is equally useful either for the direct or indirect methods of examination.

Liebreich's ophthalmoscope.

On the whole, I believe that Liebreich's small ophthalmoscope is preferable to all other instruments of the kind; it consists of a circular, concave, metallic mirror, of four-inch focal length, having in its centre a funnel-shaped sight-hole. Attached to the mirror is a clamp, by which one of the ocular lenses, to be found in the instrument case, being placed in the clip, may be adjusted behind the mirror. Object lenses are also supplied which are intended to be held before the patient's eye.

In place of the clamp behind the mirror, Dr. Noyes's ophthalmoscope is provided with a revolving disc, in which four convex and the same number of concave lenses are placed, which may thus successively be conveniently brought in front of the sight-hole of the instrument.

Binocular instrument.

The binocular principle has been applied successfully to ophthalmoscopy; and without entering upon a detailed description of the construction of this instrument, I may recommend Heath and Murray's binocular ophthalmoscope to those, who feel disposed to use a complex, rather than one of the more simple instruments above referred to.

Beale's ophthalmoscope.

Self-illuminating Ophthalmoscope.—This instrument is the invention of Dr. Lionel Beale, and consists of two brass tubes sliding within each other. At the extremity of one of these tubes a block of wood shaped to the orbit is inserted, while to the side of the other a lamp is fixed. The inner part of the cylinder carries a reflector and the ordinary ophthalmoscope lens. The ophthalmoscope can be held in the hand or may be mounted upon a stem, and as the eye is examined in a manner similar to that of looking through a telescope, it can be used in any room in full daylight or when lamps are lighted. This arrangement obviates the necessity of a dark room for ophthalmoscopic investigations. It can also be used irrespective of the patient's position, being equally applicable to the standing or recumbent posture. It has extra lenses so as to be able to form an otoscope, endoscope, or laryngoscope.*

* Dobell's "Reports on the Progress of Medicine" for 1870, p. 508.

Source of light.

Having made choice of an ophthalmoscope, our next inquiry must be as to the source of light most readily available, and best suited for ophthalmoscopic purposes.

In places where gas is available, a round full flame from a gas lamp, will probably afford the best source from which to obtain light to throw into the eye for ophthalmoscopic purposes; but in many instances we cannot procure light from a gas burner, and under these circumstances a kerosine lamp may be used with advantage; it gives a remarkably good light; the flame is steady, white, and clear, and the wick seldom requires to be trimmed.

Atropine not essential.

It is not always necessary to dilate the pupil with atropine before making an ophthalmoscopic examination; a general idea of the fundus of the eye may be gained without the use of any mydriatic. The patient should be desired to look attentively at a mark on the opposite wall of the room, so that his eye may be accommodated for a distant point; if now he close one eye, the pupil of the other will dilate sufficiently to allow of an ophthalmoscopic examination. Should it be found necessary to make a more perfect observation, a solution of atropine may be applied to the eye, of a strength not exceeding one grain to an ounce of water. A patient is often put to considerable inconvenience if a more powerful mydriatic be used, the pupil taking several days to contract; and to a man engaged in business, this is a matter of consideration, for so long as the effects of the atropine remain, he will experience difficulty in reading and writing.

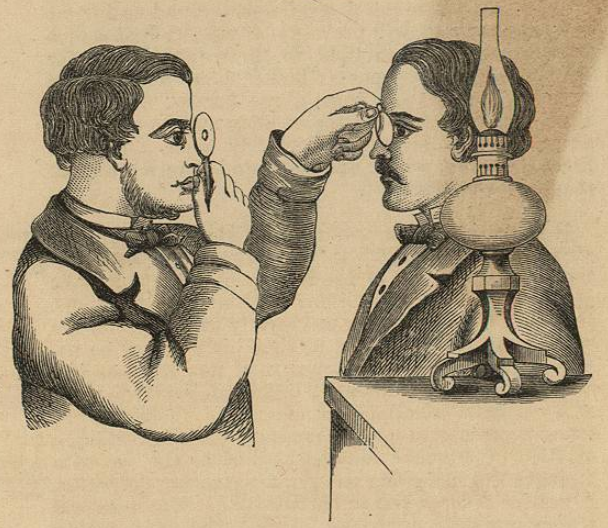
A weak solution to be used.

The two eyes to be compared.

It may be well to remind the reader that except in cases where one eye only is diseased, and the abnormal conditions are clearly and unmistakably apparent, a prognosis should not be ventured on until both eyes have been examined, the state of the one being carefully compared with that of the other. Nothing is so likely to damage one's reputation, or to shake the confidence of our patients in our judgment and skill, as giving a hasty or ill-considered opinion, which on a subsequent examination it may be found necessary to alter: for this reason, also, it is advisable to write down the appearances presented by the eye in a note-book, with which to refresh our memory, and enable

us to form an idea of the progress of the disease, if at any subsequent period the patient present himself for inspection.

FIG. 6.



The inverted image.

Examination of the actual inverted image.—The arrangement of the lamp, the patient, and the observer, when artificial light is employed, is shown in Fig. 6. It will be noticed that the eye of the surgeon, that of the patient, and the source of light are upon the same level, the lamp being placed close to, and a little behind the ear of the latter. An assistant should stand behind the observer, holding a large white card, or some such conspicuous object, in his hand, upon which the patient is directed to fix his eyes. If the right eye is under examination, the card must be held over the observer's right shoulder, and for the left one, over the left. By this means the patient's eye is inclined slightly inwards, and the rays of light from the ophthalmoscope will fall directly upon the optic disc.

Position of patient and observer.

Fixing the patient's eye.

In the case of a blind man, no arrangement of this

kind can be made, and it frequently involves a trial of patience and ingenuity, to get such a person to hold his eye steadily, even for a few seconds, in the direction required. It is necessary, however, under these circumstances, that the patient should keep his head erect, and directly opposite the observer's; unless this be insisted on, it is difficult for a person not constantly in the habit of working with the ophthalmoscope, to make a satisfactory examination of the eye.

Management of the instrument.

In using the ophthalmoscope, the sight-hole of the instrument should be applied to whichever of the observer's eyes is most convenient to himself, its rim being made to rest against his eyebrow, and as he turns his head, the instrument will move with it. The object lens in front of the patient's eye, should be held a little obliquely between the thumb and forefinger of the other hand, the ring and middle fingers resting against the patient's forehead, which thus acts as a fixed point, enabling the observer to approximate or withdraw the object lens to or from the patient's eye, so as to bring the retina into focus with the greatest precision, and also to follow the movements of the eye under examination.

The beginner may be troubled by the reflection of the ophthalmoscope from the cornea of the patient. It appears as a brilliant image of the mirror on the surface of the cornea, hiding that part of the retina which is behind it. It is easy to get rid of this reflection by slightly rotating the object lens to one side or the other, when it will disappear, and the retina be clearly seen.

The erect image.

Examination of the virtual erect image.—As I have already explained, p. 25, in this mode of examination the observer has to go inconveniently close to the patient's eye, and the lamp must therefore be placed on the side corresponding to the eye under examination. The beginner will find more difficulty in gaining a distinct view of the fundus of the eye by this means, than by the examination of the actual inverted image; nevertheless, it produces a much larger image, so that the fundus of the eye may thus be studied in detail with great accuracy, and in all doubtful cases both methods of examination should be employed. By greatly diminishing the size of the mirror perforation, we may even see the details of the fundus oculi, in the undilated pupil, by the direct method.

Lateral illumination.

The lateral method of illumination, or the examination of the eye by transmitted light.—For this purpose the observer and patient are seated opposite one another, and the lamp is placed in advance, and to one side of the latter, in order that its rays may be concentrated upon the eye under examination by a convex lens, as shown in Fig. 7. The eye being illuminated

FIG. 7.

in this way, the observer can magnify any part of the lens, iris, or cornea with a convex glass held in front of the eye.

In examination of cornea, iris, and lens.

By this means valuable aid is afforded the surgeon, especially in detecting foreign bodies in the interior chamber, or in cases of synechia and occlusion of the pupil from false membranes. Nebulæ also, which it is difficult to appreciate with the unaided eye, may thus be distinctly defined. In fact, abnormal changes going on in the lens and the structures anterior to it, are

most advantageously studied by the lateral method of illumination.

OPHTHALMOSCOPIC APPEARANCES OF THE HEALTHY EYE.

Colour of the healthy fundus,

Colour of the Fundus.—I must observe, in the first place, that the whole of the interior of the retinal sphere which can be brought into view through the pupil, or the fundus oculi, as it is usually termed, is among the natives of India, and indeed of all dark races, very different in colour from that which is present among Europeans. Fig. 1, Pl. IV., being a drawing of the latter, and Fig. 2, Pl. IV., of the former. This difference arises from the light being reflected back from the deep brown or black pigment, filling the hexagonal cells of the choroid in the native, and obscuring the vascular structure which is situated behind it, as observed with the ophthalmoscope, so that the fundus of the eye appears of a *brownish-grey* colour among these people; whereas in the European it is of a *crimson orange* hue, the incident light being reflected principally from the vascular network of the choroid, which is seen through the transparent retina.

varies in different races,

The precise tint of the fundus oculi must of course vary in each individual, depending upon the depth of colour of the pigment contained in the hexagonal and choroidal cells; for instance, the inhabitant of Bengal being comparatively fair, the fundus of the eye, when examined with the ophthalmoscope, appears of a grey colour, whereas in the very dark-skinned native of the South of India it will be almost black.* And so also with the European; in the light-haired people of the northern countries, the fundus is of a bright scarlet colour, and in consequence of the almost entire absence of pigment in the part, the larger vessels of the choroid will be clearly seen; but in the black-eyed people of Spain and Italy, the colour of the fundus will be proportionably darker, approaching, in fact, to that of the natives of India.

and individuals.

Pathological varieties.

It is by no means an uncommon circumstance to find the fundus of a native's eye of a deep red colour,

* Dr. G. Smith, Prof. of Ophthalmic Medicine, Madras Medical College: *Madras Quarterly Journal of Medical Science*, No. 15, Feb. 1864.

resembling that of the European; but this depends upon congestion of the vessels of the retina and destruction of the hexagonal cells, so that a certain amount of light is reflected from the choroid, and, combined with that from the congested retina, causes the fundus to appear red. Under these circumstances, other alterations will be at once perceptible, enabling us to determine the nature of the disease, but these I will not now stop to describe. It is sufficient to repeat, that in the healthy eye of the native of India, the fundus oculi is of an uniform greyish-brown hue, the exact shade depending upon the colour of the pigment cells of the elastic lamina and choroid, the only exception to this being in those parts of the retina occupied by the retinal vessels and the optic disc; on the other hand, in fair people, the reflection from the fundus oculi, as seen with the ophthalmoscope, is of a bright scarlet colour, in consequence of the light falling on the vascular choroid, the hexagonal cells containing little or no pigment.

Peculiarities of dark races.

After what I have stated, it is almost superfluous to add that in the healthy eye of the native it is quite impossible for us to see the sclerotic with the ophthalmoscope; for if the hexagonal cells hide the choroid, much more must they, together with the pigment cells of the choroid, entirely conceal the sclerotic. This remark does not, however, hold good with regard to the optic disc; over this spot there are no pigment cells, the only structures that cover the lamina cribrosa being the nerve fibres of the optic disc and its capillary vessels, and hence the colour of the disc, the light being mainly reflected from the fibres of the lamina cribrosa; and in the centre of the nerve, where the separation of the fibres towards the margin leaves the lamina most exposed, we may sometimes see a sort of mottling, due to the difference in colour between the fibrous tissue of the lamina itself, and the nerve tubules which occupy its openings.

The fundus in the dark races.

Appearance of the optic disc.

The *optic disc*, or *papilla*, which is the termination of the optic nerve, or the spot at which it expands into the retina, will be found about one-tenth of an inch internal to the axis of the eye; it is the first point which would naturally attract the observer's attention

in making an examination with the ophthalmoscope. The shape of the healthy papilla is circular, but it varies somewhat in different individuals: sometimes it is elongated from above downwards, but never from side to side, unless as the result of disease. Its size, too, is by no means the same in all cases, and will, of course, appear to be augmented or lessened according to the power used to magnify it. The colour also of the papilla is subject to variation: it is of a more decided pink hue in the native of India's eye than in the European—in fact, among the latter races, it is of a transparent, greyish-tint, with a slight admixture of blue; but it may be of a lighter or darker pink, without there being any reason to suppose the part is diseased. The colour of the optic disc is due to the reflection of light from the lamina cribrosa, bloodvessels, and nerve tubules composing the optic papilla.*

Its form and colour.

In many cases the ophthalmoscope exhibits round the optic disc a dark ring or crescent, which depends upon a collection of pigment in the choroid, in the immediate neighbourhood of the nerve, and has no pathological signification. At the point where the lamina cribrosa ceases, the optic nerve is contracted, and the opening in the choroid being narrow, in a certain measure compresses the nerve trunk; for this reason, a sort of double border is often seen around the margin of the optic papilla.

Varieties.

With regard however to the limits of the nerve, or the circumference of the disc, the following description is quoted from Liebreich:—"Under the choroidal margin is the line, more or less dark, that indicates the border of the opening in the choroid; under the sclerotic margin is a bright crescent or circle, formed by the curving round of the sclerotic fibres, and appearing between the choroidal margin and the fine greyish line that indicates the narrowest part of the nerve itself, and is therefore called the proper nerve-boundary." The latter under normal circumstances is not usually very sharply defined, but in abnormal changes of the papilla appears more distinct. The choroidal border is always strongly marked, especially at the outer border

Nerve boundaries.

* Professor Longmore's "Manual of Defective Vision in Soldiers," p. 48.

of the disc, presenting often a well-defined deposit of pigment, which must not be mistaken, as I have before remarked, for a diseased condition of the parts.

The retinal vessels;

The point at which the *central artery and vein* of the retina enter the eye through the optic disc is subject to considerable variation. Generally the artery passes through the whitish and depressed centre of the papilla, and, after emerging from the disc, divides dichotomously, its branches ramifying in all directions towards the periphery of the retina; but the central artery may perforate the disc at any other point; not unfrequently one or two larger branches are noticed in the centre of the papilla, while others pass through its circumference, perhaps close up to the scleral margin of the disc.

estimation of their calibre.

The apparent calibre of the vessels will vary with the magnifying power employed in observing them; practice alone will thus enable us to appreciate abnormal changes in the calibre of these vessels. One frequently reads accounts in which the retinal vessels are said to be over-full or empty, as the case may be; but in truth it is most difficult to determine this point.

Arteries double-contoured.

The retinal veins are smaller than the arteries, and in consequence of their thinner coats their contents are readily seen; they appear, therefore, when examined with the ophthalmoscope, of a darker and more uniform colour than the arteries, and the latter seem to be transparent in their centres; this arises from the difference in the degree of illumination of the prominent centres of the arteries, as contrasted with their sides: from their conformation, it is evident that the sides of a vessel would receive and reflect relatively less light, and therefore appear in shade.

Venous pulsations.

If in the normal eye the central vein be carefully examined, a pulsation may be noticed in it, which will be rendered more evident on gentle pressure being made on the eyeball. If the compressing force be increased beyond a certain point, the pulsation at once stops, and the veins become almost invisible from the cessation of the flow of blood through them. In the healthy eye no arterial pulse can be seen, but if pressure be made on the eyeball it will become apparent. We notice this in a very marked manner in cases

accompanied with considerable intra-ocular pressure, as for instance, in glaucoma.

Mottling of the disc.

The colour of the optic disc is not uniform, its outer part being greyish and mottled. This appearance is caused by the difference in the light reflected from the nerve tubules, which is greyish, and that from the white glistening bands forming the lamina cribrosa. At the point of exit of the retinal vessels the white appearance is very marked, and often presents a little pit or hollow. The inner half of the disc is of a decidedly redder tint than the outer half, because it is more thickly covered by vessels and nerve fibres, and hence there is no reflection from the fibres of the lamina cribrosa in this situation. It is absolutely necessary to become acquainted with the different appearances which may be presented by the healthy optic disc, or these varying conditions may be mistaken for indications of disease; the outer greyish-white tint, the central depressed appearance and whitish hue, together with the inner pinkish half of the disc, are conditions which vary considerably, but are more or less distinctly recognisable in all healthy eyes.

Appearance of the retina, almost transparent.

The Retina.—As I have already remarked, the retina is so transparent a structure, that when examined by the ophthalmoscope the small amount of light reflected from it is lost in the abundant reflection from the bright red background of the choroid; but in the case of the natives of India and other dark races, the retina may be distinctly recognised as a grey, striated layer, lying over the black hexagonal cells of the choroid, and extending from the circumference of the optic disc as far outwards as the ora serrata.

The macula lutea.

The macula lutea will not be recognised unless after some practice with the ophthalmoscope. It is situated in the axis of vision, and its position may be at once found from the fact of the retinal vessels passing above and below it, but not crossing the macula lutea. The region of this spot is of a bright red colour, and the foramen centrale appears as a little light ring in it.

The appearance of the choroid.

The Choroid.—In discussing the anatomy of the choroid, p. 6, I remarked that layers of very small capillary vessels are placed immediately behind the elastic lamina of the choroid, and between these layers and the sclerotic, the venæ vorticosæ and large branching pigmented cells of the choroid are situated; it follows,

in consequence of this arrangement of the vessels, that when examining the eye with the ophthalmoscope, that light passing through the transparent media, falls on the capillary layer behind the retina (provided the hexagonal cells of the choroid are transparent), and the light which is reflected back to the eye of the observer from this layer of fine capillary vessels, gives the uniform red colour of the background of the eye in the healthy fair-skinned European. In albinos, or in persons in which there is very little pigment in the choroid, the larger vessels of the venæ vorticosa may be seen. Evidently, as the vascular pigmented layers of the choroid line the inner surface of the sclerotic, it is impossible to see this latter structure with the ophthalmoscope, unless, as often happens in consequence of partial atrophy of the choroid, a portion of its vascular and cellular structures is destroyed, and then the white glistening sclerotic may be seen through the choroid.

The sclerotic.

The cornea, aqueous lens and vitreous, being in the healthy eye perfectly transparent, no light is reflected from them when under examination by the ophthalmoscope, and consequently they are not seen.

Systematic examination of the eye.

A Systematic Examination of the Eye should, as Professor Longmore remarks, be adopted in all cases of impaired vision; a patient of the kind consulting us, we should—

1st. Endeavour to obtain a clear history of the case by means of a few leading questions, and while doing this, can make an examination of the external structures of the eye, including the muscular apparatus, and also ascertain the tension of the globe of the eye.

2nd. If the nature of the disease is not determined by the above examination, we should place the patient at twenty feet distance from Snellen's test types, No. CC to No. XX, and ascertain his acuteness of vision: if this is at fault, we should hold first convex, and then concave glasses before his eyes, and note how the sight is altered thereby. First one eye and then the other must be examined in this way. If there is a suspicion that astigmatism exists, a conclusion may be arrived at on the subject by aid of Snellen's horizontal and vertical test lines. Failing to discover anything wrong in the refraction or

accommodation of the eyes, we should proceed to examine:—

3rd. As to the extent of the field of vision; and

4th. Make an ophthalmoscopic examination of the eye by the direct method, which will enable us to detect slight changes in the cornea, lens, or vitreous, also to diagnose further than we have already done by means of the examination above mentioned, the existence of myopia or hypermetropia, especially in the case of children; the lens and anterior media may subsequently be examined by the lateral method of illumination.

5th. And lastly, every part of the fundus of the eye should be carefully examined with the ophthalmoscope, by the indirect method.