deeper vessels from which they derive.

I wish to thank Sir Stewart Duke-Elder for his interest and helpful criticism, and Dr. Peter Hansell of the Department of Medical Illustration of the Institute of Ophthalmology for taking the photographs.

REFERENCES

- GRAVES, B. (1934). *British Journal of Ophthalmology*, **18**, 305, 369.
KNISELY, M. H., BLOCH, E. H., ELIOT, T. S., and WARNER, L. (1947). *Science*, **106**, 431.