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GUIDE TO THE
PRACTICE OF OPHTHALMOLOGY

PART I

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THE METHODICAL EXAMINATION OF THE EYE

BEING PART I OF A

GUIDE TO THE PRACTICE OF OPHTHALMOLOGY FOR STUDENTS AND PRACTITIONERS

BY

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TO

THE PAST AND PRESENT STUDENTS

OF THE

MIDDLESEX HOSPITAL

PREFACE

THE following pages, written primarily for the surgeon who is beginning to study Ophthalmology as a special subject, will, it is hoped, be equally of assistance to the student during his three months' course in an Eye Department required by the present regulations of the Conjoint Board of the Royal College of Physicians of London and the Royal College of Surgeons of England, and of other Examining Bodies.

The illustrations are drawn from photographs, most of which were taken by Mr. DEVEREUX MARSHALL, the Curator at Moorfields; for these the House Surgeons, Drs. E. C. FISCHER and H. V. MCKENZIE, were so good as to sit. Whilst to Mr. W. W. GRIFFIN, and to other friends, my best thanks are due for constructing the Index and for reading the proofs.

22 CAVENDISH SQUARE, W.:
August, 1895.

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THE METHODICAL EXAMINATION OF THE EYE

CHAPTER I

When the student begins to study the affections of the eye he should endeavour to acquire the habit of examining each case in a routine manner; and though at first it will take him some time to complete the examination, still, with constant practice, he will soon become a rapid and accurate observer.

In the following pages such a routine method is indicated. It will not, indeed, be necessary to examine each point in every case in this exhaustive manner, but they should all be passed in review in their proper order, which will not be done if the student always begins with the part that is obviously affected.

The examination is divided into three stages. In the first the ocular appendages and anterior parts of the eye are investigated; in the second

the vision and refraction are ascertained; and in the third the media and fundus oculi are examined with the ophthalmoscope.

The external examination.—In the first stage during the external examination the patient's face and eyes must be well illuminated, so that ordinary defects in the ocular appendages and in the anterior part of the globe can be easily seen; but minute changes require to be sought for by artificial light in the ophthalmoscope room.

The student should begin by noticing the patient's general appearance, which may suggest the nature of the eye affection; as, for instance, the physiognomy in inherited syphilis; and before examining the eyes in detail he should observe the lids and the direction in which the eyes are looking, as changes in them are more easily seen from a little distance.

The observer will then note the condition of the *forehead*, the position of the *eyebrows*, and the state of the *supra-orbital ridges*; the position, size, and shape of the *globes*, and the state of the *orbits*; the height, width, and shape of the *palpebral fissures*, and the action of the *orbicularis*; the condition of the skin and subcutaneous tissue of the *lids*, and their position, mobility, and relation to the globe, the surface and the curve of the *tarsus*, the state of the *lid margin*, and the condition and direction of the *lashes*; the position and state of the *puncta*, and

the condition of the *lachrymal sacs*; the condition of the *ocular* and *palpebral conjunctiva* and *culs-de-sac* (to examine these latter the lids have to be everted, and at the same time the *Meibomian glands* can be inspected); the condition and position of the *caruncle* and *plica semilunaris*; the contour and colour of the *sclerotic*, and the state of the vessels piercing it; the size and shape of the *cornea*, the curve and state of its surface, and the condition of its substance; the depth of the *anterior chamber*, and the state of its contents; the colour and condition of the *iris*, and the plane of its surface; the situation, size, and shape of the *pupil*, and its action to light and on convergence; the condition of the *pupillary area*; the clearness of the *lens*; the state of the *ciliary body*, whether pain is produced when the ciliary region is palpated through the lids; the *tension* of the eyes; the condition of the *muscles*, whether their action is free or limited; the *globes* steady or nystagmic; the *visual axes* parallel or deviating.

This completes the external examination.

The examination of the vision, &c.—In the second stage the near and distant vision is taken, and the refraction is tested both subjectively and objectively.

The presence or absence of binocular vision is noted, and the balance of the muscles tested, as to whether there is orthophoria or heterophoria (see page 50).

Ophthalmoscopic examination, &c.—In the third stage the media and fundus are examined with the ophthalmoscope in the dark room for opacities and other abnormalities, and if there is any indication for so doing, the field of vision and the colour vision are tested.

The method of investigating these points will now be considered in detail.

CHAPTER II

The external examination.—After noting the presence of any scars in the skin of the forehead, their shape, arrangement, and situation, and whether they are on one or on both sides, the examiner proceeds to observe the state of the frontal eminences, the wrinkles in the forehead, and the condition of the occipito-frontalis muscle : this is ascertained by directing the patient to make an effort to raise his eyebrows. If the forehead remains smooth on one or on both sides, and cannot be wrinkled, the corresponding seventh nerve is paralysed, and the condition of the other muscles which it supplies must be investigated.

When the muscles on the two sides are unequally contracted, so that one eyebrow is unduly raised, the observer presses his thumb against the lower part of the forehead, and depresses the raised eyebrow until it is on a level with its fellow ; it may then be found that the occipito-frontalis was unconsciously contracted for the purpose of raising the upper eyelid, which now droops, and cannot be elevated when the patient looks up.

Supra-orbital ridge.—The eyebrow and supra-orbital ridge are examined by passing the finger over their surface. If any abnormal swelling is discovered, its connection with the skin or bone, and its relation to the orbit and orbital contents, is investigated; and it is also palpated to ascertain whether it fluctuates, is solid, or is as hard as bone.

Proptosis.—If the eyes appear to differ in prominence, the examiner should stand behind the patient, who is seated, then raise each upper lid with the forefinger, and draw the head backwards until the cornea of the unaffected eye is in a line with the eyebrow and the observer's eye; he will then be able to see if the cornea of the other eye is in advance of this plane.

Enophthalmos.—When it is suspected that an eye is unduly sunken in its orbit, the observer holds a flat ruler, or a sheet of paper, edgewise against the angle of the mouth and the eyebrow, directly over the centre of the cornea, and notes the distance between the surface of the cornea and the ruler. By repeating the observation on the other side, an accurate measurement can be made of any difference in the position of the two eyes.

The orbit.—The orbit is examined through the lids by palpation of the margins, and of the interval between the walls of the orbit and the globe; but if it is desirable to feel very deeply,

the eye is cocainised, and the finger is passed inside the conjunctival sac, when the density of any mass, as well as its connection with the orbit and orbital contents, is ascertained. The resistance experienced when gently pressing the globe backwards into the orbit with the fingers through the closed lids is also noted, and if at the same time a thrill or pulsation is felt, the orbit and cranium are auscultated. In this connection the nasal cavities and the post-nasal space should also be investigated.

The palpebral fissure is examined as to its length and height.

When one or both fissures are abnormally long, the lids are pinched together at the outer canthus to ascertain the effect their permanent union would have in restoring the normal appearance of the fissure.

When the fissure is too short, the size of the globe is noted, and scars are looked for in the skin and conjunctiva. If the defect is congenital, the length of the fissure is recorded, and an examination is made to discover whether the shortening has occurred at the inner or at the outer canthus ; and when there is an epicanthus, the distance between the two canthi is measured and a vertical fold of the skin pinched up over the bridge of the nose to ascertain the effect that its removal, or its permanent elevation by the growth of the nasal bones, would have on the length of the fissure and on the epicanthus.

The height of the palpebral fissure depends on the condition of the orbicularis, of the levator palpebræ, and of Müller's muscle, though the presence of scars or congenital defects of the lids have also to be considered.

The orbicularis.—The action of the orbicularis muscle is tested by getting the patient to gently close his eyes as in sleep; if the edges of the lids then fail to touch, their power of meeting during winking is tested by placing a piece of blue tracing paper on the margin of the lower lid, which will stain the margin of the upper lid if the two come in contact; but when the lids do not meet during the act of winking, the patient is directed to screw up his eyes, and if the orbicularis then acts vigorously and well, the defective closure of the fissure is probably due to the shortness of the lids.

When healthy lids cannot be approximated by the strongest effort, the orbicularis is paralysed; the other muscles supplied by the seventh nerve must be examined, and also those innervated from the third nucleus.[1]

Should the orbicularis be contracted by tonic spasm, a few drops of a 2 per cent. solution of cocaine are instilled into the conjunctival sac, so that the anterior parts of the eye may be thoroughly examined; but if the cocaine does not permit the patient or the observer to open

[1] The nerve fibres running in the seventh nerve to supply the orbicularis are really derived also from the third nucleus.

the lids easily, a general anæsthetic must be administered rather than employ the slightest force at the first examination ; for, the condition of the eye being unknown, irreparable damage may easily be inflicted in an effort to forcibly separate the lids (see p. 24).

In clonic spasm of the orbicularis the condition of the eye, and also the state of the nose, throat, teeth, and ears, must be investigated.

The lids.—When the lids are ulcerated, either on their skin or conjunctival surfaces, the state of the pre-auricular gland should be ascertained. If it can be felt in front of the tragus, it is enlarged, and its degree of hardness will depend on the nature of the lid affection.

The condition of the levator palpebræ, and likewise, though to a much smaller extent, that of Müller's muscle, affects the height of the palpebral fissure, either by retracting the lid and exposing the eye too much, or by allowing it to droop and cover the cornea more or less completely.

The position of the upper lid is ascertained by noting the relation of its free border to the margin of the cornea or pupil, whilst the eyes are directed horizontally forwards. When the upper lid is retracted, as in Graves' disease (a similar condition is induced temporarily by the instillation of cocaine), the relation of the edge of the upper lid to the margin of the cornea is first noted, and the patient is then

directed, whilst keeping the head still and erect, to follow the examiner's forefinger, which is slowly moved from above downwards about 35 cm. in front of the patient's face. If the upper lid remains retracted above the cornea, or lags behind when the eye looks down, Graefe's sign of Graves' disease is present. Infrequency of winking is also to be looked for; it constitutes Stellwag's sign of Graves' disease.

When the upper lid droops, the amount of the ptosis is first noted; the patient is then asked to look up, as high as possible, whilst the action of the occipito-frontalis is suspended by the observer pressing his thumbs against the lower part of the forehead and keeping the two eyebrows on a level; the height to which the margin of the lid is now raised indicates the strength of the levator palpebræ. When the extrinsic muscles of the affected eye are also paralysed, the cornea and pupil will no longer serve as a guide to the position of the upper lid; instead its relation to the margin of the lower lid is noted by measuring the intervening distance.

The levator palpebræ is occasionally found to act in association with some other muscle, as, for instance, the external pterygoid. To elicit this associated action, the patient, who invariably has slight congenital ptosis on the affected side, is directed to look at the ground, to open his mouth widely, and to move the jaw to one side, thereby raising the upper lid well above the

cornea ; or the patient may be given something to masticate, and as he looks down the same effect is produced. Or the levatores palpebrarum may act in association with the internal recti : when the patient looks horizontally to his extreme right, the right upper lid droops, and the left upper lid is retracted, whilst the reverse occurs when he looks to his extreme left ; and during extreme convergence both upper lids are retracted.

The palpebral fissure is narrowed vertically in enophthalmos ; also in paralysis of the sympathetic, when it is associated with a contracted pupil and non-ocular symptoms ; in the latter case the application of cocaine does not cause the lids to retract or the pupil to dilate.

When the tissue of the upper lid is œdematous, superabundant, or filled with fat or air, ptosis is caused in a mechanical manner and the condition of the levator palpebræ cannot be accurately ascertained. If a drooping lid is associated with an alteration in the curve of the tarsus and also in the direction of the lashes, the lids must be everted and a search made for granular ophthalmia or for its scars.

The lashes.—The general condition and position of the lashes is noted whilst the patient looks directly at the examiner. If it be suspected that some are inverted, the lids are drawn away from the globe to inspect their position, and after the examiner has removed his hand, and

the lids have returned to their ordinary position, the patient is asked to look in such a direction that the cornea comes behind the suspected lash, when by looking at the eye from one side it is easy to see, with focal illumination, if the lash is touching the globe.

The Meibomian glands.—The forefinger is first passed along the skin over the surface of the tarsus to feel for any swelling; the margins of the lids are then tilted forwards to inspect the orifices of the glands along their free border, and the state of their secretion is at the same time ascertained by squeezing the lid between the back of the examiner's finger-nail and a smooth object, such as the ivory handle of an eye instrument. Finally the lids are everted to inspect the glands on the inner surface of the tarsus beneath the palpebral conjunctiva.

To evert the upper lid.—The upper lid is everted by either of the following methods. The patient is asked to keep his head still and erect, to turn his eyes down and look towards the ground. The observer, who faces the patient, then takes hold of the lashes of the upper lid between the forefinger and thumb of the right hand (thumb below) and draws the lid downwards and away from the globe, until it is slightly stretched. The thumb or forefinger of the left hand, or a probe held horizontally, is now placed against the skin of the lid, just above

the tarsus, and is pressed gently downwards and forwards, whilst the right hand lifts the lashes upwards and backwards ; by this combined and simultaneous movement the lid is everted. This method is employed when it is suspected that a foreign body is beneath the lid, because it does not disturb any object which may be on the inner surface of the tarsus ; but if the observer desires simply to inspect the palpebral conjunctiva, he can evert the lid in the following manner with one hand, or even both upper lids at the same time with the two hands, without causing the patient the least discomfort.

Whilst the patient with head erect turns his eyes down and looks towards the ground, the observer, who stands in front, places the end of his left forefinger on the right upper lid just above the tarsus, and his thumb on the lower lid just below the tarsus. By moving the forefinger a little upwards the margin of the upper lid is tilted forwards away from the globe ; the thumb is now made to push the edge of the lower lid upwards into the space between the upper lid and the cornea. The lower lid thus acts the part of a wedge and drives the upper lid forwards until its conjunctival surface is in contact with the thumb. When the whole thickness of the upper lid is between the finger and the thumb, the lower lid is released, and the free edge of the tarsus is pushed upwards and backwards by the thumb, whilst the forefinger presses its attached margin downwards

and forwards; in this way the lid is everted. The right hand is employed to evert the left lid.

To evert the lower lid.—Whilst the patient looks upwards the examiner places the tip of his forefinger against the edge of the lid, close to the lashes, and draws the tarsus down; he then presses the finger backwards, and the lid becomes everted.

The lachrymal gland. — The extra-orbital portion of the lachrymal gland can always be inspected if the outer end of the upper lid is drawn up with the observer's thumb as high as is possible, whilst the patient turns the eye down and in; the gland then appears beneath the lid margin. In health the orbital portion of the gland can neither be seen nor felt.

The lachrymal passages.—The inner end of the lower lid is inspected to see if the punctum is visible, and therefore displaced; if it is normally situated and invisible, the lid is drawn away from the globe to investigate the condition of the orifice, and if necessary a dilator is passed to make sure that it is patent. The end of the little finger is then pressed against the sac, when the tendo-oculi will be felt beneath the skin if the sac is empty, as it is in the normal state; whilst if it is distended with mucus or pus, its contents will usually escape under the pressure of the finger, either

down the nose or from the puncta, as can be observed if the lids are drawn away from the globe with the disengaged hand. If the contents of the sac do not escape, the case must be further investigated by the passage of probes down the nasal duct.

To ascertain if the lachrymal passage is open and acting normally, it is only necessary to place a drop of fluorescine solution in the lower conjunctival sac and dilute it with a drop of cocaine solution ; after waiting for half a minute, the patient is directed to blow his nose, when the stain appears on the handkerchief. If, after waiting for a minute, the stain fails to pass, the patency of the canal is tested by syringing some 2 per cent. cocaine solution with a Meyer's syringe through the lower and unslit punctum and canaliculus, when the fluid will either flow out through the nose, if the passage is open, or escape by the upper punctum, if the passage is closed. While doing this the patient must bend the neck forwards to avoid the fluid passing down the posterior nares.

By drawing on the outer canthus with the thumb, the tendo palpebrarum is made tense and visible beneath the skin ; its relation to any swelling or fistulous opening in the region of the lachrymal sac should always be ascertained.

The caruncle. — The relation of the caruncle to the inner canthus should be com-

pared on the two sides; but if both appear to be too deeply placed, scars must be looked for in the conjunctiva near the insertion of the internal recti, which may have been divided some time previously.

The conjunctiva.—To inspect the ocular conjunctiva the observer raises the upper lid with his forefinger or thumb, and directs the patient to look down; he then pulls down the lower lid whilst the patient looks up, and at the same time exposes the lower portion of the palpebral conjunctiva and the lower cul-de-sac; but the upper portion of the ocular conjunctiva can only be seen after everting the upper lid (page 12), and even then the upper cul-de-sac is not visible. To completely expose the upper cul-de-sac, the eye is first cocainised; the upper lid is then everted, and, whilst the patient looks down, the everted lid is seized between the blades of Graddy's forceps and the tarsus turned over once more on itself: this is easily accomplished if one blade of the forceps is passed into the cul-de-sac, whilst the other blade is placed in contact with the palpebral surface of the tarsus; or the finger and thumb may be employed instead of the forceps, but they interfere somewhat with the view of the cul-de-sac.

Conjunctival injection is recognised (1) by its brick-red colour, which is due to the

blood being so near to the surface that its true colour is seen through the extremely thin tissue of the conjunctiva and the delicate vascular walls; (2) by the great irregularity, tortuosity, and intimate anastomosis of the blood-vessels; (3) by the mobility of the vessels on the sclerotic when the lid is rubbed against the globe; (4) by the fact that no pressure applied through the lid to the globe is able to produce a visible anæmic spot in the injected conjunctiva, because the anastomosis is so very intimate that the vessels are filled immediately the pressure is removed; (5) by the injection being more intense on the lids and in the culs-de-sac, and tending to diminish towards the cornea.

With conjunctival injection there is invariably more or less secretion of mucus, muco-pus, or pus, which gums the lids and lashes together during the night's sleep, whilst in uncomplicated ciliary injection tears alone flow; therefore this purulent secretion (which may be stained and made very conspicuous by a small drop of fluorescine) must be diligently sought for in the cul-de-sac, as a single flake is sufficient for the purpose of diagnosis.

Chemosis, or œdema of the conjunctiva, whether due to acute inflammation or to albuminuria or other causes, is differentiated from solid infiltrations of the conjunctiva by pressing the lid with the forefinger against

the globe, when the fluid effusion can be displaced.

Dilated conjunctival lymphatics, which are beaded in outline, and have clear contents, are only altered in position, and not in shape, when the lid is pressed against the globe.

The sclerotic.—The surface of the sclerotic is inspected in the same way and at the same time as the ocular conjunctiva; that is, when the upper lid is raised as high as possible, the patient looks down, down and in, and down and out, and the lower lid being depressed, he looks up, up and in, and up and out. In this manner any bulging or swelling on the anterior half of the sclerotic is exposed.

The length of the globe is approximately estimated by noting the relation of the equator of the globe to the corneal margin. The lids are held apart close to the outer canthus, and the patient is directed to turn the eye as much as is possible inwards; the highest point of the scleral curve, the equator, may then be seen. In the hypermetropic or short eye it is nearer the corneal margin than normal, while in the myopic or long eye it is situated farther back.

The shape of the globe.—The shape of the front of the eyeball can be seen when the lids are held wide apart, and are drawn up and down over the globe with the observer's forefingers, so as to expose as much of the anterior

part of the eye as possible. By paying attention to the curve of the sclerotic and cornea in the two principal meridians, it is easy to recognise, when the patient looks directly at the observer, if the shape of the globe is spherical and normal, ovoid and astigmatic, or irregular.

In regular astigmatism the eye is somewhat the shape of an egg, and is placed with its long axis transversely in the orbit, the greater curve and shorter meridian being vertical, and the lesser curve and longer meridian horizontal, 'astigmatism with the rule.' Only high degrees of this variety can be recognised with certainty. But if the egg-shaped eye is placed in the orbit with its long axis vertical, 'astigmatism against the rule,' even low degrees of the defect can be easily seen; any obliquity of the axes is also readily observed.

The ciliary vessels.—The anterior perforating ciliary vessels are seen on separating the lids; their size and course do not vary much except when the tension of the eye is increased. The sclerotic is often pigmented around their points of entrance.

Ciliary injection caused by the engorgement of the circum-corneal branches of these vessels is recognised (1) by its pink appearance, due to the deep position of the vessels which are beneath the conjunctiva in the substance of the sclerotic; (2) by their running a straight parallel course in a radial direction from the cornea;

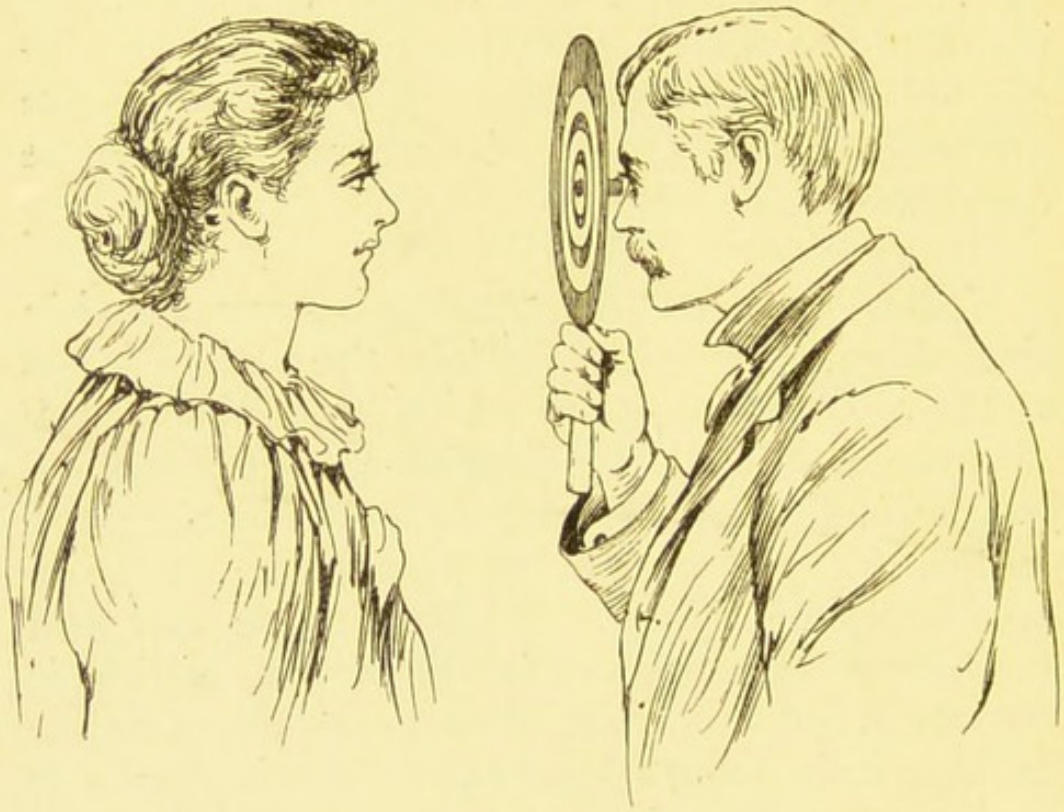
(3) by their situation in the superficial layers of the sclerotic preventing their being moved when the lid is lightly rubbed over the globe; (4) by the fact that gentle pressure of the margin of the lower lid with the tip of the forefinger against the injected area produces an anæmic spot, which again becomes pink more or less quickly when the pressure is removed; the absence of lateral anastomosis between the vessels is thus demonstrated; (5) by the congestion being most intense near the cornea and fading away towards the equator of the globe.

The cornea.—The size of the cornea is ascertained by measuring its transverse diameter with a Priestley Smith's keratometer, which consists of a millimetre scale between

two plano-convex spherical lenses set in a metal ring so that they form a convex spherical lens of 4 D. This the observer holds as close as possible in front of the patient's cornea, without touching the lids or lashes, whilst he keeps his own eye at the principal focus of the lens, 25 cm. away, and reads off on the scale the width of the cornea, which can easily be accomplished if the end of the scale is held opposite one edge of the cornea. Its average transverse diameter is 11·6 mm.

The curve of the cornea is ascertained in the following manner. Whilst the patient looks at the window, opposite which he is placed, the observer notices the reflection that it forms on the patient's cornea ; if the image is perfect, the surface of the cornea at this point is quite spherical and normal. The patient is now told to follow the observer's forefinger, which is moved about in various directions at a distance of 30 cm. in front of the eyes ; if the curve is normal, the reflection does not change, but remains the same size and shape on whatever part of the cornea it is formed, except at the extreme periphery ; but if the surface is abnormally curved or is irregular at any point, there the reflection is altered in size, or its shape is distorted. This is seen even more distinctly by means of the keratoscope, or Placido's disc, which consists of a circular piece of cardboard with a central aperture surrounded by a series

of alternate white and black concentric rings. Whilst the patient stands with his back to the light, the observer holds the keratoscope against his own eye at a distance of 25 cm. from the patient's face, and looks through the central aperture at the image of the disc which is formed



on the cornea. If, whilst the patient looks at the observer's pupil behind the central aperture, the reflection is seen to be perfect, the curve, at least of this part of the cornea, is normal; but if the image is distorted, the corneal curvature is abnormal; the image may become still more misshapen when the patient turns his eye to look in succession at the four points marked on the disc.

The surface of the cornea.—The condition of the surface epithelium is also ascertained by watching the reflection of the window that is formed on the surface of the cornea, only instead of noticing the shape of the image, it is its brightness and sharpness that are observed. As long as the epithelium is normal, the window reflex is perfectly sharp in spite of any irregularity in the curve of the cornea; but when the epithelium is rough or absent, then the window reflex is more or less dull. A large and gross defect is easily noticed, but a minute one is often difficult to detect because of the tears which cover the defective area and make it bright and smooth; but if the student applies a solution of fluorescine as a routine practice in every case where the surface of the cornea is, or is suspected to be, defective, this difficulty is readily overcome. A small drop of the fluid is applied with a glass rod to the lower cul-de-sac, and after the patient has winked the eye two or three times, a few drops of boric acid lotion or a 2 per cent. cocaine solution are instilled into the conjunctival sac to wash away the superfluous stain, which is then removed with absorbent wool. If the epithelium is absent, the denuded area is stained a bright yellow green colour; but if the epithelium is only altered and rough, as in keratitis and in glaucoma, then the defective spot does not stain. By means of the fluorescine much is revealed which cannot be detected in any other way; for example, in

a dendritic ulcer the active or growing part is stained, though before the fluorescine was applied its outline could not be distinguished from the less active part.

The depth of a corneal ulcer is ascertained by noting the distance of its floor or base from the general surface of the cornea, but this again depends on the extent of the ulcer and the condition of its floor. With a small ulcer the floor is concave as long as the tissues are thick enough to resist the intra-ocular pressure ; when the sides of the ulcer are steep, and the floor is convex and black-looking, like a small pupil, it indicates that Descemet's membrane is bulging forwards. But when the ulcer is very extensive, it is not always possible to gauge the thickness of its floor, since the affected area tends to bulge forwards as it gets thinner, and therefore an eye in which there is a large ulcer should always be dealt with as if its floor were very thin and likely to rupture on the slightest pressure.

If it is not possible to examine a cornea easily and thoroughly, even after the eye has been completely cocainised, a general anæsthetic should be administered, especially at the first consultation, when the condition of the eye is unknown, rather than that any force should be employed to separate the lids, which might lead, in the case of a deep ulcer, to the rupture of its thin floor and the destruction of the eye.

These remarks apply even more forcibly in the case of the first examination of children ; but at the subsequent visits, if there is no danger of injuring the eye, the child is held on its back on its nurse's lap whilst the examiner, who is seated opposite her, supports and grips the patient's head between his knees, which are protected by a towel. The head is thus firmly fixed, and the examiner has both hands free to separate the lids, either with his forefingers or with two retractors. The fingers are placed against the skin of the lids at right angles to the palpebral fissure, with their tips touching the lid margins, so that the tarsi can be pressed against the globe as they are drawn apart to expose the cornea. If this latter point is not attended to, the lids will be everted, and the conjunctiva will cover the cornea and prevent its being inspected. When the retractors are employed, they are inserted separately, and the lids are then gently drawn apart.

In all cases of ulceration of the cornea the daylight should be brought to a focus on the affected part by means of the large convex lens (see Oblique or Focal Illumination, p. 81).

The sensibility of the cornea is ascertained by gently touching its surface with a piece of cotton-wool which has been twisted to a point. If the sensation is normal, the patient will feel the most delicate touch and will wink. The two eyes are tested for comparison, and

the tactile sensibility of the skin supplied by the various branches of both fifth nerves is also examined by means of a blunt-pointed instrument.

The substance of the cornea.—The size, shape, and position of gross changes in the corneal substance can be observed by daylight and focal illumination ; but minute changes cannot be seen in this way, and therefore it is only possible to say that a cornea is normal after it has been examined in the dark room—first through a compound magnifying lens whilst the light is concentrated upon the cornea by the oblique illumination, and afterwards by the direct method with a plane mirror and a convex lens of 10 D, 20 D, or 30 D. Very often it is only by this latter method that certain changes can be seen.

When the cornea is vascular and the vessels are filled with blood, their position is ascertained by an examination with the oblique illumination to discover whether they are on the surface or in the substance of the cornea, and if associated with active changes or with scars. The presence of old vessels in faintly marked scars can often only be ascertained by the direct examination with a plane mirror and a high convex lens (see p. 88).

The anterior chamber.—The depth of the anterior chamber is recognised by noting

the relation of the surface of the iris to the front of the cornea, as indicated by the corneal reflex; but as the normal chamber varies in depth at different periods of life, the age of the patient must always be taken into consideration; thus it is shallower in infancy and in old age than at other periods of life.

In disease the chamber may either be empty, too shallow, or too deep.

When the chamber is quite empty, the iris is everywhere in contact with the back of the cornea, unless there is an opening in the cornea or sclerotic through which the aqueous escapes, and out of which the iris may be more or less prolapsed.

A shallow chamber is caused either by the cornea being abnormally flat or by the iris being too far forwards, whilst a deep chamber is due either to the cornea being curved too much or to the iris being displaced backwards.

Irregularities in the plane of the iris can be observed through a clear cornea when the light is concentrated upon it by the oblique illumination; but when a part of the cornea is opaque, the observer will have to look at the eye from one side in order to see if the iris plane is altered immediately behind the opacity; for there the iris and cornea may be in contact, forming an anterior synechia.

Normally the aqueous is invisible; pathologically it may be turbid or contain pus or

blood, which sinks to the most dependent point of the chamber; and this varies with the position in which the patient keeps his head.

Solid masses in the anterior chamber, whether connected with the back of the cornea, the iris, or the crystalline lens, are examined with the compound magnifying lens by oblique illumination or by the direct method and a high convex lens.

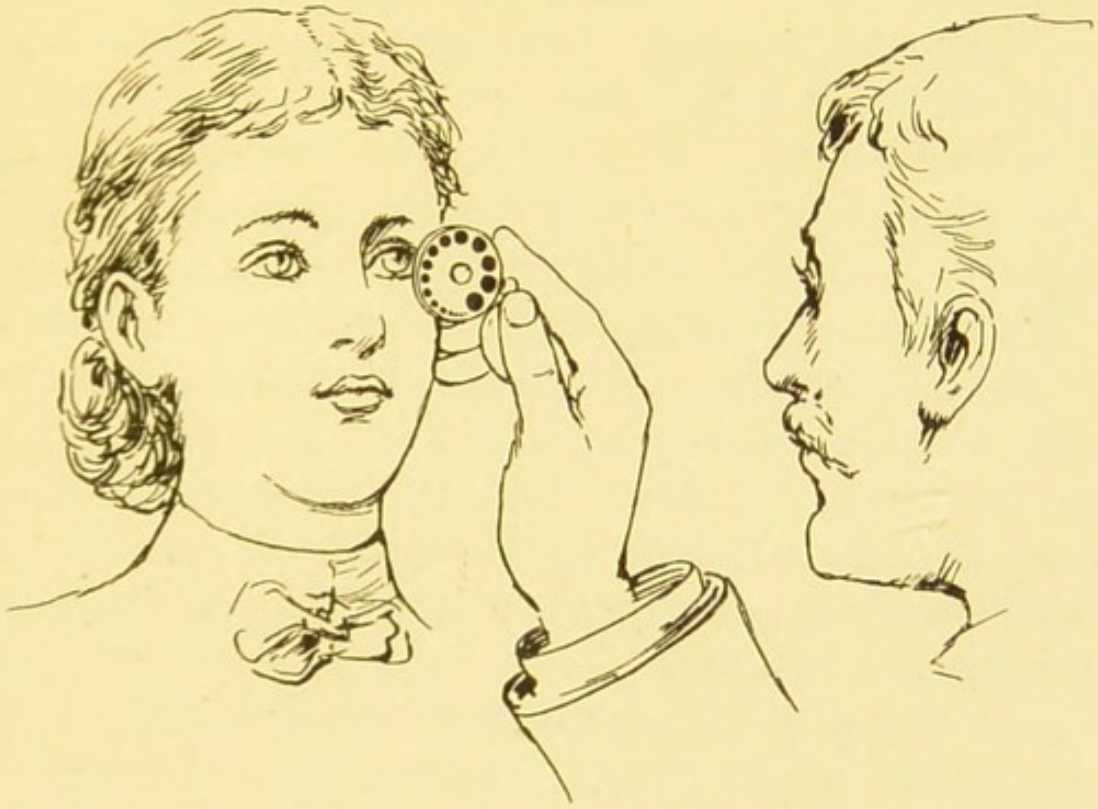
The iris.—The structure of the iris and the difference between the ciliary and pupillary parts can be examined through a magnifying lens whilst its surface is lit up by the oblique illumination; in the same way any change in the tissue of the iris, in an exudation, or in a neoplasm, can be observed through the clear cornea, whilst any alteration in its colour is ascertained by comparing the two eyes.

Tremor of the iris.—To detect tremor of the iris the patient turns the eye rapidly to one side, and then looks quickly back at the examiner's eye. The direction in which the patient turns the eye must be altered until the iris is seen to shake. Occasionally the lens trembles at the same time: this latter condition is seen much better in the dark room by oblique illumination.

The pupil.—The position of the pupil is ascertained by observing its relation to the iris,

in which it normally forms an almost central aperture.

The size of the pupil is measured with the pupillometer, which the observer holds close to the outer canthus in a plane level with the surface of the iris, whilst the patient faces the light and looks into the distance. The disc is now turned



round until an aperture is found corresponding in size to the pupil.

The reaction of the pupil to light is tested whilst the patient faces the window and looks steadily with both eyes into the distance. The observer then shades the two eyes with his two hands, quickly removes one hand, and watches for a contraction of the pupil ; he then replaces this hand and removes the other from

the second eye, and watches the reaction of its pupil. When there is any doubt about the action, both hands are removed at the same time whilst the observer watches one eye; they are then replaced and removed once more whilst the second eye is observed. If there is still any doubt, the examination is repeated in the dark room, when the artificial light, at which the patient must look, is concentrated on the eye with the large convex lens. The lens is first shifted to one side, so that the pupil is in the shade, and then the full intensity of the light is focussed on the eye. In this manner the very slightest reaction can be detected. Another method is to place the light behind the patient and then suddenly throw a beam into the eye from the ophthalmoscope mirror. The pupil may contract quickly or slowly, or it may oscillate between contraction and dilatation: this constitutes hippus.

If one pupil does not react to light, whereas the other pupil reacts vigorously, the hand is removed entirely from the first eye, and its pupil is watched to see if it dilates and contracts when the second eye is covered and uncovered—associated action.

A mydriatic should always be employed to determine the state of the pupil whenever there is any doubt about its activity, provided the tension of the eye is not increased; and whenever the pupil is unduly dilated and fixed, its power of contracting is ascertained by the

application of a myotic, more especially when the tension is increased.

When one half of the field of vision is absent (hemianopsia), the reaction of the pupil must be tested in the dark room by reflecting the light with a mirror, first on the seeing half and then on the blind half of the retina, and watching the effect on the pupil. Usually it does not react when the light falls on the blind side, but in those cases in which it does, it has an important diagnostic value.

The reaction of the pupils on convergence is observed by making the patient look first of all into the distance and then at the point of a pen or other minute object which is held close before the eyes. If the patient has only one eye, the object should be held on the opposite side of the nose, so that the internal rectus may be brought into action ; if the patient is blind, he is directed to look towards the ceiling and then at the tip of his own forefinger held close before his face, or at the end of his nose. The effect of a deep inspiration on the pupil may be noted, as also that of the Faradaic current or other painful stimulus, applied to the skin of the neck, and of a loud noise ; and whether it dilates in the shade, or after the use of cocaine, as showing the integrity of the sympathetic.

The pupillary area.—The condition of the pupillary area is investigated in the dark room by oblique illumination, aided by the

compound lens, or by the direct method and a high convex lens after the pupil has been dilated with a mydriatic to completely expose the whole area and demonstrate the regularity or irregularity of the pupil (synechiæ, &c.)

The lens.—Changes in the lens, even when they are visible by daylight through an undilated pupil, can only be thoroughly investigated by artificial light in a darkened room by the oblique illumination and the direct method, the pupil being widely dilated by homatropine or cocaine, so as to expose the whole of the lens.

But before the mydriatic is applied, the observer can detect the difference between an apparent and a real opacity of the lens: the former, due to a sclerosis of the lens substance, causes the pupil to appear grey and opaque-looking by daylight; but when the artificial light is reflected into the eye by means of the large concave mirror which is used for the indirect examination, the red fundus reflex is not obscured, whereas a partial but real opacity appears as a dark object against a red background. When the pupil is dilated, the observer stands about 25 cm. in front of the patient, and employs the mirror to detect the extent, the outline, and the density of an opacity; and when he has noted these points, he examines the lens more closely for minute changes, such as vacuoles and flaws in its substance: this he

does by the direct method with a plane tilted mirror and a convex lens of 10 D to 30 D.

When this method of examination, which is described at page 88, is finished, the observer employs the oblique illumination to detect the position, appearance, and colour of the opacity; whether it is in the anterior or posterior capsule, the periphery or centre of the cortex, or in the nucleus of the lens; whether the opacity is dotted, striated, or diffuse, and its colour grey, white, or black. These changes are noted first with the naked eye as the light is focussed on the various parts of the lens with the large convex lens of 13 D, and afterwards they are further examined through the compound lens, when a magnified view is obtained and changes are revealed which were invisible to the naked eye: this method is described at page 81.

When the iris is absent or a portion of it has been removed up to its root by a peripheral iridectomy, the tips of the ciliary processes, the suspensory ligament, and the edge of the lens can generally be seen by the direct method and a convex lens of 10 D.

The vitreous.—Gross changes in the vitreous are detected by the direct examination at a distance with the same concave mirror which is used for the indirect examination (see page 84).

Whilst the patient is seated in the dark room, the examiner, who holds the mirror in

front of his eye at a distance of 25 cm. from the patient's face, reflects the light into the pupil and asks the patient to look quickly from side to side, or up and down, and then straight at the mirror. Large opacities are thus shaken up, and the observer sees them float across the pupil; fine dust-like opacities, however, are often only seen when the vitreous is examined by the direct method, with a diminished illumination and a plane mirror with a convex lens behind the sight-hole. The strength of the lens is varied from 1 D to 10 D, so that the whole depth of the vitreous can be examined first whilst the eye is stationary, and afterwards when it is moved rapidly about, and then stopped suddenly, to shake up the opacities.

Fixed opacities in the vitreous are also examined by the direct method; a series of convex lenses are brought in succession into the sight-hole of the mirror until the opacity is clearly seen.

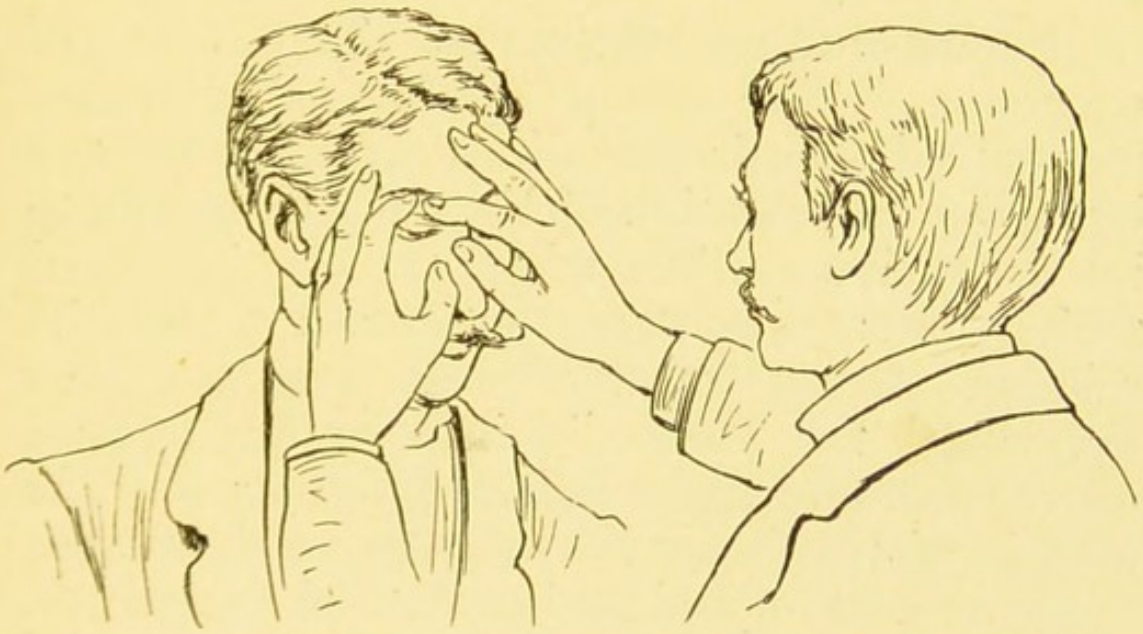
When the pupil is dilated, gross changes in the vitreous, such as hæmorrhage and connective tissue growths, or even detachments of the retina and tumours of the choroid, can be seen in their true colour by the oblique illumination (see p. 81).

The ciliary body.—The state of the ciliary body is ascertained by palpating the ciliary region through the lids. The observer places the pulp of his forefinger against the

closed lids, and makes gentle pressure upon the ciliary zone all around the cornea ; if there is an inflamed spot in the ciliary body, the patient will experience pain, wince, or cry out when it is pressed upon.

Tension.—The tension of the eye is ascertained by palpating the sclerotic through the upper lid.

The patient is directed to turn his eyes



down and look towards the ground, the upper part of the sclerotic being thus brought beneath the thin portion of the upper lid, whilst the cornea and tarsus are moved down out of the way. The observer now supports the three last fingers of his outstretched hands against the patient's forehead and temple, whilst the tips of the forefingers are placed on the upper lid over the sclerotic, which is gently dimpled

by one finger whilst the other finger is kept steady, as when examining for fluctuation elsewhere. The hardness of the globe is thus ascertained, and any increase or diminution in the tension is readily appreciated, when the observer, by practice, has once established in his own mind a standard of what is normal. The tension of the two eyes is also compared. This examination should not cause pain, and should be done with the utmost care.

Extra-ocular muscles.—The field of excursion. The extent of the ocular movements in the horizontal direction is ascertained by noting the relation of the corneal margin to its respective canthus when the eye is turned to its utmost inwards or outwards; whilst the relation of the lower corneal margin to the border of the lower lid in extreme upward movement, and the relation of the pupil to the margin of the lower lid in extreme downward movement are noted during vertical excursions.

The even action of the muscles is tested by making the patient look slowly to either extreme and watching for nystagmic movements, which occur either whilst the muscle is contracting or only when the maximum of its action is reached.

The direction of vertical, lateral, or rotatory nystagmus is noted by watching the change of position of a conjunctival or ciliary vessel in relation to a fixed point, such as the margin of

a lid; at the same time the direction in which the quick movement of the jerk occurs is also observed. The patient is then directed to follow the movements of the examiner's fore-finger, until a position either of absolute or relative repose for the globe is discovered, which is usually in the opposite direction to the position of maximum nystagmoid movement. The eyes should be kept in this position of repose during the ophthalmoscopic examination of the fundus. Very fine nystagmus may perhaps only be noticed during the ophthalmoscopic examination.

The methods of measuring the field of diplopia and the field of fixation are described at p. 64.

Pain behind the globe is elicited in some forms of optic neuritis when the eyes are gently pressed, through the closed lids, backwards into the orbits; it is also produced when the patient turns his eyes to look in some extreme direction, as when ascertaining the field of excursion.

CHAPTER III

The vision.—The vision and the refraction are both ascertained at the same time by a subjective examination, except when the patient is illiterate or the vision cannot readily be brought up to the normal ; the refraction is then ascertained by an objective examination, which is immediately followed, whenever it is feasible, by a subjective examination to control the results which were obtained objectively, and also to ascertain the maximum visual acuity.

Requisites : A well-illuminated test type which can be easily changed, so that the patient may not get to know the letters by heart ; a reading test type ; a trial frame, with an obturator to cover the eye that is not being examined ; a set of trial lenses ; a hair optometer ; and a diopter steel tape.

The patient stands or is seated six metres away from the distance test type ; the trial frame is adjusted to the face, so that each pupil is opposite the centre of the semicircle formed by the rings of the frame. The obturator is placed before the left eye, which must be kept open ; and the patient is asked to read the

lowest line of letters which he can see distinctly on the board of distant types. If he reads $\frac{6}{6}$ fluently and without a single mistake, the ametropia, if it exists, is probably spherical; but this can only be ascertained with certainty by means of finer types such as $\frac{6}{5}$, $\frac{6}{4}$, $\frac{6}{3}$, one of which can usually be read by a patient who has normal spherical eyes. If the patient makes some mistakes in the smaller type, though most of the letters in the same line are read correctly, then the eye is probably astigmatic. In any case a weak convex spherical lens, 0·25 D or 0·5 D, is placed in the frame, and if the glass does not blur or if it improves the vision, it is changed for a stronger one, and this process is continued, increasing the lens each time by 0·5 D, until finally the highest convex glass is found through which the patient sees as well as, or better than, with the naked eye. The obturator is then shifted to the right side of the frame, and the examination repeated for the left eye. The lenses thus discovered represent the manifest hypermetropia; they are left in the frame, and the obturator is removed. Additional convex glasses of 0·25 D are now placed in the frame, one in front of each eye, and these extra lenses are changed for stronger ones until the highest glass is found. which leaves the visual acuity unaltered. In this way the patient will generally accept stronger glasses than those found by the separate examination of the eyes.

If convex spherical lenses blur the sight, a convex cylinder, 0·5 D, is placed in the frame and slowly rotated in front of the eye to ascertain if it improves the vision: this should also be done after the highest spherical lens has been found. If the cylinder does improve the distant sight, it is increased in strength until the highest lens is found which gives the maximum acuity of vision. With these lenses the full manifest hypermetropia or the manifest astigmatism is corrected, and if the patient is forty years of age, or under, they will suffice for all near work.

If the patient is above forty and not more than sixty years of age, additional convex lenses will have to be placed in front of those which correct the full manifest hypermetropia. According to the rule, 1 D must be added for each five years after the age of forty; therefore if the patient is fifty years old an additional 2 D will be required; at the age of sixty all power of accommodation is lost, and it will suffice for all higher ages to add a lens of +4 D to bring the near point to ten inches. But this rule is regulated by the following one, to which there is no exception, viz. that reading glasses must never magnify the print, but only make it clear and sharp.

When the distant vision is below normal, and convex glasses make it worse, the patient is directed to hold the finest near-type at the greatest possible distance from the eye at which

it can be seen distinctly. The distance between the type and the outer canthus is then ascertained by the diopter steel measure. Instead of the print the hair optometer may be employed, as it gives more accurate results; but it requires greater intelligence on the part of the patient. A concave spherical lens of the strength indicated by this measurement is placed in front of the eye, and the distant vision is again tested. The strength of the lens is decreased, or if necessary increased, until the maximum acuity of vision is obtained with the weakest glass; the second eye is then similarly tested. When both eyes are corrected, an effort is made to reduce the strength of the glasses by placing weak convex lenses in front of them, and gradually increasing their strength in a similar manner to that employed when testing for hypermetropia. If any glass above +0·5D is accepted, the examiner's suspicions should be aroused with regard to spasm of accommodation. If the direct ophthalmoscopic examination confirms the results obtained, these lenses may be considered to be correct.

When the distant vision of a patient under thirty-five years of age is below normal, and cannot be improved by spherical glasses, the condition of the media and fundus are at once investigated ophthalmoscopically, and if no changes are observed that will account for the defective vision, a mydriatic is applied. When it is intended that the glasses which fully correct

the ametropia are to be worn constantly, or when it is suspected that there is spasm of accommodation, a 1 per cent. solution of atropine is ordered to be applied twice a day for three or more days before completing the examination. In all other cases a drop of a 2 per cent. solution of homatropine and cocaine in castor oil, applied to the lower conjunctival sac, suffices to paralyse the accommodation and to dilate the pupil. At the end of forty minutes, when this is accomplished, the media and fundus can be completely examined, and the refraction estimated by the direct method or by retinoscopy.

When the patient is unable to see the largest letter on the test type at 6 m. distance ($V = < \frac{6}{60}$), and the sight is not improved by glasses, he may either be allowed to approach the board until he sees this letter, the result being recorded as $\frac{1}{60}$, &c., according to the distance, in metres, at which it is read, or he is given the reading type, and a note is made of the smallest print that he can decipher.

When the patient cannot see any letters, he is asked, whilst standing with his back to the light, if he can count the fingers which the examiner, who faces the light, holds against his coat or other dark background; the maximum distance at which the fingers are counted correctly is recorded in metres or centimetres.

If the patient is unable to 'count fingers,' the observer moves his hand about in front of the eye, and if these 'hand movements' are

not seen, he reflects the light on the eye with the palm of his hand held close to the patient's face, and then moves the hand aside. When this 'hand reflex' is not perceived the patient is turned round to face the light, and the examiner then moves his hand about in front of the face, so that its shadow passes across the eye. When the patient cannot see 'shadows' he is asked if he can see the light or point at the window, and when he does this correctly he has 'perception of light'; but if he cannot recognise when a strong light is concentrated on the eye with a convex lens, and is unable to tell light from dark, he has 'no perception of light.'

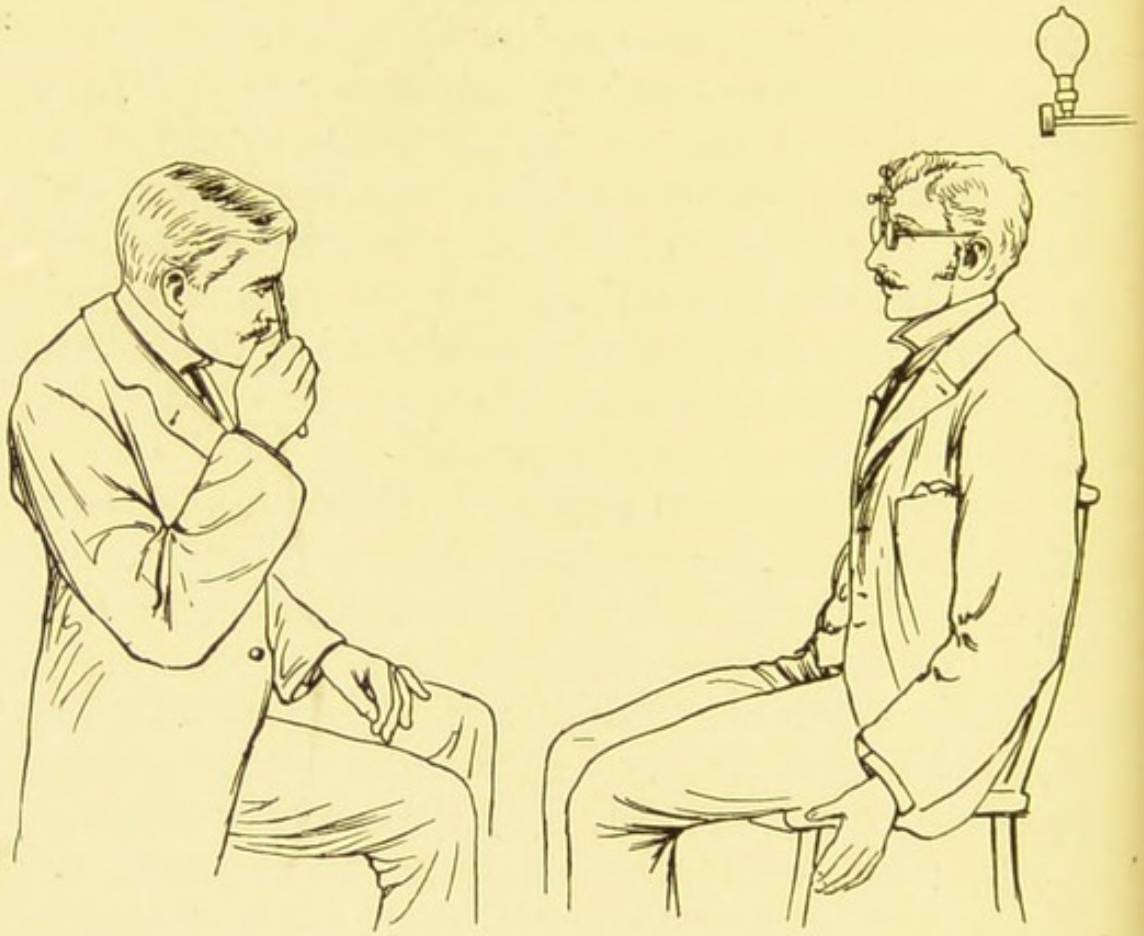
This examination may also be conducted in the dark room by artificial light. The second eye is carefully covered with the palm of the hand during the examination.

The student should always endeavour to ascertain the refraction of an eye by the direct method (page 87) before attempting retinoscopy; but when the media are not clear, or the eye is nystagmic, or if there is an extreme degree of ametropia, retinoscopy is alone serviceable.

Retinoscopy.—*Requisites*: A dark room, a bright light, either electric, gas, or oil, a trial frame with an obturator, a box of trial lenses, and a plane mirror with a 7 mm. aperture.

The patient is seated in the dark room, the

trial frame with the obturator in front of one eye is adjusted to his face, and the lamp is placed in such a position behind and above his head that the light does not fall on the trial lenses when they are placed in the frames.



The examiner sits about 133 cm. in front of the patient, or at such a distance that, when leaning forwards, he can easily change the glasses in the trial frame; if at this distance he cannot see distinctly the changes that occur in the patient's eye during the examination, he must wear his correcting glasses.

The observer now holds the retinoscopy mirror in front of his own eye, looks through the sight-hole, and reflects the light into the patient's pupil (previously dilated with homatropine or atropine) which at once appears to be more or less brilliantly illuminated according to the refraction of the eye and the portion of the fundus which is being observed. If the disc is exposed to view, the examination is more easily conducted; but as the refraction at the disc often varies by one or more diopters from that at the macula, which is the part of the eye that has to be corrected, the patient is directed to look at the sight-hole of the mirror during the whole examination.

Whilst the patient is looking at the sight-hole the observer tilts the mirror from side to side, around an imaginary vertical axis, the light moving across the eye from right to left and left to right; after he has seen the changes that take place in this meridian of the eye, he rotates the mirror around a horizontal axis, the light now travelling across the pupil in a vertical direction. During these movements of the light the observer will notice that a shadow passes across the pupil, either in the same or in the reverse direction to the light on the face. When the shadow in the pupil and the light on the face travel in the same direction the eye is emmetropic, hypermetropic, or low myopic, less than 1 D, and when it moves in the reverse direction the eye is myopic, above 1 D.

When the movement of the shadow indicates that the eye is emmetropic or hypermetropic, the examiner places a convex spherical lens of 1 D in the trial frames, reflects the light into the pupil, and again observes the movement of the shadow; if it now travels in the reverse direction to the light on the face, the eye is emmetropic; but if the shadow still moves with the light, the eye is hypermetropic, and the lens must be changed for a stronger one, until finally the glass is found which reverses the shadow. When the weakest glass which reverses the movement of the shadow has been found, the observer makes a note of the previous lens, *i.e.* the strongest lens which does not reverse the shadow: this is the correcting glass at the distance at which the examination was conducted. If the observer now retires to a distance of four metres from the patient he will find that this glass is too strong by 0·75 D; therefore if he desires to obtain the correct glass he should conduct the examination at a distance of four metres from the eye, which is the focal length of the weakest lens, 0·25 D, that is used for correcting errors of refraction; but as this is not feasible, the examiner sits as far away from the patient as is practically convenient, and makes an allowance for the error by adding −0·75 D to all the results obtained at this shorter distance.

When the shadow in the pupil moves in the reverse direction to the light on the face, the

eye is myopic, and concave spherical lenses are placed in the trial frame until the weakest glass is found which reverses the shadow and makes it travel in the same direction as the light on the face; this is the correcting glass at the distance at which the examination was conducted, but at 4 metres it is found to be too weak by −0·75 D; therefore −0·75 D is added to all the results obtained at the distance of 133 cm.

When the shadow in one meridian remains unaltered by a spherical lens which reverses it in the opposite meridian, or when the shadow moves in a reverse direction in the two meridians even before a lens is placed in the frame, then the eye is astigmatic. In these cases the less ametropic meridian, or, when the shadow in the two meridians moves in an opposite direction, the hypermetropic meridian is first corrected by a spherical lens: this glass is allowed to remain in the frame in front of the eye whilst the opposite meridian is corrected by a cylindrical lens, which is placed in the outer ring of the frame with its plane surface forwards and its axis parallel with the edge of the shadow of this latter meridian.

When the edge of the shadow of the uncorrected meridian is neither vertical nor horizontal but oblique, the mirror is rotated around an oblique axis, so that the light travels obliquely across the face, but parallel with the uncorrected meridian. The axis of the cylinder

is also placed in a correspondingly oblique position in the frame.

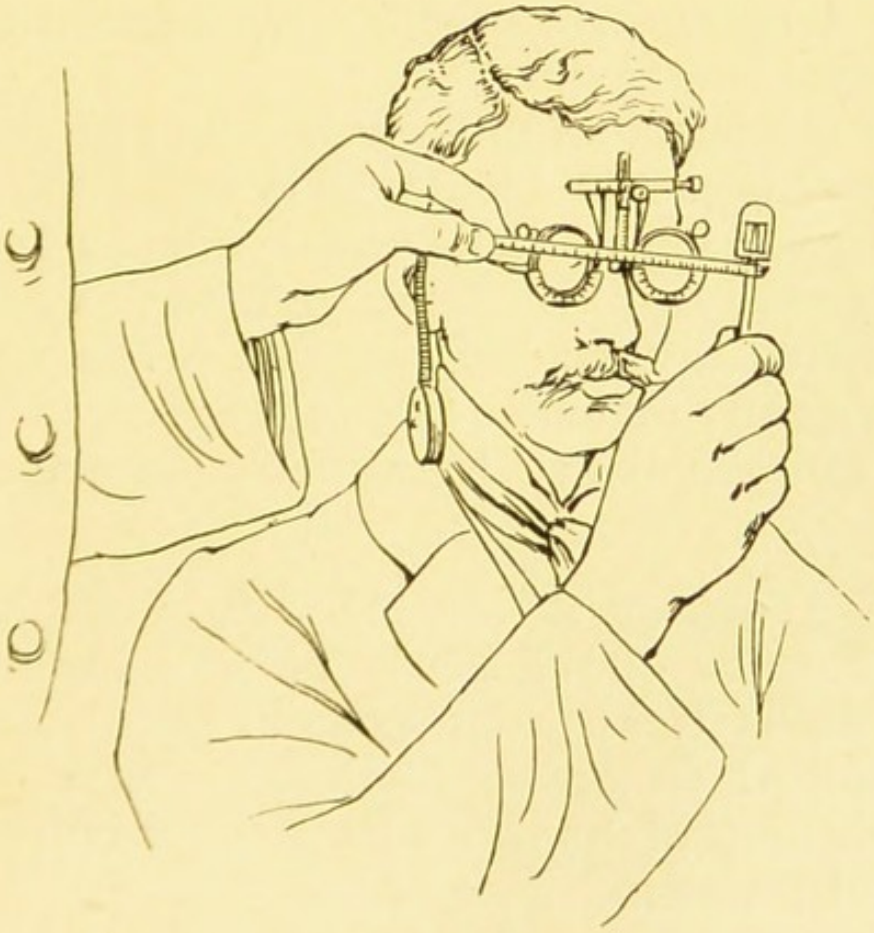
When the correct spherical and cylindrical lenses are in the frame in front of the eye, the shadow moves in both meridians in the same direction as the light on the face. A proof that these are the correct glasses is obtained by placing a convex spherical lens of 0·5 D, or in some cases even a 0·25 D in the frame, when the shadow is at once reversed in both meridians and moves against the light on the face. Should this additional glass only reverse the shadow in one meridian, the examination will have to be repeated and the other meridian properly corrected.

The obturator is now shifted to the opposite side of the frame, and the other eye is similarly examined.

When the examination of both eyes is completed, a note is made of the lenses and of the position of the axis of the cylinders. The visual acuity of each eye is then ascertained by means of the distant type, when any alteration that is necessary is made in the position of the axis of the cylinder or in the strength of the lenses, since the ordinary allowance of −0·75 D for the retinoscopy error is not always accepted by the patient, and occasionally the vision is improved by a weaker cylinder than the one indicated by the objective examination. When the subjective examination is completed, the media and fundus should be again examined

with the ophthalmoscope. A drop of a 1 per cent. solution of eserine in castor oil is then applied to the eye to neutralise the effect of the homatropine and cocaine: this is accomplished in a few hours, and at the end of two days, when the eyes have recovered completely from the previous examination, the vision is again tested subjectively to ascertain the lenses that give the maximum amount of visual acuity.

The punctum proximum of accommodation.—*Requisites*: A trial frame con-



taining the lenses which completely correct the

patient's ametropia, an obturator, the hair optometer, and the diopter steel tape.

The frames with the correcting lenses are adjusted to the patient's face, and the obturator is placed in front of one eye. The patient is now asked to hold the optometer in his hand in front of a white background, such as a sheet of paper or a white cloud, and bring it as close to his eye as possible, whilst he still sees the hairs absolutely sharply defined. When the patient has found this point the distance between the optometer and the outer canthus is measured by the steel tape, which gives the amount of the accommodation in diopters.

If the punctum proximum is so remote that the patient cannot be expected to see the hairs distinctly, a convex lens of 4 D is placed in the trial frame to bring the punctum within a reasonable distance of the eye. The 4 D is subsequently deducted from the result.

The second eye is examined in the same way.

The examination of the muscles.—The balance of the ocular muscles during repose whilst the patient looks in the distance is ascertained either by Maddox's test or by a modification of Snellen's red and green test for binocular vision.

Maddox's test.—*Requisites*: A point of light obtained by enclosing an incandescent

lamp in a box which has in one side an 8 mm. aperture covered with a piece of opaline glass; or a lighted candle. A trial frame. A Maddox's disc containing a number of short pieces of glass rod, which, when placed before the eye and looked through, converts the point into a line of light. A series of square prisms.

Whilst the patient is at a distance of at least 6 metres from the light, the trial frame, containing the correcting lenses if he is ametropic, is adjusted to his face, and the Maddox disc with the glass rods horizontal is put in the frame before the right eye, and a blue glass in front of the left. The patient now sees with the right eye a vertical line of light, which passes through the centre or on one side of the point of light seen by the left eye.

When this line of light passes through the point of light the visual axes are parallel, and the muscles are perfectly balanced (orthophoria), but when the line is on one side of the point of light the visual axes deviate, and the muscles are not perfectly balanced (heterophoria). Thus when the right eye diverges there is crossed diplopia, and the line lies to the left of the point of light (exophoria). A prism has to be found which restores the visual axes to a state of parallelism (orthophoria), when it is held in front of one eye with its apex horizontally outwards; but when the right eye converges (esophoria) and produces homonomous diplopia

the line of light is to the right, and the prism has to be placed with its apex horizontally inwards.

The Maddox disc is now turned in the frame until the rods are vertical, when the horizontal line of light is seen to pass either through the point of light (orthophoria), or above or below the light (hyperphoria). A prism must then be found which, when it is held in front of one eye, with its apex either vertically upwards or downwards, brings the line on a level with the point of light.

The degree of heterophoria in each of its three varieties is indicated by the strength of the prism required to neutralise the defect.

Red and green test.—*Requisites*: A square box 20 cm. in each dimension, which contains an electric light and has a vertical slit 20 cm. by 3·5 cm. on one side, and a horizontal slit of the same size on the opposite side; one half of each slit is covered by a piece of green glass, and the other half by a piece of red glass, so that one end is red and the other end green. Two discs, one red and the other green, are cut from the same pieces of glass, which are selected because their colours neutralise each other perfectly. A trial frame.

The patient is placed at six metres' distance from the coloured slits of light, the frames are adjusted to his face, and the disc of red glass is placed in one ring of the frame in front of the

right eye, and the green disc in the other ring before the left eye, whilst the vertical slit is presented to the patient's view. If there is orthophoria, the red half of the slit is seen vertically above the green half; whilst if there is heterophoria, the red appears to be on one side of the green, and a prism has to be found which, when it is held with its apex horizontally inwards or outwards, as the case may be, brings the red vertically above the green. The horizontal slit is next presented to the patient's view, and if there is any hyperphoria, the red half appears to be above or to be below the green, and the prism has to be found which brings the colours into a line when it is held with its apex vertically up or down in front of one eye. When employing this test the lenses, which correct the patient's ametropia, are left in the trial frames to ascertain if they affect the balance of the muscles.

The power of deviating the visual axes.—The power of deviating the visual axes is measured in four directions: vertically, upwards and downwards; and horizontally, outwards and inwards.

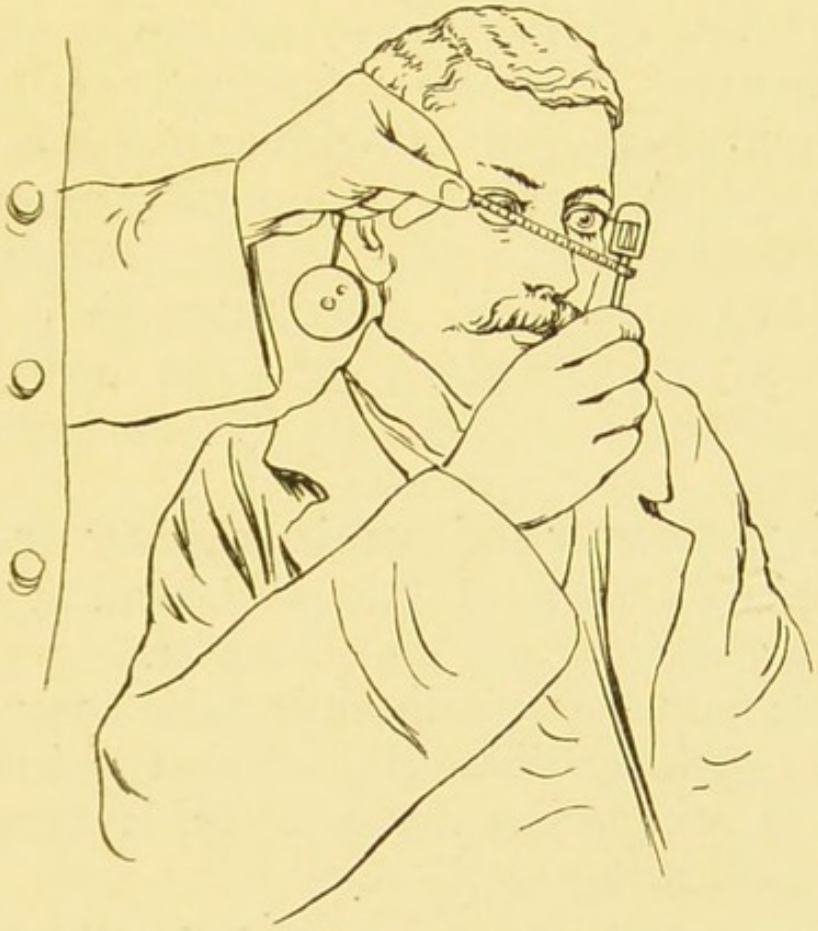
Requisites: For the first three the point of light or the lines of coloured light, which were employed for testing the balance of the muscles, the trial frame, and the square prisms; for the fourth (positive convergence), a polished gold bead at the end of the hair optometer, which

acts as an ophthalmo-dynamometer, and the diopter steel tape.

Vertical deviation.—The patient looks with both eyes at the 6 m. distant point of white light or horizontal line of coloured lights. A 1° d prism is held vertically with its apex upwards in front of one eye, when the light will appear double for about half a minute; but as soon as the images fuse the prism is increased in strength, until finally the images will not fuse; the strongest prism which is overcome indicates the patient's power of deviating the eye upwards. The prism is now held in front of the same eye with its apex downwards, and usually, if there is no hyperphoria, the same prism is overcome, and indicates the power of deviating the eye downwards.

Negative convergence.—This is the power of separating the anterior ends of the visual axes, or the power of divergence. The patient looks with both eyes at the distant point of white light or the vertical line of coloured lights, whilst a square prism is held with its apex horizontally outwards in front of one eye, thus causing the lights to appear double. When the images fuse, the prism is increased in strength, until the strongest prism is found which can be overcome: this prism indicates in degrees the amount of the negative convergence.

Positive convergence. — The patient takes the hair optometer in his hand, holds the gold bead about 25 cm. in front of his nose, and looks at it with both eyes ; the bead is then slowly brought nearer and nearer to the bridge of the nose, until finally it appears to be double ;



it is then withdrawn and reapproached until the nearest point is found at which a single image of the bead can be maintained. The distance between the bead and the outer canthus is now measured with the diopter steel tape, which gives the amount of positive convergence in metre angles.

The observer looks at the patient's eyes

during the whole examination, and watches for the first indication of either eye ceasing to converge and beginning to diverge, at which moment many patients notice that the bead appears to be double; but as this is easily overlooked, if the eyes diverge rapidly, the observer should tell the patient to look for the second image directly the eyes cease to converge, and then the diplopia is at once noticed. When the punctum proximum of convergence is nearer to the eye than the punctum proximum of accommodation, the outline of the polished bead becomes blurred and rayed, though it can be seen easily even when quite close to the bridge of the nose.

The power of maintaining convergence.—*Requisites*: The gold bead at the end of the optometer and an obturator.

The power of maintaining the convergence at the working distance, which the individual patient's occupation necessitates, is ascertained by the following method.

The patient holds the hair optometer at the required distance, and looks steadily at the gold bead with both eyes; the observer now covers one eye with the obturator, which he then immediately removes, and watches for any movement the eye may make; the second eye is examined in the same way. If neither eye makes any movement, convergence is perfectly maintained (orthophoria); but if there is hetero-

phoria, one or both eyes deviate when covered, and then move in the opposite direction when uncovered, in order to regain binocular vision.

The amount of the deviation is ascertained in the following manner.

Requisites : A card, upon which there is a word of three or four letters cut from a Snellen's 0·5 D reading type. The word is pasted across the centre of a narrow vertical line 1 cm. long, which is drawn on the card. A trial frame and a 5° d prism in a metal ring.

The patient holds the card at his ordinary working distance, and fixes his gaze on the word, which he must see distinctly ; the frames are adjusted, and the prism is placed before the right eye with its apex vertically downwards, when the word and line appear double ; the image, which is seen by the right eye, is below, either vertically beneath the other when convergence is well maintained, or displaced laterally if the eyes deviate. A prism has now to be found which brings one image beneath the other when it is placed in the trial frame in front of the left eye, with its apex horizontally inwards or outwards, according as the lower image is displaced to the right or to the left of the upper image. The strength of the prism indicates the amount of the deviation in degrees.

When estimating the power of maintaining convergence, the patient must look through the centre of his glasses if he has to wear spectacles

for near work; because if he does not do so the lenses act as prisms, especially if they are of a high power, and produce the deviation. The length of the base line is therefore measured to ascertain the distance which should separate the centres of the lenses in the spectacles for constant use or for distance; the distance between the centres of the reading glasses should be 3 mm. less.

The base line.—*Requisites*: A trial frame provided with a screw for adjusting the

distance between the spectacle rings, and a millimetre scale and index for recording the separation between their centres. Two stenopaic discs, each with a slit 0·3 mm. wide, which

extends radially for 8 mm. from the centre of the disc.

The trial frame is separated to its full extent, and a stenopaic disc, with the slit vertical, is put in each spectacle ring, one slit being above and the other slit below the centre of the rings. The frame is now placed on the patient's face, and its height is so adjusted that he can look through one slit at an object which is at least six metres away. By turning the screw the slits are brought closer together, until the patient, who is looking steadily at the distant object, perceives that one slit is vertically above the other. The distant object can now be seen through either slit without the head or the eyes being turned, and the pointer on the scale indicates in millimetres the length of the base line. The observation is repeated more than once to verify the result.

Test for binocular vision. Cuignet's method.—*Requisites*: A penholder or pencil and a page of print, which the patient is able to read with either eye.

The patient, whilst reading the print at the ordinary distance, holds the pencil midway between his nose and the book, parallel with the surface of the page and at right angles to the lines of print; if he has binocular vision the whole page remains visible, but if he only uses one eye a portion of the lines of print is completely hidden by the pencil.

The same test may be employed to ascertain whether binocular vision exists for distant objects. The patient is directed to look at a horizontal line on a wall, or at a bar in a window frame, whilst he holds the first two fingers of one hand or a narrow ruler at a distance of 50 cm. vertically in front of his nose. When the line appears intact the vision is binocular, but when a piece is hidden by the ruler the vision is monocular.

The examiner controls the observation by covering first one and then the other eye ; a patient with binocular vision sees at once the effect of using only one eye at a time ; whereas the patient who has monocular vision sees no alteration when the deviating eye is covered, but when the fixing eye is excluded the object obscures a different set of letters.

Snellen's test.—*Requisites* : A set of Snellen's transparent red and green letters and two discs of the same red and green glass. A trial frame.

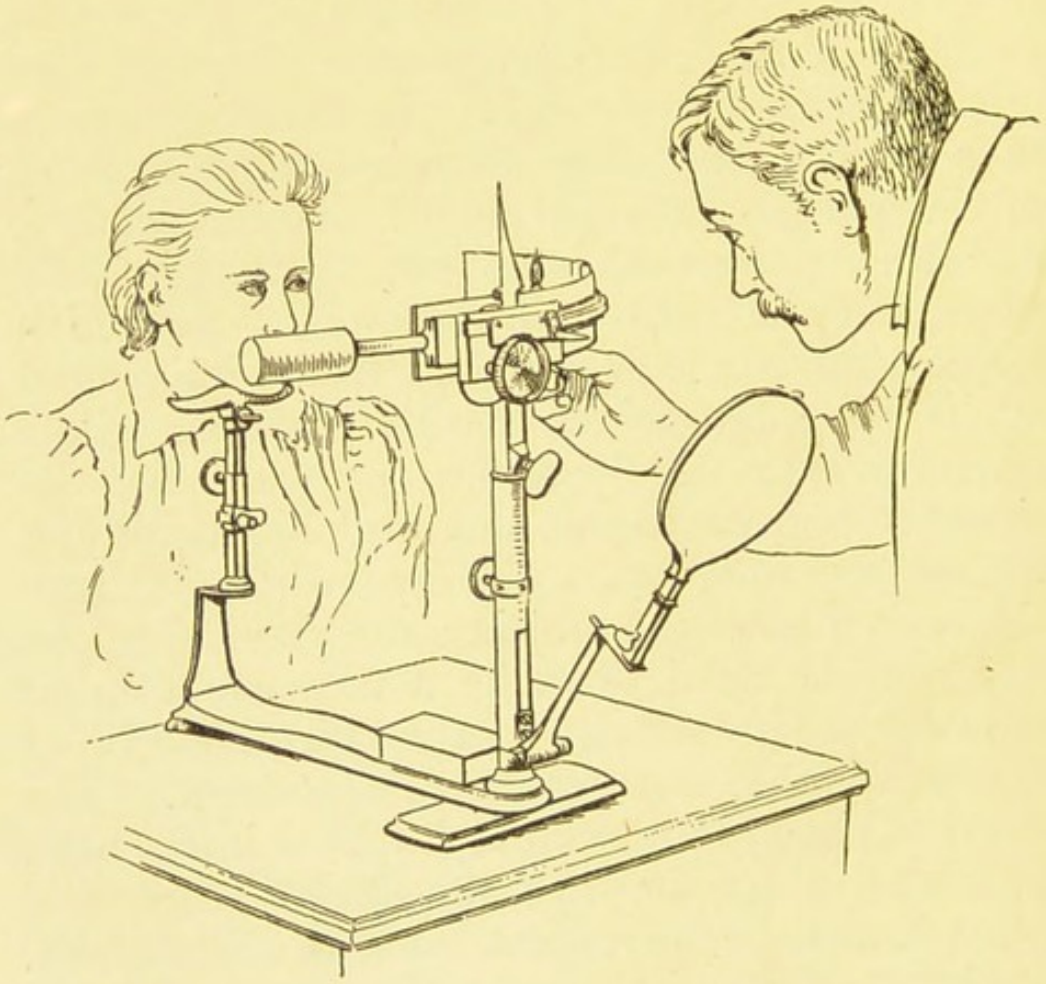
Whilst the patient stands with his back to the letters, which are placed in a window with the sky as a background, the red glass is put in the trial frame in front of his right eye and the green glass before his left. The patient is now asked to turn round and read the letters, which are 6 metres distant. If he reads both the red and the green letters, he has binocular vision, and the size of the type which is read indicates

the visual acuity of each eye. The test is used in this way for detecting simulated monocular amblyopia; it is also of service for demonstrating that binocular vision is restored after an operation for squint.

The determination of the fixing eye in strabismus.—When binocular vision exists, an apparent squint is due to a positive or negative angle gamma; but when the squint is real, the patient has either monocular vision or diplopia. With a real squint the deviating eye is thus ascertained. The observer stands in front of the patient, holds a pencil before his face, and directs the patient to look at its point; he now places a card in front of the eye which appears to be deviating, and if the uncovered eye is fixing the object it will not move. The observer now uncovers the deviating eye, desires the patient to continue to look steadily at the object, and covers the eye which he considers is fixing the object; the deviating eye will now be seen to make a movement either outwards or inwards to fix the object, according as the squint is convergent or divergent. The cover is once more removed, and if it has been in front of the fixing eye, the deviating eye will at once make a movement inwards or outwards, as the case may be, whilst the uncovered eye will move in the reverse direction, to regain its view of the object: this indicates a constant squint. If the strabismus is alternating, the

uncovered eye will continue to deviate indefinitely even when the patient is asked to wink ; whilst if it is a constant squint with good vision in the deviating eye, then as soon as the patient winks, the squinting eye deviates once more, and the fixing eye regains its normal position.

The measurement of the angle of a squint.—*Requisites* : The perimeter ; the shield



is removed, the arc is placed transversely, and the height of the chin rest is adjusted so that the patient can see through the hole

which is in the base of the pointer. A lighted candle.

The patient is seated at the perimeter with his head supported on that half of the chin rest which brings the deviating eye into the middle line opposite the hole in the base of the pointer, directly above the fixation point; and the arc of the perimeter is extended across the visual axis of the deviating eye. The patient now looks with his fixing eye through this hole at an object across the room, whilst the observer moves the light along the arc of the perimeter until he sees that the corneal image of the flame is opposite the centre of the pupil of the deviating eye. The degree on the arc against which the candle now rests indicates the angle of the squint. Whilst doing this the observer keeps his head behind and above the flame, so that his eye, the flame, and its image are in a line.

Before the total angle of the squint can be known the observer must measure the angle gamma, and add its amount to the angle of the squint.

The angle gamma (*i.e.* the angle between the visual and optical axes, often spoken of as the angle alpha).—*Requisites*: The same as for the angle of the squint.

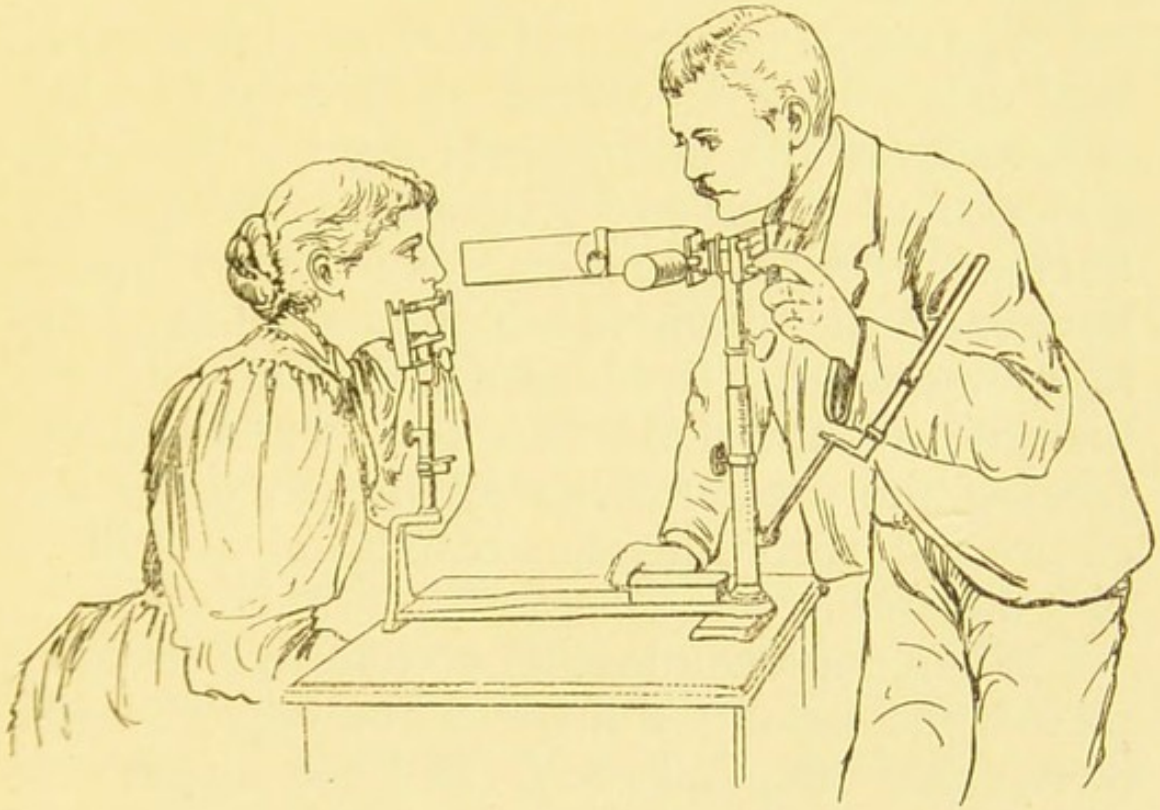
The patient is seated as before, only the fixing eye is covered, and the deviating eye is made to look at the fixation point; if necessary

the arc of the perimeter is turned to the opposite side. The flame is moved along the arc in the same way as when ascertaining the angle of the squint. If the candle is behind the fixation point when the image of the flame falls in the centre of the pupil, then there is no angle gamma ; but if the candle is to one side of the point of fixation, when the image is opposite the centre of the pupil, then there is an angle gamma. The degree on the arc against which the candle now rests indicates the amount of the angle ; and if the candle is on the temporal side of the eye, the angle is positive, and if it is on the nasal side, the angle is negative. When adding the amount of the angle gamma to the angle of the squint to ascertain the total angle of deviation, the positive and negative signs of the angle gamma must be treated mathematically ; therefore the former increases and the latter diminishes the angle of deviation.

The field of fixation.—*Requisites* : The perimeter, with or without the bite-fixation in position, which will depend upon the intelligence of each individual patient. The balanced test object, exhibiting a single word of two or three letters printed in the smallest type that can be distinctly seen by the eye under investigation.

The patient is seated at the perimeter, directly facing the fixation point, with his head erect and his chin supported on the half of the

chin rest which brings the eye that is about to be tested into the middle line, opposite the fixation spot. If the patient cannot maintain this position during the whole examination, he is asked to grip the bar of the bite-fixation apparatus between his teeth, which effectually prevents the least movement of the head. The



second eye is covered with a pad and bandage, or its lids are closed and held down by the lashes with the tip of the patient's fore-finger. The words in the test object, in various sized type, are now exhibited, and one, in the finest print that the eye can read, either without or with glasses, is exposed after the test object has been moved to the end of the perimeter arc, which is extended horizontally outwards.

Whilst the patient, without moving his head, turns his eye to its utmost outwards towards the extremity of the arc, the observer slowly moves the test object inwards towards the fixation point, but stops directly the patient can read the word, and at once records in degrees the position which the test object occupies on the arc.

The arc is now placed horizontally inwards, the test object is moved back again to the extremity of the arc, a fresh word is exposed, and the observation is repeated. When the field of fixation has thus been tested in the horizontal meridian, which is all that is generally necessary, the examination of the remainder of the field can be ascertained by placing the arc successively in each 30° of the circle, and recording the results on a field of vision chart.

When the examination of one eye is completed, the head is shifted to the opposite side of the chin rest, and the second eye is tested in the same manner.

If an ametropic patient can only see the test object through his correcting glasses, the observer must hold the correcting lens in front of the cornea, whilst the eye is turned to its utmost to one side. But if the patient is illiterate, or the eye is so amblyopic that it cannot see the test object, the examination is conducted in the following manner.

Requisites: The perimeter and a lighted candle.

The patient is placed in the position which has just been described, and is then asked to turn his eye and follow the movements of the lighted candle which the observer passes along the arc of the perimeter from the centre towards the periphery. The observer keeps his own eye above and behind the light, in a line with the corneal image of the flame, which is formed in front of the patient's pupil. When the candle has reached the limit of the field of fixation, the observer will notice that the patient's eye ceases to follow the movements of the light; and then the image of the flame no longer falls on the centre of the cornea. The degree on the arc, against which the candle rests when the eye has reached its limit of movement in this direction, is now read off and recorded.

After the field of fixation inwards and outwards has been measured in this manner, the total extent of movement in the horizontal meridian is obtained by adding the two movements together. If the patient has a large angle gamma, it must be allowed for by subtracting the amount of the angle, when it is positive, from the apparent strength of the external rectus, and adding it to that of the internal rectus; and the reverse when the angle gamma is negative.

The field of diplopia.—*Requisites*: A circular piece of plane red glass 8 cm. in dia-

meter, set in a metal ring with a handle, and a lighted candle in a candlestick.

The patient stands at the end of the room with his back to the wall, holds the red glass with one hand in front of the eye which is suspected to have its muscles affected, or in front of the right eye if this is doubtful; keeps his head erect, and faces directly forwards. The observer must see that the patient keeps his head in this position during the whole examination, and that he turns only his eyes when he follows the movements of the candle, which the examiner, who stands facing the patient at a distance of four or six metres, now holds on a level with, and directly in front of, the patient's eyes, and asks him if he sees one or two flames. If the patient sees two flames, he is asked to describe the position of the red in relation to the white flame, whether it is on the same side as the red glass or on the opposite side, homonymous, or crossed diplopia; on a higher or on a lower level, nearer or farther away, upright or tilted; the apparent distance between the images and the direction in which the flame is tilted must also be ascertained; the answers are at once recorded on the chart. Whilst recording them the observer, at least at first, had better turn round and face the same way as the patient, otherwise he will probably transpose the answers. The observer now moves the candle in the same horizontal plane two paces to the right, then two paces to the

left, of the primary position ; he then places it on the floor in three similar positions, and finally holds it in the air in the same three positions as high as possible above the patient's eye.

If there is diplopia in any one or more of these nine situations, the observer records the position in which the patient sees the red flame in relation to the white one, and when the chart is completed he will be able, from a knowledge of the normal action of the muscles, to state which are affected.

The observer should be careful not to hold the candle so close to the patient that the nose hides the flame from the eye, and if a small piece of red glass has to be used, he should see that it is kept in front of the pupil in whatever direction the eye is turned.

Colour vision.—*Requisites*: A set of Holmgren's skeins of coloured wools, which are scattered upon a white sheet.

The primary test, a skein of wool of a light green colour, is shown to the patient, and he is asked to select from the skeins any he can find that are of the same colour, though differing in shade from the test skein. The observer removes each skein as it is picked out by the patient, and if all he selects are green in colour the examination is complete and his vision for colour is normal ; but if some of these skeins do not contain any green colour the patient is

given the second test, a skein of rose-coloured wool, and the examination is continued in the same way ; and when he has picked out all the skeins which he can find containing this colour he is given the final test, a skein of red wool, which he endeavours to match in a similar manner.

The patient should not be told the name of the colour of any of the tests, nor should he be asked to pick out any colour by name, *e.g.* pick out the greens, nor asked to name the colour of any given skein.

When the examination is completed the observer draws his conclusions as to the nature of the colour defect from the mistakes which the patient has made.

In suspected functional cases one eye should be examined at a time to detect monocular achromatopsia. If it is desired to keep a record of the case the observer cuts a piece of the wool about 25 mm. long from each of the skeins, which he mounts, together with a piece of the test colour, on a sheet of paper by inserting the ends into two parallel slits that are cut in the paper about 15 mm. apart.

The light sense and light difference.— The light sense and light difference are measured by means of Dr. Chibret's chromatophotoptometer, an instrument which the patient, whilst facing the window, looks through with one eye, the other eye being covered, and

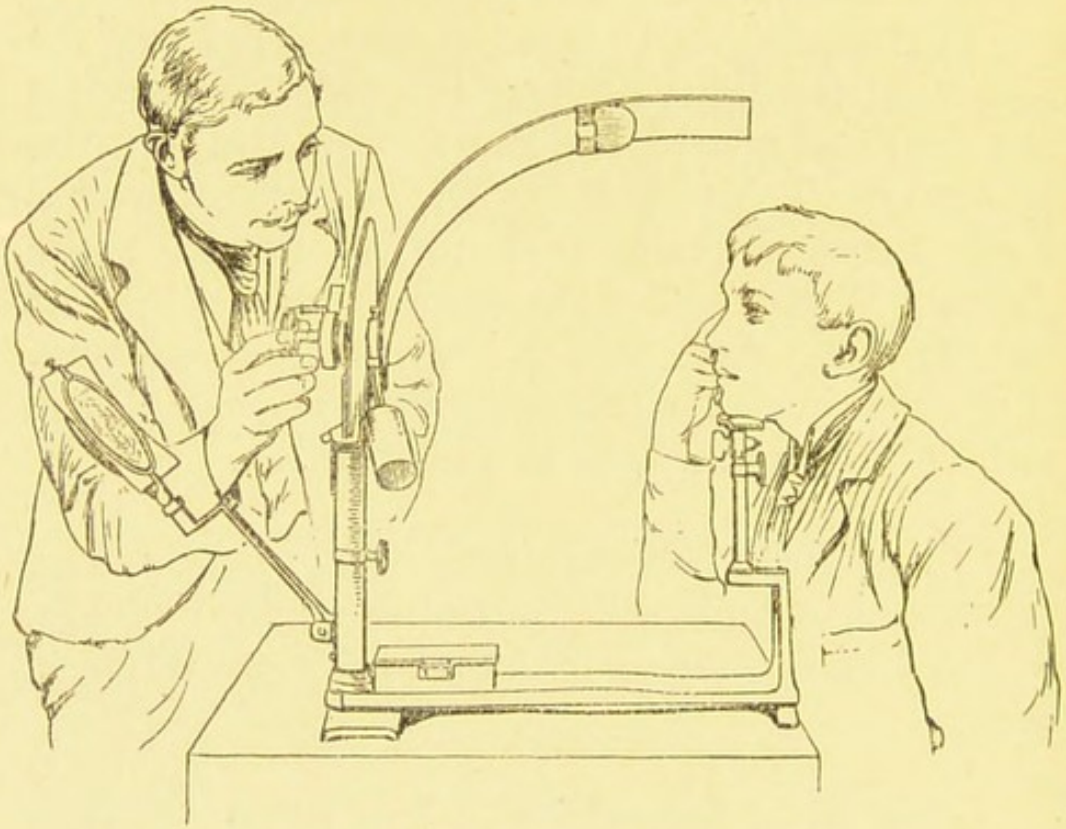
turns the eyepiece until he sees the second disc of light come into view, when the degree of the light sense is indicated on the scale. The light difference is measured by the same instrument if the patient turns the eyepiece in the reverse direction until he can detect a difference between the two points of light.

Parinaud's dark type is also employed to ascertain the light sense; it is placed in such a position and at such a distance that the top row of letters is invisible to the observer whose light sense is supposed to be normal; the patient is now asked to read as many lines as he can see; each eye is measured separately. The distance at which the type is placed will depend on the amount of illumination.

The field of vision.—*Requisites*: The perimeter and a blank chart of the field of vision. A stool which can be raised and lowered by a screw.

The field for white.—The chart is fixed in the chart box; the test object, a piece of white paper 15 or 20 mm. square, is exposed in the carriage on the arc; the perimeter on its table is placed in front of the patient, who is seated on the stool, with his back to the window; or a lamp is placed beside and behind the patient's head to illuminate the test object if the daylight is bad. If there is a great difference in the sight of the two eyes, the one

with the better vision is first examined, the patient being directed to place his chin on that half of the chin rest which brings this eye into the middle line, on a level with and opposite the fixation point. This is obtained by adjusting the height of the stool, of the chin rest,



and of the perimeter arc. The second eye is covered with a pad and bandage, or the patient is asked to shut it and hold the upper lid down by its lashes with the tip of the forefinger of the corresponding hand, but without pressing on the globe. The patient is now directed to look steadily at the fixation point and tell the examiner immediately he sees the test object,

which the observer moves evenly and slowly along the arc from the periphery towards the centre. During the whole examination the observer watches the patient's eye to see that it is not turned to one side to look at the test object.

Directly the patient sees the test object the examiner registers on the chart the position it occupies on the perimeter, then moves the object back to the end of the arc, turns the arc onwards 30°, and repeats the observation. The arc is moved on 30° after each observation until the circle is completed, when the chart is removed and the registration marks are connected by a continuous line : the enclosed area is the patient's field of vision for white. In suspected functional cases the arc is moved round a second time, so that the field is taken twice ; the result may be a spiral. The second eye is examined in a similar way.

Scotoma for white.—When it is suspected that an absolute scotoma, or pathological blind spot, exists within the field of vision, the test object is moved onwards to the fixation point, as soon as the position where it is first seen has been registered ; if there be any extensive defect within the field, the test object, as it is moved on, disappears. The extent of a scotoma is ascertained by moving the test object from within the blind area towards its periphery and registering the point where it is

seen to emerge ; the object is then moved back into the scotoma and brought out towards the fixation point, the point of emergence being again registered. If necessary these movements are repeated along each 15° of the field, and the resulting registration points are then joined by a continuous line which defines the area of the scotoma and its position on the chart. When the scotoma involves the centre of the field the patient is directed to place the tip of his forefinger against the fixation point and keep his eye directed toward his finger-tip. In this way the eye can be kept perfectly steady whilst the area of the field of vision is being mapped out.

When the field of vision is bounded by a radial line, as in hemianopsia, the test object is placed at the 10° mark on the arc, which is then swung from the blind area into the field of vision, and as soon as the object is seen, its position is registered on the chart. The arc is now swung back into the blind area, the test object is moved to the 20° mark, and the arc is again swung toward the field of vision until it is seen. By placing the test object on each successive 10° mark of the arc and then rotating the arc from the blind into the seeing area, any irregularity in a radial line is at once detected.

The field for colour.—The field for colour is ascertained in the same way as the field for white, a piece of coloured paper 15 or 20 mm.

square being substituted for the white test object.

It is not necessary to examine the field for more than one colour, and red is the one usually chosen. The observer should always employ a piece of the same material for his test object, for the size of the field varies with the intensity of the colour.

Scotoma for colour.—Whilst the patient is seated at the perimeter in the position that has already been described, the carriage with the test objects is moved up to the fixation point, and the smallest piece of red, 1 mm. square, is exposed. The patient is now asked if he sees the colour of the test object, and if his answer is correct he is asked to notice, whilst still looking steadily at the fixation point, if the colour appears to get duller or brighter as the object is moved away from the centre. When the carriage has been moved 10° away it is brought back again to the centre, the arc is turned 30° round, and the observation is repeated; and so on. When the colour of the object appears to the patient to be duller in the centre than elsewhere, he has a relative colour scotoma; and when the colour is only seen at the side and not at all in the centre, the colour scotoma is absolute. The examination for an absolute colour scotoma is conducted in the same way as for a relative scotoma, but the largest square of red which is invisible as red

to the patient is exposed in the carriage, and is then moved from the centre outwards until it is seen in its true colour by the patient, who looks steadily all the time at the fixation spot. The observer registers on the chart the point where the colour is seen by the patient, and when the circuit of the field is completed the points on the chart are united by a line. When the disease does not involve the whole of the yellow spot region, the red may be seen on one side of the fixation point and be invisible on the other side or at a little distance from the centre—an eccentric scotoma.

The following is a rapid method for ascertaining the presence of a central colour scotoma. The observer faces the light and holds, with a pair of forceps, a small piece of red cloth, 1 mm. square, in front of the tip of his nose. The patient, who stands with his back to the light, faces the observer and looks steadily at the coloured object; if the patient can tell the colour correctly, the observer moves it to one side and asks the patient, who still looks at the tip of the nose, if the colour appears brighter when held in the centre or when held to one side. The object is then moved into other meridians, above, below, and on the opposite side of the nose. In this way a relative scotoma is detected; and if the colour object is not seen when it is on the end of the nose and is looked at directly, but is seen at the side, the colour scotoma is absolute.

Examination of the field of vision by the hand or with a light.—When the patient can only see large objects, the observer places his face in such a position that his eyes are on a level with, and about 40 cm. from, the patient's eyes; he then directs the patient to cover his left eye with the palm of his hand and to look with his right eye at the observer's left eye which is in front of it. The observer now closes his right eye, and with his left watches the patient to see that he does not turn the eye to one side to look at the hand which the observer moves about in the air in a plane midway between his own and the patient's face. The hand is moved gradually inwards from the periphery until it is seen by the patient; first from the temporal side, then from the nasal side, and afterwards from above and below, as well as along the intermediate meridians, if it be thought necessary. A patient with a normal field sees the moving hand at the same time as the observer, but when the field is contracted the observer sees the hand first, either just before or a long time before the patient, according to the extent of the defect.

The left eye is examined in the same manner.

When the patient is unable to see any object, even a hand which is moved about close in front of the eye, the state of the field is ascertained in the dark room by means of a lamp and an ophthalmoscope mirror. The

patient is directed to cover one eye with the palm of his hand, to keep the other open, and to look straight before him ; the observer, who stands in front, reflects the light from the lamp, which is placed behind the plane of the patient's face, into the eye, watches the effect on the pupil, and asks the patient, when he sees the light, from what direction it appears to be coming. It is often difficult to obtain satisfactory answers from old patients with cataracts which have existed for many years, but such patients can sometimes point at or look towards the light when they are unable to say from what direction it appears to be coming.

In cases of aphasia, hemianopsia can sometimes be detected by using two tapers, one of which is held in front of the patient and the other brought in from the periphery ; as soon as the second light comes into the visual field of the patient he turns his eye towards it.

CHAPTER IV

The ophthalmoscopic examination.—This examination is conducted in a room from which daylight is excluded. It comprises four methods, for all of which a lamp and various lenses or mirrors are required. They are: 1. The oblique or focal illumination. 2. The direct method at a short distance from the patient. 3. The indirect method. 4. The direct method close to the patient.

During the whole of the examination the patient is seated on a chair with his head erect and facing directly forwards; the lamp is placed in different positions according to the method that is being employed, whilst the examiner either stands, or sits on a stool, in front or somewhat to the side of the patient.

These examinations cannot be completely carried out unless the pupil is dilated, for, though gross changes in an eye can be observed through a moderate-sized pupil, *i.e.* of about 3·5 mm., it is only possible to inspect the whole of the lens or thoroughly examine the more peripheral parts of the retina, choroid, and vitreous through a widely dilated pupil. Also when the pupil is

very small, the amount of light admitted into the eye is not only insufficient to thoroughly illuminate the fundus, but the corneal reflections of the mirror are very troublesome, so that in such cases it is often necessary to dilate the pupil with a 2 per cent. solution of cocaine or of homatropine, or a combination of the two; at the end of the examination this temporary mydriasis is neutralised by the application of a myotic, *e.g.* 1 per cent. solution of eserine.

Before applying the mydriatic the tension of the eye should always be ascertained.

The observer begins by examining the eye with the oblique illumination; this enables him to see opacities in the media which may be further investigated through a compound magnifying lens, and by the direct method with a plane mirror and a high convex lens behind the sight-hole. (See also pp. 26, 33, 34.)

He next proceeds to illuminate the eye with the light reflected from the large concave mirror from a distance of about 30 cm.; he can by this means observe the density of any opacities that may exist in the media and ascertain the refraction of the eye.

The indirect method is next employed: this gives the observer a general view of the fundus oculi and enables him to inspect it through opacities in the media that render the direct method of examination impossible, and also reveals some changes which cannot otherwise be observed.

The eye is finally examined by the direct method, which affords the observer a greatly magnified view of the fundus, and also allows him to estimate the refraction of the eye at the macula or at any other part of the fundus, and further enables him to see some changes which are invisible by the indirect method.

The oblique or focal illumination.—*Requisites*: A convex spherical lens of 13 D, 5 cm. in diameter. A compound lens which magnifies about four diameters and has a flat focus at a distance of 2 cm.

The patient is seated on the chair with his head erect, facing the examiner. The lamp, turned on to its full brilliancy, is placed 50 cm. in front of the patient's face, but a little above and to one side of the eye that is to be examined. The observer now stands or sits in front of the patient, raises the upper lid with the thumb of one hand, and brings the light to a focus on the eye with the large lens, which is held in the other hand with its surface at right angles to the rays of light which fall on the globe. The lens is approached and withdrawn until a perfect image of the flame is formed on the cornea. It is then moved about in this plane until the image has passed over the whole of the corneal surface, when any changes, either on the surfaces or in the substance of the cornea, are readily seen within the brilliantly illuminated area.

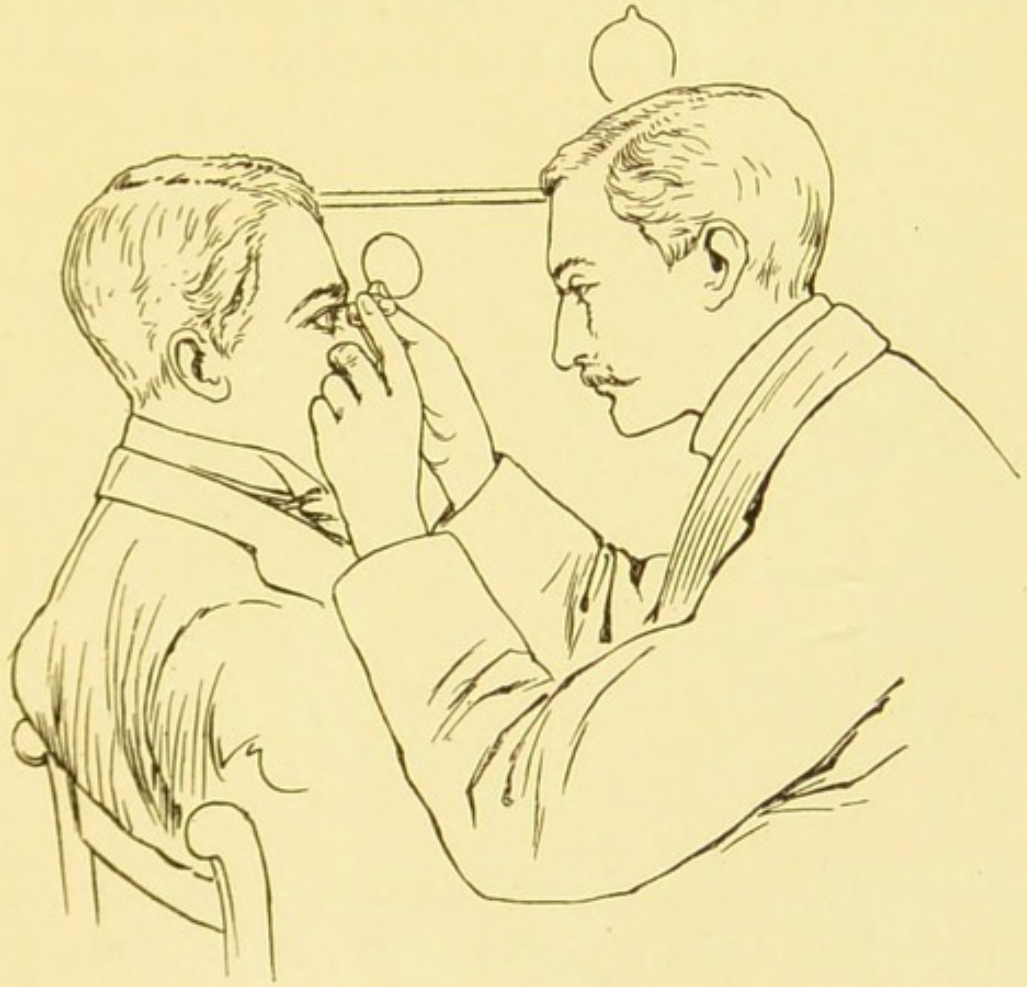
When the cornea has been inspected the lens is brought a little nearer to the eye, until the image falls on the surface of the iris and on the anterior capsule within the pupillary area, over the whole of which the light is made to travel. The cortex, the nucleus, the posterior capsule of the lens, and the anterior part of the vitreous are examined in turn in the same way by bringing the glass still nearer to the eye and then moving it about in the plane in which it is held until the whole of each part has been thoroughly inspected.

Should it be desired to obtain a magnified view of any changes which may be discovered in this manner, the observer continues to focus the light on the part with the large lens and then inspects it through the compound lens, which he holds between the forefinger and thumb of the other hand whilst the little finger raises the upper lid if necessary.

While inspecting the anterior parts of the globe by focal illumination the observer keeps his own eye in such a position that it receives the rays that are reflected from the illuminated area, upon which the light falls obliquely. When the deeper parts, the posterior surface of the lens and the vitreous, are examined (for which purpose the pupil has to be dilated), the lamp is placed directly in front of the eye though at the same distance from it as before ; the observer keeps his own eye close beside the focussing lens, to receive the rays that are

reflected by these deeper parts, and the more deeply he wishes to see into the vitreous the closer to the lens must he keep his eye.

Any opacity which is not very dense may be examined with a plane mirror by the direct method ; according as the opacity is situated in



the cornea, lens, or vitreous, a convex lens of 30, 20, or 10 D is brought before the eye. By this means changes can often be seen in the media which are invisible or not seen so well by oblique illumination. The method of conducting the examination is described at page 87.

Direct method at a short distance.—*Requisites* : A large concave mirror of 25 cm. focus with a convex spherical lens of 3 or 4 D in a clip behind the sight-hole which is 5 mm. in diameter.

The lamp is placed on a level with and to one side of the patient's ear ; the observer sits or stands close in front of the patient, holds the

mirror before his right eye, looks through the sight-hole, and reflects the light into the patient's pupil, which at once appears everywhere brilliantly illuminated if the media are perfectly clear ; but if they are partially opaque, the opacity if it is at all large will appear as a dark mass against the bright background. The patient is next directed to turn the eye from side to side, and to look up and down ; the observer will then notice how the opacity

behaves, whether it moves only with the globe or floats about and continues to move after the eye is at rest. By paying attention to the direction in which a fixed opacity appears to move, *i.e.* in the same or in the opposite direction to the movement of the front of the eye, an idea of its depth can be obtained.

If during this examination the retinal vessels be seen, the eye is ametropic.

The indirect method.—*Requisites* : The lamp, chair, and stool. A large concave mirror of 25 cm. focus with a 5 mm. aperture. A convex lens of 13 D, 5 cm. in diameter. If the observer is emmetropic, a convex spherical lens of 3 or 4 D is placed behind the sight-hole in the mirror ; but if he is ametropic, a combination of this lens with his correcting glasses is employed in its stead, unless the observer wears his spectacles, which is not so convenient.

The lamp turned fully up is placed to one side of and on a level with the patient's ear. The observer sits on the stool facing him, whilst with his right hand he supports the ophthalmoscopic mirror against the brow and side of the nose in such a position that he looks through the sight-hole and reflects the light into the patient's right pupil, which appears to be bright red in colour provided that the media are clear. The patient is directed to look, without turning his head, at the tip of the observer's right little finger, which is extended

outwards from the ophthalmoscope ; on interposing the convex lens, with the left hand, some 7 or 8 cm. in front of the patient's eye, an inverted image of the optic disc comes into view. When the left eye is being examined, the patient is asked to look at the observer's left ear, a similar image of the left disc being obtained. If the image does not appear sharply defined, the observer approaches or withdraws the lens or his head, or both, until the disc is

seen distinctly. At the same time the lens is tilted slightly around a vertical axis to move aside the two images of the lamp which are formed on its surfaces and interfere with the fundus image.

After examining the disc the observer investigates the remainder of the fundus : this is done in a systematic manner by following each of the main branches of the retinal vessels from the disc to the periphery, where they are lost to view. The examiner does this by altering the

position of his own head, and by directing the patient to turn the eye and look in various directions upwards, downwards, inwards, or outwards, or in any intermediate position. In this manner no gross changes will be overlooked.

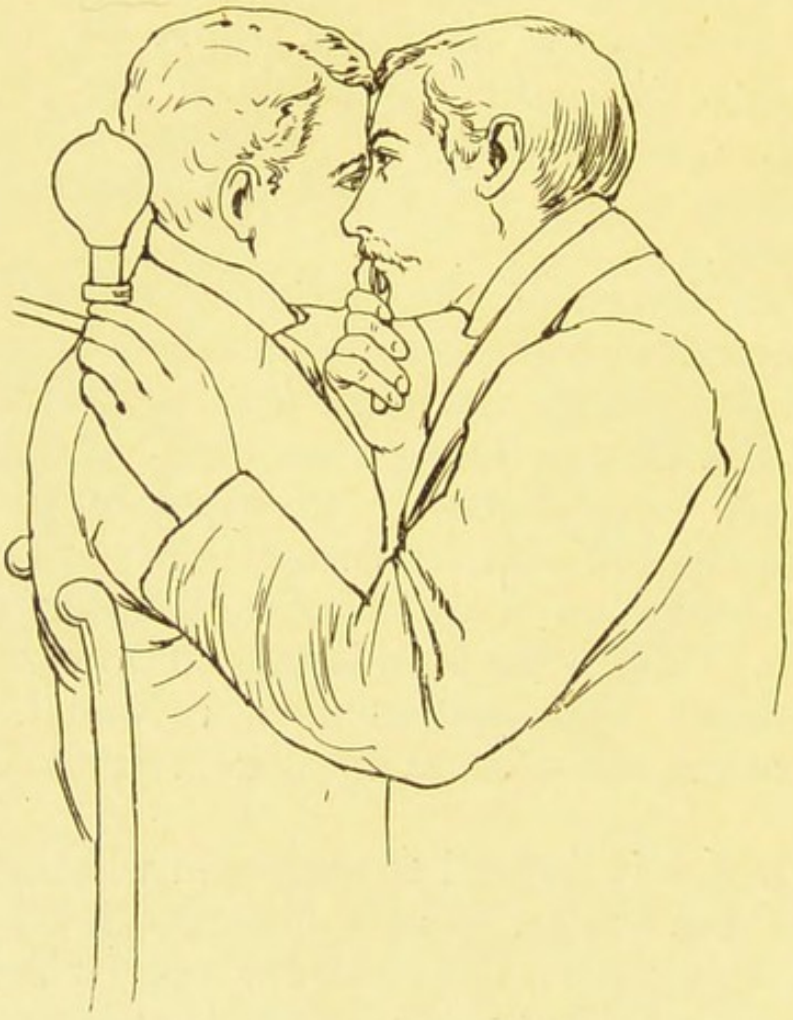
The macula is examined whilst the patient looks directly at the sight-hole, if the pupil is dilated, or at the observer's forehead just above the mirror, if it is not under the influence of a mydriatic.

The nature of the patient's refraction is ascertained with the indirect method by gradually withdrawing the large lens from the eye whilst the disc is being examined; the image will then appear either to increase in size, myopia; to diminish, hypermetropia; or to alter in one meridian more than in another, astigmatism. When the lens is moved towards the eye, these appearances are reversed. In emmetropia no change is observed in either case.

When it is desired to ascertain whether one part of the fundus is at a different level from an adjoining part, the observer moves the lens slightly from side to side, and notes whether one part seems to move over the other; for instance, in cupping of the optic disc, the margin appears to move on or over the deeper surface.

The direct examination.—*Requisites*: A refraction ophthalmoscope with two tilted mirrors, one plane, the other concave, with a

focus of 7 cm., and each with a central aperture 2 mm. in diameter. In the disc behind the sight-hole is placed the lens which corrects any ametropia the observer may possess: this



avoids the necessity of making a calculation each time the refraction of an eye is estimated.

For the examination of the right eye the lamp is placed on the right side of the patient's head, on a level with the eye, and in a line with and about 20 cm. from the ear. The examiner's stool is placed on the right side of

the patient's chair in such a position and at such a height that when the observer sits on it, his right eye is directly in front of the patient's right eye.

Whilst thus sitting almost side by side, facing each other, the patient, with head erect, is directed to look at a distant fixed object directly in front of and on a level with his eyes. The observer now holds the ophthalmoscope in his right hand, supports its upper end against the side of his nose and right eyebrow, looks through the sight-hole, and reflects the light into the patient's right pupil, which at once appears brilliantly illuminated provided the media are clear.

In order to accomplish this with the utmost ease, the observer turns the apex of the wedge formed by the tilted mirror a little upwards above an imaginary horizontal line, passing through the centre of the sight-hole ; in this way the apex is made to point towards the root of his nose when he holds the instrument vertically with its broadest surface parallel with his face. With his disengaged left hand he moves the lamp about until the dark point in the centre of the area of light reflected by the mirror, which corresponds to its central aperture, falls on the pupil ; as soon as this occurs the fundus details can be seen distinctly, provided that the observer looks with relaxed accommodation into an emmetropic eye, or through a lens which corrects the patient's error of refraction

if he is ametropic. For this purpose the observer keeps his forefinger on the driving wheel of the ophthalmoscope, and brings lens after lens into the sight-hole until the fundus details are seen distinctly.

The above description applies also to the examination of the left eye, if the word 'left' is substituted for 'right'; therefore the observer must employ his right eye in the examination of the patient's right eye, and his left for the patient's left.

The disc is seen by the direct method if the observer looks obliquely backwards and inwards, towards the posterior pole of the eye, the patient meanwhile looking directly forwards. The yellow spot comes into view when the patient looks directly at the mirror, and the remainder of the fundus is examined by tracing each of the main retinal vessels along its course from the disc to the periphery, where it is lost to view; the patient is directed to turn his eye in an appropriate direction as the course of each vessel is being followed.

The strongest convex or the weakest concave lens through which the observer can distinctly see a small vessel close to the yellow spot is the measure of the patient's ametropia; and if two vessels which are as nearly as possible at right angles to each other are not seen distinctly with the same lens, the eye is astigmatic; the weaker lens gives the spherical glass, and the difference between the two re-

presents the cylinder. But before the student can rely on estimating the patient's refraction correctly by this method, he must be able to completely relax his own ciliary muscle, otherwise the lens chosen will, in part at least, or even wholly, represent the amount of accommodation he has exercised when looking into the patient's eye. The patient's accommodation must also be at rest.

The power of completely relaxing the ciliary muscle can be acquired whilst the observer wears the glasses which fully correct any error of refraction he may possess by practising the following exercises: (1) The observer looks up towards the ceiling, and then holds a sheet of paper, upon which there is an ink-spot, just above his eyes. When he notices that the spot appears double, the paper and the eyes are to be slowly lowered, and as long as the gaze is still directed into the distance the dot will continue to appear double even when it is below the level of the eyes. (2) When the observer has mastered this exercise, he may proceed to hold a pen or pencil about 25 cm. in front of his nose, and if he keeps his gaze directed into the distance the object will appear double, and the two images will be almost as wide apart as his base line is long. (3) Finally, if whilst reading a piece of fine print, which is held as close to the eyes as possible, the observer looks through the book, as it were, the letters will run together and become obscured;

at the same time he will feel that his eyes cease from converging and begin to diverge until they are parallel. These exercises are repeated many times until the observer can bring an object close to the eye without attempting to converge or accommodate.

Having thus got control of his accommodation he is in a position to estimate the refraction of any part of the fundus by the direct method, and to say whether one part of the fundus is more elevated or depressed than another. Difference of level may be expressed in diopters or millimetres, for 3 D = 1 mm.

The accuracy of the results obtained by the direct method should be tested by comparing them with those obtained by retinoscopy and the subjective examination.

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