The Systematic Use of Cylinders in Making the Shadow Test.

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It is no new idea to use cylinders in making the shadow test. I believe that it is as much as nine years ago since I heard Dr. W. E. Lambert advocating this practice and explaining its utility in connection with his refractometer. But cylinders are not used as much as they should be, and several of our best known treatises on refraction and the shadow test contain little or no reference to their employment; yet I am convinced that their *routine* use is of eminent importance in the diagnosis of astigmatism as enabling us to determine with the utmost precision (a) the amount of astigmatism, (b) the axis of astigmatism, and (c) the exact spherical correction.

What appears to me the best method of applying cylinders in skiascopy can be most readily shown by a concrete example.

Using the concave mirror* at one metre I find a movement against the mirror in all meridians. I add convex glasses. When a convex + 2 D. has been added the reflex becomes quite bright and begins to form a rather distinct band running in the meridian of 75° or 80°. I now move my mirror in the direction of this meridian only and keep adding + glasses, until in the meridian of 75° I get the shadow just beginning to move with the mirror. Suppose it takes +2.75 to do this. No. +2.75 then is the reversing glass for the meridian of 75°. I now have a quite sharp band of light running in the direction of this meridian.

Leaving the +2.75 on, I now move the mirror at right angles to the band of light, *i. e.,* in the meridian of 165°, and find that the movement of the shadow is still against the mirror. There being evidently quite a little astigmatism, I take a strong cylinder, say +2.00, and place it with its axis at 75° (*i. e.,* in line with the

* I habitually use the concave instead of the plane mirror in skiascopy. While the plane mirror is perhaps easier to apply, and gives a more readily observable reflex, I am convinced that the concave mirror affords more accurate results. This is particularly so in oblique astigmatism, when, as we attempt to move the mirror either in the direction of the band of light or at right angles to it, the cross-shadows, which are so confusing, are with the plane mirror made more conspicuous and more difficult to evade.

band of light), and then again moving my mirror in the meridian of 165°, see if reversal of the shadow has yet been secured. If not I replace the +2.00 with stronger cylinders. Finally with a +3.50 cylinder I find that I just succeed in making the shadow go with the mirror in the meridian of 165°.

If this cylinder of +3.50 at 75° truly represents the amount and axis of astigmatism, then I should, with my two reversing glasses (+2.75 spherical ⊂ +3.50 cylinder), get the following:

(a) At one metre there should be a bright circular reflex uniformly illuminating the whole pupil.

(b) The shadow should move with the mirror in all meridians alike and precisely in the same line as the mirror moves, not swerving from the path of the latter; that is, not making any oblique movement.

(c) When I advance to just within one metre the shadow should begin to move against the mirror in all meridians and for all alike at precisely the same distance from the eye.

If my correction of the *astigmatism is wrong in amount, e. g.,* if the cylinder should be +3.25 instead of +3.50, then, as I approach the patient from a distance of one metre, I shall at a certain distance from him find that in the meridian of 165° the shadow moves with the mirror, while in the meridian of 75° it still moves against it. When this happens I simply change the strength of the cylinder until reversal takes place at just the same distance from the eye for all meridians alike.

If my *cylinder is at the wrong axis, i. e.,* if it ought to be at 80° instead of 75°, then as I sweep the mirror from side to side or up and down I will notice that the shadow, instead of traveling along the same line as that in which I am moving my mirror, makes a skew or oblique movement, sliding off, as it were, to one side or the other. When this happens I shift the axis of my cylinder one way or the other, until this obliquity of movement disappears.

Finally, if my *spherical alone is at fault* then reversal takes place evenly indeed in all meridians, but either too close to the eye or too far from it. I then alter the strength of the spherical accordingly, until reversal takes place at just one metre.

In making the test in this way it is essential for the observer to get into the habit of *constantly varying his distance from the patient*—moving his head slightly backward and forward so as to be sometimes just within a metre's distance from the patient, sometimes just beyond it. I regard this forward-and-back movement of the head as a very important part of the shadow-test, however conducted. In other words, I do not think it sufficient merely to stand at one metre from the patient and determine that at that distance we get reversal with a certain glass. We should, in addition, show by moving our head forward a little that this glass no longer produces reversal when we have got a few inches closer to the patient's eye and have thus passed his far-point. A little practice soon makes one quite expert in doing this. Thus with a patient who is truly hyperopic 2 D, we find when we put a +3 D glass before his eye that as we gradually recede from him the shadow keeps moving against the mirror until we are very nearly a metre off, then for a very short space the movement is indeterminate; and again, just beyond this region the shadow moves clearly with the mirror. The patient's far-point lies in the space of indeterminate movement lying between the point where the shadow begins to move with and the point where it begins to move against the mirror. The closer we can get these points together the more precisely shall we estimate the position of the patient's far-point and hence his refraction. It takes only a little practice to so sharpen our powers of observation as to enable us to say positively that at one point the shadow moves distinctly with the mirror and at a point not four inches off moves distinctly against it. This, when reversal is secured at one metre, means precision in estimating the refraction to within 1/8 D. If on the other hand, we are content with the mere statement that reversal takes place at one metre, without finding out whether it may not also take place at some little distance inside of this point, we may be in error by at least 1/4 D.

I would not speak of this point had I not found so many employing the shadow test who do not avail themselves of this accurate means of fixing the far-point, and who even, indeed, seem to be unaware of the principle underlying it.

While this way of determining astigmatism with the shadow test by cylinders may seem a little more circumstantial than that by the use of sphericals alone, one for one meridian and one for the other, it really takes very little more time and is so greatly superior in point of accuracy that the additional minutes given to it are minutes well spent. Moreover, I usually find that time is saved in the end, for it has been my experience, over and over again, to find that the glass thus shown by skiascopy was the one that the patient upon subjective testing immediately accepted—absolutely no change, either in the strength of the glasses or in the axis of the cylinders, being tolerated. I have thus often been enabled to shorten the subjective testing—always so wearisome to surgeon and patient alike—to the absolute minimum.

I utilize the same test, applied in the same way, as a check in *ascertaining whether the correction found with the trial lenses is probably the best obtainable.* Thus, suppose the glass found is +2.50 ⊃ +1.50 cylinder 90°.

I add +1.00 to this, making it +3.50 ⊃ +1.50 cylinder 90°. This should make the patient myopic 1 D. If he really is so, precise reversal will take place with this glass for all meridians alike at one metre. If, however, the spherical is of the wrong strength, or the cylinder is incorrect in either strength or axis, I shall discover the error in the way just mentioned and can remedy it in a moment. I have thus, in a number of instances, been able to decide as to the proper glasses and particularly as to the proper axis of the cylinder, when the patient's answers were not satisfactory.

This method is readily *demonstrated and practiced on the skiascopic eye-model.* The latter, when used for this purpose, should have an additional slot in front of it for holding the correcting cylinder. If in this case we produce an artificial astigmatism by a cylinder of say —2 D, it is easy to show how, when reversal has been secured in the axis of the astigmatism by means of the proper spherical, a rapid and accurate estimate of the astigmatism can be made by a +2 cylinder placed in the additional front slot. If this cylinder is put at 5° or 10° from the right axis, the skew movement above described can readily be evoked, and if a cylinder greater or less than 2 D is used, the failure to correct the amount of astigmatism can easily be shown by the fact that, as we approach the eye, we secure reversal in one meridian before we do in the other. It is easy in this way to prove how accurate the test is when thus conducted—to show, for example, that it can detect errors of ¼ D or even ⅛ D in the amount of the astigmatism and also very slight errors in the estimation of the axis.

I am sure that those who have once familiarized themselves with the details of the method just described will not readily return to the old way of estimating the refraction in skiascopy by sphericals alone.