IMPROVED ILLUMINATION IN INDIRECT OPHTHALMOSCOPY*

BY

O. E. E. ANDERSON

San Francisco, California

THE indirect method of ophthalmoscopy offers several advantages over the direct method; these include larger field of view, better penetration of hazy media, greater depth of focus, and closer approach to the ora serrata (Schepens and Bahn, 1950). These features are of especial importance in cases of detachment of the retina, where the necessity of studying the topography and locating all the tears was pointed out by Gonin (1934), and has since been stressed by several authors, including Weve (1934), Arruga (1946a), Schepens (1951), and McDonald (1951).

Unfortunately, many ophthalmologists consider the indirect method difficult and unsatisfactory, objecting that the illumination is feeble and/or that the field is not much larger than obtained by the direct method. The problem may be studied qualitatively by means of simple ray diagrams.

Fig. 1 shows a typical arrangement using the Morton or Loring reflecting ophthalmoscope. For the purposes of the comparisons to be made, it will be assumed that the source of light is a frosted bulb in a chimney, that the concave mirror has a focal length of 25.0 cm. and a diameter of 2.8 cm., and that the lens is at about its own focal length from the patient's pupil. Rays of the observing system are omitted. It will be seen that the mirror intercepts a narrow cone of light from the source and reflects it through the central portion of the lens into the patient's eye. The field of illumination is determined by the angle of the cone of rays in the vitreous, which is limited in this case by the diameter of the mirror. The field of observation, however, is not limited by the mirror, and is ordinarily larger than the field of illumination (Duke-Elder, 1938).

FIG. 1.—Typical path of illuminating rays, using small concave mirror.
A, patient's eye ; B, lens ; C, mirror ; D, observer's eye ; E, source of illumination.

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The usual method of enlarging the field of illumination is to replace the concave mirror with a plane one, as shown in Fig. 2. Here the mirror receives a narrow cone of light and reflects it through the full aperture of the lens into the eye. While the cone of rays in the vitreous has been widened, the amount of light received from the source is no greater than before, and thus the unit brightness on the retina is diminished. Although, with either the concave or the plane mirror, some improvement may be made by using a light source of greater brilliance and larger area, the scattered light has a tendency to degrade the contrast of the ophthalmoscopic image and to impair the observer's dark adaptation.

FIG. 2.—Typical path of illuminating rays, using plane mirror.

There remain other, more efficient methods. One ingenious solution has been described by Arruga (1946b); here focal illumination is directed on to the mirror from a small lantern-slide projector, in which the focusing adjustment provides control over the convergence or divergence of the light, and the slide carrier provides a convenient means of restricting the light by diaphragms or filters. Certain types of microscope illuminators should serve as well. Epstein (1950) has adapted an otolaryngologist's head-lamp for use in ophthalmoscopy during surgery. Of the self-luminous hand ophthalmoscopes, only the larger models with 6- or 12-volt bulbs furnish sufficient light for satisfactory indirect ophthalmoscopy. For routine clinical and surgical use, however, an arrangement simpler than any of the foregoing may be preferred.

Increasing Brightness and Field

One answer to the problem is shown in Fig. 3. Here a concave mirror of large diameter gathers a wide cone of light from the source, and on reflection gives it such

FIG. 3.—Path of illuminating rays, using proposed large concave mirror of long focal length.

convergence that it just fills the aperture of the lens. As in the original stand-type instrument of Ruete (1852), the maximum field of illumination is assured not only by the use of the full lens aperture, but also by the light being brought to a focus closer to the focal point of the lens than would be the case if a short focal length concave mirror were used. The intensity of the illumination is proportional to the area of the mirror. An experimental mirror has been made with a focal length of 53.0 cm. and a diameter of 8.0 cm. Through a dilated pupil in an emmetropic eye it evenly illuminates a field of up to about eight disk-diameters, depending on the lens used. In detached areas the field is less because of the quasi hyperopia. The brightness is approximately seven times that from a plane mirror.

The advantages of such a wide field and such brightness in the study of detachments in the surgery, at the bedside, and in "ophthalmoscopic control" in the operating theatre are evident.

Two important features of an ophthalmoscope for use during surgical operations are that it be "boilable", and that it be arranged for use with a headband, so that the surgeon may have a free hand. It is proposed, therefore, that a mirror of 51.0 cm. focal length, 8.9 cm. diameter* and 0.4 cm. central opening be mounted on an aluminium backing having a ball fitting, similar to that of an otolaryngologist's head mirror. No (Recess) lens disk is necessary if the surgeon has normal accommodation or wears appropriate spectacles. If the headband mounting is not desired, a handle may be screwed into a threaded hole in the ball fitting, and the mirror used as in the "simple" ophthalmoscope of Liebreich or of Follin.

While the effect of the focal length of the lens on the ophthalmoscopic image is well known, the influence of the form of the lens is often neglected. The symmetrical biconvex form of lens is usually supplied for this purpose, although the peripheral blurring and field-limiting effect of spherical aberration may be slightly reduced by use of the plano-convex form (Polack, 1939). Still better results may be obtained by use of an aplanatic lens of the type formerly made by Zeiss for the Gullstrand series of ophthalmoscopes. The coating of the lens with magnesium fluoride to abate reflections is a worthwhile improvement.

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* Computed for use with an aplanatic lens of 7.0 cm. focal length and 5.0 cm. diameter.