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THE

LIGHT REFLEX ON THE RETINAL VESSELS.

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THE LIGHT REFLEX ON THE RETINAL VESSELS.[a]

EVER since the invention of the ophthalmoscope, ophthalmologists have been familiar with the appearance of a light reflex or light streak on the retinal blood-vessels, but they are not, even at the present time, quite in accord as to the precise cause of this phenomenon. The history of the subject is briefly as follows:—

The very earliest observer, E. von Jaeger, attributed the reflex to a reflection from the walls of the vessels, though he subsequently, and I think erroneously, modified his theory by assuming that it came from the convex surface of the blood column, the vascular walls being, in his opinion, too transparent and too much of the same coefficient of refraction as the retinal tissue to produce the reflex. This theory of a reflection from the convex cylindrical surface of the blood, or of the vessel wall has been opposed by Loring[b] in 1871, who holds that the light streak is caused by refraction of light transmitted from the illuminated background through the convex cylinder of the blood column, which in fact acts as a convex lens, and this view has again been advocated by Davis, in the "Archives of Ophthalmology," of which paper an abstract can be seen in the *Ophthalmic Review*, 1891, p. 88.

Loring supported his theory by the following arguments:—

1. The light streak is too broad to be a reflection from the convexity of the vessel or the blood column.
2. The blood column is too transparent and non-reflecting to give so brilliant a streak.
3. If the blood column reflected the streak, the latter would be best marked when the vessels are full; but in venous pulsation it disappears when the vein is most full. (Loring describes

[a] Read before the Section of Anatomy and Physiology of the Royal Academy of Medicine in Ireland, Friday, March 25, 1892.

[b] Archiv. of Ophthalmology. Vol. II., No. 1, p. 95.

venous pulsation as inducing a temporary stasis, and the crowding of the globules together renders the blood column so opaque that the light does not pass through it to cause the reflex.)

4. The state of the background affects the light streak—*e.g.*, it is absent in detached retina.

He supported his theory by the results of an experiment. A glass tube containing carmine solution placed in the bottom of a small box gives a light reflex when a mirror is placed beneath it, and none when the background is a non-reflecting surface—the illumination in both cases being that of ordinary ophthalmoscopic examination.

Loring's theory has been submitted to an elaborate refutation by Schneller.[a] His view is that the reflex is an image of the ophthalmoscopic light reflected from the convex wall of the blood-vessels.[b] This he establishes by a mathematical analysis of what the size of the reflection should be, the data being given—viz., the size of flame of lamp, the curve of mirror and diameter of blood-vessels, and the various distances.

The facts as observed by him agree with his calculations, as, for instance—

1. The reflex is narrower with short-focus mirrors and in myopic eyes.
2. The reflex moves with the rotation of the mirror.
3. The reflex is almost white—not red, as it should certainly be if Loring's view were correct.
4. The reflex is shortened in longitudinal diameter by backward curves of the vessels.
5. The absence in detachment is merely due to a want of perpendicularity of the vessel to the line of sight.
6. Besides, if Loring were right, the coefficient of refraction of the blood must be very much greater than that of the retina, which we have no reason to believe it to be; and the reflex could not be absent in vessels lying obliquely to the line of sight.

The reflex from the veins differs from that from the arteries, because the vascular walls are thinner, the vessel is more elliptical in shape, and lies deeper, and the walls of the veins are rougher and more wrinkled than those of the arteries.

[a] Von Graefe's Archiv. XVIII., 1, p. 113.

[b] Jaeger's Archiv. No. 1.

Otto Becker[a] treats of the same subject, but comes to no definite conclusion. He states that the vessels of a frog's mesentery have the power, which Loring assumes for the retinal vessels, of refracting transmitted light.

Jaeger[b] defends his own view—

1. The reflex cannot come from a tissue beneath the vessel, for it remains unaltered by the background—*e.g.*, it is the same whether the vessel passes over the lamina cribrosa, the ordinary fundus of a dark or light-haired person, a white exudation, or a dark pigment spot.
2. The vessels cast an intense shadow on the underlying tissues, which can be observed easily under certain conditions.
3. The fact that the light streak is not red is enough to disprove Loring's theory.
4. The convex vascular wall, again, cannot cause the reflex, for it disappears when the vessel is empty, as in embolism.

And if the wall were less transparent than the surrounding tissues it would be visible under normal conditions at the sides of the blood column—

a. If the vessel wall caused the reflex by its coefficient of refraction being different from that of the tissues it would also be visible.

b. And its borders would be marked by dark lines due to total reflection.

c. And they would distort objects beneath.

Now, the light streak can be seen on a vessel right up to the border of the blood column of another vessel crossing above it at right angles. Jaeger allows that a small, colourless, hardly visible line can be seen at the edge of the blood column of the upper vessel, more distinctly when the latter is a vein.

Besides, if the vessel wall refracted the light, the streak could be seen through the wall of the upper vessel when, by movements of the head and mirror, it was invisible on the rest of the lower vessel.

Jaeger illustrates his views by experiments made with carmine solutions in two glass tubes, one crossing over the other at a right angle. When the tubes are immersed in a fluid of the same coefficient of refraction as the glass, the streak of light reflected from the lower tube is visible unaltered through the glass wall of

[a] V. Graefe's Archiv. XVIII., 1, 281.

[b] Ergebnisse der Untersuchung mit der Augenpiegel. 1876. P. 51.

the upper tube, and is only arrested by the column of carmine solution—in fact behaves exactly as Jaeger asserts that the light streak on the retinal vessels does.

Schneller returns to the subject of the light reflex in v. Graefe's "Archiv.," XXVI., p. 71, and upholds his own view against Jaeger's. He asserts that both the arteries and veins of the retina have walls which are visible with the ophthalmoscope at least in the larger vessels. Jaeger himself perceived a white line along the border of the vessels, which he erroneously thought to be a layer of white blood corpuscles. Schneller states that the thickness of the arterial walls compared with the radius of the lumen of the vessel is as 1 is to 3; that of the venous walls is as 1 is to 6 or 8. The inner surface of the vascular walls is smooth, the outer surface of the arterial wall is also smooth, while that of the vein is slightly rougher.

On each side of an artery which crosses over a vein a light yellowish-white line can be perceived of from one-tenth to one-sixth the breadth of the blood column. This cannot be the layer of white blood corpuscles imagined by Jaeger, for the thickness of a white blood corpuscle is too little to be ophthalmoscopically visible, and the white corpuscles do not form a continuous layer along the wall of either veins or arteries. This white line can be nothing else but the optical effect of the wall of the blood-vessel.

The vascular walls, therefore, are not absolutely transparent but translucent, hiding underlying blood vessels like faintly muffed glass. The effect cannot be produced by total reflection, as no dark bordering line is present, such as can be seen in a dislocated lens, &c. The smallness of the vascular wall prevents any prismatic effect, and its translucency prevents it casting a visible shadow on underlying objects.

Schneller rejects Jaeger's argument drawn from the disappearance of the light streak when the vessel is empty, as it may be the absence of the cylindrical convexity of the wall which causes the obliteration of the reflex. Jaeger's second point—that the coefficient of refraction of the vesssel wall is too nearly equal to that of the retinal tissue—has been dealt with above. The effect is caused by slight milkiness of the wall. Jaeger has subsequently advanced the hypothesis that the refractive index of the blood is actually less than that of the retina; but this cannot be the case. The average index of the vitreous is, according to Krause, 1·3485,

and that of the retina must be practically the same. Now Thomas Young (it is interesting to find that a German in 1880 has to go back to Thomas Young in 1801 for an authoritative statement on a point of physiology!) determined the index of blood serum to be 1·354—*i.e.*, actually higher than that of vitreous or retina.

Schneller has attempted to estimate the relative luminosity of the light streaks on the veins and arteries, optic disc, &c.

That on the arteries is brighter than that on the veins. On Jaeger's theory the reverse should be the case (by contrast with the colour of the blood the arterial streak should appear less bright than that on the veins), and the thicker arterial wall should make the arterial reflex less clear and sharp than that on the veins. Besides, the venous reflex should not be so irregular as it is, for the surface of the blood column is perfectly smooth.

All these difficulties are removed if we assume that the reflex comes not from the blood column, but from the vessel walls. The smooth arterial wall reflects a sharper image than the more wrinkled venous wall, and as it is also thicker, the reflex is brighter.

There are, then, only three theories suggested to explain the light streak on the retinal vessels. Which of these may be regarded as the correct one? There can be no reasonable doubt as to which is incorrect—viz., Loring's. The arguments by which it is supported are unsound, and the experiments are inconclusive. All that they prove is that a cylindrical column of carmine solution has the power of refracting light—a statement which no one wishes to controvert; and Davis has merely shown that a blood column has the same power, which was observed by Von Becker years ago; all these being observations made in air. As to the breadth of the light streak being too great to be a reflection from the convexity of the vessel, why the breadth of the streak depends entirely on the size of the source of light, which may be as large as the diameter of the pupil, or even larger. I can corroborate Schneller as to its varying directly with the magnitude of the source of light. Then, as to the transparency of the blood column, we all know it is not transparent, but only faintly translucent. Its shadows are visible, not alone objectively but subjectively in the well-known vascular figure of Purkinje.

As to the curious argument drawn from the absence of the light streak in the veins when distended by venous pulsation, I have not been able to observe the phenomenon, though I have carefully looked for it; and, if it were a fact, its explanation would be easier

by the assumption of a change in the form of the surface of the vessel, making its surface no longer perpendicular to the line of sight.

The absence of the light streak in detachment of the retina is better explained by the slanting course of the vessels than by the change of background, while it is not improbable that the real agent may be something quite different from either theory, and the streak is not always absent. I have frequently observed it in typical cases of retinal detachment.

Loring's experiment is the most unsatisfactory proof of all. With a mirror placed beneath his glass tube, one sees the tube twice over—viz., the real tube and its image in the mirror. If these two objects are made to coincide the tube seen appears nearly double as bright as it would otherwise appear, but nothing at all resembling the light streak on the retinal vessels can be made out on it which cannot be seen on glass tubes over a dark background. A light streak can be made out easily enough on a glass tube with a less luminous background. In any case Loring's experiment should not be made in air, but in some medium with an index of refraction pretty nearly equal to that of the glass tube and its contained fluid. If this be done (as in the tubes exhibited sunk in glycerine jelly) anyone can convince himself that the only reflex at all resembling that on the retinal vessels is that on the anterior surface of the tube.

Again, Schneller's observation that the light reflex moves with the rotation of the mirror is perfectly correct, and disproves Loring's theory completely, as does also the even more incontrovertible fact that the light streak is not red, but white. The absolutely unchanged character of the reflex, no matter what be the background—white, as in optic disc; black, as over pigment spots; or red, as over subjacent blood vessels—is also in my own experience an easily observed fact, and one vouched for by the acutest of all ophthalmoscopic observers—the late Ed. V. Jaeger, and it is completely destructive to Loring's theory.

When we come to a choice between Jaeger's second theory and his first—which is the one advocated by Schneller—the decision is not quite so easy; but I have myself no hesitation in electing to stand by the latter—viz., that the light streak is a reflex from the wall of the vessel.

Jaeger's experiment with the glass tubes is perfectly correct, so far it goes, but does not disprove the theory that the light streak comes

from the vascular wall, if we assume with Schneller that the wall does not differ appreciably in refraction from the retina, but is slightly opaque, and by its slight opacity causes the reflex. Or even if the reflex was caused by the refraction of the wall being high, still Jaeger's experimental argument could not be pertinent unless the whole thickness of the wall exhibited the high refraction. If it were only an extremely thin layer of the wall no visible effect would be produced on the light streak reflected from subjacent vessels.

But I can corroborate Schneller's observation that the walls of the larger retinal vessels are distinctly visible in ophthalmoscopic examination. In fact, since I have looked for them I have never failed to see them, and when in pathological conditions the vascular walls are thickened and opaque (in perivasculitis), the vascular light reflex is quite as marked a phenomenon as it is when the vessel walls are difficult to detect, as in young and healthy eyes.

A very striking and convincing observation can sometimes be made in young eyes which have that so-called shot-silk appearance in their retinæ. The vascular light reflex can, in these eyes be seen as an intensification of the retinal reflex. As the light flashes over the retina it illuminates the arterial wall just in the same way as it does the shot-silk surface. The two reflexes are apparently caused by similar surfaces—that on the arteries being generally on a plane somewhat deeper than that reflected from the internal limiting membrane—if it be the internal limiting membrane which causes the shot-silk appearance.

I may add that in these eyes with that rare affection detachment of the choriodea I have seen the reflex.