PERIMETRIC CHART USED FOR MEASURING RETINAL LESIONS.

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The chart here referred to serves to indicate the actual size of retinal lesions corresponding to any given scotoma or narrowing of the visual field. The need for this is pointed out and other methods considered.

This paper is presented in an endeavor to show the practicability and usefulness of what is thought to be an improvement over our present methods for estimating more accurately the size and location of retinal lesions—an improvement that

scientific if the size and location could be given in millimeters.

In an attempt to facilitate measurements of this kind Epkens and Donders made an elaborate ophthalmoscope, with a micrometer attachment which was used

Fig. 1.—Diagram of projection of inside of eye, 22 mm. diameter. 1. Center of cornea. 2. Circle corresponding to attachment of iris, 6 mm. from center of cornea.¹ 3. Ora serrata, irregular shape and sharp projections directed toward corona ciliaris.² 4. Sensitive portion of retina, the normal average field. 5. Optic nerve. 6. Area centralis, center of which is the fovea.²

might be of clinical value, in that we are enabled by its use, to picture in the mind's eye, these conditions in their actual size.

The real size of the fundus, being seen highly magnified, is seldom appreciated. It requires an imagination to think of the disc as being only about 1.5 millimeters in diameter, and the fovea only $\frac{3}{4}$ or 3.5 millimeters² away from it. An observer will define a lesion as being "about the size of a dime," by comparison with the size of the disc, or that it causes a scotoma of so many degrees. It is felt that the representation would be more

for calculating the size of the parts seen. Schneller made a similar attachment for measuring the inverted image, which could be applied to any ophthalmoscope. Zander⁶ gives complete descriptions and illustrations of both the above devices, which were made very shortly after Helmholtz developed his first ophthalmoscope. Frost and Stephenson⁶ designed a fundus-gauge, consisting of a rectangular network of fine wires, which when attached to an ophthalmoscope, threw its shadow on the fundus, thus mapping it out into squares. In 1886, Dr. Thomas Reid of Glasgow, designed an electric

ophthalmoscope with a prismatic reflector and a micrometer scale, an image of which was projected on the fundus.⁷

There are several methods by which a certain area on the retina may be estimated after being charted by the aid of a perimeter or campimeter. The formula most often used and which needs no ex-

portion. For example, take an object 66 cm. in size and 33 cm. in front of the nodal point. By either of the above methods the size of the retinal image would be twice the distance of the nodal point from the retina, or 30 mm. This object would lie within an angle of ninety degrees and the opposite angle within the

Fig. 2.—A. Opaque nerve-fibres, O. S. B. The record, made on Bissell chart, with lines 1° apart and equal to $\frac{1}{4}$ mm. on the retina, making the reading easy. The inner oval is the outline of the blind spot of the right eye, which is normal. By inverting the reading it will be seen that the greatest extent of interference with retinal function is below, about $\frac{3}{8}$ mm. Vision O. U. = 6/5.

planation is that the size of image =

$$\frac{15 \text{ mm.} \times \text{size of object}}{\text{distance of object from nodal point.}}$$

If this method is used for calculating the actual size on the retina of one degree on the arc of a McHardy perimeter, it will be found to be .263 mm.; on the Peter campimeter one degree corresponds to .253 mm.; and on a Bausch and Lomb stereocampimeter, .247 mm.

Another way would be to multiply the tangent of the angle by 15 mm. For example, the tangent of an angle of ten degrees is .1763, multiplying this by 15 mm., we have 2.6445 mm. on the retina, corresponding to ten degrees in the field.

These methods are not mathematically correct and can be used only for a small

eye being the same, would make the image cover $\frac{1}{4}$ of the circumference of the inner surface of the eye. If we should consider 30 mm. as the distance covered on the retina by this image, and since it covers $\frac{1}{4}$ of the whole circumference, lying within an angle of ninety degrees, then the whole circumference would be four times as great or 120 mm. This cannot be, as it would make the inner diameter of this globe over 38 mm. It can thus be seen how these methods are not applicable to a large portion of the retina as they would always give a greater area than the actual size of the retina involved, the ratio being 4 to 3.

Another line of reasoning which altho it has no practical value, may be mentioned because it seems interesting. The

macular cones vary from .0025 mm. to .003 mm. in diameter,³ and correspond to a visual angle of one minute. In order to find the number of cones in one degree, we multiply the diameter by 60. This would give us the distance on the retina corresponding to one degree in the field if the macula were flat; but this is always a depression, oftentimes conical. In order to make it easy for calculation, it may be considered at the fovea, hemispherical, which is perhaps a fair average. Therefore, if the diameter of the cone is multiplied by $60 \times 3.1416/2$ the result is the distance on the retina corresponding to one degree in the field.

Fig. 3.—Central atrophic choroidal spot, charted on Bissell Record Card. The light lines are 1° apart and equivalent to $\frac{1}{4}$ mm. on the retina. In describing a case of this kind it is necessary only to give the size and location, without the bother of submitting the chart.

This result varies from .233 mm. to .282 mm., an average of .257 mm.

The modified chart suggested in a previous paper⁴ would eliminate the necessity of any calculation whatever. In this article it was reasoned that if it were not for the obstruction offered by the nose brow and cheek, and if the retina were sensitive all around as far forward as at its most anterior attachment, the normal field of indirect vision would be circular in outline and extend ninety degrees in every direction. Twenty-two millimeters was taken as a working average of the inside diameter of the globe. This was multiplied by 3.1416 to find the circumference from which was deducted one third for the anterior segment and the result taken as the diameter of the

retina if it could be projected into a flat circular disc.

The diameter of this flat circular disc was divided by one hundred and eighty, the number of degrees in the field which it covers and the conclusion was reached that each degree was equal to .255 mm., or about one fourth of a millimeter on the retina. On the basis of this theory any existing perimetric or campimetric chart could be so modified by placing on it a series of lines, four degrees apart in the horizontal and vertical directions, that it would be made into an actual plan of the retina, drawn to scale, the squares each representing one square millimeter on the fundus.

By taking the field or mapping out the blind spot or scotomata with any perimeter or campimeter and making the record of such on this modified chart, the size and location could be seen at once and without need of reckoning. As the modification does not in any way interfere with the readings in degrees, the new chart may be used in place of the old one, whether or not the scale is read. Charts, such as the Lloyd or Bissell, being marked in squares of one degree, which correspond to $\frac{1}{4}$ mm. on the retina, could not be changed except that instead of every fifth line, the fourth line be made heavy, making the large square equal to a square millimeter on the retina.

The method of projection used for the chart is shown in Figure 1, as it would be applied to the whole inside of the globe. The measurements are what might be considered fair averages and the scheme is drawn actual size. The few simple cases are shown merely as an illustration of the practicability and clinical advantage of the method suggested.

In conclusion, it might be said that, for practical purposes, as the results of the different methods of estimation vary so very slightly, whether or not the chart is used, four degrees in the field can be considered almost exactly equivalent to one millimeter on the retina.

Fig. 4. Modified chart for recording fields. The series of vertical and horizontal straight lines are placed at a distance equivalent to one millimeter on the retina.

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