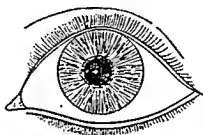


## ON THE VALUE OF OPHTHALMOSCOPIC CORNEAL IMAGES.

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WHEN an eye is illuminated by reflection from an ophthalmoscope, a brilliant spot of light appears to rest on the cornea, produced, in reality, by reflection from its surface as from a strong convex mirror. This is shown in Fig. 1. The beginner in ophthalmoscopy is only too well

FIG. 1.



To show the corneal image in an average eye; the pupil displaced slightly inward, and the corneal image displaced still more inward.

acquainted with this spot, which gets in his way whenever he attempts to explore the fundus. It is well, therefore, to know its powers for good as well as evil, and that in a variety of ways the very same reflection can be turned to good account. A corneal image produced by light reflected from a perforated mirror, such as that of an ophthalmoscope, affords far greater precision in the clinical investigation of the position of an eye than a corneal image formed in any other way, provided attention be given to one or two simple details. The first of these details is to insure that the patient's attention is directed at least to the mirror, and preferably to its central aperture, while the light is flashed on to first one eye and then the other.

Under these conditions, the visual axis of each observed eye coincides in turn with the visual axis of the observer's eye, and the spot of light maps out with very fair precision the point in each cornea which is traversed by the visual axis of that eye.

Under no other conditions does it do so, so that, unless the patient looks at the aperture of the mirror, corneal images produced by the ophthalmoscope possess no advantage over those produced by, for instance, holding a lighted match before the eyes, or making the patient look at the window. Suppose a patient appears to have a slight squint, and we do not know whether it is only apparent or real, the question is at once decided by flashing the light first on to one eye, then on to the other.

If the corneal images occupy symmetrical positions in the two corneæ, as in Fig. 2, no squint exists, and the cause of an apparent squint will at once be evident from the fact that the corneal image in each eye will be found to occupy an unusual position, showing that the visual axis traverses the cornea at an unusual point, thus producing the appearance of a squint. Suppose, again, that a patient complains of total blindness in one eye, without any visible changes to account for it. If we find the corneal images are sufficiently unsymmetrical to prove the existence

FIG. 2.



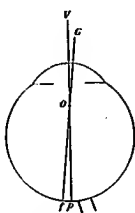
of a slight squint, this would afford strong evidence of the blindness being real. A large squint would be no evidence, but the slighter the squint the greater the evidence, for the more easily would the diplopia be overcome were binocular vision to exist.

In one such case I found the test of great value in furnishing evidence that a monocular blindness was not, as at first suspected, feigned, but real, for patients have no voluntary power for suppressing the desire for fusion. Again, with babies the test is of special service, for though they cannot, of course, fix the central aperture, they cannot help gazing at the bright light from the mirror, which answers almost as well, and then by rapidly flashing the light from one eye to the other, it is easy to see, not only whether any deviation exists, but also which is the squinting eye. To be expert, a little practice is necessary, but the same is true of every method of examining the eyes. Many a doctor's perplexity in the endeavor to solve an anxious mother's query about her child's eyes would be at once dispelled if these corneal images came to the rescue. It is a matter for surprise that they have not come into general use long ago.

When the vision of babies is imperfect, or the two eyes do not work well together, it is easy to find whether each eye possesses the power of central fixation by observing whether each corneal image occupies what I have called the "fixation position" with steadiness. This leads me to describe the "fixation position," and mention the second precaution to be observed—namely, to allow for the angle alpha and its variations. The very name of this angle is apt to frighten the unmathematical reader, since it is generally only spoken of in connection with physiological investigations, but it can very easily be turned to the simplest clinical uses, without carrying the reader into needless refinements. We will, for simplicity, suppose that the eye has only two axes, as in Fig. 3, viz., the geometrical axis and the axis of vision, and explain these briefly:

The geometrical axis ( $G$ ) is the axis on which, so to speak, the eye is built, passing from the centre of the cornea in front to the posterior pole of the eye behind, and passing, on its way, through the centres of the various media. With this axis, however, the axis of vision ( $V$ ) does not coincide, for, curiously enough, we do not see straight out of our eyes, but obliquely out of them.

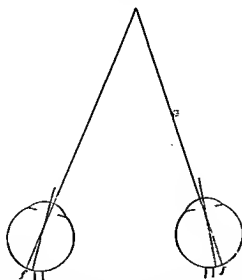
FIG. 3.



This is due to the fact that the "fovea centralis" ( $f$ ) does not lie exactly at the posterior pole of the eye ( $p$ ), but slightly to its outer side and below it.

Consequently, the axis of vision intersects the geometrical axis at the optical centre ( $o$ ) of the eye, as shown in Fig. 3, where for simplicity

FIG. 4.



To illustrate how each visual axis traverses the cornea to the inner side of its centre; drawn to scale one-half life size.

the two nodal points are reduced to one, and then traverses the cornea to the inner side of its centre. In consequence of this, the corneal image,

visible while the patient looks at the centre of the ophthalmoscopic mirror, and which, as we have already said, maps out on the cornea the point of its transit by the visual axis, appears to the inner side of the centre of each cornea. (See Fig. 4.) The average angle between the two axes is, in emmetropia,  $5^{\circ}$ . In hypermetropia the angle is greater, the average given by Donders being nearly  $8^{\circ}$ , and in myopia it is less, sometimes even negative, the average given by Donders being less than  $2^{\circ}$ .

In consequence of these differences, hypermetropic eyes appear slightly divergent, and myopic eyes slightly convergent, and hence arise the two well-known varieties of "apparent squint." The apparent position of the corneal image on the cornea, while the centre of the mirror is fixed by the patient, might, as already mentioned, with advantage be called the "fixation position" of the image. We have seen that in emmetropia the fixation position is to the inner side of the corneal centre; in hypermetropia it is still further to the inner side, because the angle  $\alpha$  is greater; in myopia it is less to the inner side, or even, in some cases, slightly to the outer side of the corneal centre, because the angle  $\alpha$  is smaller, or even negative. In emmetropia the most common condition is, as represented in Figs. 1 and 2, for the pupil to be slightly to the inner side of the centre of the cornea, and for the corneal image to be again slightly to the inner side of the centre of the pupil. It is important, however, to note any anomaly in the position of the pupil, lest it should mislead, and if the pupil be misplaced, the position of the image in the cornea should be studied rather than its position in the pupil. In an eye free from nystagmus, and which possesses the power of central fixation, the corneal image occupies the fixation position with great steadiness. If central fixation, however, be lost, the image is seen to wander aimlessly about the cornea, though really, of course, it is the cornea itself which wanders.

Mr. Priestley Smith has made a very interesting observation that in tobacco amblyopia the power of central fixation is retained, while in some cases of retro-bulbar neuritis it is lost. An absolute scotoma involving the macula would, of course, destroy it, and it might very likely be abrogated by functional or organic changes at the macula, produced by looking at strong light, or by constant use of the microscope, etc. With a little practice, it is quite easy to surmise from the corneal image alone whether an eye is much hypermetropic or myopic, and I have pointed out elsewhere that a high angle  $\alpha$ , as indicated by an unusually incentric corneal image, should, in an apparently emmetropic eye, make us suspect the presence of latent hypermetropia and induce us to paralyze the accommodation. It may, perhaps, be well to explain that, since the cornea acts as a strong convex mirror, any image which is formed by reflection from its surface is, of course, a virtual image, the

distance<sup>1</sup> of which behind the cornea depends on the distance of the flame, and the position and shape of the mirror, but in practice the depth of the image need not concern us, and we may regard the cornea, the pupil, and the image as all in one plane.

The nodal points of the eye do not always lie in the geometrical axis, and this would, of course, affect the angle alpha, but clinically this consideration also can be waived. The existence of the angle alpha was first proved by Senff, Helmholtz, and Knapp, and its increase of magnitude in hypermetropia and decrease in myopia were subsequently demonstrated by Donders.

Its character in astigmatism does not appear to have been studied fully yet. In some cases of hypermetropic astigmatism in which the deficient curvature was horizontal, I noticed a greater angle alpha than in emmetropia.

For exact measurements Helmholtz's ophthalmometer would be necessary, but that transports us out of the clinical field into the physiological. The beauty of ophthalmoscopic corneal images is that we are able, as it were, to actually see in a moment what point of the cornea is traversed by the axis of vision (see Fig. 4 again), and by the distance at which this point lies from the centre of the cornea to guess approximately the amount of the angle alpha. Any instance of an unusually high or low angle at once strikes us, and should set us to try and account for it by looking for some abnormal condition of refraction, excentric fixation, or unusual shape of the eye.

The clinical recognition of the angle alpha is, I believe, the key to the successful use of ophthalmoscopic corneal images, and it is this which

FIG. 5.



To show the asymmetry of the images when the eyes look away from the mirror, though the eyes are not squinting - illustrating how *not* to use corneal images.

makes me enforce the necessity of the patient's attention being directed to the mirror, and, if possible, to its central aperture, since, then, in normal eyes two images are equally displaced inward, and, therefore, symmetrical (Fig. 2). If the same eyes be allowed to wander to one or other side, the images will, of course, appear unsymmetrical, for one will be nearer the edge of its cornea than the other, by a distance equal to the combined original inward displacement of each. (Fig. 5.) The

<sup>1</sup> The cornea is a mirror whose "principal focus" lies 4 mm. behind its anterior surface, and, therefore, about the plane of the pupil.

vertical element of the angle alpha, shown by the corneal image lying slightly above the horizontal diameter of the cornea, seems of less clinical importance, and it is often imperceptible, though its amount is also subject to variation; I have not devoted much attention to it.

It is very pretty to see how faithfully the corneal image occupies its correct "fixation position" in cases of lamellar cataract not quite large enough to fill the pupil, even though the image appears to lie opposite the most opaque portion of the cataract. The visual axis, therefore, traverses the cataract, as, of course, it should do, on simple optical principles. Similarly, in cases of very peripheral iridectomy for occluded pupil, and when the iris is drawn to one side as in old cases of prolapse, the corneal image still occupies its proper position, though against an opaque background, and demonstrates, perhaps more prettily than anything else could do, the fallacy of supposing that a peripheral iridectomy predisposes to strabismus, or alters the relations between convergence and accommodation.

Now let us consider a difficulty in the detection of strabismus by corneal images which arises very occasionally. The angle alpha may be different in the two eyes, so that the corneal images appear unsymmetrical. The asymmetry in these cases is, however, so slight that its very smallness leads us to suspect its true cause, and if we place the hand over each eye in turn, it will be found that the "fixation position" is not the same in each. A "monolateral" squint is one in which the same eye always fixes and the other always squints, in contrast to an "alternating squint" in which either eye fixes indifferently. In squints of high degree it is most easy to determine whether they are alternating or monolateral, without the aid of corneal reflections, by simply covering the fixing eye for a few moments, so as to make the other eye take up fixation instead; if the latter continues to fix when uncovered, the squint is alternating, but if fixation is at once transferred back to the originally fixing eye, the squint is "monolateral!" With minute squints, however, it is not so easy to settle this point without the aid of corneal images which enable us at once to see which is the fixing eye, and whether by covering this eye temporarily fixation can be transferred to the other. A still more important point to settle is that of "concomitancy," because by this alone can we tell whether or not a squint is *paralytic*. In paralytic squint the degree of strabismus increases on looking in the direction of action of paralyzed muscle, whereas in concomitant squint the degree remains the same in whatever direction the patient looks. The following method is one which I can thoroughly recommend: Lay the palm of the left hand on the patient's head, with instructions to let the head follow the most gentle guidance of the hand without resistance. Now note the exact position of the corneal reflex on the squinting eye, while the fixing eye is directed to the central

aperture of the mirror, and steadily turn the head to the right and left, up and down, and into intermediate positions, to notice whether the position of the reflection is unchanged by these manoeuvres. If it is unchanged, the squint is concomitant; if otherwise, the squint is paralytic, provided that the movements made are not too great to bring in the fallacy of mechanical impediment from one of the corneæ reaching almost to a canthus. Vertical squints are just as easily detected as horizontal ones. The last use of corneal images which I shall describe in this paper is one which I have sometimes found of value, viz., to test for binocular fixation when its existence is doubtful.

Binocular vision and binocular fixation are often assumed to be idealical; but the latter may, at least hypothetically, be supposed to exist without the former, since the seat of binocular vision is in the occipital lobes, and that of binocular fixation in the corpora quadrigemina, or their vicinity. Mr. Berry was kind enough to let me try my test on a case, which I think was one of binocular fixation without binocular vision—a patient of his with congenital paralysis of the left external rectus. The left eye could not be moved beyond the middle line; loss of abduction, in other words, was complete. No diplopia could by any means be elicited, and yet on looking to the right both eyes seemed to move in perfect unison. Corneal images showed that on looking to the right each eye was accurately fixed for the mirror, until suddenly the middle line was reached, when the squint appeared. After operating for strabismus, and setting a squinting eye apparently perfectly straight, we are often at a loss to be sure whether both eyes are able to work together. We have some interest in finding this out, because if they do we know it will be a great preservative from any return of the strabismus, and we can give a better prognosis accordingly. By subjective tests it is often impossible to settle the question, the patients being so frequently either too young or too unintelligent to give us any assistance. An objective test, even though difficult, is, therefore, a great help, and I may repeat the description which I have given elsewhere:

"After operation, for some weeks at least, the eye operated on tends to remain more stationary than its fellow, so that by turning the head slowly to the right or left, we make, if binocular vision is absent, the corneal image on the squinting (and operated) eye slowly and steadily move across part of the cornea. If binocular vision be present, it may be strong enough to overcome the sluggishness of the squinting eye, in which case its image remains in the "fixation position" throughout. But even if the desire for single vision is not strong enough to effect this, there is always, if it be present at all, a part of the field of fixation over which the "fixation position" is maintained, and at the edge of this region the corneal image *suddenly* moves to another point. It is the continued maintenance of the fixation position during lateral move-

ments of the head, or else the sudden abandonment of the fixation position, instead of only gradually moving away from it, on which I count in making the test."

It is right to say that the use of Mr. Priestley Smith's excellent "tape method" of measuring squint at a metre was what first led me to make a study of corneal images at closer quarters and binocularly—as my first paper on the subject<sup>1</sup> elicited he had been simultaneously doing.<sup>2</sup>

A paper by Gullstrand (Sweden) must, by its review<sup>3</sup> later on, be a good one, but I have not yet had access to it. He prefers a laryngoscopic mirror, so as to illuminate both eyes at once, and I find it does so very prettily, though it has to be held at rather too great a distance, and in practice, of course, ophthalmic surgeons would always prefer to use the instrument in their hand—the ophthalmoscope. A dark room is not necessary, as the method is, if anything, rather easier in a light room. The chief difficulty with a beginner is to avoid being misled by the irregularities which prevail in the size and position of the pupil. Asymmetry of the pupil is immensely more common than asymmetry of the corneal images. Frequent practice, however, soon dispels the difficulty, and since a few seconds suffice to make the observation, practice is worth cultivating on nearly every patient who is seated for examination of the fundus.

## GONORRHOEAL ARTHRITIS; WITH NOTES OF CASES.

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THE complications of gonorrhœa are sometimes very painful and serious. Its sequelæ are numerous, often undermine health, or give rise to very grave symptoms. The most lamentable and unfortunate feature about this venereal malady is that the contaminated may infect the innocent; and that its virulence may, with all its intensity, fall on the latter, imperilling life or inducing organic disease, while the former is but slightly disturbed by it. Another strange and inexplicable character belonging to it, is its diverse and protean manifestations. Probably there are more lives lost from it, directly and indirectly, than are recorded. The physician, from a sense of respect for the family, or other equally worthy motives, is loath to set forth in the mortuary-certificate the real cause, and, by an evasion, substitutes something else. For

<sup>1</sup> Edin. Med. Journal, January, 1892.

<sup>2</sup> Ophth. Review, December, 1892.

<sup>3</sup> Ophth. Review, February, 1892.