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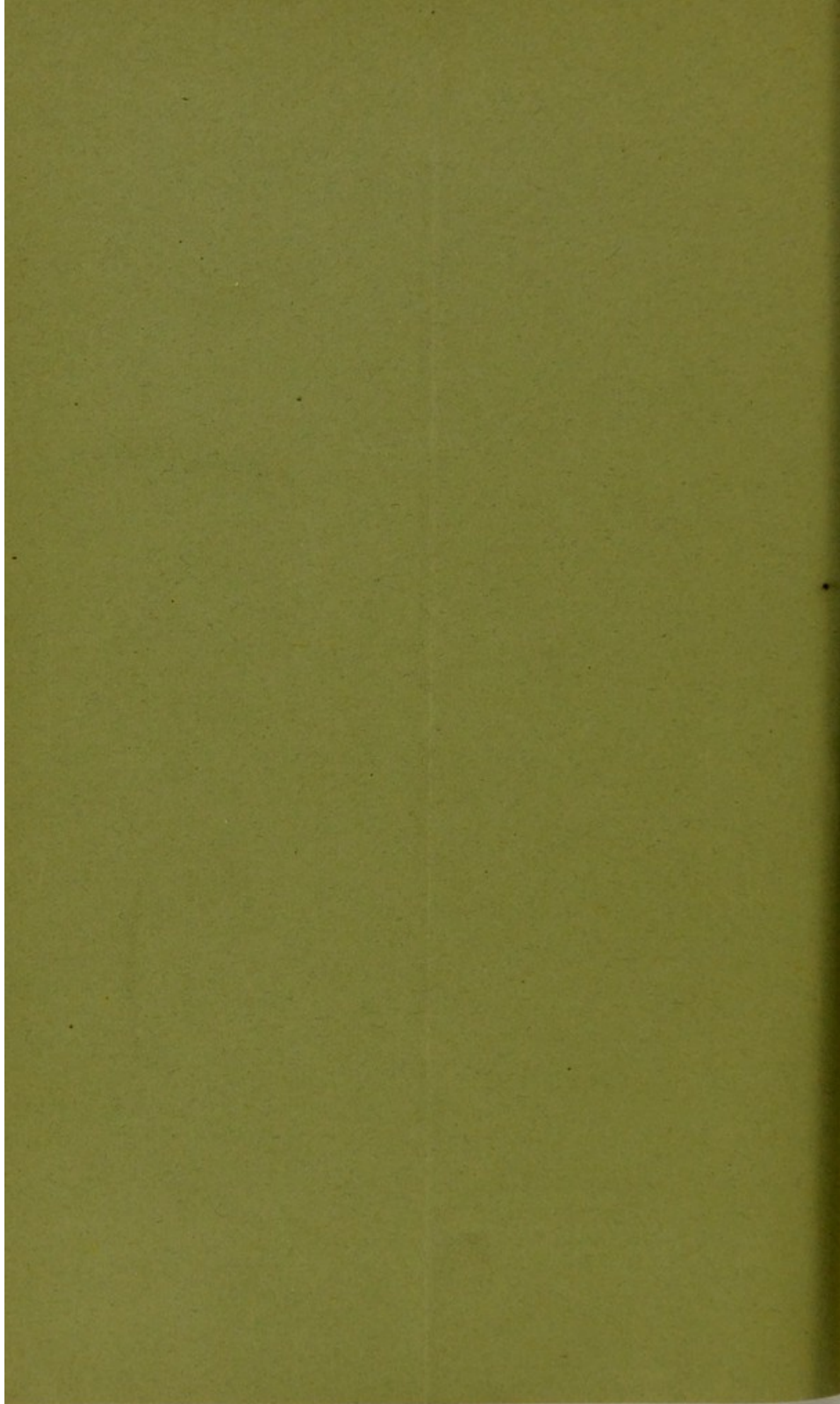
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Corneal Images

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THE CLINICAL STUDY OF OPHTHALMOSCOPIC
CORNEAL IMAGES.

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(Late Syme Surgical Fellow, Edin.)

IT is well to know in how many ways the much-neglected reflection from the cornea, which often puts us to inconvenience in ophthalmic work, may redeem its character by doing good service in other directions.

Sometimes much time and trouble is spent over doubtful cases of strabismus, in the endeavour to ascertain whether they are apparent or real, when the matter would be at once settled by noticing the position on each cornea of the image formed by throwing the light on it by reflection from the ophthalmoscope.

The patient should be directed to look at the central aperture of the ophthalmoscopic mirror, which is held in the usual position before the observer's eye at a distance of about two feet from the patient.

A brilliant spot of light will then be seen on each cornea, as the light is thrown first on to one eye, then on to the other. In at least one cornea the image will be seen to occupy what may be called the *fixation position*, viz., near the centre of the pupil, and generally a little to the inner side of it. This eye is therefore fixing the centre of the mirror. If the image on the other cornea occupy a very different position the latter is the squinting eye. If, on the other hand, the two images occupy *symmetrical* positions in the two corneæ, there is almost certainly no strabismus: there is only one possible fallacy [1] and that a very unlikely one, and even this is removed by taking the precaution to cover first one eye, then the other, to ensure that each image remains unmoved from its former

[1] The fallacy referred to could only occur if the difference between the two angles γ were great enough to equal, and disguise, the squint.

position when the fellow eye is covered. Should the two images occupy slightly different positions, the case may be one of squint, or may not. If, on covering one eye, the image on the other cornea shifts to a different position from that occupied when both eyes are uncovered, the case is certainly one of strabismus, and the squinting eye is that one on whose cornea the image shifts its position. Suppose, however, there be no such shifting with either eye, and yet the spots of light are unsymmetrical, what is it then? It is either one of those cases in which some part of the retina other than the fovea centralis has became the new point for fixation, the whole field of vision having shifted its position; or else it is a case in which the angle γ (to be explained shortly) is different in the two eyes. We are helped in this difficulty by the consideration that when the field of vision shifts, it generally takes a very long time to do so, and the squint is almost always of high degree, whereas the difference between the two angles γ is always comparatively very small. Cases, therefore, in which any doubt as to their nature could be felt, must be very rare.

It will now be well to give a simple explanation of the angle γ. It is the angle between the " optic axis " and the " line of fixation ; " or, in other words, between the geometrical axis of the eye and the functional axis of the eye. The " optic axis " may for clinical purposes be considered as the antero-posterior axis on which the eye is built, passing from the centre of the cornea in front to the posterior pole of the eye behind. The centres of the various media lie in it, as well as the centres of curvature of their surfaces. It is, therefore, the *geometrical* axis of the eye. It is true that all the centres referred to do not lie exactly in this line, but in a clinical paper it is important to weed out the scientific refinements which may with safety be neglected. Curiously enough, we do not see straight out of our eyes, but obliquely out of them. In other words, the functional axis of the eye is inclined at an angle to the geometrical axis. The degree of this angle differs in different persons. It depends on the fact that the " fovea centralis " is not situated exactly at the posterior pole of the eye, but generally to the outer side of it, and since the " line of vision "[1] of course connects the " fovea centralis " with the object looked at, and since it *must* pass through the nodal point of the eye, it follows that it cuts the cornea to the *inner* side of the geometrical axis. As a matter of fact the average angle between the two axes is about 5° in each eye. It follows that when we look at a distance, and our *visual lines* are practically parallel, our two *corneæ* really diverge from each other (*i.e.*, face outwards) by an angle of 10°. We are not only so accustomed to this that we do not think it a squint, but when the angle is absent, as it is in some myopes, so that the eyes look straight geometrically as well as functionally, we

[1] For practical purposes the line of vision and the line of fixation may be taken as coincident. Really they are not the same.

miss the natural discrepancy, and are apt to consider the case one of convergent strabismus. Differences in the angle γ constitute so-called "apparent strabismus," for the detection of which corneal images are invaluable. In hypermetropes the angle α (which we may consider for practical purposes as identical with the angle γ) is generally greater than in emmetropes, the average being given by Donders as 7° 55′. I have noticed that in hypermetropic astigmatism, in which the horizontal meridian possesses the least curvature, the angle is also generally greater than in emmetropia. In myopes the angle tends to be less than in emmetropes, and may be "nil," in which case the two axes coincide; or even negative, in which case the visual line lies on the other side of the optic axis. Donders gave the average in myopia as less than 2°.

The angle γ may be different in the two eyes. When this is the case, it is generally associated with a difference in refraction, but not always. It is of much clinical interest to know that the position of the corneal image when the eye is fixing the virtual source of light, or, in other words, the "fixation position" of the corneal image, maps out with fair precision that spot of the cornea which is traversed by the visual line.[1] It therefore generally lies, not in the centre of the pupil, but a little to the inner side of the centre, even though the pupil itself lies generally nearer the inner than the outer margin of the cornea. We are able, therefore, in a sense, to *see* what part of the cornea is traversed by the line of vision, and by the distance at which this point lies from the centre of the cornea we are able to guess approximately the amount of the angle[2] of the obliquity of vision in the eye under observation. Any instance of an unusually high or low angle at once strikes us, and may set us to try and account for it by looking for some abnormal condition of refraction, or unusual shape of the eye.

It is now a great number of years ago since corneal images were used to measure the radius of curvature of the cornea by the aid of the ophthalmometer invented by Helmholtz. Rather later, the flame of a candle, movable along the arc of a perimeter, was used to measure strabismus, by noting the position of the candle on the arc required to bring its image into the centre of the cornea of the

[1] I arrive at this by taking the centre of curvature of the cornea as coincident with the nodal point of the eye ; it is not really quite coincident, but the discrepancy is more or less neutralized by the ellipsoidal shape of the cornea, and therefore for practical purposes the simplification is permissible.

[2] The angle α is the angle between the "line of vision" and the optic axis : the angle γ is that between the "line of fixation" and the optic axis. The "line of vision" extends from the object fixed through the nodal point to the fovea. The "line of fixation" extends from the object fixed to the "centre of rotation" of the eye.

The discrepancy between the angles α and γ in a given eye is greater (1) the nearer the object fixed, and (2) the higher both angles are.

In the *Græfe und Sæmisch Handbuch*, Snellen and Landolt truly observe. "We can for practical purposes quite well take the angles γ and α as equal to each other."—Band iii., p. 211.

squinting eye, the observer viewing the image from just behind the candle. Later still, Hirschberg showed how, by holding a lighted taper before the patient's face in a case of strabismus, the degree of squint could be guessed by remarking the part of the cornea occupied by the image of the flame. His method does not seem to have come into use, perhaps for want of sufficient elaboration in detail, and too much neglect of the angle γ. His method, however, is certainly of value, by enabling us to guess the amount of squint present.

Ophthalmoscopic reflections from the cornea do not appear to have been utilized at all, till comparatively recently Priestley Smith showed how the image on a squinting eye can be used to measure the squint by his excellent " tape method," to which I am indebted for interesting me in such corneal images. I leave, however, to be treated elsewhere the subject of the measurement of squint, confining myself now to its ophthalmoscopic detection and analysis, as being of value in general practice.

Does one eye always squint, or either indifferently, is a question to be always put to one's self. In other words, is the squint " alternating " or " monolateral " ? In those of high degree it is most easy to settle this without the aid of corneal reflections, by simply covering the fixing eye for a few moments, so as to make the other one take up fixation instead. If the latter continues to fix after the removal of the hand, the squint is seen to be transferred to the eye which at first was straight, and the case is one of alternating strabismus. With minute squints it is not so easy to make out this point, and corneal images give immense assistance by letting us see at once which is the fixing eye: it is of course that eye in which the image occupies the fixation position: we can easily observe then, whether by covering this eye the other can or cannot be made to take up fixation. Another still more important point to settle is that of " concomitancy," because by this alone can we tell whether or not a squint is *paralytic*. By concomitant squint we mean one in which the degree of squint remains the same when the patient looks in different directions. In paralytic cases, on the contrary, the squint increases on looking in the direction of action of the paralysed muscle. Thus, in paralysis of the right external rectus, the squint increases on looking to the right, and so on. To test for concomitancy, I can strongly recommend the following simple method. Holding the ophthalmoscope in the usual way with the right hand, 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 any resistance in the neck. Now bid the patient look at the central aperture of the mirror while the light is thrown on the squinting eye, and the exact position of the corneal reflex noted. Now slowly turn the head to the right and left, then up and down, etc., and notice if the position of the reflection is unchanged by these manœuvres: if it is unchanged, the squint

is concomitant. It is true that such observations require a good deal of practice before certainty can be acquired, but the same is true of retinoscopy, ophthalmoscopy, etc., and there is no reason why corneal images from the ophthalmoscope should not receive sufficient attention to gain the requisite dexterity. As it is, they do not seem to be even mentioned in the text-books.

Vertical squints, if slight, are often difficult to verify at first sight, for if any ptosis be present in a case where there is no squint, the appearance is misleading. Corneal images at once clear up such cases, by letting us see if they are of equal height on the two corneæ.

I have found corneal images come in very usefully in the examination of the eyes of babies. Sometimes when their vision is imperfect, or the two eyes do not work well together, it is not easy to tell if they possess power of fixation; and I have found it useful to reflect the light of a flame into each eye in turn, to see whether the corneal image occupies the " fixation position."

Another application of corneal images, which I think I have worked out, is to use them in testing for binocular vision after operations for strabismus. Because the eyes appear to be set straight it does not follow that they possess stereoscopic vision, and by subjective tests it is sometimes exceedingly difficult to know whether binocular vision is restored or not, the patients being frequently young children too unintelligent to give us any assistance. An objective test is therefore a great help. To make it we proceed as in testing for concomitancy, making the patient slowly turn his head from side to side. 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 it *suddenly* moves to another point. It is the continued maintenance of the fixation position during lateral movements of the head, or else the sudden abandonment of the fixation position, instead of only gradual moving away from it, on which I count in making the test.

I hope it will be evident, from the uses which have been enumerated, that corneal images are well worthy of more attention, both by surgeon and physician.