ON THE DIRECT MEASUREMENT OF OPHTHALMOSCOPIC OBJECTS.

By THOMAS REID, M.D.,
Surgeon to the Glasgow Eye Infirmary, and Waltonian Lecturer on Diseases of the Eye in the University of Glasgow.

IN a lecture on the enlargement of ophthalmoscopic images, by Dr. Landolt, which appeared in the number of the BRITISH MEDICAL JOURNAL for January 3rd, 1880, the author says that the results obtained by the direct method are only relatively exact; "for, unfortunately, the fundus oculi does not present any object of constant size, or directly measurable". Now, it so happens that, by a particular application of the "law of Bravais"*, an image of known magnitude and constant size (say of a grating) can be projected on the fundus oculi, and seen by the direct method, simultaneously with any object there which it may be required to measure. The "law of Bravais", shortly stated, is as follows. When the distance between two dioptric systems is equal to the sum of their principal foci, parallel incident rays emerge from the compound dioptric system parallel; and the ratio of the size of an image to its object is constant, whatever may be their relative distances from the system—viz., that of their adjacent principal foci. In the case of the eye, when the convex lens used in the indirect method is so held that its principal focus coincides with the anterior principal focus of the eye—which is about 12 millimètres in front of the cornea—the conditions of the "law of Bravais" are fulfilled, and the ratio of the size of an object in the fundus to its aërial image is constant, viz., $\frac{\phi}{f}$; ϕ being the anterior principal focus of the eye, and f the principal focus of the lens.

The late Dr. George Rainy, shortly before his death in 1869, had a compound ophthalmoscope constructed on this principle, with which he proposed to measure the absolute size of objects in the fundus oculi, in all cases of axial ametropia, as well as in emmetropia; and, at the same time, to determine the refraction. The instrument consisted essentially of two plano-convex lenses, of 2¼ inches focus; one fixed in the anterior part of the tube, in the position required by the "law of Bravais" (the objective); the other (the ocular), at the other extremity, in a draw-tube, with a micrometer in its focus, to measure the absolute size of the aërial image. This having been found, the size of the object in the fundus was easily deduced from the formula, $\frac{\beta}{\beta_1} = \frac{\phi}{f}$ in which β represents the size of the object, and β_1 that of its image on the micrometer. To avoid reflected images from the surfaces of the lens, the illumination was effected by three plane parallel plates set obliquely in front of the objective. When the instrument is in position, an image of the micrometer can be projected on the retina by transmitting the light sent to the eye directly through the tube. The ratio of the size of the divisions of the image to that of the micrometer is as before, $\frac{\phi}{f}$. But this arrangement, which, to a certain extent, resembles that of the Epkens' and Donders' instrument, is not very convenient in practice.

Fortunately, the ophthalmoscope of Coccius furnishes the required optical conditions. This instrument consists of a plane mirror with a condensing lens of short focus between it and the lamp. If, when the instrument is held in the position for direct examination of the eye (and corrected, if necessary, for refraction), the principal focus of the lens coincides with the anterior focus of the eye, the conditions of the "law of Bravais" are fulfilled; and if a micrometer screen be held between the lens and the lamp in the conjugate focus of the retina with the compound system of the eye and the ophthalmoscope, its image will be seen along with the part to be measured.

In practice, it suffices to attach a graduated rod perpendicularly to the handle of any ophthalmoscope with a plane mirror (a Jäger's in the present instance) to carry the lens and screen, which should be accurately centred with the mirror. The inclination of the supporting rod to the axis of vision may vary from 60° to 90°; the mirror, in any case, being equally inclined to both. The adjustments are simple and easily executed. The principal focus, the lens in front of the mirror, as also the principal focal distance of the screen, are determined experimentally. The positions of the screen for different degrees of ametropia are readily found; for that of the principal focus of the lens coincides with the conjugate focus of the emmetropic eye, and marks the zero point on the supporting rod; the other positions are got from the formula of Newton: $l\,l^1 = f^2$, in which, if l is taken equal to one dioptric, $l^1 = f^2$ a constant quantity which is the size of the divisions, each being equal to one dioptric. For example, with a lens of 75 millimètres, $l^1 = 75^2 = 5.6$ millimètres, the amount of displacement of the screen for each dioptric of ametropia. The degree of refinement to which the measurements can be carried depends on the size of the divisions on the screen whose image can be seen on the fundus under the low magnifying power of the eye itself. With a lens of 75 millimètres, divisions of .5 millimètre, whose image is $\frac{15}{75} \times .5 = .1$ millimètre, or about $\frac{1}{250}$ inch, can be distinctly seen. Measurements of the normal optic disc in emmetropic and slightly ametropic eyes gave, with remarkable uniformity, 1.6 millimètres for the vertical diameter; the horizontal, in some cases, being rather less. Well marked atrophy, with filling in of the margin, consequent on embolism of the retinal artery, measured 1.5 millimètres in the vertical and horizontal diameters.

In a case of amblyopia, with atrophy of the choroid, but without staphyloma, the diameter of the optic disc was two millimètres. The diameter of the superior and inferior branches of the retinal veins over the disc in the normal eye was found to be not more than $\frac{1}{150}$ inch, and the corresponding arteries about $\frac{1}{250}$ inch. In congestion of the veins, the diameter varied from $\frac{1}{150}$ to $\frac{1}{100}$ inch.

To check the accuracy of the measurements, plano-convex lenses of 4.5, 6, 7.5, and 15 centimètres were employed, which gave images of the screens of $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{5}$, and $\frac{1}{10}$ respectively; the results obtained were practically the same. When the translucency of the disc is such that it cannot retain the image of the screen, there is some difficulty in measuring accurately the size of the vessels. For more accurate measurements and demonstration, it is necessary to fix the instrument on a stand. An arrangement,* similar to that of Follin's stationary simple ophthalmoscope, with a micrometer screen added, answers perfectly.

Plano-convex lenses were invariably used, because the first principal plane and optic centre lie on the vertex of the convex surface, and therefore admit of a more accurate determination of the focal length than is possible with biconvex lenses of short focus. Screens of different form and sizes, with divisions of from .5 millimètre to 2 millimètres, on the model recommended by Dr. Gowers, were employed. The screen should be moved by rack and pinion, so as to admit of the conjugate focus of the part examined being found, while the eye is under examination. The distance of the lamp should be so arranged that its conjugate focus coincides, as nearly as possible, with the optic centre of the eye—a position which gives the best illumination.

A lens of 75 millimètres was found to be the most convenient, giving as it does an image of $\frac{1}{5}$, which, either in its vulgar or in its decimal form, adapts itself perfectly to the metric system. For example: if the image of four of the 2 millimètres divisions of the screen measure exactly the diameter of the optic disc, its real size will be $\frac{8}{5} = 1\frac{3}{5} = 1.6$ millimètres, and with decimals, $8 \times .2 = 1.6$ millimètres.

It will be obvious, from the preceding, that this method is not applicable either to cases of refraction, of ametropia, or to the eyes of animals unless the optical constants have been previously determined.

* *Dioptrische Untersuchungen*, Art. XI and XII. Von C. F. Gauss: Göttingen. 1841. Also note appended to translation of the same by Bravais: Paris. 1856.

* *The Ophthalmoscope*, by Dr. Adolph Zander, p. 13.

ON COLOTOMY.†

BY CHRISTOPHER HEATH, F.R.C.S.,
Holmes Professor of Clinical Surgery in University College, London.

NO operation has probably undergone greater change of estimation of late years than colotomy. Confined originally to cases of obstructive disease of the sigmoid flexure or rectum, recourse was had to it only as a last resource, and when the patient was *in extremis*. I have, on several occasions, been called upon to operate under these circumstances, and the result has too often been disappointing. Not only is the risk of death from exhaustion very great, but there is also the great liability for the bowel to give way before, or soon after, the operation, either just above the stricture or at the cæcum, which latter seems to be especially liable to perforation by ulcer when much overdistended. At the same time, I have seen so many recoveries, with considerable prolongation of life, after colotomy, in apparently desperate circumstances, that I should not feel justified in refusing to operate, unless the symptoms pointed distinctly to perforation, and consequent peritonitis. Death from overdistension of the bowels is one of the most painful and distressing terminations of life we can have to witness; and, to obviate this alone, colotomy will be justifiable, even under circumstances of the greatest gravity.

But it is as a means of relieving the suffering caused by cancer of the rectum, or incurable ulceration, or recto-vesical fistula, and of thus pro-

† Read before the East Surrey District of the South-Eastern Branch.