DETERMINATION OF THE REFRACTION OF THE EYE BY MEANS OF THE OPHTHALMOSCOPE

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BY

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DETERMINATION OF THE REFRACTION OF THE EYE BY MEANS OF THE OPHTHALMOSCOPE.

EDWARD G. LORING, M.D., NEW YORK.

If the ophthalmoscope was one of the most brilliant inventions ever known to medical science, it was certainly, also, one of the most complete, for the very method first proposed by Helmholtz still remains by far the most beautiful, comprehensive, and truthful of all the means yet in our possession for the exploration of the bottom of the eye.

As a knowledge of this method—that by the upright image—is absolutely necessary for the determination of the optical condition of the eye, a few words as to the manner in which it should be performed in general, may be of service to the reader before proceeding to the more difficult task of determining in a given case the nature and exact degree of refraction.

The position of the patient and examiner is not without importance. The observer should sit well to the side of the patient, and on the side, of course, of the eye to be examined. If the right eye is to be examined, the patient should be directed to look slightly towards the right; if the left eye, then towards the left.

In fact, the directions are exactly opposite to those given for the inverted image, and just the contrary from what are usually laid down in the books.

This position in the examination throws the optic axis away from the median line and places the optic nerve just opposite the pupil, and allows the observer to approach very near the observed eye without bending too much over the person examined.

The observer must learn to use either eye and either hand as

occasion may require, so as to be able to examine the patient's right eye with his right, and the left with his left, holding the ophthalmoscope in the right or left hand, as the case may be.

As the examination by the upright image consists of looking directly through the pupil to the fundus beyond, the observer should bring his own eye as closely to the observed eye as is possible; for when obliged to look through a narrow opening, the nearer we bring our eye to the edges of the aperture, the wider will be the field of view of what lies beyond. Also, as a matter of course, the larger the pupil, the easier the inspection and the greater the extent of fundus seen. For this reason the first attempt of the observer should be with a dilated pupil.

For an observer to see the details of the fundus clearly with the upright image, some knowledge of the optical condition of his own eye is necessary, as well as that of the eye to be observed, and any existing fault should be corrected by the proper neutralizing glass.

The inexperienced observer, even if emmetropic and able to relax his accommodation perfectly for distant objects, is usually a little, sometimes a good deal myopic for the ophthalmoscope. This comes from the fact, that he is unable to adjust his eye for parallel rays, when looking into an eye which he knows to be only a short distance from him. He instinctively accommodates and transforms his eye for the time being from an emmetropic to a myopic eye. This must be corrected by a suitable concave glass behind the mirror.

It is better for the beginner not to waste too much time in trying to correct his myopia, either natural or acquired, too exactly; but to take such a glass as will enable him to see the fundus with ease and distinctness, and this having been attained the observer will gradually learn to discard the use of too strong a glass by gradually substituting for it a weaker one. The weaker the concave glass, consistent with perfectly clear vision, the better. If on the other hand, the observer is hypermetropic and can so relax his accommodation as to be able to use a convex glass, this should be as strong as possible, so that he may see with as little strain on his accommodation and get as large an image as can be secured.

The general direction for the movements of the patient's eye, up and down, to the right and left, are of course the same as with the inverted image, only it must be borne in mind that the positions of the objects are really as they appear and not, as with the inverted image, reversed. The macula lutea is found by following a line directly outwards from a little below the centre of the optic nerve and for a distance from its edge of a little over two of its diameters.

The observer having become so at home with the upright image that he can readily obtain a perfectly distinct view of the fundus through an undilated as well as a dilated pupil, should then, but not before, turn his attention towards what may be called some of the niceties, if not the beauties, of the art, chief among which is the ability to determine the optical condition of the eye. To do this in a satisfactory manner, the observer should have a suitable instrument.

The great aim in the construction of an ophthalmoscope should be largeness of field of view with a suitable and sufficient illumination. These requirements seem to be fulfilled best in the shape and construction of what is known now as Liebreich's smaller ophthalmoscope, which consists of the concave mirror with a central aperture first introduced by Reute, attached to a short straight handle. The mirror is usually about seven inches focal length, with a clip at the back for the necessary correcting glasses.

Unfortunately Liebreich's instruments, as made abroad, though cheap, are comparatively worthless, from the mirrors not being true, and from the annoying reflections arising from the edges of the perforation and back plate of the mirror. The whole instrument is, moreover, so flimsily constructed, as to be liable to break with the most careful handling.

For lightness, durability, freedom from reflections, and general usefulness, there are no superior instruments to those now made in New York, and notably by Mr. Hunter.

The instruments of this maker in the way of workmanship and optical accuracy are unsurpassed.

As Liebreich's instrument was not compendious enough to meet the growing requirements of ophthalmic science, the following

modification[1] of the instrument was made, the principal feature of the change being the substitution of detachable cylinders for the ordinary clip, or for the fixed Rekoss disk. In the present case but three cylinders are employed, though these might be multiplied indefinitely were there any occasion for so doing. Each cylinder is pierced for eight glasses, forming in the aggregate the following series:

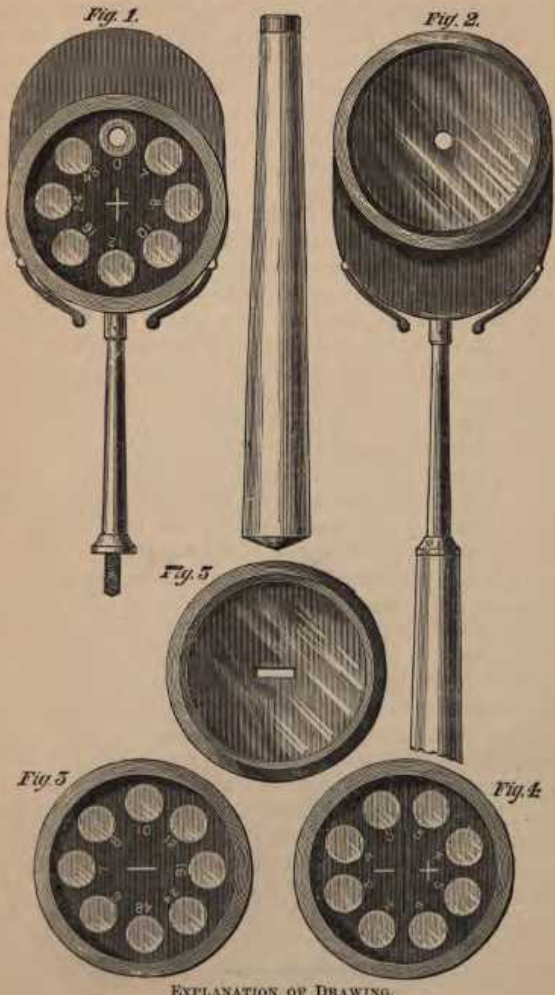
Convex..... 0, $\frac{1}{48}$, $\frac{1}{24}$, $\frac{1}{16}$, $\frac{1}{12}$, $\frac{1}{10}$, $\frac{1}{8}$, $\frac{1}{7}$, $\frac{1}{6}$, $\frac{1}{5}$, $\frac{1}{4}$, $\frac{1}{3}$.
Concave..... $\frac{1}{48}$, $\frac{1}{24}$, $\frac{1}{16}$, $\frac{1}{12}$, $\frac{1}{10}$, $\frac{1}{8}$, $\frac{1}{7}$, $\frac{1}{6}$, $\frac{1}{5}$, $\frac{1}{4}$, $\frac{1}{3}$, $\frac{1}{2}$.

Thus we have a series of glasses extending, with but comparatively slight differences in focal value, from convex 1-48 to 1-3, and from concave 1-48 to 1-2.

The manner in which the glasses are divided among the cylinders will be readily understood from the accompanying drawings. The first cylinder is made up entirely of convex glasses, by means of which all ordinary degrees of hypermetropia can with sufficient exactness be determined. One hole (0) is left vacant to represent emmetropia, without the necessity of removing the cylinder, and for examination by the inverted image without an eye-piece; should, however, the latter be desired, the observer has a large selection at his command. The second cylinder contains the concaves of moderate focal power, and the third is composed of the high numbers, both positive and negative. These strong numbers are designed for the determination of the highest degrees of errors of refraction and for the measurement of the inequalities of the fundus, such as excavations and elevations of the optic nerve, projections of tumors, retinal detachments, membranes in the vitreous, et cetera. With the stronger convex, such as 1-3, opacities of the cornea and lens can be viewed under considerable enlargement.

The cylinders fit into a cell at the back of the instrument and are held firmly in their place by means of the two small springs shown in the engraving, which, projecting into a groove in the side of the cylinders, prevent these from falling out, yet do not interfere with their rotation. In turning, the centre of the glass comes opposite the centre of the hole in the mirror.

[1] Trans. American Ophth. Soc., July, 1869.



EXPLANATION OF DRAWING.

Fig. 1. Back of instrument with cylinder in position.
Fig. 2. Front view of instrument.
Figs. 3 and 4. Remaining cylinders detached.
Fig. 5. Astigmatic optometer and mirror.

Great care was taken to have the mirror, which is concave, seven inches' focal distance, ground exceedingly thin—as thin almost as a metal mirror—while all the surrounding brass work is so beveled away that as little impediment as possible is offered to the passage of the rays, thus rendering the image perfectly distinct, and I think unusually brilliant.

The mirror being contained in a separate case of its own is made detachable from the rest of the instrument, which can then be used as an optometer, the patient himself revolving the cylinder till the suitable glass is obtained. As the perforation through which the patient looks when the mirror is removed is equal to the diameter of the glass (three lines), and is much larger than the normal pupil, the peripheral rays are not cut off, which is usually a source of error when smaller diaphragms are used.

The handle of the instrument has purposely been made unusually long, so that the observer's hand shall not interfere with an easy and close proximity to the observed eye, which is a great advantage in examination by the upright image.

The instrument, the three cylinders, and a convex two and one-half inch lens for examination by the inverted image, are all contained in a small pocket-case, measuring four and three-quarter inches by two and one-half square by three-quarters thick.

The common weak mirror, consisting of three plates of plane glass, can be easily fitted to the instrument should it be desired.

The second mirror was originally designed for a stenopæic slit to be used with the instrument when employed as an optometer for the determination of astigmatism. It consisted of a thin plate with a slit in it, whose length was equal to the diameter of the perforations in the cylinder. This was mounted like the mirror, and made to fit in the mirror cell in which it revolved, so as to allow the slit to correspond with any given meridian of the cornea. The meridian once determined, the patient turned the cylinder till the suitable glass was obtained. This plate was subsequently made with a polished surface in front, and then was made to serve also as a mirror for determining, by means of the ophthalmoscope, the amount of astigmatism in the principal meridians of the eye. Practically, however, this is of little use, as the simple round perforation answers every purpose.