SMALL ELECTRIC OPHTHALMOSCOPES*

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DR. HARDCASTLE'S reference in the June issue to the electric ophthalmoscope prompts me to offer some general comments on this instrument; it has such obvious advantages in being easier and more rapid to use than the ordinary direct ophthalmoscope if only because the observer is rendered less dependent on a fixed attitude of the patient's head. The observer can sit in front of the patient and examine either eye as the patient leans forward without the necessity to move his seating to the side of the patient; or if sitting on one side of the patient it is not necessary to move to the other side in order to examine the opposite eye, it being sufficient that the patient turns his head sideways. Observation by the direct method of the influence on the venous pulsation at the disc when the patient turns his eye to the extreme outward direction is only practically possible by means of a self-luminous ophthalmoscope.

Apart from obvious advantages due to non-dependence on an accessory light-source, there are certain other advantages peculiar to the electric ophthalmoscope which I feel are worth emphasis because the majority of the instruments I have seen are constructed without regard to simple principles of illumination on which some of those advantages largely depend.

Of the factors influencing fundus visibility, three of them—the extent of illumination first, of the corneal surface area; secondly, of the transparent media through which observation must be made; and thirdly, of the selected retinal area—depend mainly on the concentration of and the solid angle subtended by the rays emerging from the ophthalmoscope. A wide illumination of the corneal surface and of the transparent media is at all times disadvantageous, though it is less so when the pupil is large than when the pupil is small. Fundus details are better studied, through either large or small pupil, when the illumination is concentrated over no more than a small area of the fundus, for reasons partly subjective and dependent on contrast, partly objective and dependent on “haze.” The present common principle on which electric ophthalmoscopes are designed should make reasonable concentration of the light, by focussing of the image of the lamp filament, an easy matter to attain, and yet various if not most makers aim to produce diffuse illumination and to eliminate this image of the filament. The pattern of small

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lamp now usually employed, having a single "end-on" looped filament* whose summit mainly provides the illuminating rays affords a reasonably restricted light-source. When this is suitably focussed in the instrument the image of the summit of the curve of the filament forms on the fundus a single straight linear streak of light, which in a sense partly simulates in effect the bundle of light derived from a slit-lamp. When the ophthalmoscope is so adjusted it provides a most valuable means of simple inspection of the macula in detail through the undilated pupil—a procedure which is impracticable when the instrument is adjusted to render a more diffuse illumination. Some instruments are so designed that the focussing of this image on the retina is impossible; I have seen even frosting of the lamp-bulb resorted to in order to prevent it. The appearance of the macula is enhanced by concentration of the light alternately to its side or directly on it. A small pathological elevation of the fundus shows in better contrast by such "proximal illumination." Restriction of the cross-section of the path of the rays also facilitates examination of the fundus viewed through imperfectly transparent media—whence it is easier to see a fundus through partial opacities of the cornea and lens, with a properly constructed electric ophthalmoscope, than with the ordinary direct ophthalmoscope. It is not a correct criticism to say that restriction of the area illuminated tends to hinder detection of the fundus peculiarities; fundus details are not picked up by the observer's peripheral vision, but by his deliberate concentration ("macular fixation"). If, however, it is argued that some wider illumination is really necessary, then over and above the rays forming the linear streak, there is, with the electric ophthalmoscope, as at present made, sufficient aberrant but dimmer light on the surrounding fundus area to provide for its faint illumination.

The macula is more easily seen through a small pupil when the linear filament-image on the fundus is vertical than when it is oblique or horizontal; from this it follows that an electric ophthalmoscope should be provided with means to rotate the lamp easily so that the linear image may be at will always vertically set. Why the vertical disposition of the streak should facilitate viewing of the macula seems at first peculiar; but, I think, it results from various factors which admit of its explanation. First, the macula is sought by making the light streak travel from the disc outwards across the fundus; the observer's gaze, following the streak, will the more readily find the macula when the streak is disposed at right-angles to its own path of movement than when the streak is disposed horizontally and in line

* Trial and selection of the lamps is necessary; the filament may be bent or set unsuitably; the glass may present a terminal thickening distorting the path of the rays.

with that path. Nevertheless, even when the macula is detected its scrutiny is, I think, still easier when the light streak is vertical. The explanation of this would seem to be multiple; first, the surface corneal reflex is automatically evaded by combined rotatory and lateral movements of the instrument, and these are effected the more easily when—as obtains with a vertical disposition of the light streak—the necessary movements for rotating the instrument take place about an axis corresponding to the long diameter of its handle; secondly, the upper lid, if it comes low, is likely to cut off no more than a limited portion of the rays proceeding to form the vertical streak; thirdly, the surface corneal reflex creates a vertically elongated image of the illuminated face of the mirror—which may be appreciated by noting the change in disposition of the image as seen through the ophthalmoscope held horizontally—and it is easier, therefore, to make observation past one side of this than past its upper or lower extremity.*

When, as in direct ophthalmoscopic examination, the observer's eye is close to the observed eye this corneal reflex lies so much beyond the near-limit of the observer's accommodation that he only sees the image out of focus as an enlarged product of the reflex. A result of this is seen when the observer brings the ophthalmoscope lenses into use—with the concave lenses, provided the observer is not too close to the eye, the apparent area of the reflex image increases in size; with the convex lenses it diminishes in size to reach its minimum when the plane of the image is brought into focus, this being one factor in rendering the fundus of a hypermetrope easier to see by the direct method than the fundus of the myope. Now, when the lens or vitreous is being examined, *e.g.*, by the use of the +12 in the ophthalmoscope, the corneal reflex is not so far from being also in focus, *i.e.*, reduced to a smaller size; and it will be found, in examining through the undilated pupil, that fine changes in the lens and vitreous, focussed with the +12, are seen as clearly when the linear streak is horizontal as when it is vertical.

The direct electric ophthalmoscope, used with its +12 lens, affords a particularly easy means to detect fine lens changes in the early stage of their manifestation; fine vacuolar changes in the lens thus focussed are revealed with great clearness. There is, however, a class of case which does not reveal itself as a lens opacity in the ordinary sense if it is viewed in close focus by the direct electric ophthalmoscope and +12, because this lens does not thus interrupt the intensity of the diffuse red fundus reflex. It is a class of case revealing a very diffuse change of the lens-substance mainly between Vogt's anterior senile nuclear surface

* This vertical elongation of the image does not occur with all makes of electric ophthalmoscope.

and anterior embryonic nuclear surface, of such a physical character as to distort rather than interrupt the path of the rays. (The condition is, therefore, not so rapidly revealed in direct illumination by the Gullstrand slit-lamp.) It may be remarked by an observant patient complaining of distortion of straight lines, or even of monocular diplopia, but not by his complaining of "glare" in bright light; it will be detected by the observer, not during his close focussed direct ophthalmoscopic examination of the lens, but either during his examination of the fundus, when he will note distortion of the view (much as in cases of early keratoconus), or during plane mirror distant retinoscopy examination, by which no demonstration of this condition is afforded equal to the view seen when using the direct electric ophthalmoscope at a distance of about two feet from the patient. When using the electric ophthalmoscope thus the emerging rays must be concentrated into a focussed streak the vertical or horizontal disposition of which is immaterial, the only virtue in the formation of the streak for this purpose being the resulting concentration of the rays in sufficient intensity to yield the maximum red reflex at the greater distance from the eye at which the instrument is being used; the electric ophthalmoscope, therefore, cannot be used for this purpose if it is constructed without facilities for proper focussing of the filament. This method of using the instrument is uncommon but it affords what is the easiest way for students to see and appreciate in an early stage of their manifestation such diffuse lens changes, whose detection by the more ordinary of the simple methods of examination they are apt to find quite difficult.

The question is sometimes raised as to whether the electric ophthalmoscope possesses any advantage over the ordinary ophthalmoscope fitted with the small plane mirror in the detection of fine floating "dust" and "hair" like or filamentary deposits in the vitreous. When the examination is made casually and through a dilated pupil the difference in the relative advantages of the two instruments is not great, but, such as there is, it is in favour, I think, of the electric ophthalmoscope. Through the undilated pupil these features are certainly more easily seen with the aid of the electric ophthalmoscope. Certain details are worth emphasis to facilitate detection of the very finest of these "opacities." The battery must be fresh; the light must be concentrated to a focussed streak as described above; the observer should place the +12 lens in position and then approach the eye until he sees the pupil in focus. He then approaches a little closer and so brings the vitreous into focus, directing his light and his gaze so that the white blurred unfocussed image of the optic disc forms an illuminated background to the opacities

which he is seeking. If the observer loses his appreciation of the plane of the vitreous, he need only come back to the focus of the pupil from which to start again. It is better to do this than to maintain a fixed distance and to focus by rotating into position lenses of varied strength. If desired the little finger may rest on the patient's chin to maintain the necessary distance. To observe movement imparted to these opacities it is helpful to give the patient a fixation object (*e.g.*, small light specially arranged) horizontally in front, and for the observer to take up his view with the optic disc as a background when the patient is fixing the distant object; then the patient may be instructed to look up and back again with the certainty that he will automatically bring his optic disc back to the desired position relative to the observer's gaze. The finest of these vitreous products lose the movement imparted to them almost immediately the eye ceases to move; if the white background is not automatically brought into the line of the observer's gaze, and he has to seek it, no movement is seen by the time he recovers the direction of the disc. These details may sound a little laboured, but there is some excuse for emphasizing them when it is considered how fine these products may be and how important is their early detection in various clinical types of cases.

Dr. Hardcastle* refers to the subject of back-glare at the inspection hole of the ophthalmoscope. The employment of a metal mirror, in which any thickness at the edge of the inspection hole is bevelled with the concavity of the bevel facing the observer, does much to reduce glare, as also for obvious reasons does the conversion of the hole to a slit with an open thick end. It is assumed that neighbouring parts accessible to the rays are kept blackened. Beyond these factors others on which the back-glare depends have reference to the intensity and concentration of the source of light, the relative distances separating source, condensing lens and mirror, and the angle of inclination of the mirror. Scatter of light at the edges of a slit in a thin plate bearing a reflecting surface is modified by the angle of incidence in the line of the slit of the light upon the surface. In an ophthalmoscope I have experimented with, the employment of more than one mirror enables the light to be incident on the final mirror at a more acute angle than is usual.

Dr. Hardcastle states his desire to employ a stronger source of light. I have used daily for the past two or three years one make of pocket electric ophthalmoscope which, though it does not lack room for improvement in its design, is at any rate constructed with due regard to some of the features referred to above, and

* I speak without the advantage of having tried the application of the prism suggested by Dr. Hardcastle.

comes as near to the desired standard as any which I know at present on the market. In this particular make of instrument the lamp is a 2.5-volt one worked by a two-cell dry battery. This lamp gives quite sufficient light for ordinary routine clinical work provided the battery is of full strength. I have the instrument in constant use; the battery, costing little, is renewed about once a month. Some makes of battery are apt to fall rather below their initial strength early in their use; I have found Messrs. Siemens' batteries keep up to their initial strength for a long time. The battery for a 2.5-volt lamp being small is easily accommodated in the handle of the ophthalmoscope; a flexible wire connected with an independent battery is inconvenient. The enlargement and increased length of the handle of the ophthalmoscope to accommodate the battery necessitates projection of the patient's head slightly forward to enable the large handle to clear his chest. The current is always used at full strength; the only use I have found for a rheostat to diminish the light is to enable the instrument, by removal of the ophthalmoscope proper, to be used for testing subjective projection to light, when a very convenient means is thereby provided for roughly mapping out a field of, *e.g.* a cataract patient, to light-stimulus of varied strength.

If the instrument is to be carried much in the pocket the switch should have some sort of catch to prevent accidental contact turning it on. The instrument being heavy is apt to fall easily from the pocket: a fixed ring for the attachment of a safety tape would be useful.

For those who use the direct electric ophthalmoscope to the exclusion of the ordinary one it may be asked for what purpose, if any, is it unsuitable. The fundus of a myope of moderate degree may be viewed with greater ease by the direct electric ophthalmoscope than by the ordinary one, but with myopes of high degree the direct method is unsuitable with either instrument. Given an electric ophthalmoscope, and for high myopes a concave mirror fitted with the usual +2 lens in its observation hole (and possibly combined with a plane mirror for retinoscopy), the observer is well equipped with the portable instruments necessary for deep observation in routine work.

Provided the electric ophthalmoscope conforms generally to the indications outlined above, I think that the comfort and ease afforded by its use (especially in the examination of children), the enhanced visibility of minute conditions of the media—particularly of the lens and vitreous—the improved view of the macula in particular through the undilated pupil or of the fundus generally through impaired media, all give to the electric ophthalmoscope advantages which in practice render it superior to the ordinary ophthalmoscope.