CLOSED BRANCHES OF CONJUNCTIVAL VESSELS*†

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NORMAL conjunctival vessels have been studied with the slit lamp by many observers, including Koeppe (1920-22), Vogt (1930-31), Graves (1934), Berliner (1943), and Meesmann (1927). The conjunctival vessels are capillaries, many of which are seen to be filled with red blood corpuscles; some of these capillaries are fairly large, but others are fine. These capillaries, containing one row of red blood corpuscles, have been traced from artery to vein (Graves, 1934). It is very important that no definite walls have been found in these fine vessels, even with a high-power slit lamp.

The normal conjunctival blood vessels can be irritated with chemical, traumatic, or bacterial agents, one of the simplest ways being to insert a drop of dionin 2 to 5 per cent. as I have described in a previous communication (Loewenstein, 1944). The dilated conjunctival blood vessels can then be studied, and there is an increase of ten to twenty times the number of small capillaries in eyes so treated. I tried to study the normal area supplied by the capillaries, but it is not easy to examine eyes with the slit lamp when using a high magnification. Finally, I kept my own eye at rest under high power, and our artist, Mr. G. Donald, sketched the conjunctival capillaries (Fig. 1).

There were many very fine capillaries containing red cells, but I expected to find some very fine capillaries apparently empty as had been previously noted, and such very fine capillaries were found in my conjunctiva, apparently empty and colourless. Some had no red blood cells in them, while others contained various types of blood corpuscles

FIG. 1.—Blood-free capillaries of the conjunctiva seen in high-power slit lamp.

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scattered singly, and others appeared to be collapsed. These fine colourless capillaries have a clear glass-like wall which can be perceived with diminished illumination under high magnification.

It is significant that some of the larger conjunctival blood vessels are very pale. The deep episcleral vessels contain a smaller proportion of red blood corpuscles (Fig. 1), as found by Lauber (1901), and the blood seems to be diluted with aqueous (Ascher, 1942).

Some fine capillaries were closed and free of blood. I have the impression that some fine twigs were closed where they joined larger vessels. I have not seen a sphincter *clinically*, but an anatomical sphincter in the conjunctiva is described below. Quite frequently, subconjunctival haemorrhages are demonstrated with sheathings and these are assumed to be lymph channels. The lymph spaces in conjunctival haemorrhages are sharp, hard, and clear. These perivascular spaces were seen in the middle layers only (Loewenstein, 1944). On the other hand, I have often seen glassy nodules in the conjunctiva with the slit lamp, as described by Busacca (1934, 1948). The clear lymphatic perivascular spaces are sharply delineated, while the irregular nodules,

FIG. 2.—Closed conjunctival vessels without blood.

FIG. 3.—Twigs completely closed in a case of diabetic hypertension. Haematoxylin. 150 $\times$.

which are obviously quite different, are prominent and localized.

I examined fine razor-slices of ocular conjunctival tissue, without staining, with and without reduced light, or stained with haematoxylin, Weigert, aniline blue, and other stains. The network of conjunctival vessels (Fig. 2) were nearly all equally filled with blood, but some were collapsed, others partly dilated, and others irregular, while yet others were only branches (Fig. 3). Sometimes the twigs were completely closed.

It is especially important to note that the branches were partly filled with endothelial cells and partly solid. Some branches were only narrowed and a lumen was present, although others were closed completely (Fig. 4).

I often found short solid "bands" joining two conjunctival vessels completely closed. These bands were filled with many solid endothelial cells, and some contained lymphocytes (Figs 5, 6, and 7). Some of these bridges were filled with masses of endothelial cells, but I do not understand their function. Are they controlled by a

FIG. 4.—Closed branches. Haematoxylin. 300 $\times$.

FIG. 5.—Linkage between two vessels showing endothelial cells and empty lumen. Haematoxylin. 300 $\times$.

FIG. 6.—Short bands, some closed with endothelial cells. Haematoxylin. 300 $\times$.

FIG. 7.—Vascularization in the cornea. Haematoxylin. 675 $\times$.

est. They were shown in other tissues by Chambers and Zweifach (1944), and by Clark and Clark (1935, 1943); Evans (1947), and Loewenstein (1947a, b), proved that they were also present in the vessels of the retina. Some of these bands were closed links between two open vessels containing blood. This solid junction might arise through a swelling of the endothelial cells (Figs 5 and 6); later, there might be a shrinking of the endothelium and the lumen would be reformed and filled with blood cells. The slit lamp does not show a sphincter in vessels with a blood-filled lumen; it is only seen in stained sections of thin razor-slices of conjunctiva. So far the paraffin slides have not been successful, and the razor technique described above proved to be preferable.

I found that some of the finest conjunctival capillaries at the limbus terminated in end-capillaries, there being no returning vessel carrying the blood back to the venous side. These end-capillaries I have called "finger processes" (Fig. 7); they reach directly into

nervous mechanism? Do they perhaps result from a sphincter action?

I found many sphincters on these twigs (Figs 8 and 9). Sometimes the nuclei were present, but sometimes the lumen was narrowed and no nuclei of the sphincter muscles could be found. Their function in the conjunctiva is inter-

FIG. 8.—Sphincters. Haematoxylin. 600 $\times$.

FIG. 9.—Sphincters. Haematoxylin. 300 $\times$.

the cornea, and some of them are filled with single red blood corpuscles, while others have none. Some of these finger processes have typical endothelial cells, sharply outlined and swollen (Fig. 7).

Some of these end-capillaries in the limbus are surrounded by a substance which is a real jelly, and is easily visible with restricted lighting. The fine gelatinous tissue surrounding the blood-filled end-capillaries is very characteristic. This visible jelly may contain single red blood corpuscles, have a fine granular substance, or be composed of single granular cells.

It is most interesting that retina from diabetics, examined in bulk, showed new-formed vessels in a gelatinous matrix.

Ballantyne and Loewenstein (1943) and Loewenstein and others (1946) described retina in bulk, unstained, with prominent new-formed vessels and fine-walled loops surrounded by a similar jelly, in cases of Eales's disease. The new capillaries in the retina were examined by Ballantyne (1949), who showed that they had a pre-retinal and vitreous gelatinous base, a primitive connective tissue from the adventitia.

Some of these capillaries in the limbus are filled with new blood corpuscles and enter the jelly as a pathological reaction. The whole jelly might be a supporting matrix of transparent primitive type, like an embryonic structure. The function of the described conjunctival and corneal tissue in the capillaries is still unknown.

SUMMARY

(1) The normal conjunctiva was examined with the slit lamp under high power. Very fine capillaries were seen, some having clear, pale, glass-like fibres, with no blood corpuscles, but others having single red blood corpuscles also appeared.

(2) These very thin capillaries become dilated and blood-filled after instillation of dionin. These dilated conjunctival vessels are then 10 to 20 times more numerous than the fine, pale capillaries.

(3) The bulbar conjunctiva was examined anatomically, using razor-slices, and the conjunctival tissue was stained.

(4) Some twigs of the conjunctival branches were found collapsed.

(5) Some closed twigs were filled by endothelial cells, others contained single lymphocytes.

(6) Some branches of certain twigs were controlled by sphincter muscles in the conjunctiva, as in the retinal capillaries, but cushion cells were not found.

(7) Processes or "finger vessels" at the limbus reach into the cornea. Some of these processes are empty of blood cells while others show a thin lumen with a single line of red blood corpuscles.

(8) The termination at the limbus of certain capillaries was surrounded with a gelatinous tissue. The function of this jelly is not known.

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