PRINCIPLES OF OPHTHALMOSCOPY

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FOREWORD

As THE table of contents would indicate, this book is designed after the routine of ophthalmoscopy. The four chapters are the four parts of the complete examination. The table of contents, therefore, is the protocol which any serious ophthalmoscopist must follow if he is to avoid missing any important detail. It would probably be better for the ophthalmoscopic examination to be neglected rather than be misread. The author has learned to be suspicious of any report which gives a diagnosis without specifically stating the exact features noted. It may or may not follow that the examiner knows how to recognize the changes which he has described.

It is doubtless the fault of ophthalmic literature itself that the average doctor is left to his own devices to discover what eye findings mean exactly what. Altogether too often the medical examiner will "find" in the eye "evidence" of whatever systemic condition the patient is known to have. In other words, he will note something and interpret it as pathological in a perfectly innocent attempt to substantiate a medical diagnosis. Others are satisfied upon finding "suggestive" evidence to call it "positive" evidence for the disorder under consideration. The result of all this confusion is that the ophthalmoscopic examination becomes unreliable and eventually comes to have no meaning.

When an accurate description of the ocular changes has been made and these changes summarized, what is to be done with the information? Seldom is the ophthalmoscope necessary for diagnosis, although frequently the patient's first complaint may be visual defect. Even if the diagnosis is made on the ocular findings alone, it is eventually up to the internist or family doctor to treat the patient. In answer to the question, then, the ophthalmoscopic report can explain some of a patient's visual symptoms, and can be somewhat of a guide to those responsible for treatment. If a report is confused or couched in incomprehensible terms, or—worse yet—reaches invalid conclusions, then it is of no value whatsoever.

In the treatment of hypertension, the eye report may be of value in handling the disease. An astute ophthalmoscopist would not be so alarmed by the retinopathy that he would overlook the arteriolar sclerosis and fail to predict incipient uremia. (What does it behoove us to treat a patient for hypertension if a reduction of his pressure will lead to uremia?) Of course, the ocular findings are only part of the examination and suspicions can usually be confirmed by clinical and laboratory findings.

In diabetes, the internist should follow the course of the eye lesions so that he may get information about the probable state of the renal arterioles. (Some day, statistics will be available to correlate the number of patients having diabetic exudate who also have intercapillary glomerulosclerosis.) Also, he should be aware of the patient's retinal lesions so that he can determine how much or how little of the visual symptoms are retinal in origin and which may merely require a change in glasses.

The treatment of ocular fundus lesions is the treatment of the causative systemic condition in most cases. Even in cases of thrombosis of the central retinal artery, the treatment is entirely medical (vasodilators and anticoagulants). The prognosis of most eye lesions is that of the systemic disease, and it lies certainly within the province of the internist to discuss the eye problem with his patient.

Assuming that the report is comprehensible and valid, can the eye findings be used for prognosis? In general, the severity of the retinopathy only roughly parallels the severity of the disease. An example of discrepancy may be the severe retinopathy of toxemia, which may be completely reversible after delivery of the child. Diabetic hyperglycemia may be present for a dozen years before the patient develops a single diabetic ocular lesion. Yet he may die in the interim of his disease. Again, a massive edema of the disc may be due to a completely removable meningioma, while a mild edema may be due to a glioblastoma. The answer to this question is that the prognosis can be determined only from the clinical findings after a satisfactory general examination. It is true that the ophthalmoscopic report is part of that complete examination, but it would be very unwise to make it the sole criterion of prognosis.

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PRINCIPLES OF OPHTHALMOSCOPY

CHAPTER I

The intelligent use of the ophthalmoscope must begin with an examination of the ocular media. To omit this detail would be to ignore the anterior nine-tenths of the eye, for the ocular media consist of all the ocular structures through which light must pass in order to reach the retina. Thus, from the front of the eye, light traverses first the cornea, then the anterior chamber, crystalline lens, and vitreous body, in that order. Because these structures are transparent, light reaches the retina and is reflected back through the same ocular media in the reverse order. If the ocular media are clear, we are able to see, through the ophthalmoscope at any distance from the eye, the red image of the retina. Everyone has seen the bright fundus reflection of an animal's eye when automobile headlights strike the eye. Precisely the same image is noted in the human eye, except that with a normal, small, round pupil, a smaller reflection is seen. The size of the image depends, of course, upon the size of the pupil, and any holes or ruptures in the iris will appear as accessory pupils.

Up to this point it is assumed that light is perfectly free to enter and leave the eye through the pupillary area. Suppose, now, that an opaque body lies directly in front of or behind the pupil. Light entering the eye will behave differently from that leaving. Entering light, although somewhat impeded by the opacity, is still intense and diffuse enough that some rays get back to the fundus by going beside the obstruction. No well-formed shadow is formed on the retina by the opacity. On the other hand, rays reflected from the retina are so nearly parallel that this same obstruction stands out as a black silhouette against the red color of the fundus. Standing about one foot from the patient and focusing on the iris (using any lens necessary to see clearly) the pupil is now seen as red rather than black. Should the reflected image not be round, regular, and homogeneously red, an opacity can be inferred, and it's location should be determined.

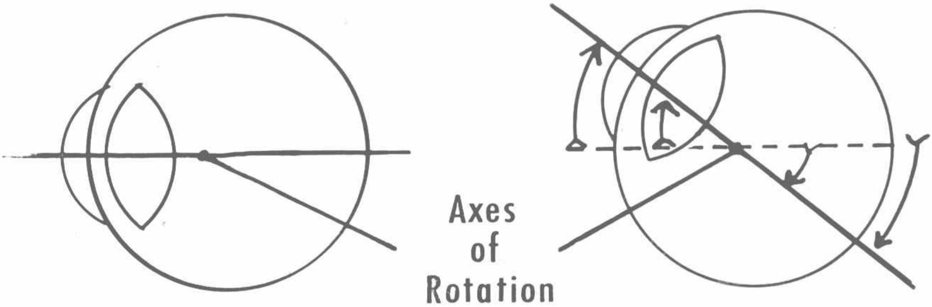

Figure 1.

Common sense tells us that lesions in the front of the eye should appear closer to the observer than those in the lens or vitreous. However, these structures are so small and close together that the exact location of an opacity may not be easy to determine by simple observation. Another technique may be employed if the principle of the above diagram is understood. With any vertical rotation of the eye one should note (1) which structures move in the same and which in the opposite direction (2) how much or how little are they displaced by rotation.

In response to question (1) it can be seen that structures in the cornea and lens will move in the same direction in which the eye is rotated, while structures in the vitreous will move in the opposite direction. In answer to (2) it should be obvious that lesions in the cornea will move a greater distance than those in the lens, and those lesions in the front of the vitreous further than those in the back. Frequently opacities are present in more than one of the ocular media. It would be out of place here to list all possible ocular opacities, but it might be well to name the most common lesions of each medium.

OPACITIES OF THE OCULAR MEDIA

Cornea: In order to be seen as a silhouette against the fundus reflex, lesions of the cornea must be located in front of the pupil. Any ulcerative, degenerative, or cicatricial lesion will distort the fundus reflex. Foreign bodies, bubbles, and blobs of mucus will also be seen, but the last two will disappear, of course, with blinking.

Anterior chamber: Red and white blood corpuscles tend to settle to the bottom of the chamber, but large protein molecules of inflammatory exudate remain suspended as a cloud. Inflammatory and cicatricial tissues may fill in the pupillary aperture of the iris and can be seen adhering to and fused with the iris. It requires careful observation to distinguish this occlusion of the pupil from a cataract of the lens.

Lens: Any opacity here is known as a cataract regardless of its density or its involvement of vision. In the early stages, a senile cataract may appear against the fundus reflex as a group of vacuoles or as peripheral wedge-shaped opacities. Harder to detect is the senile change resulting in the gradual decrease in transparency of the lens, much as isinglass turns brown with heat. Finally, the mature senile cataract is milky-white, and no fundus reflex can be seen through the dense opacity.

Vitreous humor: Red and white corpuscles generally give diffuse, hazy appearance to the fundus. It is extremely important to make this observation before examining the disc, as a hazy vitreous will make disc margins and other structures appear blurred. Through failure to examine the media, disc margins thus blurred, may lead to the mis-diagnosis of papilledema. Discrete, shiny (cholesterol) or flaky, white (soaps) opacities are occasionally seen and give respectively the appearance of a duststorm or a hailstorm. These may interfere remarkably little with the patient's vision and may be unilateral. Having ascertained the location and extent of an opacity, it is possible to answer two significant questions:

(1) How well can the observer see into the eye? A large, dense opacity will naturally obstruct more light than a discrete, small one. However, with dilation of the pupil, ophthalmoscopy may be possible even with fairly extensive opacification. The observer need not conclude that a fundus is invisible after a single attempt at looking through a small pupil. At times it is even possible to see around a dense, localized opacity.

(2) How well can the patient see out? This is one of the most significant questions in ophthalmology and should well be considered at the time of ophthalmoscopy. It is certainly a truism

that small, nebulous opacities interfere less with vision than large, dense ones. And yet, in spite of this perfectly obvious fact, many cases of blindness are wrongly blamed on a slight clouding of the lens, through which the observer can easily see—and which the patient can see through too. If the patient is having more visual difficulty than would be expected from the minor importance of the opacity, he *must* have another lesion behind the opacity. It is well to remember that the patient can see through an opacity about as well as the observer can see into his eye. Any incongruity between what the observer is able to see and what the patient is able to see demands investigation. Even with the densest opacity, the otherwise normal eye should be able to distinguish light and shadow. Should the opacity be this dense, no light is reflected from the retina, and the ophthalmoscopic technique cannot be used for its investigation.

Since the estimation of the patient's total refractive error is not a part of the routine ophthalmoscopic examination the technique will be described in the Appendix.

CHAPTER II

Just as human faces differ one from the other, so do the ocular fundi. As with faces, these differences are subject to anatomic analysis, and the variations of normality separated from pathology. Through experience, an anthropologist could say, "That is a South American Indian"; likewise, an experienced ophthalmoscopist can say, "That is a normal disc." Yet in both cases, the diagnostician has tacitly analyzed the details and compounded his impression from them. These, then, are the details, the variables, that must be considered in every examination of the disc (or optic papilla).

NORMAL FEATURES

A. Size of Disc

It must be remembered that the structure seen as the optic disc is an image magnified about fifteen times. Since there is no ocular structure of constant size for comparison, experience itself will help the examiner know when a disc is large, average, or small. However, it is of some help to note just how much of the disc space is covered by the retinal vessels. In the figure below, the vessels are the same size and only the discs vary. The physiological depression has been purposely omitted as it is the tendency of many people to estimate disc size *a posteriori* from the depression size, rather than estimate size independently. At any

Figure 2.

rate, it should be obvious in the diagram that on the small disc, the vessels obscure proportionately more disc area than on the large disc. Since disc size affects each of the other disc features, it must again be considered under each of these in turn.

B. Margins

Normal margins vary from a sharp, black line to a scarcely perceptible arc of demarcation. Reasons for these variations are always found on microscopic section. Considering the microscopic section in Plate I, it can be seen that the sclera runs to the edge of the disc and joins with the dura; the choriod, with its heavy pigment runs to the margin and stops; the pigment layer of the retina also runs to the edge of the disc and stops. Thus it can be deduced that a disc will have sharp margins when choroid and pigment layer stop together right at the disc margin. When one or the other fails to reach the disc margin at one side, a crescent-shaped area results with its concavity toward the disc. Should one of these layers fail to reach the disc margin anywhere, a light-colored *halo* will surround the disc. These highly pigmented and vascular layers, ending at the same place, give sharp definition to the margins of the disc. In another common variation, pigment can be seen overlying the edge of the disc so that the ophthalmoscopic picture is one of a pigmented crescent or circle around the circumference of the disc (see Plate I).

Several normal, anatomic factors tend to obscure the margins at one or all points. First of all, some 500,000 to 1,000,000 nerve fibers (estimates vary) run over the edge of the disc and tend to make margins harder to see. Secondly, the blood vessels, even though their walls are transparent, tend to obscure the superior and inferior margins. Thirdly, the oblique entrance of the nerve into the globe renders the nasal margin harder to visualize. Finally, most important of all, is the relative colors of disc and retina. If the retina is dark orange and the disc is bright yellow-orange, then the margins will be easy to see. On the other hand, if both are nearly the same color, then it will be nearly impossible to see where one leaves off and the other begins. However,—and this is a crucial point in the differential diagnosis—difficult though it may be, the margins can be faintly detected most of the way

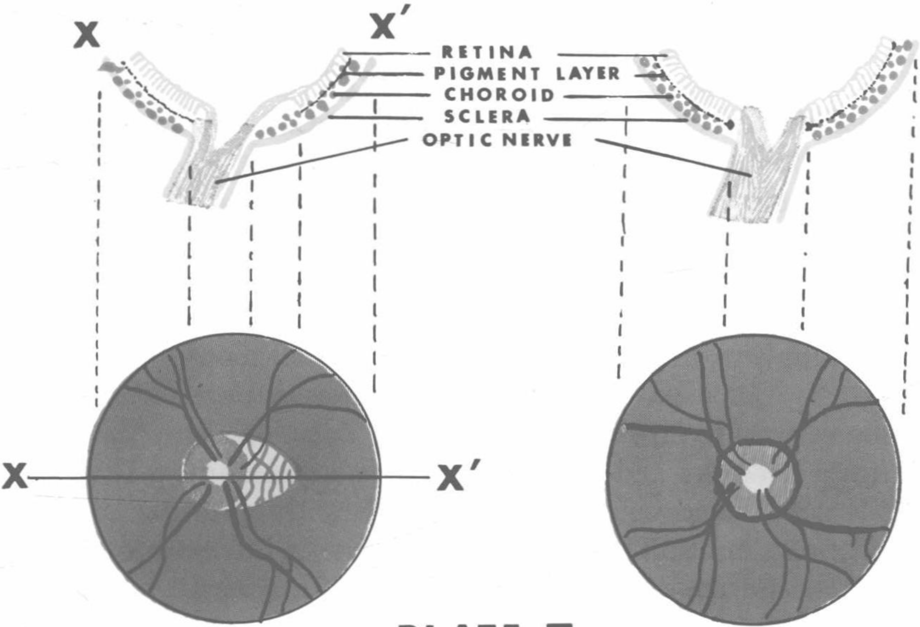

PLATE I

PLATE I. Plate I depicts two funduscopic pictures with corresponding microscopic sections. The line XY running through the ophthalmoscopic picture locates the position of the microscopic section, depicted above. The microscopic section had to be oriented 90 degrees to the ophthalmoscopic picture in order that it not be viewed end-on. However, the two pictures continue to correspond as indicated by the dotted lines. The outer dotted lines indicate merely the arbitrary edge of the picture. The two center-most dotted lines indicate the edge of the optic disc. By these diagrams, one can learn at a glance the histological significance of all the ophthalmoscopic details.

Figure A shows a crescent resulting from a defect in the retinal pigment layer. In the microscopic section above, it can be seen that on the right hand side (temporal) the pigment layer fails to reach the edge of the disc. Thus the underlying choroidal vessels are exposed to the retina and we are then able to look directly through the transparent retina into the choroidal blood vessels. These vessels are seen in cross section in the microscopic section. In the ophthalmoscopic picture however, they are seen lengthwise, and are characterized by their curious, snake-like twists and turns. This peculiarity always helps in distinguishing them from retinal blood vessels which take a more or less straight course. However, here, the location of choroidal vessels next to the disc both identifies them and leaves no doubt that the reason they can be seen is that the pigment layer is defective.

Figure B shows a pigment crescent running around the circumference of the disc. At first glance it would appear to be an annular melanoma, as indeed its color is due to melanin. However, by reference to the microscopic section, its nature can readily be seen. On both sides of the disc the pigment layer is hypertrophied, giving a characteristic bunching up of pigment at the disc margins. This bunching up of pigment is seldom symmetrical and is usually quite irregular. Thus in the ophthalmoscopic picture it has a somewhat jagged appearance.

It is to be underscored that neither of these crescents is pathological. They have been discussed here only in order that they might not confuse the observer into making something more serious of them.

around the circumference of the normal disc, especially on the temporal side. Indistinctness of the temporal, as well as the nasal margin, will be considered again under papilledema.*

C. Color

The neuraxones which form the optic nerve receive their blood supply as they cross over the retina from the retinal vessels. Once they have passed over the disc margin on their way out of the eye, these fibers must depend for their blood supply on the intrinsic arterioles and capillaries of the nerve and disc. Thus, any viable nerve head will be characterized by the presence of functioning capillaries. These tiny vessels give to the normal disc its characteristic color; namely, red-orange. In contrast to this we find in eyes blinded by optic atrophy that the disc has none of this vital red hue and shows only the color of the underlying, non-vascularized tissues. It appears that the capillaries have atrophied in the wake of decreasing nerve function.

Color should be recorded exactly as seen by the observer. The statement that a disc is "normal" or "pale" has, unfortunately, too little accuracy to be reliable. What is "pallor" for one disc may be "normal" for another. In the many questionable or borderline cases it is impossible for the most experienced observer to determine from the ophthalmoscopic picture whether disc color is beyond normal limits. In these cases, diagnosis is made by subjective examination of the visual pathways (visual fields). If color is recorded in terms of its hue, any gradual change in either direction could be detected on subsequent examination.

It is probably safe to assume that the number of fibers leaving the eye in the optic nerve is the same in one eye as another. However, disc size does vary, rather markedly, from person to person, and often between the two eyes of the same person. This means that the same number of nerve fibers will have to pass one time through a very small disc, and another time through

* Since the difficulty in locating disc margins in normal, small discs is purely structural (due to the compactness of the fibers) it may be well to speak of these margins as "indistinct" to avoid inference of disease. Under pathological conditions, margins which originally were distinct, or, at worst, simply "indistinct," now become "blurred." The word "blurred" could then accurately be equated with disease.