A practical treatise on diseases of the eye / by Édouard Meyer ; translated with the assistance of the author from the 3rd French ed., with additions as contained in the 4th German ed., by Freeland Fergus.

Contributors

Meyer, Édouard, 1838-1902.
Fergus, A. Freeland 1858-1932.

Publication/Creation

London : Charles Griffin, 1887.

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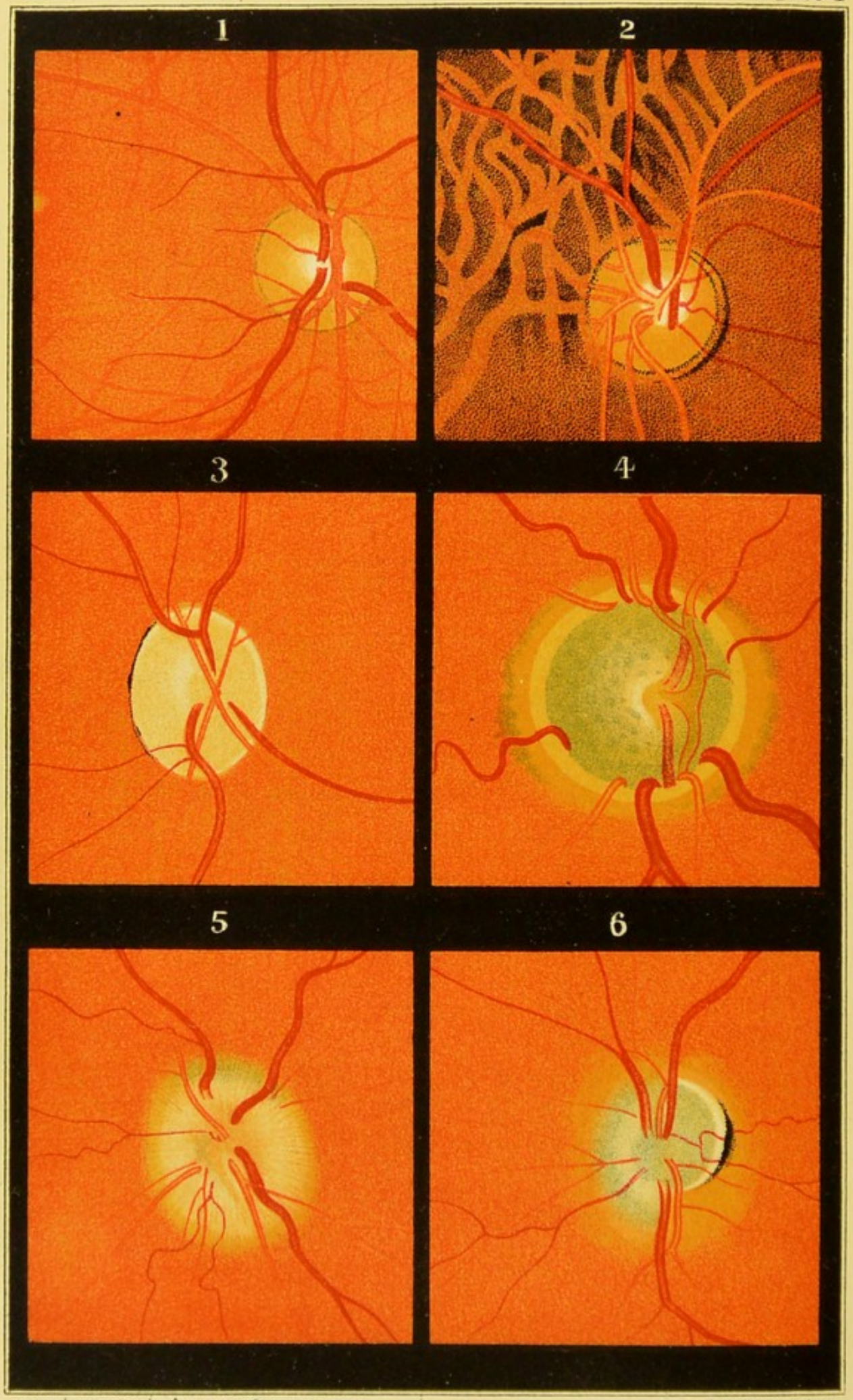

FROM LIEBREICH'S ATLAS OF OPTHAMOLOGY.

J. W. WATSON, LITH.

PLATE I.

Figs. 1 and 2—*The Normal Fundus Oculi.*—In fig. 1 (which is taken from the eye of a person with very light hair and a blue iris) the disc is of a rosy tint. The blood-vessels emerge at the centre of the disc, which is here of a deeper white. The paler vessels are the retinal arteries, the darker ones the veins. They pass over the disc to the retina, where they divide in different directions, chiefly upwards and downwards. The fundus of the eye is of a pale, brilliantly red colour, on which the finest branches of the choroidal vessels can be distinctly traced.

In fig. 2 (which is taken from a person with black hair and a dark-brown iris) the optic nerve entrance appears circular and of a yellowish-white tint. The fine grey film in the region of the disc and yellow spot is due to the reflection from the retina; it is only observable in dark eyes, and is consequently altogether absent in fig. 1. The fundus of the eye is of a rich dark-red tint, and only the retinal vessels are apparent, those of the choroid being hidden by the density of the pigment in the epithelial layer and stroma of the choroid.

Fig. 3 represents a case of *white atrophy* after meningitis. The disc is very white, and faintly cupped. The vessels, and particularly the arteries, are much diminished in calibre.

In fig. 4 is represented a very marked degree of *glaucomatous excavation*, the cup being very deep and abrupt. The disc is surrounded by a pale light girdle, its colour is much darker at the periphery than in the centre, and the retinal vessels are more or less considerably bent or interrupted at the edge of the papilla.

In fig. 5 is represented the swollen and enlarged papilla consequent upon *optic neuritis*, the opacity of the disc being denser and markedly striated. The retinal veins are enlarged and tortuous, the arteries diminished in size, and, here and there, hidden by the exudation.

Fig. 6 shows the condition of *optic neuritis* when consecutive *atrophy* has supervened in some parts of the disc. The opaque tint, as well as its somewhat ill-defined margin, help to distinguish it at a glance from the progressive form of white atrophy (fig. 3).

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A PRACTICAL TREATISE

ON

DISEASES OF THE EYE.

BY

DR. ÉDOUARD MEYER,

PROF. À L'ÉCOLE PRATIQUE DE LA FACULTÉ DE MÉDECINE DE PARIS, CHEV. OF THE LEGION OF HONOUR, ETC.

Translated, with the assistance of the Author, from the Third French Edition, with additions as contained in the Fourth German Edition,

BY FREELAND FERGUS, M.B.,

OPHTHALMIC SURGEON, GLASGOW ROYAL INFIRMARY; ASSISTANT SURGEON, GLASGOW EYE INFIRMARY.

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PREFACE.

"*Habent sua fata libri!*" The fate of this book is a peculiar one. It was first published fifteen years ago for the purpose of replacing, in the hands of the French student, an English Treatise—Wharton Jones's celebrated work on Diseases of the Eye—which had been translated into French, and was generally used in France. The last edition having been exhausted, I was asked by the publisher in 1872 to provide it with a fresh infusion of modern ophthalmology, but this, in my opinion, the old frame could not stand. I preferred to write a new text-book, arranging, for this purpose, my public lectures at the *École Pratique de la Faculté de Médecine de Paris*, some portions of which—those relating to Refraction and Accommodation, and to Ophthalmic Surgery—had been already published. Such is the origin of this book, which has now gone through three French and four German editions, and has, besides, been translated into Italian, Spanish, Polish, and Russian—even a Japanese translation (of which a copy was presented to me last year by Dr. Inouy of Tokio) has been issued.

When first asked to grant authorisation for an *English* version, however, I must confess that the request perplexed no less than it pleased me, knowing well how many valuable Treatises on Ophthalmology already exist in the language, by authors of renown at home and abroad. Nevertheless, I did not think it right to refuse permission.

My best thanks are due to Dr. Fergus for his careful translation, and to Dr. Liebreich for his permission to illustrate the work with coloured plates chosen from his well-known Atlas of Ophthalmoscopy.

It will be a pleasure to me to learn that the English edition proves useful, and finds favour with my English-speaking *confrères* and students on both sides of the Atlantic.

ED. MEYER.

73 Boulevard Haussmann,

Paris, *April*, 1887.

"L'ENVOI,"

BY THE TRANSLATOR.

"*À bon vin il ne faut point de bouchon*"—and Dr. Meyer's Treatise on Ophthalmology needs no comment from me. Therefore, in laying the work before an English public, I would only express a hope that it may prove as helpful to others as it has been to myself. The original work struck me as being not only the most concise, but also the most comprehensive, Manual on the branch of which it treats that I had ever perused; and it was this conviction which led me to undertake the Translation—in the belief that the excellence of the subject-matter would be found to outweigh far any deficiencies on my own part.

My best thanks are due to Mr. Andrew Marshall for his able assistance during the progress of the work through the press.

F. F.

41 Elmbank Street, Glasgow,
April, 1887.

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PRACTICAL TREATISE

ON

DISEASES OF THE EYE.

CHAPTER I.

GENERAL CONSIDERATIONS ON THE DIAGNOSIS AND TREATMENT OF OCULAR AFFECTIONS.

ART. I.—Examination of the Eye with a View to Diagnosis.

Symptoms.—The symptoms, by means of which we recognise the situation and nature of an affection of the eye, may be divided into two groups—*the objective symptoms* and *the subjective symptoms.* To the first of these groups, the **objective,** belong all the material changes which the surgeon himself can see and touch; to the second, the **subjective,** belong the functional disturbances, that is to say, alterations in vision, pain, and other morbid sensations, of which the patient must inform us.

Experience teaches that it is preferable to begin the examination of the diseased eye by the investigation of the objective signs. In this examination, the surgeon should accustom himself to follow a definite plan, reviewing successively, and in their anatomical order, the several portions of the eye. Thus are readily acquired that capacity and precision, so beneficial to the surgeon and agreeable to the patient, which enable him at once to recognise the condition of the diseased organ, to localise the seat of the disease, and to distinguish, amongst all the symptoms present, those which are essential from those which are due to the secondary affection of the structures next to the principal seat of the

disease. Again, we observe, especially in external inflammations of the eye, that the anatomical, nutritive and functional relations existing between the various membranes frequently produce such a rapid extension of the disease that a careful consideration of the symptoms is required before we can determine what is the **primary** affection; a determination which is nevertheless indispensable, if the surgeon would effectively attack the evil at its source.

The customary method of examining the diseased organ when we wish to arrive at a diagnosis is as follows:—

I. Investigation of the objective symptoms, either by natural light, with or without the use of a magnifying glass, or by artificial light—focal illumination.

II. Investigation as to the state of vision.

III. Investigation of the media and deep structures by means of the ophthalmoscope.

It is evident that the surgeon does not require always to use all these means. The information furnished by the patient and the surgeon's own experience, easily determine the best and shortest method to be followed in each case.

Objective Examination of the Eye.

Examination of the External Parts.—1. The eye must first be examined without touching it. Nothing is more common than to see students, when asked to examine a patient, placing their hands on the eyelids to separate them. Not only does this action nearly always frighten the patient, but it also provokes, especially in the case of inflammation, an afflux of blood, lachrymation, &c., which may easily give rise to a mistake as to the condition of the diseased parts.

The patient being conveniently seated so that the parts to be examined are properly illuminated, the eyebrows, the margins of the orbit, the eyelids and the region of the lachrymal sac are successively passed in review. If during this inspection any irregularity be found, this condition is compared with that of the same part of the other eye, and the examination is completed by careful palpation.

2. On asking the patient to open the **eyelids**, we notice the greater or less facility with which the palpebral margins are separated, and we also observe the presence, quality and quantity of the conjunctival and lachrymal fluid which may be found between the eyeball and the ciliary margins of the lids. If we then discover an

abnormal quantity of the lachrymal secretion, it is well, with the point of the finger, to press on the anterior wall of the lachrymal sac backwards and inwards, so that we may ascertain if this pressure cause a reflux of tears by the puncta.

In our examination, the free margins of the lids must not be overlooked; to inspect them properly, we must lightly separate the lids from the ball. This is best accomplished by placing the hand flat on the temple and lifting up the upper eyelid with the thumb, whilst the lower lid is drawn lightly downwards and outwards by the index and middle fingers of the other hand. With the hands thus applied, all pressure on the eyeball should be avoided. The same course is followed when we wish to separate the lids in order to examine the anterior surface of the eyeball, with this precaution, that, in order not to distend the commissures unduly, the upper lid ought to be less raised when the lower is drawn well down, and *vice versâ*. In this way we examine the position of the puncta lachrymalia, the state of the palpebral margins, and the position and direction of the eyelashes, carefully seeking for the small pale pseudo-cilia, which, turned towards the eyeball, touch it as soon as the lids return to their normal position.

When it is desired to examine the **internal surface of the lower lid,** we separate it from the ball by drawing down the skin of the lid, and, in order thoroughly to expose the sinus or inferior palpebral cul-de-sac, the patient must be asked to turn the eyeball upwards, whilst we make slight pressure with the thumb of the other hand on the eyeball itself through the lowered upper eyelid.

To examine the **internal surface of the upper lid,** it must be everted in the following manner:—Having requested the patient to look downwards, we take hold of the eyelashes and of the margin of the lid, near the centre, with the thumb and index finger of the left hand. The lid being thus firmly held, we draw it downwards and at the same time away from the eyeball; then we place the point of one finger of the free hand, or the end of a thick probe, on the external surface of the lid, a little above the upper margin of the tarsal cartilage. Finally, we effect the eversion of the lid by depressing the upper margin of the tarsal cartilage, and at the same time carrying the margin of the lid forwards and upwards. The eversion thus accomplished, if we do not wish the lid to return at once to its normal position, we must direct the patient to keep looking downwards, whilst we retain the everted lid against the superior orbital margin, at the same time slightly pressing on the eyeball through the inferior lid. We then see the folds of the conjunctival sinus separating and becoming distinct.

On everting the lids, we can easily assure ourselves as to the state

of the palpebral conjunctiva and of the Meibomian glands, and also as to the presence of foreign bodies, which are often found fixed on the internal surface of the upper eyelid.

Finally, when the lids have resumed their normal position, we examine the **caruncle,** and the **semi-lunar fold** which is situated between the former and the white of the eye. In making this examination, we should ask the patient to turn his eye towards the temple, as his doing so materially assists our observation.

3. The **eyeball** should be examined and compared with its fellow as to its position in the orbital cavity, its direction, mobility, prominence, and consistence (tension). In order thoroughly to appreciate this last, we must direct the patient to look upwards, whilst the index finger of the left hand is pressed against the sclerotic through the inferior eyelid towards the angle of the eye, in order to fix the eyeball in this position, and counter-pressure is made with the index finger of the other hand on the opposite side of the sclerotic. This has to be done successively on both eyes to compare their tension. If we wish to examine in the same way, through the superior eyelid, the tension on the upper part of the sclerotic, and the superior equatorial region of the eyeball, care must be taken, in comparing both eyes, that they have exactly the same position, looking downwards.

Lastly, by making the patient turn the eye as far inwards as possible, and by separating the lids towards the external angle, we may form an idea of the curvature of the sclerotic near the equator of the eyeball, and from this we may estimate the length of its antero-posterior axis.

4. To examine the **anterior part of the eyeball,** we must uncover it by separating the lids. We have already described the manner in which this should be done so as to cause the patient the least possible inconvenience. Yet the difficulties of this examination are often sufficiently great when the lids are tumefied, especially in children, who contract their orbicular muscles, and thus evert the eyelids, so that the palpebral mucous membrane is seen, whilst the eyeball itself is entirely hidden.

When the surgeon deems it necessary to ascertain the condition of the eyeball, there must be no delay in overcoming all the difficulties of the examination; every care should be taken, but nevertheless a degree of firmness exercised, for the annoyance which the patient suffers lasts only for a few moments, whilst the omission of this examination may lead to very serious consequences.

In these difficult cases of children the surgeon should be seated on a chair, with a towel spread over his knees. To his left and a little in front of him should be seated on another chair his assistant, holding

the child in such a manner that its head may rest on the knees of the surgeon, who can thus fix it firmly. Whilst the assistant keeps the child still, the surgeon separates the lids with his fingers, as already described, and keeps the eye open by holding the margins of the lids with his index finger and thumb against the orbital edges. When the lids are inverted so that the eye is hidden, he may advantageously use small metal, or, better still, tortoise-shell elevators* (see Fig. 1).

Fig. 1.—Lid Elevators.

In the examination of the scleral surface of the eye, it is important, first of all, to pay attention to the condition of the **ocular conjunctiva,** noting its vascularity, the presence or absence of redness, and its attachment to the sclerotic, from which it is separated by a cellular tissue that may become the seat of an extravasation of blood or of an accumulation of serous fluid. Through the semi-transparent conjunctiva we may readily observe any alteration in the colour of the **sclerotic,** as also any partial or general ectasia of this membrane. The portions of the conjunctiva and sclerotic immediately surrounding the circumference of the cornea, and also the **conjunctival limb,** require a special examination as to their vascularity, and as to the presence of partial exudations or of thickening of the conjunctiva.

5. In order thoroughly to examine the **cornea,** the patient must be placed so that the light shall fall obliquely, from the temporal side, on the eye to be examined. We thus escape all reflection from the surface of the cornea, and may observe alterations in its brilliancy, polish, transparency, curvature, and sensibility. The degree of sensibility of the cornea may best be estimated by lightly touching its inferior half with the extremity of the index finger, or with the end of a soft roll of paper; while, at the same time, the patient is directed to look upwards; and touching of the lashes is avoided by drawing the lower lid somewhat downwards. When the patient does not try to escape from our touch by throwing back his head or closing his eye, we may be certain that there is a diminution of the excessive sensibility of the cornea—a symptom of the greatest value in the diagnosis of certain morbid conditions.

* For very sensitive eyes, one or two drops of cocaine put on the conjunctiva render good service in taking away the local sensitiveness and allowing the eyelids to open without pain.

To estimate roughly the degree of curvature of the cornea, it is well to examine it in profile, comparing it with the cornea of the other eye. But in small degrees of anomalous curvature, we cannot pretend to obtain in this way an indisputable result. It is, then, better to confine our attention to the observation of corneal reflexes, carefully examining the size of the images formed by any object whatsoever (*e.g.*, the bars of the window) on the right eye and on the left, and on different parts of the same cornea, for which purpose we make the patient change the position of the eye. The size of the image formed by the same object, placed at a given distance, on a convex mirror (and we can regard the cornea as such) is in direct proportion to the curvature of the reflecting surface. Thus, to compare the curvatures of the two corneæ, we place the same object—say, the flame of a candle—alternately before each eye at the same distance, and compare the images reflected by the surface of the cornea. The greater curvature will belong to the cornea with the smaller image. When, on moving the flame of a candle before the cornea, we observe variations in the size of the reflected image for different portions of the same cornea, we may conclude that there exists some irregularity in the form of this membrane.

To avoid other reflections than those of the candle-flame, this experiment must be made in a darkened room.

The examination just described becomes easier, and its results more exact, and directly measurable, when we use, as an object of reflection, a disc made of metal or cardboard, painted with concentric black and white circles (Fig. 2—*Keratoscope of Placido, Javal-Schiötz, Hirschberg*). Placing it before the eye of the patient, who has his back turned to the light, we observe, through the aperture in the centre of the disc, the image of the concentric circles reflected by the cornea.

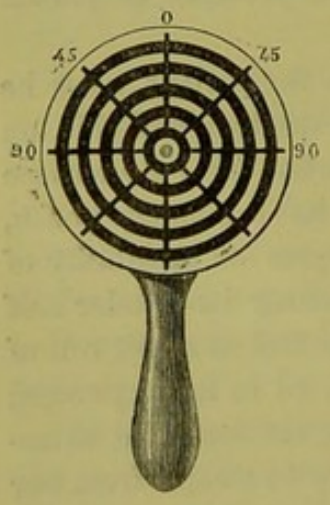


Fig. 2.—Keratoscope.

The examination of the cornea should be immediately followed by that of the **Anterior Chamber**, its dimensions and its contents being noted. The size and form of the anterior chamber are determined by the distance between the cornea and the iris, which consequently must be observed at the same time.

As for the **iris**, the surgeon's attention should be given to its colour, texture, curvature, and position. In regard to the last, he must first view it generally—*i.e.*, estimate the distance separating it from the cornea, ascertain if this distance is constant, or if there is tremulous

iris, and then examine attentively the sclerotic insertion of the iris and its pupilary margin. Both are found, in different diseases, sometimes pushed forwards towards the cornea, sometimes drawn backwards towards the lens.

The examination of the central margin of the iris leads us to that of the **pupil.** In the first place, we observe its form and size. Its form, normally circular, may undergo the most different variations when the margin adheres at one or more places to the capsule of the lens (Synechia posterior) or to the cornea (Synechia anterior). Posterior synechiæ are sometimes visible only when we artificially dilate the pupil (as described further on). The diameter of the pupil varies according to age, to the amount of light entering the eye, and to the adaptation and position of the eyeball. In the normal condition, it is more dilated if the individual be young, his eye little exposed to light, and if he be looking at objects at a distance. The greatest importance must be attached to the careful examination of the **mobility** of the pupil. To effect this, the patient should face the light. The surgeon, standing or sitting before him, closes both of the patient's eyes by drawing down the upper lids. After a moment of rest, he suddenly uncovers one eye and observes the degree of dilatation of the pupil, as also the rapidity with which it contracts when exposed to the light. After having again closed both eyes, he suddenly uncovers the other eye, and submits it to the same tests.

The colour of the pupil, deep black in youth, varies with age, so that in elderly persons it assumes a greyish or yellowish aspect, and may cause the observer to conclude that a cataract is present.

Under normal conditions, we can only extend our examination as far as the pupil, since to see accurately into the interior of the eye behind the iris, requires the use of instruments, of which we shall speak in another chapter. But even at this stage certain appliances will be found exceedingly useful in the examination of the superficial structures of the eye for the better distinguishing of the details of a lesion. We refer to the **magnifying glass** (*loupe*) and to the method of **lateral or focal illumination.**

The former, which is very widely used, sufficiently magnifies the images of the various points surveyed in the investigation; and the **magnifying glass of Brücke** may advantageously be employed. This glass is so constructed as to give a considerable enlargement (from three to eight times), and in using it the surgeon is not obliged to come inconveniently near the eye of the patient.

Focal illumination consists in directing obliquely towards the eye rays from a lamp made to converge by a bi-convex lens on any point which we may wish to examine.

As is shown in Fig. 3, the lamp must be placed on the temporal side and a little in front of the eye, the lens in the path of the luminous

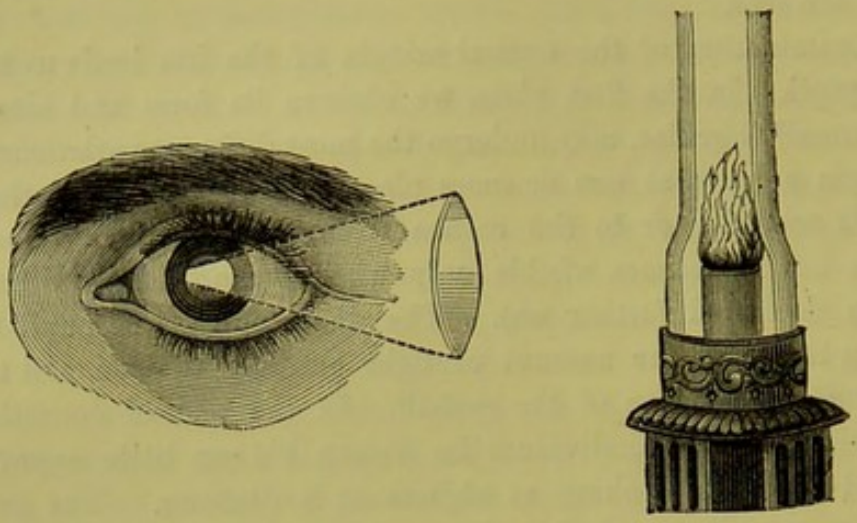


Fig. 3.—Focal Illumination.

rays, so as to concentrate them on the part to be examined—cornea, iris, or pupil.

This examination, which should be made in a dark room, requires a certain amount of practice, to derive from it all the information possible. Thus, it is obvious that, in order to illuminate successively the different parts of the anterior hemisphere of the eyeball, we must change the position of the bi-convex lens by slightly rotating it on its axis, and we must also vary its distance from the eye which we are examining. We may also employ the magnifying lens at the same time that we illuminate the eye in the manner indicated. Lateral illumination is of the greatest utility in the examination of the cornea, iris, pupil, crystalline lens and even of the anterior portions of the vitreous humour. If, however, we wish to employ it in examining the pupil or the structures behind the pupil, it is necessary to increase the field of observation by previously dilating the pupil by means of a few drops of a weak mydriatic solution (homatropine, atropine, duboisine, or cocaine).

Of the various **mydriatics** mentioned, the effect of *homatropine* is the least prolonged, rarely lasting more than twenty-four hours, and often a much shorter period. The hydrobromate may be used for mydriatic purposes. As it also paralyzes the muscle of accommodation, it may be advantageously used instead of atropine, when it is found necessary to have recourse to mydriatics in correcting errors of refraction (strength 1 – 150 of water).

In using *atropine*, the liquor atropiæ sulphatis is to be preferred to the ordinary liquor atropiæ, which is exceedingly unsatisfactory, in so far that the alkaloid is very often not perfectly dissolved, while, from the spirit contained, the solution is apt to irritate the eye. It has recently been shown that although the sulphate of atropine is not soluble in vaseline, the alkaloid itself is, by means of a gentle

heat; and possibly one of the best methods of using atropine is in the form of an ointment, containing from 4 to 8 grains of atropine to 1 ounce of vaseline.

Duboisine may be employed in the strength of from 1 to 2 grains to the ounce.

Cocaine may be used in the strength of 2 to 4 grains to the ounce. It is best dissolved in camphor water, or in water containing a little spirit of camphor, as the aqueous solutions undergo fungoid changes which spoil the efficacy of the drug.

Mydriatics should be used with caution, for in certain cases they seem to determine an acute attack of glaucoma.

In using these mydriatics, it must not be forgotten that the solution which we are in the habit of employing to dilate the pupil, even although weak (cocaine excepted), at the same time modifies the power of accommodation of the eye, so that if it is proposed to examine the accommodation we must do so *before* using the mydriatic. For a similar reason, we investigate the visual functions before exploring the fundus of the eye with the ophthalmoscope, because this also, in a certain number of cases, requires the previous dilatation of the pupil. Again, the use of the ophthalmoscope produces a perceptible dazzling by the greater quantity of light projected into the eye, and if the visual functions are examined immediately after, the patient is in the condition of a person who has passed from a bright light to a darker. The results of an examination made under such unnatural conditions may cause the observer to err as to the real state of the patient.

Formerly, for the objective examination of the state of the *parts of the eye behind the pupil* the means at command were very inadequate. In order to judge of the transparency of the crystalline lens, the images of a flame reflected by its two surfaces were examined—a method which has now become useless, since we are able to ascertain, by means of lateral illumination and of the ophthalmoscope, the presence of the smallest opacities. While using lateral illumination we must investigate the condition of the pupilary margin and of the lens, and, having dilated the pupil, it will be easy to investigate the pupilary field, the capsule of the lens, and the lens itself in its entire thickness. All these structures being in their normal state quite transparent, this examination will reveal to us the existence of the smallest opacities, their extent, form, and colour.

Examination of the Internal Structures of the Eye.

The Ophthalmoscope and its Use.—The vitreous body and the deep membranes of the eye can only be examined by an ophthalmoscope.

The problem of illuminating the fundus of the eye, and of rendering it accessible to investigation, has been solved by *Helmholtz*. He has shown us both how to illuminate the fundus of the eye and how to observe accurately the assemblage of rays which are reflected by the fundus—that is to say, the image of the fundus of the eye as it is formed externally.

While illuminating an eye, in order that the observer may be able to see the fundus, he must place his own eye in the axis of the rays entering the eye which he examines, because, in accordance with an optical law discovered and enunciated by the inventor of the ophthalmoscope himself, the light follows the same path in leaving the eye as

Fig. 4.—Ophthalmoscopic Mirror.

in entering it. For this purpose a reflecting mirror, pierced at its centre, is employed (Fig. 4). Thus, when a lamp is placed at the side of the patient, the flame being at the same level as his eye, it is easy to illuminate the fundus by throwing the light of the lamp reflected by the mirror into the eye, and to observe it, when so illuminated, through the small central aperture (Fig. 5).

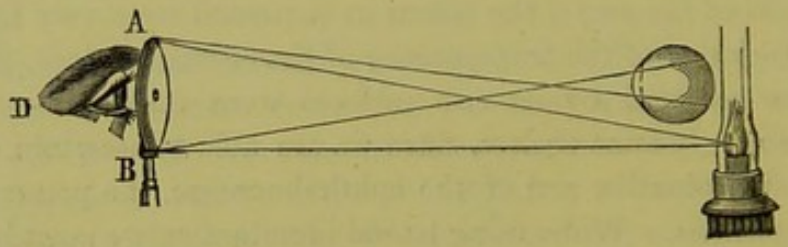


Fig. 5.—Illuminating the Fundus of the Eye.

The pupil now appears red, and if the media of the eye are transparent, the posterior hemisphere of the brightly illuminated eyeball is visible, although as yet we are unable to distinguish any of the details. The mirror must fulfil certain conditions in order to be useful. The first employed was a simple plain one, but soon it was found that such a mirror did not sufficiently illuminate the eye. Various other forms were tried, such as a plain mirror in combination with a bi-convex lens, or a bi-convex lens in combination with a convex mirror, or again a concave mirror, and this last is the one now generally adopted. The most suitable focus is found to be 20 centimetres.

To see the details of the fundus of the eye which is being examined, a distinct image of the fundus must be formed on the retina of the observer's eye. What, then, are the conditions which must be fulfilled if we are to succeed in this, the aim of an ophthalmoscopic examination?

If the eye which is being examined is **emmetropic**—*i.e.*, of normal refraction—and if the accommodation is at rest, luminous rays, in order

to be brought to a focus on the retina, must enter the eye parallel to each other. All rays which emanate from the retina of such an eye are also parallel on emerging. Again, if the observer's eye is emmetropic, parallel luminous rays coming from another eye will be brought to a focus on his retina, and thus he will receive a distinct image of the details of the fundus which he is examining (Fig. 6).

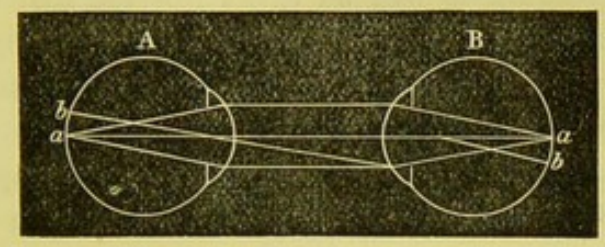


Fig. 6.—Formation of an Ophthalmoscopic Image of the Emmetropic Eye.

If the eye which is being examined is **myopic**—*i.e.*, possessed of a refractive power relatively too great—only divergent rays are brought to a focus on the retina, and rays emanating from this retina are convergent. An emmetropic observer must, by means of a *concave lens*, make such rays parallel before he obtains a distinct image (Fig. 7).

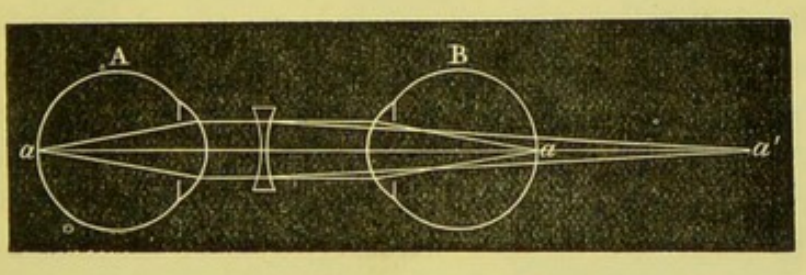


Fig. 7.—Formation of an Ophthalmoscopic Image of the Myopic Eye.

If a **hypermetropic** eye—*i.e.*, an eye with an insufficient refractive power is being examined—rays coming from the retina diverge on leaving the eye, just as if they proceeded from a point a' behind the retina. To focus such rays on his own retina, the observer must first make them parallel, either by means of a convex lens (Fig. 8), or, instead of this lens, by his own accommodation.

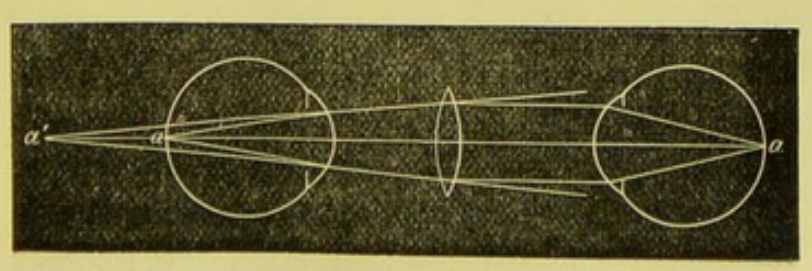


Fig. 8.—Formation of an Ophthalmoscopic Image of the Hypermetropic Eye.

In all these cases, we have supposed that the eye of the observer is

emmetropic. If it is not, he must correct the anomaly of his refraction by appropriate lenses. Such correction is indispensable for myopia; in hypermetropia, however, an effort of accommodation often suffices.

Again, the myopia or hypermetropia of the observer may be more or less completely compensated for by the hypermetropia or myopia of the patient, so that correcting-glasses may not be required.

From the preceding it will be easily inferred that by this ophthalmoscopic examination we can at the same time ascertain the refraction —emmetropic, myopic or hypermetropic—of the observed eye, while determining also the exact degree of any anomaly. If the observer be emmetropic, or have rendered his eye so by an appropriate glass, and keep his accommodation at rest, he can only see the ophthalmoscopic image of an emmetropic eye whose accommodation is entirely in abeyance. Should he require a convex or concave glass in the same conditions, the examined eye is hypermetropic or myopic, and the number of the glass that produces the most distinct image shows the degree of the hypermetropia or of the myopia. To be quite sure that the patient's eye does not make any effort of accommodation, it is sometimes necessary to use atropine.

To facilitate this examination the ophthalmoscopic mirror may be furnished with a series of convex and concave glasses, which can be interposed at pleasure between the eye of the observer and that of the patient, so that the instrument may easily be adapted to any condition of refraction in the one or the other (*vide* chapter on Refraction).

In such an examination, the observer sees the details of the fundus of the patient's eye in their natural position; the image which he receives is erect and enlarged. On this account this method is often called examination by **the erect image.** The refractive media of the patient's eye act as a magnifying glass; and, in order that the field of our ophthalmoscopic examination may be as large as possible, we must come as close as we can to the diaphragm of the magnifying glass—*i.e.*, to the pupil of the eye which we are examining.

The other method of ophthalmoscopic investigation, which gives a smaller image but a larger field of observation, is examination by the **inverted image.**

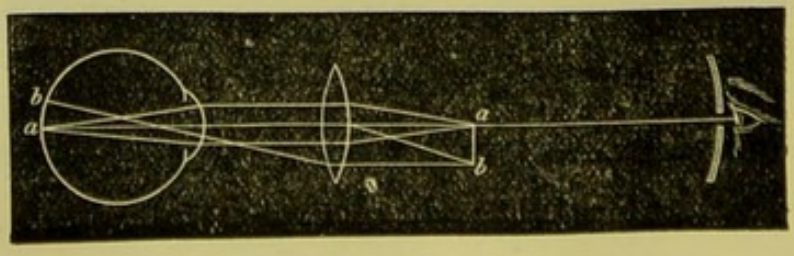


Fig. 9.—Formation of the Inverted Image.

When the observer places before his patient's eye a convex glass of 20, 16 or 12 dioptrics, luminous rays coming from the eye form an inverted image in the air, between the observer's eye and the convex lens. The image is formed at the principal focus of this lens, and the observer must adapt his accommodation for the distance at which the inverted image of the eye which he is examining, is situated (Fig. 9).

In practice, the examination must be made in a darkened room; the previous dilatation of the pupil by atropine is not necessary—for those, at least, who are accustomed to this kind of examination—unless when we are specially investigating the periphery of the fundus, or when the pupil is very contracted, as happens in the case of elderly persons and in certain affections of the spinal cord.

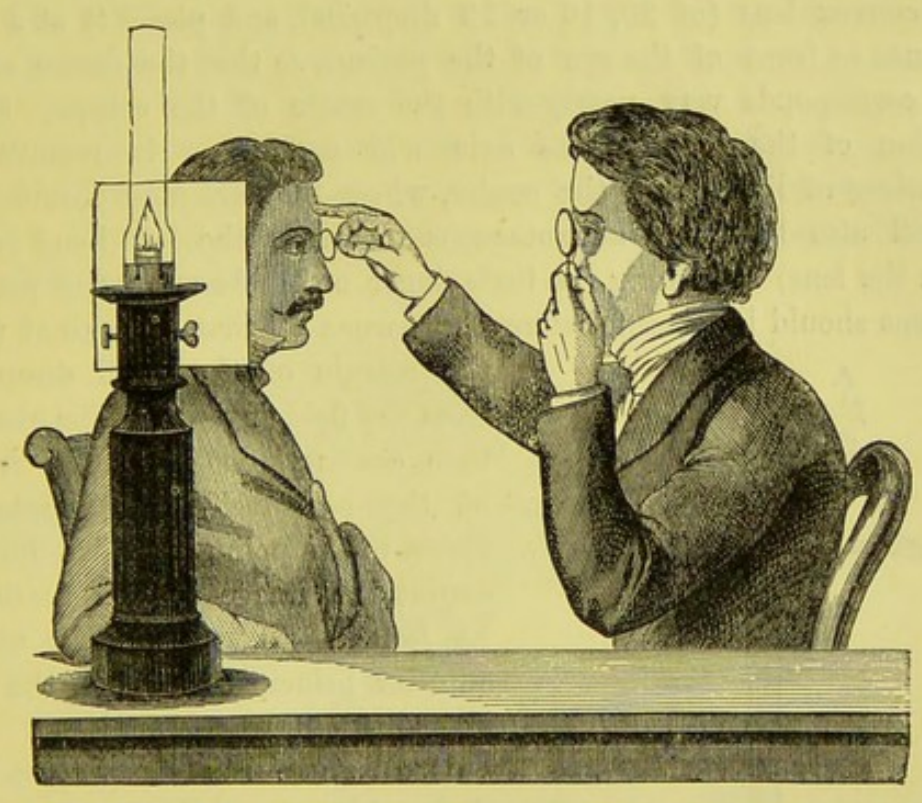


Fig. 10.—Ophthalmoscopic Examination of the Eye by the Inverted Image.

The patient being seated to the side and a little in front of a lamp, the flame of which should be at the same level as the eye to be examined, the surgeon takes a seat opposite to him and in such a position that his eyes are on the same level as those of his patient (Fig. 10). To illuminate the eye properly, he endeavours to direct the rays of light, emitted by the lamp and reflected by the mirror, into the pupil. The mirror ought to rest on the superciliary ridge, and at such an angle that the reflection may fulfil the conditions of the optical law according to which the angles of reflection and of incidence are equal. Beginners do not always find it easy to obtain at once the proper inclination of the mirror, or to maintain it during the time required for

an examination. Again, the frequent transition of the eye from an exceptionally bright light to darkness is very fatiguing for the patient; a sufficient amount of practice in this, as in any other part of the examination, is therefore quite indispensable. On the other hand, it is not difficult to acquire the requisite readiness of manipulation, if we become accustomed to follow the reflection of the mirror with the left eye, modifying the inclination of the mirror, so as to cause the light to enter the pupil. This accomplished, the direction may be maintained by steadying the mirror on the margin of the orbit, and, if necessary, by resting the elbow on the table.

Through the central aperture of the mirror, the observer now sees the red reflection from the fundus of the eye; he takes in his left hand a bi-convex lens (of 20, 16 or 12 dioptrics), and places it at a short distance in front of the eye of the patient, so that the centre of the lens corresponds very nearly with the centre of the cornea. Slight rotation of the lens on its axis will enable us to remove the reflections of light from the centre, where they are most troublesome. It will also be found advantageous to steady the left hand (which holds the lens) by resting the little finger on the brow of the patient; the lens should be placed before the cornea at that distance at which the margin of the pupil disappears from the field of vision. The observer then ceases to look into the fundus of the eye itself, and adapts his vision to the point at which he may expect the image of the fundus to be formed—that is, nearly at the anterior principal focus of the lens on the side nearest himself.

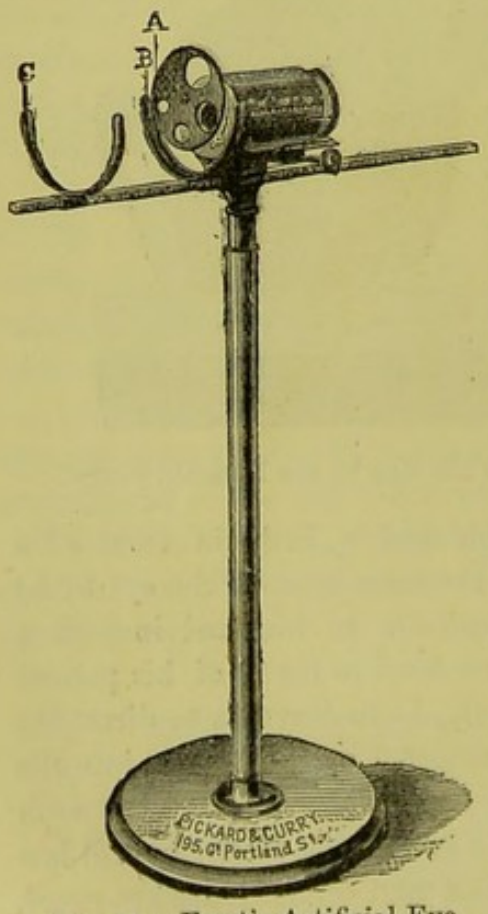


Fig. 11.—Frost's Artificial Eye.

If all these conditions have been thoroughly attended to, there will be no difficulty in recognising any detail of the fundus of the eye, whether it be a vessel of the retina, or a portion of the papilla of the optic nerve. This last, which must always be sought for first of all, is situated to the inner side of the posterior pole of the eye, so that the patient should be requested to direct the eye under examination somewhat inwards.

The necessity for exact and minute compliance with all the details of

an ophthalmoscopic examination, and the difficulty which the student finds in adapting his eye for a nearer distance than that of the part he is examining, sufficiently explain why the use of this method requires diligent and persistent practice before it can be of much service.

The artificial eye of *Perrin* or that of *Frost* (Fig. 11) affords, to those who are beginning the study, a valuable means of experiment.

It seems superfluous to speak of the great number of instruments which have been constructed since *Helmholtz's* first publication on the ophthalmoscope; they are all based on the same principle. We need only mention that an ophthalmoscope, the mirror of which is obliquely placed (inclined on the vertical axis, *Wadsworth, Hirschberg*), is to be preferred for the examination of the erect image. *Coursserant's* small apparatus, which can be applied behind the usual ophthalmoscopic mirror, procures, during the examination of the inverted image, a *second* distinct image visible to another observer. The most important innovation is that introduced by *Giraud-Teulon,* whose ingenious instrument permits of the observer using both his eyes simultaneously, and thus obtaining all the advantages of binocular vision, whilst it affords him more relief.

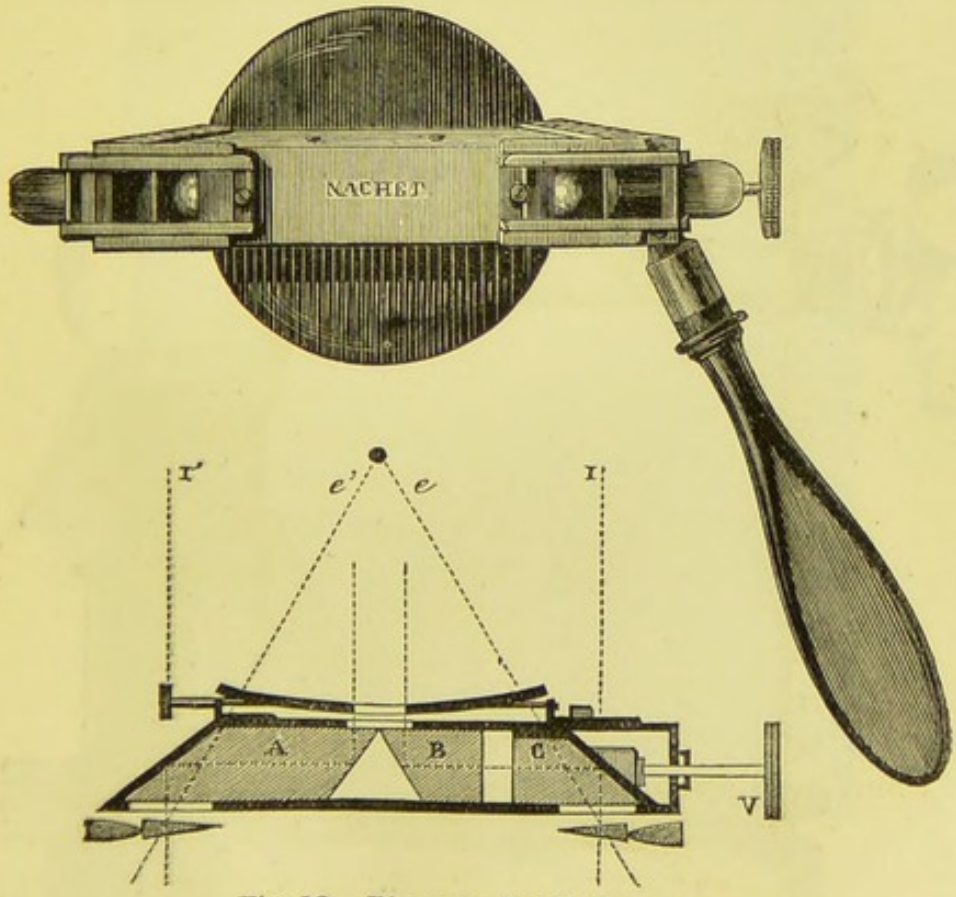


Fig. 12.—Binocular Ophthalmoscope.

The annexed figure indicates how the luminous rays are made to diverge by two rhombohedra, so as to be carried to the observer's two

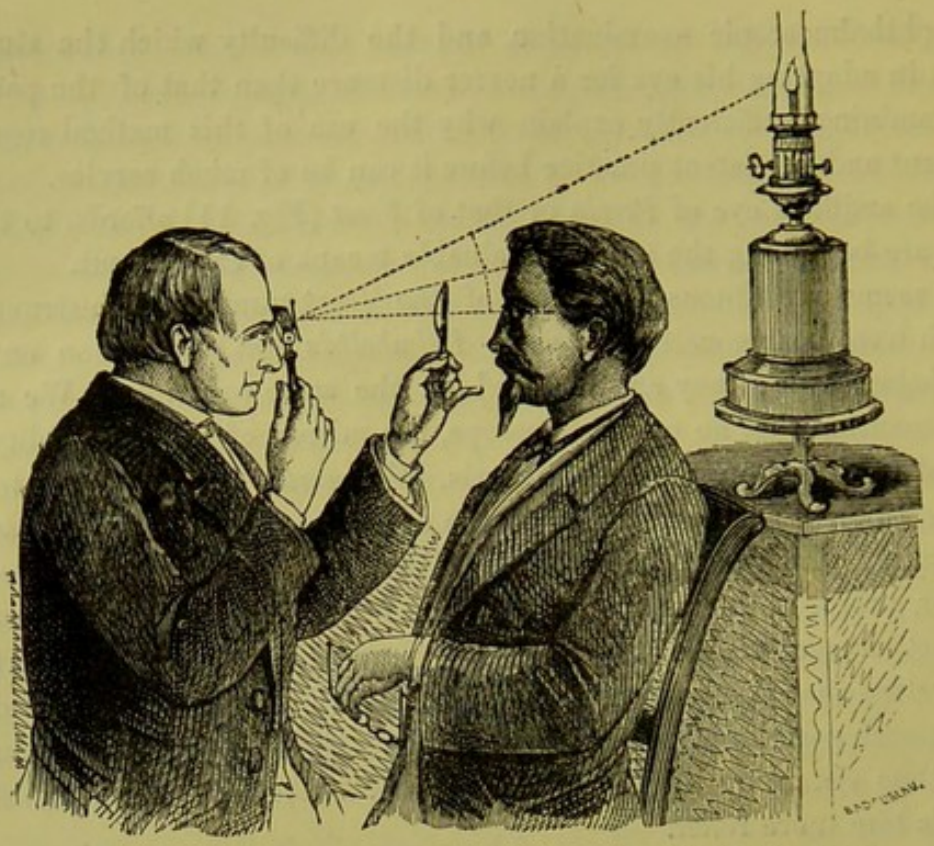


Fig. 13.—Examination of Eye with Binocular Ophthalmoscope.

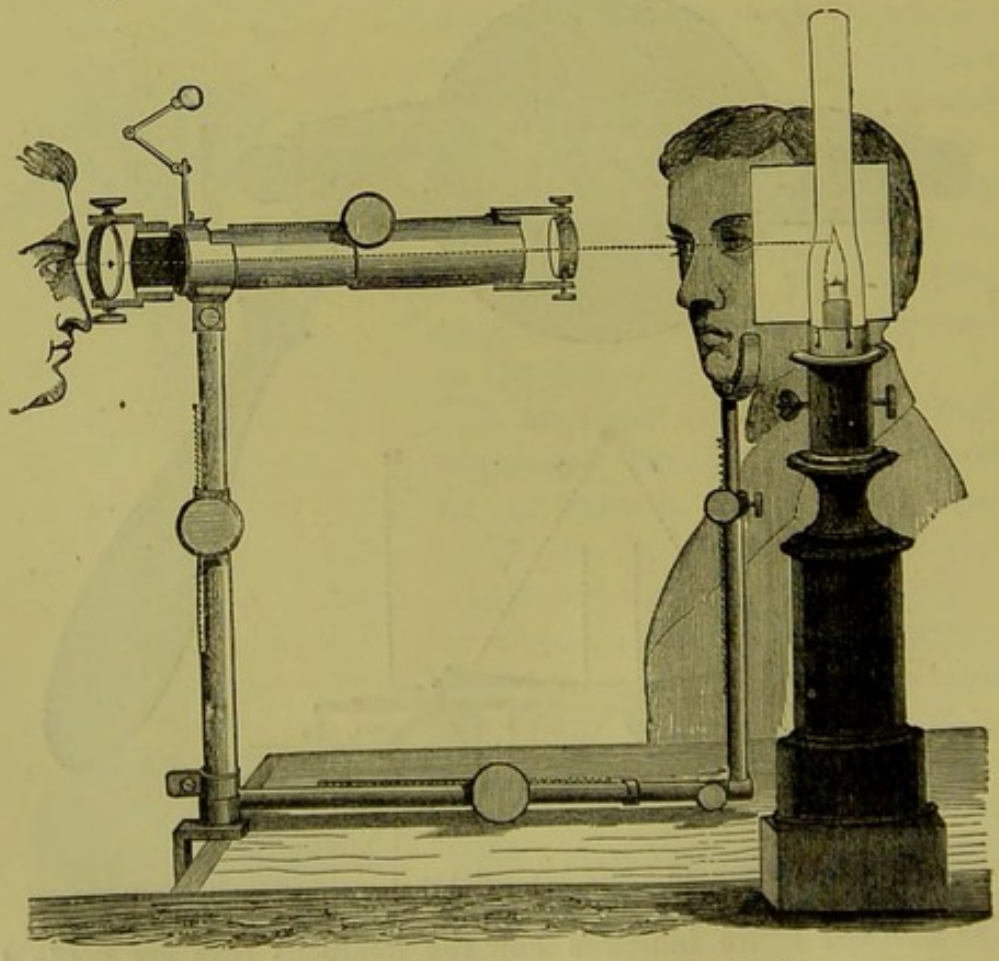


Fig. 14.—Fixed Ophthalmoscope of Liebreich.

eyes, before which prisms are so placed as to fuse the two images into one (Fig. 12). In using the ophthalmoscope, the lamp has to be placed behind and above the head of the patient (Fig. 13).

For greater facility in teaching, and for those who are not as yet familiarised with the ophthalmoscopes which we have just described, there has been devised, in addition to the different pieces forming the ophthalmoscope, stationary apparatus, by means of which both the reflecting mirror and the bi-convex lens may be placed at the proper distances from the eye which is being examined. The image of the fundus of the eye, which is thus invariably formed at the same spot, is easily seen, and may be studied and sketched at leisure. The first of these instruments was constructed by *Liebreich*, modified very slightly by *Follin*, and simplified by *Cusco*, *Donders* and others. We annex a diagram of the fixed ophthalmoscope of Liebreich (Fig. 14), The binocular instrument of *Giraud-Teulon* has also been arranged as a fixed ophthalmoscope.

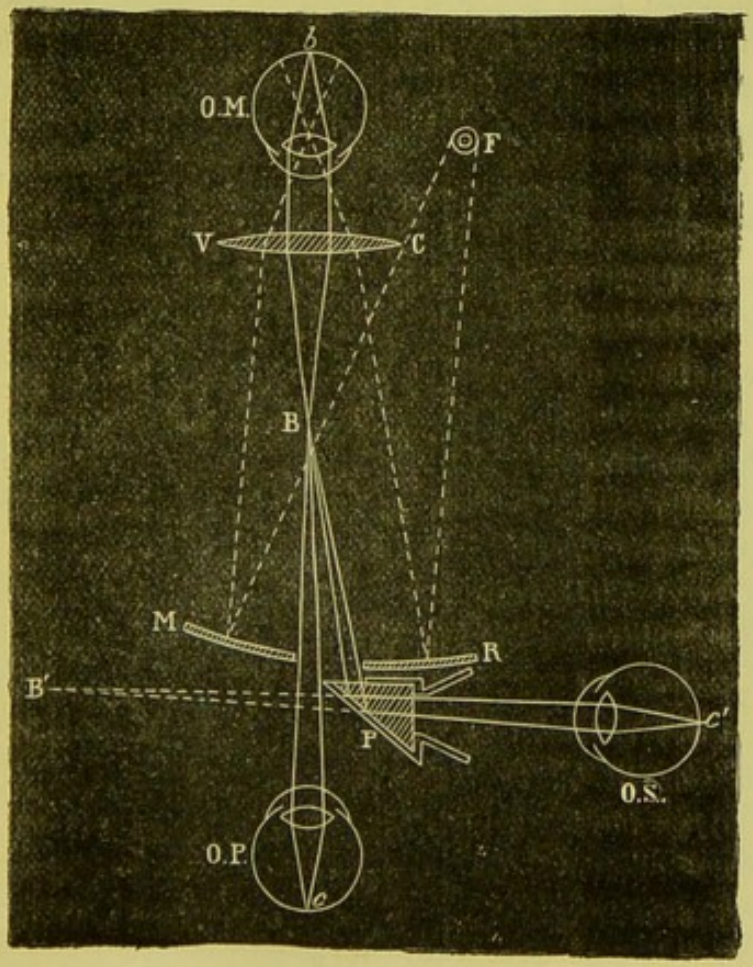


Fig. 15.—Ophthalmoscope of Sichel.

The ophthalmoscope of *Sichel* (Fig. 15) is specially designed to exhibit simultaneously to several persons the image of the fundus. This is done by rectangular prisms, which receive a portion of the

light coming from the ophthalmoscopic image and reflect it towards the eyes of a second and of a third observer, whilst another portion of the light enters directly the eye of the first observer. This ophthalmoscope, primarily arranged by *Sichel* for two observers, has since been constructed, on the same principle, for three by *Monoyer*.

It is evident that these fixed instruments cannot replace the movable ophthalmoscopes, with which an experienced observer can so easily make a complete examination, and more rapidly since he readily follows the movements of the patient's eye. So much cannot be said of the fixed ophthalmoscope—for this reason, that the least change in the position of the eye under examination causes the image, which we have seen an instant before, to disappear, and necessitates a readjustment of the apparatus.

From what has been said, it will be gathered that an essential condition of successful ophthalmoscopic examination is transparency of the refractive media of the eye. The slightest opacity in the path of the luminous rays projects a distinct shadow on the surface of the illuminated fundus, and the simple reflecting mirror thus becomes the most certain means of ascertaining its presence, and of determining its extent. We are now in a position to detect with precision the smallest opacity, either in the cornea, the pupil, the lens or the vitreous body.

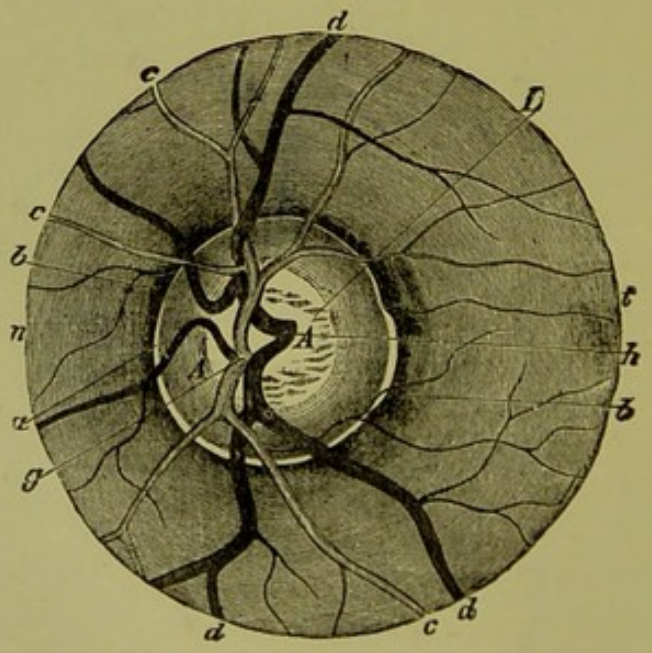


Fig. 16.

The entrance of the optic nerve with the adjacent parts of the fundus of the normal eye (after *Ed. Jæger*)—*a*, Ring of connective-tissue; *b*, choroidal ring; *c*, arteries; *d*, veins; *g*, division of the central artery; *h*, division of the central vein; L, lamina cribrosa; *t*, temperal (outer) side; *n*, nasal (inner) side.

It remains for us to describe the appearance of the **fundus of the eye** in its normal condition.

The first object of our investigation is the entrance of the optic nerve, known as the **optic papilla** (see Fig. 16).

We find it, either by following a retinal vessel towards its point of emergence, or by making the patient look in such a direction that the optic papilla will be situated in the axis of the observer's vision. It then appears as a round or slightly oval disc, of a yellowish-rose colour. On looking at it attentively, we may observe that the coloration is not the same throughout the whole surface; it is whiter at the centre and at the circumference than in the intermediate circle.

The circumference is formed by the sheath of the optic nerve, which, in passing through the opening in the sclerotic, intermingles its fibres with those of that membrane. The centre of the papilla sometimes presents a dotted appearance, corresponding to the lamina cribrosa. A practised eye frequently distinguishes on the surface of the optic papilla a more or less deep depression, known as the **physiological excavation.**

The circumference of the papilla is sometimes bounded by a narrow whitish circle, which is nothing else than the margin of the sclerotic opening left uncovered by the choroid. At other times, a well-defined black line is seen in this situation, due to the accumulation of choroidal pigment at this point.

At the centre of the papilla appear the central arteries and veins of the retina, which, dividing into several branches, are distributed all over the fundus. The veins are distinguished by their winding course, their larger calibre and deeper colour.

On leaving the papilla and directing our attention to the fundus in general, we observe marked variations in the shade of the reddish coloration present, according as the individual examined is fair or dark. But, the retina being quite transparent, the tint which is observed essentially depends on the choroid. This membrane encloses, in the various layers of which it is composed, a quantity, more or less great, of pigment, deposited either in the interstices of the vessels or above them. Hence it will be easily understood that when the layer which covers the vessels of the choroid is very rich in pigment, the fundus is generally of a deep shade, and the vessels of the choroid themselves can then be distinguished only with difficulty; these vessels, on the other hand, are very distinctly seen as a network, whose interstices are uniformly filled with pigment, when the internal layer of the choroid has relatively little. When the choroid, in its entire extent, is very deficient in pigment, as, for example, in albinos, the whole fundus of the eye appears so much the lighter, because the luminous rays which have penetrated to the sclerotic are reflected to us by that membrane.

As to the retina itself, it is very rarely perceptible. In cases where the fundus is very dark, it is visible, appearing then as a semi-transparent finely-pointed veil, spread out before the choroid. That portion of the retina where the **macula lutea** is situated deserves very careful examination. We must look for it at the posterior pole of the eye, the patient gazing straight into the reflecting mirror, so as to bring the posterior pole into the field of observation. It can only be seen in a certain number of cases, appearing as a small spot, of a deeper red than the rest of the fundus, and encircled with a bright ring whose diameter is slightly larger than that of the optic papilla.

This short description of the normal aspect of the fundus will be completed in greater detail when we come to speak of the pathology of each of its constituent parts.

Subjective Examination of the Eye.

Examination of the State of Vision.—The functional examination of the eyes should begin with the study of the acuteness of vision. Formerly, the surgeon was compelled to confine himself to a determination of whether the patient could read, could distinguish only very large objects, or had his visual power reduced to a mere perception of light.

At present, the means of examination have, in this respect, reached a much greater degree of precision, and we find ourselves in the fortunate position of being able to verify the statements of patients, amongst whom there is always a certain proportion disposed to self-deception in one direction or another as to their real condition.

The functional study should begin by the examination of *each eye separately*. In the case of each we investigate—1, the acuteness of the direct or central vision; 2, the condition of the field of vision; 3, the sensibility of the retina in general to light; 4, the power of distinguishing colours. This being accomplished, there remains to be studied the combined action of the two eyes—*binocular vision*.

I. **Examination of the Acuteness of Central Vision** (V *c*).—We use a series of printed letters, their size being determined by the distance at which they ought to be read by the average eye. These letters, calculated to a fixed visual angle, the value of which has been verified by experiment, vary in size from characters which should be recognised at 60 metres, to those which should be recognised at 50 centimetres. They have been called scales, and advantageously replace the test-books of *Jaeger*, which only approximately answer the purpose. We employ the test-types of *Giraud-Teulon*, or the optotypes of *Snellen*, the latter preferably, because they are

constructed of letters placed side by side without forming words, which an intelligent patient may sometimes guess without seeing them exactly.

Those test-types are placed at a known distance. They are generally hung on a wall facing the window, and the patient turns his back to the window during the examination. It would be still better to examine the visual acuteness in a dark room, illuminating the letters by a steady light (a lamp or constant gas-jet). The patient having shut one eye, with the palm of the hand and not with the fingers, is asked to read the series of letters, commencing with the largest and proceeding till he comes to those which he is unable to discern. The degree of visual acuteness may, by a very simple calculation, be deduced from the lowest line which he is able to read. Let us suppose, for example, that the lowest series read is that which a normal eye should distinguish at 6 metres, and the eye which we are examining reads it at that distance, we say that the visual acuteness is normal ($V = \frac{6}{6} = 1$). On the other hand, if the patient is obliged to go 3 metres nearer before he can see them, his acuteness is equal to $\frac{3}{6}$ ($V = \frac{3}{6}$); that is to say, it is reduced to one-half.

It will be easily understood how these experiments may be multiplied and made to check each other. If the patient can only see No. 6 of the test-types (which the normal eye sees at 6 metres) by approaching to 3 metres, he will be able to see only No. 12 at the distance of 6 metres, No. 24 at 12 metres, and so on.

When the acuteness of vision is below $\frac{1}{10}$ of the normal, we determine it by the distance at which fingers can be counted. The ability to count fingers is considered equal to No. LX. of *Snellen's* scale, so that, if they are accurately counted at the distance of 2 mètres, $V = \frac{2}{60}$. When the eye is not able to count fingers, we examine at what distance it recognises the movements of the hand, and this faculty we consider equal to No. C C C of *Snellen's* scale. Again, if it distinguishes only darkness and light, we say that it has only quantitative perception of light, and, if even this be absent, the eye is considered blind, $V = 0$.

It only remains for us now to determine whether this diminution of the visual acuteness is not simply *apparent*, depending on some anomaly of the refraction of the eye. For this purpose we alternately place before the eye of the patient a convex and concave glass (of 0·50 or 0·75 D), and observe if these glasses improve or diminish his sight. If the concave glass does not improve the vision, or the convex glass blurs it, we must then conclude that there is a real diminution of visual acuteness. If, on the other hand, the vision is improved by a glass, we must take into account the anomaly of refraction before judging as to the actual condition of the visual acuteness.

For patients who cannot read scales made with letters or numbers,

a series of figures, constructed of lines or of points, is substituted for the letter test-types, which figures are drawn to the same scale as the letters. (Scales of *Mayerhausen*, geometrical scales of *Boettcher*, and international scales of *Burchardt*.)

If we wish to determine the influence of light on the visual acuteness (*examination of the sense of light*), as we are obliged to do in diseases of the optic nerve and retina, we diminish progressively the intensity of the lamp or of the gas-jet which illuminates the test-types, or we place before the eye to be examined smoked glasses of increasing darkness. The observer has each time to compare the diminished visual acuteness thus produced with the acuteness of his normal eye placed under the same conditions.

Having ascertained the acuteness of vision for each eye, we can at once examine the *power of accommodation* which the patient has at his disposal. For this purpose, the remote and proximate points of distinct vision are determined as follows:—The patient is shown number 0·50 or 0·60 of the letter test-types, and, having ascertained the farthest distance at which they are still distinctly seen, we then gradually bring them nearer the eye till the point is reached where the patient ceases to distinguish them.

The distance between these two limits sufficiently indicates for ordinary purposes the condition of the accommodation. For more precise investigations we require more delicate test objects, such as the silk threads in *Graefe's* optometer, or the small luminous points in *Landolt's*.

II. **Examination of Peripheral (Eccentric) Vision** (*Ve*).—The field of vision of an eye may be defined as the entire space included in the vision while the eye is fixed on one and the same point.

To determine its extent, the patient is placed in front of and a little way from a black board—say at the distance of 30 centimetres (about 1 foot). The head of the patient should be fixed. We then draw on the board, with chalk, a small white cross, at which the patient must look steadily with the eye which is being examined. This arranged, we move the chalk over the surface of the board in lines radiating from the cross as centre. The points where the patient can only confusedly see the chalk held in the hand, and those where he can no longer see it at all, are noted. In this way, we can obtain a very complete drawing of the field of vision for 40° from the point of fixation. (*Examination by field measurement.*) To complete the examination of the field of vision, we may use the perimeter first devised by *Aubert* and introduced into ophthalmic practice by *Förster*. In order to combine at once the advantages of the field measurement and of perimetry, I have had constructed by *Collin* the following instrument.

My perimeter consists of a quadrant, which, rotating round its summit, describes a hemisphere, at the centre of which we place the patient's eye under examination. This eye should be constantly fixed on the mark at the summit of the arc, whilst the other eye is bandaged.

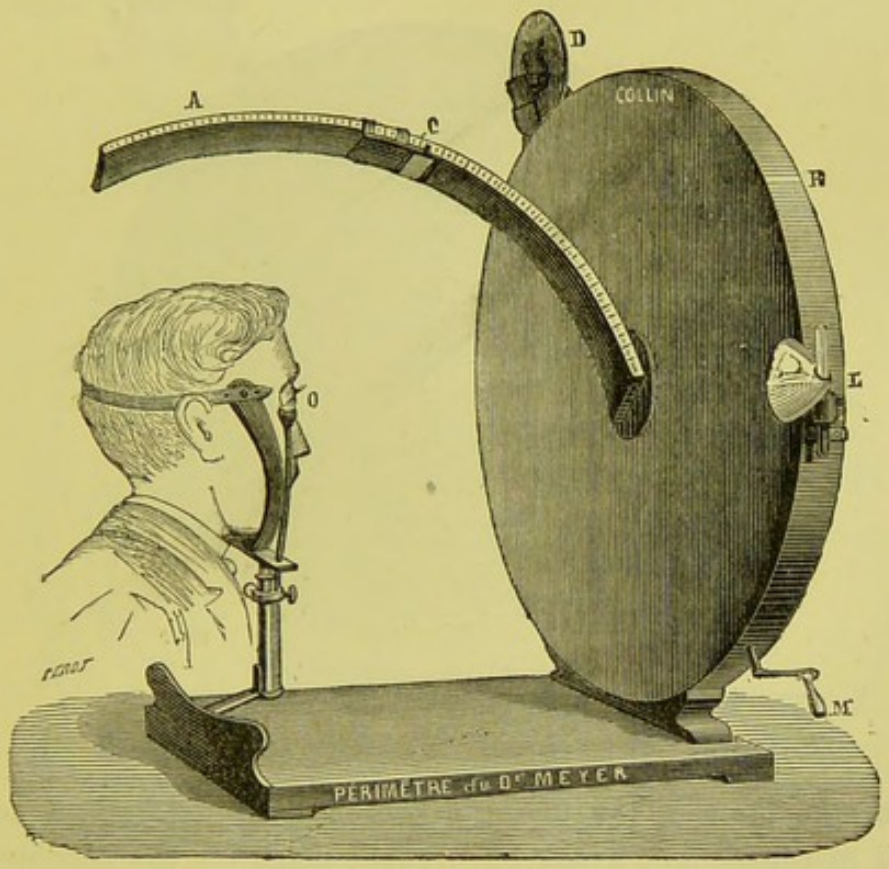


Fig. 17.—Meyer's Perimeter.

The arc of the perimeter being placed in a given plain (for example, the vertical plain), the observer moves the carriage, C, slowly from the periphery to the centre. The carriage is so constructed as to slide on the arc, and, according to the purpose of examination, it is furnished with a white or a coloured square, a figure or a letter of the alphabet. The sliding movement of the carriage, C, is obtained by means of an endless chain, which runs on the back of the arc, which is set in motion by a small crank, M, so placed that the patient cannot see the observer's hand. The examiner stops the movement as soon as the patient recognises the object placed on the carriage; he reads off the number of degrees, marked on the back of the arc, corresponding with the situation of the carriage, and indicates by a chalk mark on the black slate at the back, R, the degree found by this examination.

This slate is nothing else than the projection of the sphere of the perimeter; the side towards the patient is blackened; on the other side (represented in Fig. 18), a series of concentric circles, divided by radii, is drawn. The radii serve to indicate the position of the arc, which

the observer may ascertain at any moment on the small card, D, on which a needle, J, moves, turning so as to correspond with the movements of the arc.

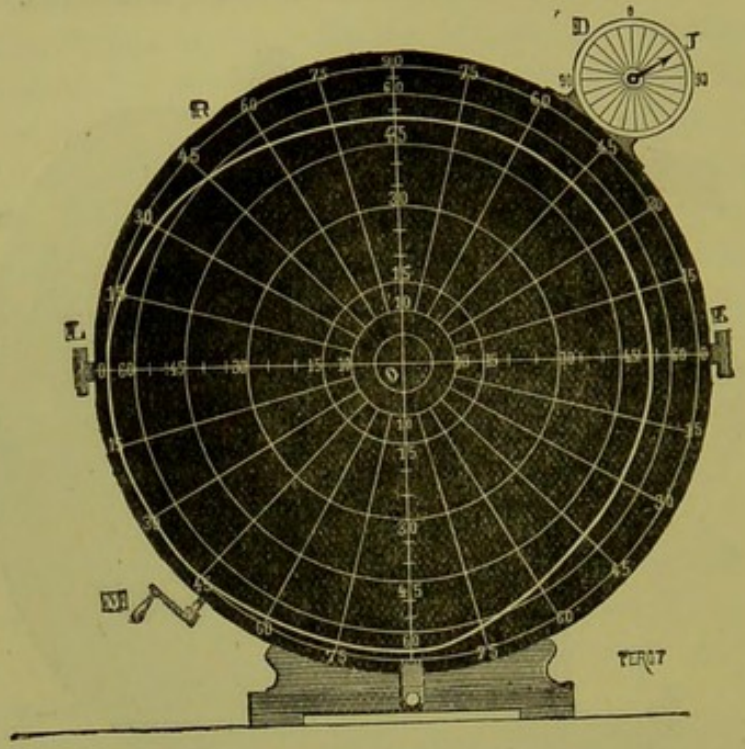


Fig. 18.—Meyer's Perimeter.

When the limit of the visual field has been determined for the vertical meridian, and noted by a chalk mark on the corresponding point of the slate, as already explained—the arc is turned into another meridian, and we determine for this the point at which the object placed in the carriage becomes visible as it is moved from the periphery towards the centre. This point having been marked on the slate, at the exact point of the projection which corresponds with the position of the carriage, we pass to another meridian, and so on, till the arc has described the entire hemisphere. It now only remains for us to unite by a continuous line the various points which we have marked out, in order to gain a complete tracing of the field of vision on the plan traced on the back of the slate. The extent of the normal visual field in general, as also for the colours red, green, and blue, is shown in Fig. 19.

For ordinary purposes it may suffice to examine the limits of the visual field as follows:—The surgeon places himself in front of his patient; the latter shuts one eye, and with the other looks straight at the eye of the surgeon, who also must keep one of his eyes firmly closed. At an equal distance from his own eye and that of the patient, the surgeon moves his fingers in all directions, and asks the patient to indicate the extreme point at which he is able to count the fingers held

up, and that at which he is able only to see the movements. The observer has thus the twofold advantage of controlling the exact fixation of the patient, and of judging immediately the difference between the extent of his patient's field of vision and his own, which he measures at the same time.

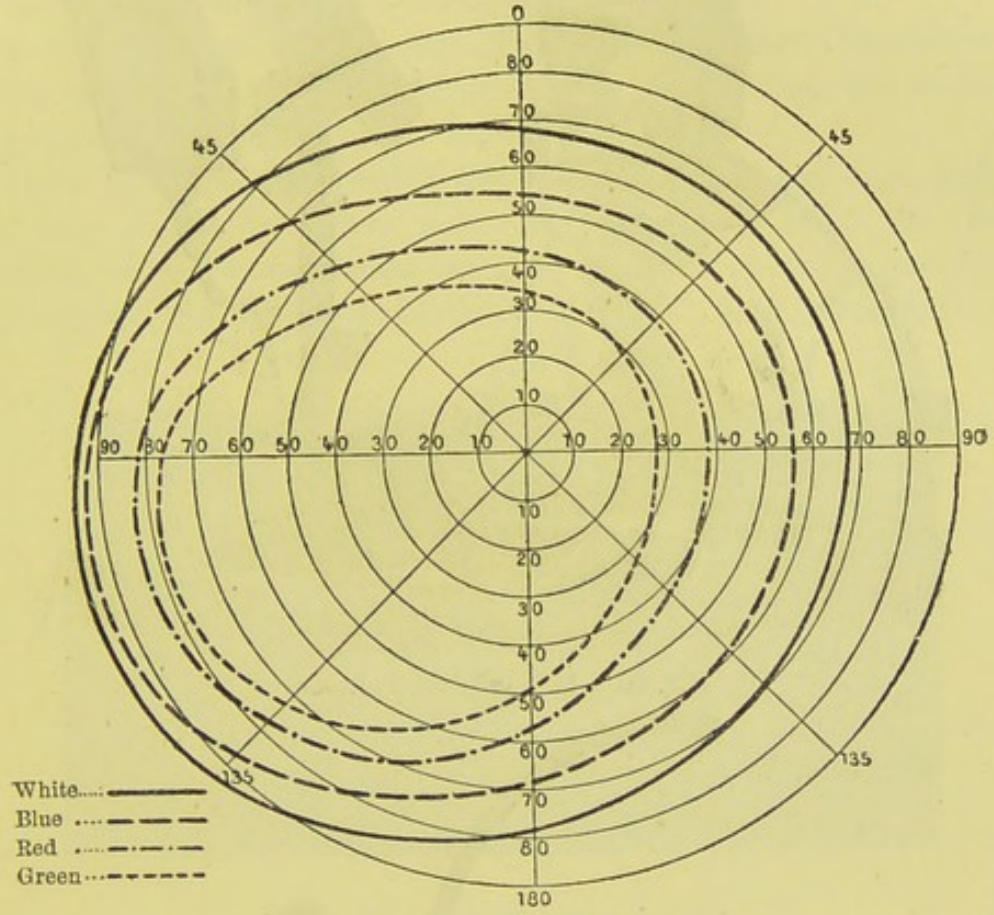


Fig. 19.—Field of Vision of the Left Eye.

It is often of importance to make this examination, not only in daylight, but also in a darkened room, by artificial light, which allows us, by varying the amount of illumination, to determine the influence of the intensity of the light on the extent of the visual field (*examination of the sense of light*), an influence which varies according as the retina possesses normal sensibility, or a certain degree of anæsthesia. On examining the visual field by both methods, it is found to be either normal throughout its whole extent and in its limits, or decidedly retracted by imperfections, more or less irregular at its periphery; or, again, interrupted by fixed central or peripheral absolute defects. Such a defect is called a Scotoma.

III. **Examination of the Retinal Sensibility in General.**—In a certain number of cases—for example, when an opacity of the lens prevents the light from striking the retina—the examination of the retinal sensibility cannot be made by the method

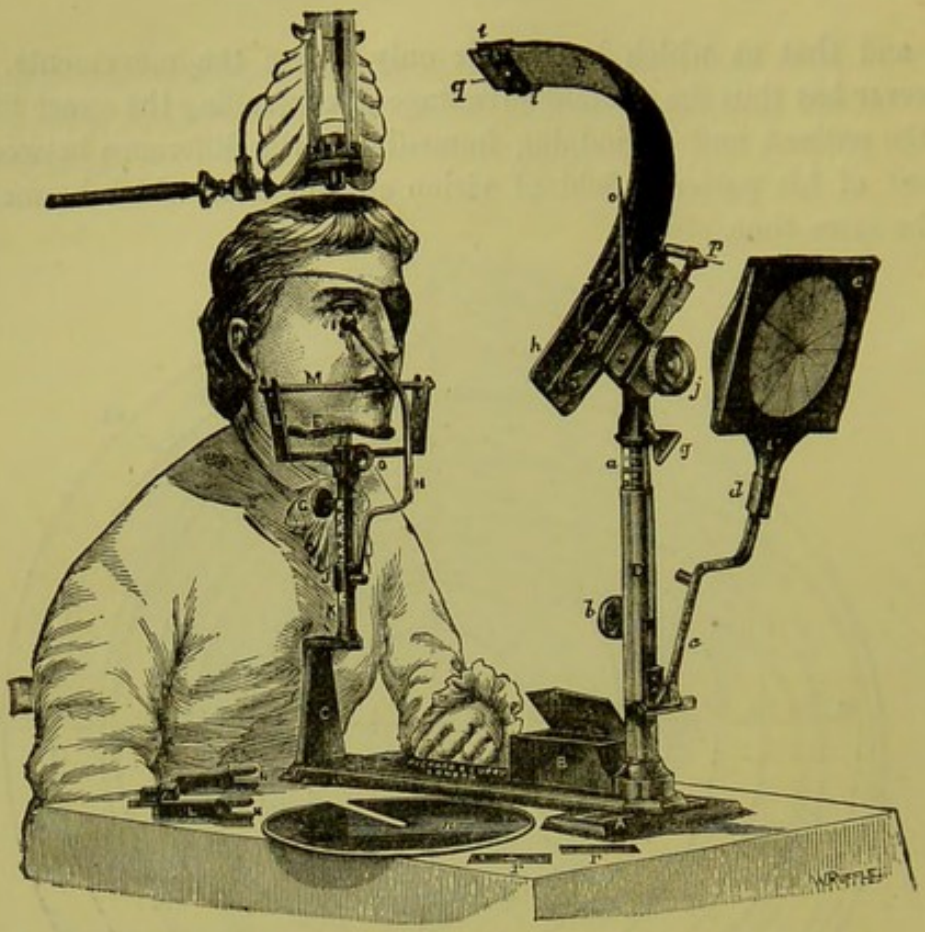


Fig. 20.—M'Hardy's Perimeter.

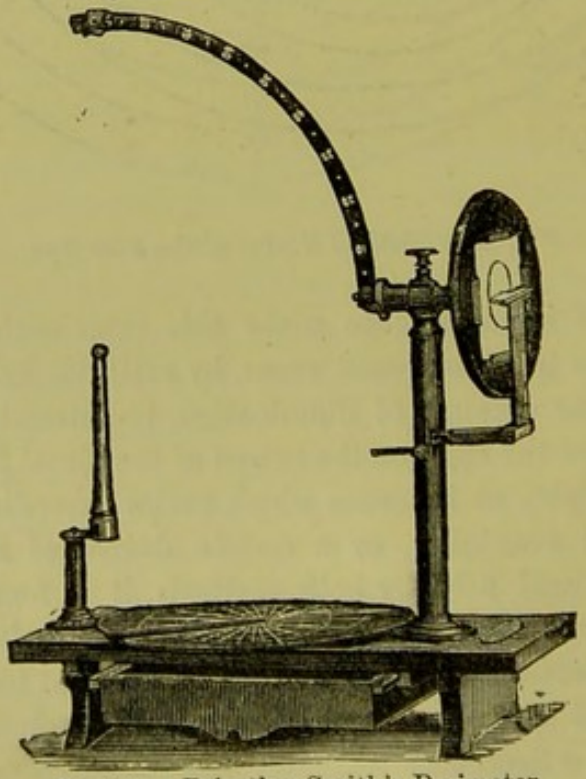


Fig. 21.—Priestley Smith's Perimeter.

Figs. 20 and 21 show two forms of self-registering perimeter—an instrument of great utility. The figures, with a description of each, are to be found in Landois and Stirling's *Physiology* (Griffin & Co., 1885), vol. ii., pp. 1006 and 1007. These instruments are to be had from Pickard & Currie, London.

which we have explained. And yet this examination is in these cases an absolute necessity.

Formerly, indications of the state of the retina as regards its sensibility were sought exclusively in the reaction of the pupil to light, because the pupil reacts more slowly, or not at all, when the sensibility of the retina is diminished or destroyed.

Another method of examination consisted in the observation of luminous apparitions provoked by steady pressure on the external portions of the eyeball.

These apparitions, to which the term *phosphènes* has been applied, are very readily produced when we rub lightly with the distal phalanx of the small finger, with the rounded end of a pencil, or with a penholder on several points of the eyeball through the lids.

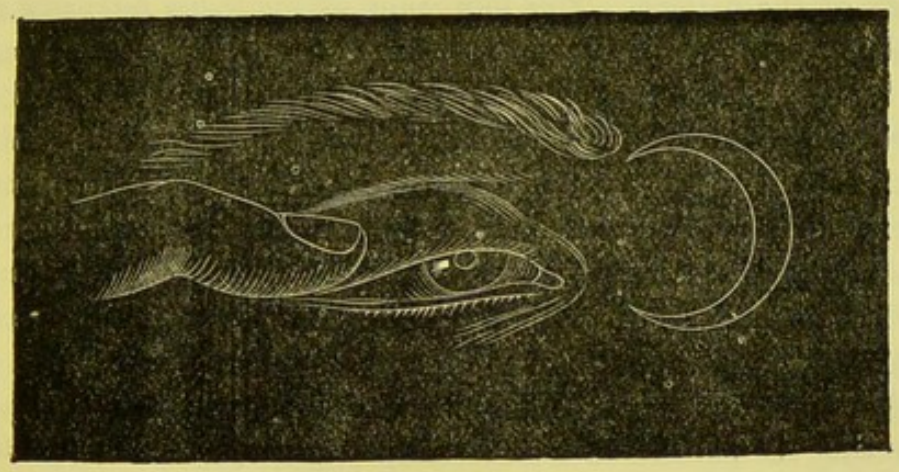


Fig. 22.—Temporal Phosphene.

During this rubbing, the patient is asked to look to the side opposite to that on which pressure is made. Four kinds of phosphenes have been distinguished which have been named according to the point on which the pressure producing them is made—frontal, jugal, nasal, and temporal phosphenes.

In some cases, where the patient is wanting in intelligence, the experiment must be repeated several times to enable him to distinguish the luminous rings; whilst other patients again, deceiving themselves, affirm the existence of luminous sensations, which in reality they do not perceive. We must not, however, forget that the investigation of phosphenes gives an indication of the sensibility of the retina only to pressure, and not to light. On the other hand, it tells us nothing as to the degree of sensibility preserved by the retina. This method of examination (which is nevertheless of importance in certain cases to which we shall have to allude) has therefore been advantageously replaced by

the direct investigation of the functional state of the retina by means of a lamp.

The patient being placed in a dark room, we proceed to ascertain the minimum intensity of light of which the eye is sensible, or the greatest distance at which the eye can still perceive the light of an ordinary lamp. If it is wished to determine the minimum intensity of light of which the eye is sensible, the lamp is placed at 80 centimetres to the side, and a little in front of the diseased eye, the other being firmly shut. We then interpose the hand before the eye which is being examined, so as to shield it from the light of the lamp, and place it in total darkness; the hand is then suddenly withdrawn. If the patient declares that he perceives the light, the brilliancy of the lamp is gradually decreased. After each diminution the experiment is repeated, until the observer can just distinguish the shadow of his hand against the face of the patient. This minimum of luminous intensity should still be perceived by the patient if the fundus of the eye is normal.

As for the distance at which the light of a lamp should be distinguished, we know, from experiment, that, for an eye affected with cataract, for example, but otherwise normal, this distance is about 4 or 5 metres. If the patient can only distinguish the lamp at 2 metres, we may conclude that the retina possesses but a quarter of its normal sensibility, in accordance with the optical law that the intensity of light diminishes in the ratio of the square of the distance.

In the same conditions the periphery of the visual field is explored, by directing the patient to look steadily at a lamp placed a few feet in front of him, whilst another lamp is moved about in all directions to the limits of the visual field. The patient must indicate at each moment the position of the second lamp. In this way may be ascertained, at the same time, any deficiency of the eccentric vision or any defects of the visual field resulting from the different affections of the fundus, of which the direct investigation is rendered impossible by the disturbance of the media of the eye.

The examination of the *sense of light* requires the determination of the minimum of light sensible to the eye in coming out of darkness, as in *Förster's* photometer, or in ascertaining the influence of illumination on central and peripheral vision, as already described, and on the power of distinguishing colours.

IV. **Examination of the Power of Distinguishing Colours.**—To complete the functional study of the eye, it remains for us to examine the faculty of distinguishing normally the colours, a faculty impaired by certain affections, or altered by a congenital condition known as *daltonism*. For exact and rigorous experiments, the colours of the spectrum are the best. There is a difficulty, however, in

producing these of sufficient intensity, and in using them conveniently; and, although this difficulty is nearly removed by *Donder's* and *Hirschberg's* apparatus with double spectra, yet it has caused them to be replaced in practice by a series of variously-coloured wools or papers, which the patient is asked to arrange according to shade (*method of Holmgren*). A normal eye will perform this task in a few minutes, whilst a patient affected with deficient colour-perception will accomplish it with difficulty, hesitating in the choice of objects, and confounding certain colours or certain shades. To check the results of this examination, characters printed in various colours may be used with advantage (*method of Stilling*), or complementary colours produced by the superposition of a greyish ring on coloured papers (*H. Meyer, Weber*). The quantitative (numerical) determination of the power of distinguishing colours may be obtained by coloured discs of various sizes, according to the method of *Donders*, or by the graduated tables of *Dor* and *Ole Bull*, or, again, by the apparatus of *Weber*, constructed to measure chromatic vision.

Lastly, *Wolffsberg* has described (in *Graefe's Archiv*, xxx. 1) a mode of investigation combining very ingeniously the examination of the visual acuteness, of the sense of light, and of the power to distinguish colours. It allows the differential diagnosis of their anomalies and of the ætiological conditions to be easily made.

If it is necessary to examine the extent of the visual field specially for each colour, the perimeter should be used, a coloured object being placed in the carriage.

Examination of Binocular Vision.—The functional examination of each eye should be followed by the study of binocular vision. In the normal condition, when we look at an object, the visual axes of our eyes are so directed as to converge on the object, the image of which is then formed in each eye, on corresponding points of the retina, at the point known as the *fovea centralis*. Thus we begin by examining the direction of the two eyes, and, if it be normal, we ascertain whether binocular vision exists, or the patient without being aware of it, only uses one eye. This is done by causing the patient to shut each of his eyes alternately.

In many cases in which there is a diminution in the power of the internal recti, binocular vision is only effected by strong muscular effort. The diminished power of the internal recti, however, may not be apparent till we have prevented any effort at fusion of the images by stopping binocular vision. To ascertain the presence of these conditions, the patient is asked to look at an object, such as the end of the finger, placed at 40 centimetres from him, and each eye is hidden alternately by interposing the hand between it and the object.

If the two eyes are similarly directed, they remain immovable at the moment when they are uncovered. On the other hand, if an eye, at the instant when its fellow is covered, makes a movement so as to place its optical axis in the direction of the object, we may conclude that there was previously deviation behind the covering hand. Further examination to ascertain the special mode and degree of deviation is then required, which we shall have to explain in the chapter on muscular insufficiency. This experiment is only necessary when, at the first inspection, we do not notice any deviation of one of the eyes—a condition which, of itself, precludes the possibility of simple binocular vision.

When the optical axes no longer possess the parallelism necessary for normal vision with the two eyes, the existence of binocular vision is at once revealed to us by the presence of diplopia, a symptom which the patient will not fail to indicate directly, or by complaining of some visual disturbance that gives us the clue to it.

This symptom, diplopia, always demands a special study on the part of the physician, who ought to ascertain, in the first place, the position of the two images, and then to find out to which eye each image belongs. The best method of performing this experiment is to use the flame of a candle placed at a few metres from the patient, who is provided with a piece of coloured glass (violet). This glass, which ought to be placed before the eye that he uses by preference, has a two-fold advantage—viz., it diminishes slightly the distinctness of the image seen by the better eye, and consequently diminishes the difference existing between the two sensations, of which the patient is always inclined to suppress the weaker; and secondly, the different coloration of the two images allows us to distinguish to which eye each belongs. This done, we have only to observe whether the image situated on the patient's right corresponds to his right eye or not; finally, we take note of the distance separating the images, and remark whether they are parallel or converge towards each other at their extremities.

If, in presence of deviation of one of the eyes, there is no diplopia, and each eye is endowed with good vision, we may conclude that the patient has accustomed himself to avoid diplopia by suppressing the central perception of the image furnished by the deviating eye.

ART. II.—General Considerations on the Treatment of Ophthalmia.

The essential aim of therapeutics, in regard to inflammatory affections of the eye, is to promote the return of the diseased parts to the equi-

librium of normal nutrition. For this purpose, the treatment should meet: 1, The *causal indication*, in reference to which it will consist specially in removing everything that may contribute to the irritation of the affected organ; 2, the *morbid indication*, when it will aim at arresting the pathological process and re-establishing the normal state.

A. Causal Indications.

The causes of irritation of the eye may be mechanical, chemical, physical or organic.

1. Among the **Mechanical Causes** we notice, first, *touching* or *rubbing the eyelids* in consequence of itching or burning sensations, or even the disposition shown by children to hide their eyes with their hands or arms when they are affected with photophobia. In the case of adults, a simple direction is generally enough to induce them to give up this custom, whilst with infants the physician must employ such means as shall render it impossible for them to hurt themselves.

The best method is the application of a protecting bandage. The eye is first covered with a small compress of very clean linen or lint, over which a few pieces of cotton are placed, so as to fill up the irregularities of the orbital cavity round the eyeball, thus giving a uniform surface, to which is applied a bandage, either woven or of flannel, 40 centimetres long and 5 centimetres broad and furnished with tapes at its extremities.

In applying it, the bandage is taken in both hands and placed over the lint so as to cover the eye obliquely, ascending from the lower angle of the jaw towards the opposite side of the forehead, then the tapes are crossed behind the occiput and fastened in front.

Dust is another cause of irritation, all the more carefully to be avoided, since the means at our disposal for protecting the eye against its influence are very inadequate. Indeed, the spectacles which have been constructed for this purpose, and which are made of metallic gauze surrounding a piece of glass, do not prevent dust entering the eye, and are not without inconvenience to the sight. We prefer to these even ordinary spectacles with large, round or shell-shaped glasses, as also the use of veils by women and children. But it must be borne in mind that these means are imperfect, and that it is better to withdraw the eyes from every condition in which they would be exposed to dust.

Children whose eyes are not protected by a bandage often touch them with their hands, and, in so doing, soil the eyelids and even the conjunctiva. Such inconveniences may be obviated simply by scrupulous cleanliness and frequent washing of the face and hands.

2. **Chemical Causes.**—Another source of danger arises from the application of therapeutic agents, such as *pomades, tinctures, cataplasms, &c.*,

in the neighbourhood of the eyes; and the same is true of *vesicatories* applied to the brow or temple, because the desiccation produces crusts and an itching, which induce the child to scratch the parts. *Snuff* readily becomes a source of irritation, especially in those who are not accustomed to it; in such cases, indeed, lachrymation and redness supervene when the eyes are in the normal condition. Nevertheless, it is allowable, sometimes, even during the course of an inflammatory affection, to concede the use of snuff to those who have been long habituated to it, and who could only give it up with difficulty.

Conditions specially to be avoided in the case of persons affected with external ophthalmia are—the frequenting of crowded assemblies, and the remaining in an atmosphere vitiated by tobacco, dust, or the exhalations inseparably connected with certain occupations (carding, work in sewers, &c.)

Pure air being requisite for the recovery of such patients, frequent walks must be prescribed, and the physician should also point out the dangers which may arise from lengthened visits to cafés, theatres, concert-halls, ball-rooms—in a word, any place of concourse where these varied noxious influences are concentrated, together with the evil of exposure to a dazzling light.

Tobacco smoke is very injurious to irritated eyes, and its use must therefore, in such cases, be absolutely forbidden, allowing those to whom this would be an insupportable privation to smoke only in the open air.

3. **The Physical Conditions** prejudicial to eyes affected with external inflammation are—*Wind, heat and a brilliant light.* As for *cold*, if not extreme, it is much better borne, and produces a certain alleviation in cases of conjunctivitis. On the other hand, cold must be considered as a danger in the deeper inflammatory affections, such as iritis, choroiditis, &c. We need scarcely indicate how important it is for this class of patients to avoid draughts and any sudden variation in temperature, without, however, stifling them by screens, wrappings, or curtains when obliged to remain in bed. A patient always requires air, and he should be able to breathe freely. As to light, there are certain cases demanding complete darkness, which may be obtained by bandages or by closing the windows with thick curtains. We must, however, avoid having recourse to these remedies unless when absolutely compelled; because, in the first place, protracted stay in a dark place is not without detriment to the general health; and, secondly, it requires a slow and gradual return to ordinary light, and thus prolongs the duration of the treatment. In the majority of cases, a soft light adapted to the sensibility of the patient is much to be preferred. What must specially be avoided are sudden transitions from darkness to light, badly supported by even a healthy eye.

Amongst the colours, green and blue are the least, yellow and orange the most, irritating, a difference which is manifested not only subjectively, but also by the reaction of the pupil.

The means of shielding the eyes from too intense daylight vary according as the patient is confined to his room, or not.

In the house, the necessary degree of shade is obtained by drawing the curtains before all the windows, and even by protecting doors when they open on a brilliantly-lighted room, by folding screens.

The colour of these curtains should be grey, the general preference for green being only justified in the case of surfaces from which we receive reflected light, as turf; green penetrated by direct light becomes yellow. Shades can only be used when they can be placed before the source of light, as, *e.g.*, before lamps, for which purpose a uniformly grey paper should be preferred.

Out of doors, the patient may be protected from excessive light by a grey or black veil, but especially by spectacles. The green glasses, formerly so highly vaunted, do not deserve their reputation. Blue glasses are to be preferred to these, but the smoked ones are even better, as they leave to objects seen through them their natural colour, modifying only the intensity of the light. In choosing these glasses, it is important to make sure that the smoked tint is not mixed with violet, a shade easily detected by placing the glass on white paper.

It is well to avoid selecting glasses of too deep a shade, because the patient becomes so habituated to them that he has difficulty in giving up their use. Moreover, they mar the distinctness of the vision for distant objects, and necessitate considerable efforts on the part of the patient.

For reasons easily understood, round or shell-shaped glasses should be ordered; they afford the greatest possible amount of protection to the eye on all sides; if necessary, also, they should be furnished with black silk, and mounted so that the distance between the glasses corresponds with that between the eyes.

It goes without saying that the patient should use these glasses exclusively when exposed to broad daylight, and that he should not discontinue them suddenly, but by passing through intermediate shades.

4. Amongst noxious influences, an important place should be assigned to the **efforts of the eyes** to obtain distinct vision.

When the eyes are seriously affected, patients of their own accord stop all work, either because it has become impossible to them, or because they experience discomfort.

When they are less affected, however, patients do not take into account the hurtful influence of these efforts, because the sequelæ

are not so instantaneous. In general, patients affected with an inflammatory attack should neither read nor write, and should avoid every kind of work which requires efforts of accommodation. It must not be forgotten that the majority of patients are always disposed to exceed the limits of work which we may see fit to prescribe for them, and this must be kept in mind when giving them directions. When their condition permits of their returning to their occupations, they must only be allowed to do so gradually.

5. Another casual indication, to which treatment must be directed, is met with in local or general **affections of the circulation**, as also in the existence of any dyscrasia.

Venous engorgement may exist as the primary cause of the affection, or as one of the sequlæ which retard recovery; it is due either to a diminution of the motive force of, or to some increase in the resistance offered to, the venous circulation, or, again, to a combination of both. This distinction is of very great importance, because the first of the causes does not admit of antiphlogistic treatment, but, on the contrary, demands the application of means suited to maintain or to increase the strength of the patient.

In the second case, we must specially take into consideration every circumstance which may hinder the circulation.

Under this head, and specially in cases of severe inflammation, we must not lose sight of the fact that forced expiration, as in loud crying, efforts of the voice, singing and coughing, produces a certain compression of the jugular veins. For a like reason, everything which restrains respiration, such as cravats, stays, tight clothing, must be avoided, as also anything tending to produce obstruction to the circulation in the portal vein, such as an overloaded stomach, or the too abundant presence of fæcal matter in the alimentary canal.

Patients ought to eat little at a time, abstain from sleeping after meals, and select a diet easy of digestion.

In cases of passive congestion, the defective tonicity of the walls of the blood-vessels must be combated by the local use of astringents and of a compress and bandage. Directly, we combat the hyperæmia by blood-letting, especially in recent cases—that is to say, when the blood-vessels still retain their contractility. The action of this remedy is only temporary.

B. Morbid Indication.

It is evident that, having to deal with inflammatory affections, we can best meet this indication by antiphlogistic remedies, and, as one of the distinctive characters of every inflammation consists in an

elevation of the temperature, our efforts ought to be directed to its reduction to the normal.

1. The first of the antiphlogistic remedies is **cold,** employed in the form of **cold compresses.** Douches are not available for this purpose, on account of their injurious mechanical action, and because they can only be applied during a relatively short time, which does not suffice to produce a permanent effect, but rather produces a reaction.

The compresses should be changed as often as is necessary to prevent their becoming warm, and their application should be stopped as soon as the temperature of the diseased parts, or of the neighbouring parts, falls below the normal.

It is well to allow the last compresses to remain on a little longer, so as to escape a too sudden contrast, and to renew their application whenever the temperature begins again to rise.

It is only in very severe cases of inflammation that they must be employed without intermission. The best method consists in using compresses cooled by contact with ice, and made sufficiently small to prevent their acting on the neighbouring parts. During their application the patient should be kept recumbent, otherwise they are easily displaced; and a bandage ought not to be used to keep them in position, because it produces an elevation of temperature.

The patient should not apply them himself, in order to avoid the perpetual contact of his hands with the cold; and the nurse should shun disturbing the diseased eye, by taking the compress by its two ends whilst applying or removing it. If compresses steeped in water are employed, then distilled water should be used, and they should be wrung out before being applied.

For those persons whose skin is very sensitive, especially if it is already excoriated, it is well previously to smear it with some greasy substance, such as spermaceti ointment or glycerine.

Instead of compresses, *Leiter's* tubes, and hand-rubber balloons filled with cold water incessantly streaming, have been used, but in spite of their advantages (easy application and uniformity of temperature), we have been obliged to abandon them, most patients being unable to endure for any length of time the pressure which they exert on the diseased eye.

2. A second means of combatting the hyperæmia is **blood-letting.** The withdrawal of blood, formerly so much in favour, does not in anywise meet the object which we have in view; local bleeding at best can only prepare for, or form a useful adjunct to, subsequent treatment. Its effect is essentially temporary, and it is important to employ it at the proper moment. In these affections there exist exacerbations and remissions of the inflammation which recur with

considerable regularity. In most cases the exacerbation takes place towards the evening, and that is the time which is chosen for blood-letting when it is indicated.

If the periods of exacerbation cannot be foreseen, we must watch for their appearance, or, if the period is passed, we may operate at the moment of greatest intensity; never, however, during a remission.

The methods of practising blood-letting are—*scarification* of the conjunctiva, *leeches*, the *artificial leech* of *Heurteloup*. Scarification produces only an insignificant depletion, and is especially useful in cases of engorgement of the palpebral mucous membrane; leeches are used by preference in the external ophthalmiæ, and the artificial leech of *Heurteloup* in inflammations of the deeper membranes of the eye. Care must be used in applying leeches to the eyelids or their immediate neighbourhood, on account of the extravasations which frequently result, and which are apt to frighten the patient; they are best applied to the temple in front of the ear.

Their application to the mastoid process is only advisable when the inflammation is complicated with hyperæmia of the meninges of the brain. At other times the part to which they should be applied is indicated by special features in the case, such as the interruption of a hemorrhoidal or catamenial discharge, or of a habitual epistaxis.

The number of leeches to be prescribed is on an average six for adults, three or four for children, and only one for infants.

An excellent method of prolonging the effect of the leeches consists in using them one at a time, applying another only when the first has fallen off.

Heurteloup's artificial leech adds to the effect of a rapid depletion that of a strong suction, permitting us at the same time to limit exactly the amount of blood which we wish to withdraw. It is of the greatest importance to bear in mind while employing blood-letting that it is inevitably followed by a reaction, which consists in a more considerable afflux of blood preceding the remission than is desirable. The degree of this reaction varies within wide limits, according to the constitution and nature of the individual. To keep it within proper bounds we must avoid throughout its entire duration every cause of general excitement or of irritation of the eyes. To attain our object we make it an absolute rule to apply these remedies in the evening, and to leave the patient for at least twenty-four hours at rest and in darkness. For nervous persons this time should be even longer.

3. The general surgical principle, which places **pressure** amongst the antiphlogistic agents, in so far as it mechanically diminishes the calibre of the vessels, and thus retards the secondary phenomena of hyperæmia, such as transudation, is also applicable in ophthalmology. The com-

pressive bandage is a mere modification of the retaining bandage which has been already described, and consists of a bandage three metres and a half long and three centimetres broad, made of fine flannel, which should be as elastic as possible.

After covering the whole of the eye and the entire orbit with lint and cotton, as already detailed, so as to make a completely uniform surface, the bandage is applied as follows:—We begin by an oblique turn over the eye which we are about to cover, starting from a point situated between the ear and the angle of the inferior maxilla, and carrying the bandage to the opposite side of the forehead; this turn should specially fix the lint. The bandage is then brought round behind the occiput, back to the forehead, and, making a complete circle, is carried on to the nape of the neck, whence a second oblique turn is made over the diseased eye, compressing it more firmly than the first. We continue by a second circle round the head, and then by a third turn over the eye. The last turn is so arranged as to keep the two first from being displaced. The process is completed by a third circle round the head.

4. **Antiphlogistic regimen** has for its object the modification of the nutritive constituents of the blood, and the avoidance of everything which would excite the nervous system or accelerate the circulation. It is only when the inflammation is serious and running very high that we prescribe a strict regimen—that is to say, entire rest of body and mind, with limitation of the quantity of nourishment to what is absolutely indispensable, and this limited diet should be exclusively vegetable.

In general it is enough to advise moderation in all respects, to forbid alcoholic or aromatic drinks, as also highly seasoned food. Care must be taken not to weaken the patient by an insufficient diet, especially in chronic inflammatory affections, when it is often necessary to prescribe for delicate persons a tonic and even a stimulating diet.

5. **Antiphlogistic Remedies.**—Amongst the numerous remedies which come under this category, such as mercurials, iodides, antimony, nitre and dilute acids, there are few which are of general use in the ophthalmiæ, properly so called.

Mercurial preparations have been long regarded as specifics against diseases of the eyes. Calomel is the preparation used by preference when we wish to obtain a rapid effect in certain acute affections, and we give it then in fractional doses, 1 to 2 centigrammes ($\frac{1}{6}$ to $\frac{1}{3}$ grain) every hour; but, from the facility with which it produces salivation and diarrhœa, it is of all mercurial preparations the one most unsuited for prolonged administration. The protoiodide, in doses of from 5 to 15 centigrammes ($\frac{3}{4}$ to $2\frac{1}{3}$ grains) daily, is often preferred,

although it produces salivation almost as readily. The best method of exhibiting it is to give the Liquor of Van Swieten or the albuminised sublimate in increasing doses, beginning with 5 milligrammes ($\frac{1}{13}$ of a grain) twice daily. The dose is increased every second day by its own amount until we are giving 3 centigrammes (nearly $\frac{1}{2}$ grain), which dose may be maintained for some time and then gradually diminished.

Again, when it is desired to make the mercury penetrate the system rapidly and in great quantity, so as to obtain an immediate effect (as, for example, in exudation and syphilitic ophthalmiæ), the surest way of procuring this result is to employ inunction, combined with the internal use of iodide of potassium. During this treatment the patient should be confined to a room kept at a constant temperature, as nearly as possible 65° or 70° F.

These inunctions are made with 1 or 2 grammes (15 or 30 grains) of the mercurial ointment (a mixture of the simple and compound ointments in the proportion of 3 to 1), care being taking to wash the parts with soap before applying it. On the first day the ointment is rubbed into the calves of the legs and the flexures of the knees; on the second, into the internal surfaces of the thighs; on the third, into the abdomen and chest; on the fourth, into the inner sides of the arms; and the process is repeated in the same order, always avoiding those regions which are covered with hair. After the inunction, which should be administered about an hour before bed-time, the part is covered with linen. Next morning we promote slight perspiration, either by diaphoretic drinks or by subcutaneous injections of pilocarpine (5 drops of a solution of the hydrochlorate of pilocarpine of the strength of 15 grains to 150 m. of water), and the part is carefully washed. During the day the patient takes iodide of potassium in the usual doses.

The regimen should be suited to the strength of the patient. His bowels should be kept sufficiently free to give him a motion once every day. He must be enjoined to take the greatest care as to the cleanliness of his mouth and teeth; and in cases of salivation we should employ chlorate of potash, touching the gums, should they become excoriated, with the tincture of opium. The duration of this treatment should be from twenty to sixty days, according to the effect produced. After the last day a bath is prescribed, and the patient continues the iodide of potassium and the hygienic precautions which his condition may require.

Another mode of mercurial treatment which we employ very often, and with great advantage, consists in subcutaneous injections (in the back and loins) of the sublimate, which are repeated daily or every two days in increasing doses from 2 to 5 milligrammes ($\frac{1}{30}$ to $\frac{1}{13}$ of a grain) and even more.

6. **Drastic Cathartics** are of only very restricted utility, and are exclusively used when it is desirable to empty the intestinal tube completely and rapidly.

In cases of habitual constipation we have recourse to ordinary purgatives, and more especially to mineral waters.

7. **Cutaneous counter-irritants,** in the form of moxas or setons, which formerly held a conspicuous place in ocular therapeutics, under the idea that their action withdrew irritation from the eye, are not generally used, because in idiopathic ophthalmiæ they are as a rule more injurious than the disease itself. We reserve them for such indications as may arise from a general disease, of which the ophthalmia is only one of the symptoms. Vesicatories, sinapisms to the limbs, mustard foot-baths, dry cuppings to the nape of the neck, and general shampooing of the skin, constitute a derivative treatment which is often of use in the course of ophthalmic affections.

8. **Narcotics,** which effectively check the pain, sometimes so intense in ophthalmiæ, at the same time procure for the patient salutary repose, quieting the nervous irritation which increases the disease by favouring its progress.

The remedies most usually employed are *morphia,* the best mode of exhibition being by subcutaneous injection, and *chloral,* given either by the mouth or (to infants) by clyster. The subcutaneous injections are made with a solution of the acetate, hydrochlorate or tartrate of morphine—3 to 15 minims being injected—with a *Pravaz's* syringe as modified by *Luër.*

The advantage of this instrument is that the canula is hollow, and thus at the same time answers the purpose of a trocar. It should also be noted that the piston of this syringe is not pushed forward by turning a screw, but by simply moving it on till it is stopped, with the advantage of greatly shortening the time taken by this small surgical operation.

The best place for these injections is the temple. When operating in this situation, neither extensive ecchymosis nor irritation of the skin are observed, even after a number of injections made at intervals of one or two days. The Sensibility also appears to be less at the temple than in other portions of the skin. Again, it is easy to lift a fold of skin here, since the cellular tissue which separates it from the fascia is very loose. For the same reason, a considerable quantity of the solution may be injected, without producing disagreeable tension of the skin.

When about to make the injection, a fold of the skin in the temporal region must be firmly lifted up, and the point of the canula steadily thrust into the cellular tissue; when we feel that it moves freely there, we let go the skin, and push the piston forwards. If we continue

to hold the skin whilst injecting, the pressure of the fingers on the cellular tissue may cause a portion of the injected solution to escape when the canula is withdrawn. After the injection, and the withdrawal of the canula, the skin must be slightly rubbed, in order to spread the liquid in the connective tissue.

9. The use of **Mydriatics** and **Myotics** in certain inflammatory affections of the eye is justified by their simultaneous action on the vessels and intrinsic muscles of the eye, the sphincter of the iris and the muscle of accommodation. *Mydriatics* effectively check any spasmodic irritation of these muscles, and, at the same time, by relieving the terminations of the ciliary nerves from the muscular pressure, they counteract any disturbance of these nerves. *Myotics* counteract any paralysis of these muscles; they have also the power of contracting the vessels of the eye, and consequently of diminishing the secretion of serous fluid into the interior. Mydriatics and myotics may then, according to circumstances, indirectly reduce intraocular tension.

As a *mydriatic*, a solution of cocaine, homatropine, atropine, or duboisine, is generally employed; as a *myotic*, a solution of eserine or pilocarpine, which is dropped into the inferior cul-de-sac. Cocaine and homatropine have the advantage of acting chiefly on the pupil, and that for a comparatively short time; so that they are used by preference when we wish to dilate the pupil for ophthalmoscopic purposes only. Atropine, on the other hand, acts both on the sphincter of the pupil and on the muscle of accommodation. Duboisine has, without doubt, a stronger reaction than an equal dose of atropine. We prefer pilocarpine to eserine, because eserine very soon becomes decomposed, often within twenty-four hours, which renders its action unequal, and because its use is often followed (especially in children) by follicular conjunctivitis. Pilocarpine is free from these disadvantages, and the solution may retain its properties for some months.

After each instillation, it is well, for a few seconds, to make slight pressure in the region of the lachrymal sac, to prevent the absorption of the remedy by the puncta lachrymalia and its introduction into the nasal canal.

It has also been proposed, to obviate any risk of poisoning the patient through carelessness, to use the drug to be instilled, in combination with glycerine, 5 grammes of glycerine to 5 centigrammes of the sulphate of atropine or duboisine (*i.e.*, a drachm and a quarter of glycerine to three-quarters of a grain of atropine).

In cases of poisoning by atropine, the most rapid and efficient remedy is the subcutaneous injection of a solution of morphine.

10. As a means of producing local anæsthesia of the eye, **cocaine**, specially introduced into ophthalmological practice by *Koller*, of Vienna,

deserves special mention. It acts with great rapidity and efficacy on those parts with which it is brought into immediate contact, so that it must be applied directly to the mucous membrane (after the eversion of the lids) or to the cornea. To prevent its escaping by the corners of the eye, the lower lid must be slightly raised from the eyeball. With a few drops of a 2 per cent. solution, local anæsthesia lasting from five to ten minutes may be obtained, accompanied with slight ischæmia (pallor of the lids), widening of the palpebral fissure, and diminution of the tension of the eyeball. Vision is in no way altered, and the action of the drug is the same on diseased cornea and conjunctiva as on the healthy structures. Repeated injections give a more complete and more enduring anæsthesia.

Cocaine may be used in cases in which the inspection of the eyeball is prevented by spasmodic contraction of the lids, due to photophobia or pain, both of which conditions are at once removed by its action. It is also of service for all examinations which render the dilatation of the pupil desirable, as also to relieve pain in keratitis and conjunctivitis; it will also prevent pain being felt during the application of caustic or any form of cautery. In all such cases, pain is felt as sensibility returns to the tissue.

Cocaine is of extensive application in ophthalmic surgery, since it makes all operations on the conjunctiva and cornea painless. We obtain the same result on the iris by injecting a few drops with a syringe into the anterior chamber, on that part of the membrane which is to be taken hold of with the forceps, or cut. We also use it advantageously in strabotomy, a few drops being introduced from a dropping-glass through the conjunctival opening, so as to reach the muscle.

All mydriatics have to be used with caution in cases in which the eye is predisposed to glaucoma, experience having shown that in such eyes they may produce an acute glaucomatous attack.

CHAPTER II.

DISEASES OF THE CONJUNCTIVA.

Anatomy.—The conjunctiva is a mucous membrane, which lines the internal surface of the eyelids, beginning at their free border, and which, having formed the palpebral cul-de-sac, is folded over the sclerotic, near the equator of the eyeball, and covers it to the margin of the cornea. It even reaches beyond the sclerotic, forming the conjunctival limb at the margin of the cornea, over which it is continued as an epithelial layer. It therefore presents a perfect sac when the eyes are closed.

The conjunctiva is thus divided into three portions; the name of palpebral conjunctiva is given to that portion which lines the eyelid; that which covers the sclerotic is known as the ocular conjunctiva (conjunctiva of the ball); and the third portion is that of the palpebral cul-de-sac.

The structure of the conjunctiva is similar to that of all mucous membranes.

It is composed of a special tissue, the basis of which is an adenoid tissue, formed by a network of fine meshes presenting at the points of intersection many nuclei, and filled with a mass of lymphoid cells. This layer of special tissue is united to the subjacent parts by cellular tissue, and is covered by a layer of epithelium.

In the palpebral conjunctiva, the tissue proper is thick, the epithelium is pavemented; the papillæ of the conjunctiva only begin at 1 millimetre from the ciliary margin, and, when swollen, give to the conjunctiva its peculiar velvet-like appearance. They diminish in number and increase in size as we approach the cul-de-sac. The cellular tissue which unites the tissue proper to the subjacent structures is very dense, and unites the conjunctiva very firmly to the tarsal cartilage.

In the culs-de-sac, on the other hand, the cellular tissue is much more free, and contains a greater number of tolerably strong elastic fibres, united together into bundles. The conjunctiva in this situation is thick, its epithelium is cylindrical, and the papillæ, though few in number, are large.

The ocular conjunctiva is white, thin, and possesses some elastic fibres. It adheres to the sclerotic by a cellular tissue, which is more

dense than that of the cul-de-sac, but which nevertheless allows a certain amount of mobility. The epithelium in this situation is pavemented.

At the internal angle of the eye, the ocular conjunctiva forms, by folding on itself, the semi-lunar fold, which surrounds the caruncle. This last is composed of a mass of sebaceous glands, fatty cells, and a few follicles. The superior cul-de-sac is traversed near the external angle of the eye by the excretory ducts of the lachrymal gland, six to ten in number. The conjunctiva, besides, includes some lymphatic follicles and the acinus glands; the former are found in both culs-de-sac, the latter only in the superior. These glands seem to be the principal source of the fluid which lubricates the surface of the eye.

The vessels of the conjunctiva are very numerous. The arteries are ramifications of the muscular, palpebral, lachrymal, dorsal of the nose, frontal, angular, supra-orbital, and infra-orbital branches of the ophthalmic artery. The ocular conjunctiva also receives a few small ramifications of the anterior ciliary arteries, which are branches of the lachrymal, or arise directly from the ophthalmic artery. The veins are branches of the facial and of the ophthalmic. On looking carefully at the white of the eye, two kinds of vessels are easily distinguished; some of them are seen to follow any displacement of the conjunctiva; the others are fixed in the sub-conjunctival cellular tissue. The latter disappear near the margin of the cornea; the former perforate the sclerotic from before backwards in the neighbourhood of the cornea.

The nerves, very abundant, are supplied by the first division of the trigeminal. Their terminations present an important peculiarity; they end in special small organs which have been called claviform terminal corpuscles. There is not complete unity of opinion as to the nature of these corpuscles.

The secretion of the conjunctiva is composed of the product of the acinus glands, which is very similar to that of the lachrymal glands, and in which there appear superficial epithelial cells, these cells being constantly shed and renewed. The secretion acts as a continual lubricator of the surface of the eyeball, and preserves the clearness of the cornea. The importance of this secretion may be inferred from the fact that the fluid which is found between the eyelids and the eyeball is composed almost entirely of conjunctival secretion, while the tears, properly so-called, are of such secondary importance that the extirpation of the lachrymal gland does not entail any disturbance of the functions of the eye, although the destruction of the conjunctiva is followed inevitably by the loss of the eye.

ART. I.—Conjunctivitis.

The various inflammatory affections of the conjunctiva cannot be considered as so many morbid entities. They must rather be regarded as different modifications of the same pathological process, these modifications depending, on the one hand, on the cause of the disease, its intensity and duration, and, on the other, on the particular state of the tissues at the time when the exciting cause made itself felt. If the majority of clinical facts did not force it upon our observation, the classification of conjunctival diseases might thus be considered as entirely theoretical, since we may meet these various affections either as so many phases of the same disease, or in intermediate conditions resulting from their combination.

We distinguish in these affections the following groups :—

1. Simple hyperæmia of the conjunctiva, or hyperæmia accompanied by a mucous catarrhal, puro-mucous, or entirely purulent secretion (**catarrhal, blennorrhœal, and purulent conjunctivitis**).

2. The conjunctivitis in which the morbid secretion shows a tendency to become plastic, forming solid deposits, either on the surface or in the thickness of the conjunctival tissue (**pseudo-membranous and diphtheritic conjunctivitis**).

3. The conjunctivitis in which the secretion only takes place at certain places and elevates the epithelial layer in the form of pustules (**phlyctenular conjunctivitis**).

4. Conjunctivitis in which the products of the disease take a special form, granulations, the anatomical nature of which is still a matter of discussion (**granular conjunctivitis, trachoma**).

I.

1. Hyperæmia of the Conjunctiva.—Dry Catarrh.

Diagnosis.—When the hyperæmia is very pronounced, we find, on the internal surface of the lids, an abnormal development of the vessels which more or less mask the Meibomian glands, changing the usual rose colour into a bright red irregularly distributed. In the palpebral sinus the red seems still more saturated, and in protracted cases the coloration becomes livid.

The mucous membrane is slightly tumefied, but the papillæ begin to be visible, giving to the conjunctiva, especially over the tarsal cartilage, a velvety appearance.

When the hyperæmia spreads to the eyeball, the semi-lunar fold and caruncle are injected, and the white of the eye becomes, from the appearance of a network of vessels, more or less red.

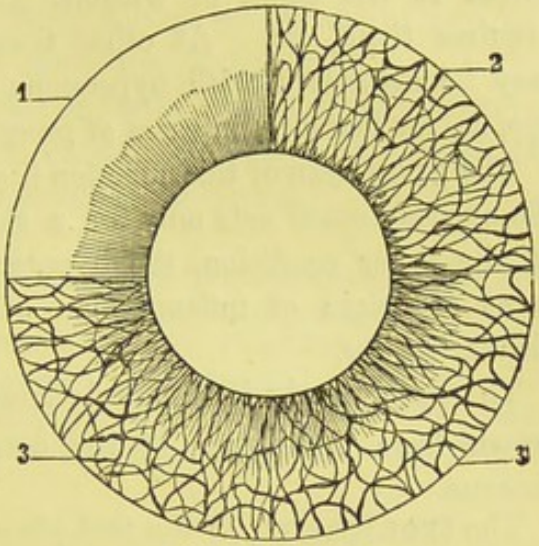


Fig. 23.—Conjunctival and Sub-Conjunctival Injection.

The injection of the white of the eye demands a special study, because the different forms under which it is seen afford valuable indications in the diagnosis of various affections. When the inflammation is situated in the conjunctiva, the vessels are large and tortuous, and, by their anastomoses, form a kind of network. This network, to which the red coloration of the hyperæmia is due, increases in intensity as we approach the eyelids (Fig. 23, 2), and is less in the neighbourhood of the cornea. A second form of injection produces a rose-coloured zone round the cornea, which gradually becomes paler as we recede from that membrane (Fig. 23, 1). Careful examination of this redness shows that it is formed by very fine vessels, radiating in straight lines all round the cornea. This injection is situated in the episcleral tissue, and indicates an inflammation of the cornea or uveal tract (iris, ciliary body, and choroid). A third form of injection only occupies a portion of the white of the eye, and assumes the form of an irregular and livid patch; it is produced by an inflammation of the sclerotic, the bright red colour being modified by the optical effect of the semi-transparent layers which cover it.

In dry catarrh there is nothing abnormal in the secretion; at most there is a hypersecretion of the lachrymal gland, caused by the accidental irritation, and the tears feel uncomfortably warm.

Patients complain of a sensation like that caused by the presence of foreign bodies, such as grains of sand, and suffer from itching, pressure, heaviness of the lids (more pronounced in the evening), and, in protracted cases, from a very peculiar dryness, which hinders the opening of the eyes, especially after sleep. They also feel an excessive sensibility to light after any prolonged effort of vision. These symptoms increase with every influence and circumstance which promote the hyperæmia, such as remaining in a heated or vitiated atmosphere, acceleration of the circulation after food, hard work, rubbing the eyelids, &c. Otherwise, the intensity of the sensations varies in each individual case, and seems to be much greater when the lids are closely and firmly applied to the eyeball than when they are loose and wide.

The **causes** of this affection are very various—atmospheric influences, such as severe cold or the contrary, the presence of a foreign body, an infarction of a Meibomian gland producing a small concretion, affections of the lachrymal passages, exposure to a vitiated atmosphere, or pro-

longed sleeplessness. We must likewise add to the foregoing, other causes, such as arduous work pursued under injurious conditions—for example, working on very fine objects in a bad light with glasses not suited to the sight, or without glasses when the state of the eyes requires them, &c. At other times, hyperæmia of the conjunctiva may be associated with hyperæmia of the deeper membranes of the eye, as, for instance, in cases of progressive myopia.

The **progress** of this affection is either acute or chronic, according as the exciting cause acts only for a short period or more continuously. In the latter condition, the hyperæmia may extend, and become the point of origin of inflammation of the Meibomian glands, or of a blepharitis, &c.

The **prognosis** is absolutely good, and if the patient can be withdrawn from the causes of the disease, the cure is generally spontaneous.

The **treatment,** in the first place, is directed to the avoidance of all noxious influences, and to removing the patient from those which have promoted the hyperæmia. Ocular hygiene, such as has already been explained in the preceding chapter, the use of suitable spectacles and of some cooling lotion, being sufficient in a number of cases.

The lotion may be replaced with considerable benefit by the douche played on the closed eyelids. In using the douche, however, all violent shocks should be avoided, and, for this purpose, the spray is of great service. If these remedies are not sufficient, astringents may be used along with them, applied as compresses to the eyelids. The liquor plumbi acetatis (6 drops to a glass of water) applied three times a-day for a quarter or half an hour, or sulphate of zinc (3 grains to nearly 5 ounces of water by weight), as a rule answer the purpose.

The same remedies, in stronger solutions, may be employed in the form of instillations once or twice daily. A perceptible amelioration is sometimes obtained by using a lotion made of laudanum (equal parts of laudanum and distilled water).

When the hyperæmia has already become chronic, a solution of nitrate of silver may be used with advantage (1½ grains to about an ounce of water), applied with a brush to the internal surface of the eyelids. This application may be repeated every four or five days, or even oftener if necessary. It need scarcely be said that when there exists any *mechanical* cause of the hyperæmia, such as hypertrophy of a Meibomian gland from infarction, a displaced cilium, an affection of the lachrymal passages, &c., the exciting cause must be removed.

After a hyperæmia of long duration, hypertrophy of the papillæ is often observed, for they become apparent as very minute transparencies in the neighbourhood of the palpebral sinuses. In cases of chronic

hyperæmia, therefore, these regions should be carefully examined, the lids being everted, and if these papillæ are seen, they should be lightly cauterised with the subacetate of lead (mixed with an equal quantity of water). This medicament can only be used with everted lids, and should be washed off with water to avoid deposit of acetate of lead on the cornea, all the more so when its epithelium is defective.

It is very rarely necessary, and in the majority of cases even injurious, to have recourse to cauterisation with sulphate of copper and nitrate of silver mitigated by the addition of the nitrate of potash.

For cauterising with nitrate of silver, we use mitigated crayons, which are composed of nitrate of silver and nitrate of potash, in the proportions of 1 part of the nitrate of silver to 2 of the nitrate of potash, or of equal parts, and sometimes of 2 parts of silver salt to 1 of potash. After cauterising, the excess of caustic is immediately neutralised by brushing the cauterised part with a little salt and water, after which the whole region is washed with cold water applied by means of the brush.

Each cauterisation is followed by a sensation of heat rather disagreeable to the patient. Its intensity must be checked by cold compresses or by the douche applied for a few minutes.

2. Catarrhal Conjunctivitis—Follicular Catarrh.

Diagnosis.—Catarrhal conjunctivitis consists in a hyperæmia of the conjunctiva, accompanied by secretion. Consequently, we have all the symptoms of hyperæmia already described, only in a more pronounced degree. The injection of the palpebral conjunctiva is so intense that we are no longer able to find any traces of the glands of Meibomius. The mucous membrane takes on a brilliant red appearance, and is turgescent, as is also the mucous membrane of the palpebral sinuses. The white of the eye is more or less injected, and the vascular network is so much the more prominent as the affection is intense.

The secretion varies with the degree of catarrh; it may be perfectly liquid, and so scanty as to render the eye only a little more humid than usual, or so copious as to produce continual stillicidium. Sometimes there are only a few mucous filaments amongst the folds of the conjunctiva or on the cornea; sometimes they are found in considerable quantity at the internal angle, always separated from the lachrymal fluid, with which the mucus does not mix, thus giving a very characteristic sign. If the irritation of the eye is considerable, there is also a hypersecretion of the lachrymal gland (dacryorrhœa), and the tears wash the mucous filaments towards the internal angle and the margin of the lids, and over the external surface of the inferior eyelids; hence we have

here excoriations of the skin, especially in the case of patients with a fine skin, or who cannot be kept from rubbing their eyelids.

During the night, the secreted mucous matter accumulates, and is deposited as crusts on the ciliary margin. These crusts must be carefully distinguished from those of ciliary blepharitis. The latter are situated at the base of the cilia, which they unite into the form of a pencil. They are large and soft, while the others form a more general layer on the margin of the lid and are dry and brittle.

In chronic catarrh, or after the cure of an acute attack, the secretion sometimes so diminishes during the night that the patient feels his eyelids hot and very dry, and has difficulty in opening them. Catarrh of the conjunctiva is not accompanied with severe pain, but with disagreeable sensations, as of itching or of the presence of grains of sand. These sensations increase when the patient is placed in unfavourable conditions, *e.g.*, surrounded by smoke, dust, vitiated atmosphere, &c.

Photophobia is chiefly felt when the eyes are exposed to a bright light. If it is permanent and very pronounced, and the patient complains of severe pain, there is every reason to suspect that the cornea is also affected.

The patient often recovers in a week or more without any other treatment than a rational hygiene for the eyes. More frequently the affection becomes chronic, and the injection of the ocular conjunctiva disappears. Complications of the cornea are rare, except in old people; moreover, amongst them the prolonged swelling of the mucous membrane easily produces eversion of the margin of the lower lid. When this has taken place, the displacement of the lachrymal punctum prevents the normal drainage of the tears, and the retention of this fluid is a new source of irritation to the mucous membrane, which becomes more and more swollen until a real ectropion is formed.

Catarrhal conjunctivitis is often only a preliminary phase, more or less prolonged, or a complication, of some other affection of the mucous membrane, *e.g.*, of blennorrhœa, phlyctenular conjunctivitis; a fact which deserves our attention on account of the different therapeutic indications.

Causes.—This affection may be due to any of the causes which have already been mentioned in connection with hyperæmia. To these causes we must add trauma of the conjunctiva, loss of protection to the eye (as in ectropion), contagion or direct inoculation of infectious material, participation of the mucous membrane in cutaneous affections of the face, such as erysipelas, impetigo, eczema, and the various acute exanthemata (measles, scarlatina, &c.); and again, a general predisposition to catarrh of the mucous membranes, which is observed in many persons to exist from childhood.

The **prognosis** is perfectly good, although we would remark that, at the beginning of the disease, there is uncertainty as to its being the commencement of a more serious affection, and, at the termination, there is the possibility of its becoming chronic.

Treatment.—In addition to a proper hygiene, the affection should be treated at first by the occasional application of cold compresses, made with a weak solution of boracic (3 to 100 of water) or carbolic acid (1 to 200 of water), applied every two hours for fifteen or twenty minutes, and, if necessary, by the administration of mild purgatives.

It is indispensable to prescribe for the patient great cleanliness, and to be careful that all the mucus which is secreted is removed without irritating the eye by rough handling. The best way is to have the eyes washed every two hours with the antiseptic solution above mentioned, mixed with an equal quantity of warm water.

It is only when the conjunctiva becomes relaxed and thrown into folds, loses its bright red colour, and becomes livid, that it is advisable to use astringents, such as the sulphate of zinc or of copper, or alum, in the strength of from 0·05 gramme to 0·15 gramme (1 to 3 grains) to 30 grammes (about an ounce) of distilled water, applied as a compress several times a day.

When the catarrh is limited to the eyelids and tends towards recovery, its progress may be hastened by instillations of the same remedies in weaker doses (gr. $\frac{1}{3}$ to 1 ounce), repeated twice or thrice daily.

These applications frequently produce considerable irritation, which, if excessive, must be checked by cold compresses or by douches.

For chronic catarrh hot astringent lotions are used, especially a solution of the subacetate of lead (gr. 60 to 10 ounces of water), or instillations of a few drops of a lotion composed of 20 centigrammes sulphate of zinc, 10 drops tincture of opium, and 20 grammes of distilled water.

Zinci Sulphatis, ...	gr. iv.
Tincturæ Opii, ...	♏ 10.
Aquam ad, ...	℥ i.
	—*Solve.*

Strong solutions of the nitrate of silver (3 to 6 grains to 1 ounce of water) may be applied with advantage, or the mucous membrane of the palpebral sinuses may be cauterised with solid sulphate of copper or mitigated nitrate of silver; in the last case care being taken to thoroughly neutralise all excess of caustic by washing with salt and water.

To prevent the formation of crusts, fatty matters are used, such as glycerine, or an ointment composed of white wax, 15 grains; oil of sweet almonds, 4½ drachms; spermaceti, 15 grains.

Generally speaking, we prefer the use of nitrate of silver when there is any discharge of mucus and sulphate of copper after it has disappeared. For patients very sensitive to the pain produced by the cauterisation some drops of cocaine may be applied beforehand.

The disagreeable dryness, stiffness and difficulty in opening the lids, of which patients often complain, may be cured by putting into the eye every evening one drop of equal parts of Tinct. opii and Aq. distill.

We must not forget to add that the number of remedies, simple or compound, which are used in catarrhal conjunctivitis, comprises many besides those enumerated; but success depends much less on the remedy chosen than on its mode of application. This is regulated by close observation of the phenomena which follow the use of the remedy employed, and must necessarily vary with the result obtained.

When the catarrh of the conjunctiva is maintained by an analogous state of the mucous membrane of the nose, a circumstance which is not rare in children and even in adults, we prescribe nasal injections of hot water and salt, or of a hot solution of borax or alum, given by a syringe specially adapted for the purpose. We likewise take care to keep in abeyance, by appropriate means (frictions of the skin, hydro-therapeutics), any general predisposition to catarrh manifested by the other mucous membranes.

Follicular Conjunctivitis, or **Follicular Catarrh** of the conjunctiva, is distinguished from the affection just described by the presence of small, round, pinkish prominences in the conjunctiva, the size of a pin's head (tumefied lymph follicles), situated chiefly in the fornix, and isolated or arranged in a row parallel to the margin of the lid. They are not so high nor so prominent and red as hypertrophied papillæ; when acute they are nearly white and under the level of the surrounding conjunctiva. The symptoms of catarrhal conjunctivitis accompanying the appearance of follicles are generally not very severe, and the patients (children mostly and young people) only complain of slight photophobia and painful sensations, which prevent their continuing close work for any length of time.

Follicular conjunctivitis lasts often for months, but, as the follicles disappear, it leaves the mucous membrane in its normal state. In a great number of cases we find that it is caused by bad hygienic conditions, and occurs, endemically, in pauper-schools, asylums and prisons. The use of atropine is liable to bring on the disease (as we shall see further on).

The **treatment** consists in hygienic precautions (fresh air, change of residence), lotions with freshly prepared Aq. Chlori., mixed with an equal quantity of warm water, and the use of an ointment of sulphate of copper from 2 to 5 centigrammes ($\frac{1}{2}$ to 1 grain) in 5 grammes

(about 1 drachm) of vaseline, of which the patient inserts a piece the size of half a pea into the conjunctival sac in the evening, a quarter of an hour before going to bed. The degree of irritation produced by this application decides whether it should be used daily or every two days, or at greater intervals.

3. Purulent Conjunctivitis — Blennorrhœa of the Conjunctiva—Ophthalmia Neonatorum—Gonorrhœal Ophthalmia.

Diagnosis.—The boundary separating purulent conjunctivitis from the form which we have just described is not clearly marked. The symptoms of these affections differ in their intensity rather than in their special characters. In purulent conjunctivitis, the vascular network of the mucous membrane is more developed and more turgid, the injection of the conjunctiva is greater, and the palpebral sinuses are more easily made prominent on everting the lids, which is due to the greater turgescence of their tissue. They appear covered with papillæ, which are sometimes pointed, sometimes broader; or with true papillary excrescences, which easily bleed on the slightest touch. The conjunctiva being thus impregnated with fluid, and even softened, there being a serous effusion which extends to the subconjunctival tissue, we find tumefaction of the eyelids. The œdema is so great as to cause the furrows of the external skin to disappear; and the increased weight and relative insufficiency of the levator palpebræ superioris causes a greater or less drooping of the eyelid.

The patient experiences a certain difficulty in opening the palpebral fissure. The external skin of the eyelids is livid and the temperature elevated. The ocular conjunctiva is also injected and shining, and the infiltration of the subjacent tissue becomes the source of the chemosis which, in very severe cases, encircles the cornea as a thick cushion.

The secretion is more abundant than in catarrhal ophthalmia. It flows over the eyelids and runs down the cheek. Its quality varies with the period of the disease. At first it has the characteristics of a severe dacryorrhœa, and the mucous material is clearly separable from the tears. Then a certain quantity of purulent elements is blended with it—the purulent elements mixing with the lachrymal fluid, at last it becomes uniformly purulent (Pyorrhœa).

At first the patient complains of a feeling of heat and of smarting, then more or less severe ciliary pain supervenes, accompanied by shooting pain in the head.

In nervous subjects we sometimes even find a febrile movement,

which, as a rule, ceases when the secretion is freely established, and reappears when the purulent ophthalmia is complicated with an affection of the cornea.

Progress and Termination.—When unaccompanied by any complication, and when not passing into the chronic condition, purulent ophthalmia generally lasts for three or four weeks. The first period of the disease, that which precedes the establishment of the secretion, may be so short as to pass almost unperceived.

When the disease terminates directly in cure, we see, as for example in ophthalmia neonatorum, all the symptoms gradually diminishing and the conjunctiva slowly returning to its normal condition.

In other cases, the affection passes insensibly into the chronic form, characterised chiefly by swelling of the conjunctiva, by papillary excrescences on its surface, with more or less bulky folds in the palpebral sinus. Again, and this is the feature which constitutes the gravity of this affection as compared with catarrhal ophthalmia, in a great number of cases the cornea is seriously involved.

There are three different ways in which the cornea may be affected :—

I. There are formed, at different places, by loss of substance in the epithelium of the cornea, small facets, which are apt to be overlooked, especially at the beginning of the affection, when the cornea still preserves perfect transparency. If this loss of substance supervenes in the final period of the disease, and if the patient is carefully watched, the alteration may go no further, and regeneration of the destroyed tissue may begin.

If this complication of the cornea appears when the inflammation is at its height, the smaller facets extend deeper into the cornea and become united, and thus an ulcer is formed which is covered with yellowish matter; the ulcer becomes deeper and deeper, terminating in perforation of the membrane.

II. There appear towards the centre of the cornea, the general transparency of which is diminished, greyish points (infiltrations), which increase in size, become fused, and tend to the formation of abscess.

III. The infiltration takes place at the margin of the cornea, in the form of a more or less complete ring; this alteration, if it occupies a considerable portion of the corneal periphery (more than a third), indicates a deep-seated affection of the nutrition of this membrane, and becomes the starting point of a general necrosis, which almost inevitably causes the loss of the eye.

The cause of this participation of the cornea is due either to the inflammation of the subconjunctival tissue compressing the nutrient vessels of the cornea, to the direct action of infectious matter on the

cornea, or to the mechanical friction of the palpebral conjunctiva, which is swollen and covered with hypertrophied papillæ.

In consequence of these complications, purulent conjunctivitis may produce permanent opacities of the cornea, staphylomatous deformities, or even complete destruction of the eye.

We may add that, especially in old people, the eyelids do not easily regain their elasticity, and, if the inflammation extends to the tarsal cartilage, very troublesome ectropion may supervene.

The importance of the affection which we are considering, and the danger which arises from an insufficient or misdirected treatment, make it necessary clearly to define the differential diagnosis of purulent conjunctivitis. It may be confounded—1, With *catarrhal ophthalmia:* we have already stated that it is only a question of difference in intensity between these two affections, the treatment of which otherwise is almost identical. 2, With *acute granular conjunctivitis:* in this affection the secretion is much less copious, the injection much less pronounced, and, constituting the chief characteristic distinction of acute granular, we have the presence of small whitish spots surrounded by vessels, which appear first of all at the level of the conjunctiva, while in purulent ophthalmia we have noticed the existence of pointed or large papillæ, which form true excrescences. An error of diagnosis would be fatal, for the application of caustic, so beneficial in purulent, would only aggravate acute granular conjunctivitis. 3, With *diphtheritic conjunctivitis:* in this case the mucous membrane is tender, pale, and covered with yellowish membranes, without any trace of vessels. We also find in diphtheritic isolated spots of ecchymosis, elevated temperature of the eyelids, and severe pain. The secretion does not present the homogeneousness of a purulent secretion, but is rather bloody serum, in which shreds of the diphtheritic membrane float. We may also add that diphtheritic never exists in the new-born, most frequently occurring in children of from six months to six years old. In dubious cases, decision may be arrived at by microscopical examination of the discharge; that of infectious blennorrhœa generally contains a peculiar micrococcus (*Neisser's* gonococcus) in the shape of diplococcus, situated in the globules of pus, or in colonies resembling mulberries.

The **prognosis** in purulent ophthalmia is not absolutely bad when there is no complication. Yet, as complications are very frequent, and may arise at any period of the disease, caution and reserve are always necessary. If obliged to pronounce an opinion, we must take into account the period and the intensity of the disease, and, in cases where it is epidemic, the character of the epidemic. If the cornea is once affected, the prognosis becomes much more serious.

Ætiology.—Any catarrhal conjunctivitis may become blennorrhagic, the morbid state of the tissues furnishing, then, a particularly favourable soil for any infectious matter; so that we have at first to recall the various exciting causes of this disease. Any infectious matter—and it becomes so by the presence of micrococci—coming in contact with the mucous membrane of the eye may determine a blennorrhœa of the conjunctiva. As a matter of fact, this affection is most frequently produced by direct inoculation, as in

gonorrhœal ophthalmia and in the ophthalmia of the newly-born—in the latter by contact of the eyes with the vaginal secretion, in the former by the urethral discharge being carried by the fingers to the eyes.

We often see purulent ophthalmia appearing simultaneously in a number of persons exposed to the same epidemic influences—in barracks, prisons, and schools—and the contagion then spreads rapidly. Opinion is still divided on the question whether transmission takes place exclusively by direct contact with the products of secretion, or through the air. For our own part, adopting the view of *von Graefe*, we believe that in the latter mode the contagious elements are conveyed by exhalation.

What seems to us more important is, that the inoculation of the products of the secretion does not always produce the same form of the affection. We try to explain this fact by the varying condition of the soil which receives the infectious matter.

Thus, in one case of inoculation, we see a simple catarrhal ophthalmia supervening; in another, a purulent conjunctivitis; and in a third, especially if the disease is epidemic, a diphtheritic ophthalmia.

Treatment.—In the early stage of the disease, when the mucous membrane is still stretched and the secretion insignificant, we must abstain from applying to the eye any remedy which is astringent or caustic. The remedies are cold compresses, kept on till the temperature falls to the normal; if there is considerable hyperæmia, repeated scarification of the mucous membrane of the palpebral sinus; or, again, a horizontal incision beginning at the external angle of the eye, and carried through the skin, muscle and fascia, taking care of the conjunctiva, so as to avoid all danger of ectropion (*von Graefe*).

This incision, which involves a few small arterial vessels in direct communication with the conjunctiva, has the double advantage of active depletion and of diminishing the pressure of the eyelids on the eye (by section of the orbicularis). When the general state of the patient permits of it, this small operation may be replaced by the successive application of a few leeches.

The so-called *abortive* method, consisting in the energetic use of a concentrated solution of nitrate of silver, should be rejected, because at this period of the affection we are ignorant whether or not we are dealing with an incipient diphtheritic conjunctivitis, in which case the application of caustics would be very injurious to the eye. It is better to try the effect of the systematic exclusion of air, by using a protecting bandage, taking the precaution of changing it morning and evening, so as to ascertain the condition of the eye. This exclusion of air may be better accomplished by covering the eye with a large round

piece of lint, firmly applied against the margin of the orbit, and kept wet by an ice-cold solution of boracic or salicylic acid. In any case, with the first appearance of secretion, we direct the frequent application of antiseptic lotions, such as the solution of sublimate (1 to 5–10,000), freshly prepared Aq. Chlori., or carbolised water. These lotions and the above-mentioned ice-compresses and scarifications are the only admissible local treatment during the first stage, with exclusion of any caustic application if the secretion presents at this or at any period a tendency to become plastic. Such tendency is revealed by a greyish, sometimes membraneous, deposit on the conjunctiva, which does not appear red, and does not bleed so easily as in the other cases.

The purulent nature of the disease being once made clear, the remedy considered as sovereign in this affection is the application of caustics. A strong solution of the lapis divinus, acetate of lead, or nitrate of silver may be used.

Lapis divinus or Nitrate of Silver, . .	50 centigrammes (8 grains).
Distilled Water, ...	30 grammes (1 ounce).
Or,	
Subacetate of Lead Solution, . . .	15 centigrammes (3 grains).
Distilled Water, ...	15 grammes (½ ounce).

But those who are in the habit of using the solid mitigated nitrate of silver prefer it, and very rightly, to the other remedies mentioned. It has the advantage of limiting the action of the caustic to any portion desired, which is important in an affection where the mucous membrane is not uniformly affected.

The pencil of pure nitrate, which acts very deeply upon the structures, easily producing cicatrices, should only be used when the conjunctival infiltration is very deep, the papillary excrescences already excessive, and the secretion very abundant.

As a rule, we use a pencil composed of equal parts of nitrate of silver and nitrate of potash, which is applied in the following manner:—The upper eyelid is everted so as to make the palpebral sinus prominent, the lower eyelid is carried up over the cornea so as to protect it, the pencil is applied to the mucous surface, more or less freely, according to the degree of action which we wish to obtain. Any excess of caustic is immediately neutralised by means of a camel's-hair pencil, dipped in salt and water, and the entire surface of the mucous membrane is washed with pure water before the lid is allowed to assume its natural position. The same operation is performed on the inferior eyelid, the cornea being then protected by the upper one.

Mode of Action of the Caustic.—On a healthy mucous surface an eschar is formed after the cauterisation, having the effect of a foreign body, of which the tissues try to get rid. A serous exudation takes place in the tissues beneath the

eschar, which is thus raised so as to rub against the mucous membrane of the eye-ball. The pain, which till this time has not been severe, increases until the eschar is separated, and then gives place to a dull feeling, which lasts till the tissue destroyed by the cauterisation is regenerated. On a blennorrhagic mucous surface, cauterisation also produces an eschar; the resulting pain is very severe on account of the great sensibility of the parts; but, as a matter of fact, the effect of an equal amount of cauterisation is less than on the healthy mucous membrane, since the engagement of the conjunctiva produces a more rapid neutralisation of the caustic.

Whilst the eschar is being detached from the subjacent tissue by the serous exudation, the temperature is very high, and it only falls at the period of regeneration. At this period, the membrane is still deprived, in places, of its epithelium, and blood-stained at different points; but the tissues become collapsed, and there is an almost complete cessation of the secretion. It begins again, however, when the period of regeneration is terminated, and then the caustic must be again applied.

These different periods (hyperæmia with serous exudation, separation of the eschar, regeneration of the epithelium) generally occupy about four-and-twenty hours, but there is no absolute rule as to this; it is therefore necessary to watch the patient carefully after the first cauterisation, that we may ascertain the time at which the secretion has recommenced, in order to know the exact time which must intervene between two cauterisations. If they are repeated too often, the irritation of the eye will naturally be increased in a permanent manner; if, on the other hand, too seldom, the disease will gain fresh strength each time, and the efficacy of the treatment will be diminished (*von Graefe*).

When one eye only is affected, the other must be protected from contagion by a lint bandage made into a fixed compress by diachylon, and rendered impermeable by a thick layer of collodion. It is unnecessary to point out that this bandage must be frequently changed, so that the condition of the eye may be ascertained. Again, a sufficiently large spectacle glass, round, and made in the form of a shell, may be used with very great convenience to the surgeon and to the patient. The glass should be encircled by a large band of leather, which should rest against the margin of the orbit, and be fixed behind the head by means of a buckle. For greater safety the occlusion may be made still more perfect by fastening the leather band to the margin of the orbit with court plaster or with goldbeaters' skin, covered with a thick layer of collodion.

We must insist on the patient observing the greatest possible cleanliness; the diseased eye should be frequently cleansed, and the products of the secretion, which if allowed to remain would irritate the eyeball, removed. For this purpose, the best method is to employ a current of the antiseptic solutions above mentioned, projected from a short distance either from a sponge or a syringe.

It is important to make the patient and those who are around him aware of the danger of the contagion, and how best to avoid it.

Immediately after the cauterisation the reaction, which is sometimes very strong, may be best checked by cold compresses, and, in cases

where the mucous membrane is swollen, the patient experiences great relief from scarification of the membrane after the application of the caustic, before the eschar is detached, because at this time the congestion is greatest. The eschar then becomes detached more rapidly, and the pain is diminished. Scarifications have thus a particular value in

Fig. 24.—Desmarres' Scarifier.

cases where there is some complication of the cornea, and where we are anxious to avoid the hurtful rubbing of the eschar on that membrane. Scarification is performed with a special scarifier (Fig. 24), by means of which small superficial incisions parallel with each other are made.

The flow of blood may be kept up by lightly drawing the lid in the direction opposite to that of the incisions, and by carefully washing the places scarified. We must avoid making the incisions too deep, otherwise conjunctival cicatrices may be formed.

When chymotic swelling surrounds the cornea and prevents the shutting of the lids, it is advisable to allow the serous fluid which produces it to escape. To this end small incisions are made with curved scissors at the margin of the cornea in the chymotic swelling. When the point of the scissors has penetrated the subconjunctival tissue, it must be incised throughout the entire extent of the chemosis; then the escape of the fluid is facilitated by making slight pressure through the eyelids, directing it from the top of the chemosis towards the incision.

The excision of a fold of conjunctiva should generally be avoided, because it may be the source of troublesome conjunctival cicatrices, and also because it does not effectually attain the end in view. Again, excision of the conjunctiva only gives egress to the fluid which is immediately beneath the portion of the membrane elevated, for the effusion is enclosed in the cellular spaces of the subconjunctival tissue, and will remain there so long as this tissue is not incised.

When the purulent ophthalmia is complicated with an affection of the cornea, the anti-blennorrhagic treatment must be continued, since blennorrhœa of itself favours the extension of the disease in the cornea. After cauterisation we must carefully neutralise, *i.e.*, repeatedly wash with salt and water, the cauterised surface, hasten the rapid separation of the eschar by scarifications, and remove it directly it is detached. If the ulceration of the cornea penetrate its tissue deeply, the most assiduous treatment will not always succeed in preventing perforation of this membrane. This perforation, however, may be limited in its

extent, and consequently rendered less dangerous than the perforation of a large portion of the cornea.

The intraocular pressure, even if not increased in this affection, naturally acts with a relatively greater force on the ulcerated part of the cornea, which offers less resistance to it, than on the healthy part. We must therefore employ all the means which experience has shown to be adapted to diminish the internal tension. In the first place, instillation three or four times daily of a drop of pilocarpine, 0·20 gramme (4 grains) to 10 grammes (ʒij), or of the sulphate of eserine, 0·05 gramme (1 grain) to 10 grammes (ʒij). The advantage of these alkaloids over atropine, which is specially remarkable in extensive ulcerations of the cornea (*Ad. Weber*), lies in their myotic action, and in their power of contracting the vessels, which diminishes the secretion of serous fluid in the interior of the eye, and so reduces the intraocular pressure.

Another way of accomplishing our object is by paracentesis of the anterior chamber, perforating the cornea at the bottom of the ulceration; taking care, however, that the aqueous humour escapes very slowly. This small operation is followed by the application of a compress and bandage, which helps the cornea to resist pressure. This diminution of the ocular pressure possesses at the same time the advantage of accelerating the nutrition of the cornea, as is apparent in the more rapid regeneration of the destroyed tissue, which begins by the deposition of greyish matter in the bottom of the ulcer. Puncture of the anterior chamber is always indicated where the thinnest part of the ulcer shows by its prominence that it is about to yield to the pressure

Fig. 25.—Paracentesis Needle.

of the anterior chamber; for it is very important to prevent spontaneous perforation, which, taking place irregularly, may easily induce a considerable prolapse of the iris, advancement of the lens, loss of vitreous humour, and hæmorrhage, and may ultimately lead to destruction of the eye. In any case, the cicatrix which follows spontaneous perforation will, because of its extent and irregular form, leave an opacity much more prejudicial to vision than the insignificant cicatrix of paracentesis.

The instruments required for this small operation are a paracentesis needle (Fig. 25), fixation forceps, and a small blunt-pointed bent probe. After the application of some drops of cocaine, the head of the patient being firmly fixed, and the lids sufficiently separated, it is well to steady the eye with fixation forceps in every

case where the patient is unable to keep it perfectly at rest. In this way only can we be sure of avoiding ineffectual attempts before we succeed in puncturing just at the proper point, the performance of paracentesis at any other place than that at which we desire to perform it, or the giving of a wrong direction to the instrument. The paracentesis needle should be introduced obliquely, so as to make a linear incision 3 or 4 millimetres long. By so causing the instrument to penetrate through the cornea, we run the least risk of consecutive prolapse of the iris. As soon as the point of the needle has entered the anterior chamber, we lower the handle of the instrument, so that the point may not wound the iris or the lens, which, in consequence of the evacuation of the aqueous humour, come forward. On withdrawing the needle, as a rule, the aqueous humour is seen to escape, coming out with greater or less force according to the state of the internal pressure of the eye and the direction of the wound in the cornea. But it sometimes happens

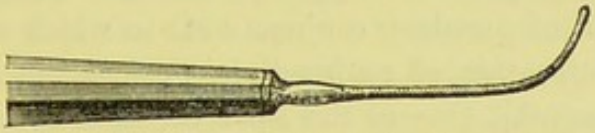


Fig. 26.—Convex Probe with blunt point.

that the aqueous humour only issues when the lips of the wound are separated either by light pressure with the point of the needle or by means of a small probe. (Fig. 26.) Again, by pressing lightly the rounded and flattened point of this instrument on the margin of the wound we may renew when necessary the discharge of aqueous humour before the wound completely cicatrises.

After perforation of the cornea, if we find that the iris is involved in the wound, we must try, by means of pilocarpine and atropine, to restore it to its normal position. The alternate application of these two remedies may occasionally succeed, but often the prolapse is too great to allow of our trusting to these means. In such cases it is best not to touch it, but to leave it to normal cicatrisation. But if it adds to the irritation of the eye, preventing the escape of the aqueous humour, it must be incised or removed. By neglecting this precaution we run the risk of having the tension of the eyeball increased. Often when the lens projects forwards, it becomes necessary even to remove it from the eye through a transverse incision of the cornea. If after the extraction of the lens the vitreous body makes a hernia in the corneal wound, a few drops of it may be drained off by puncturing the hyaloid membrane. By so doing we promote the formation of the cicatrix. Complete loss of the eye is thus prevented, and we may even have a chance of restoring, at a later period, by operation for artificial pupil, a useful amount of sight to the patient.

A loss of vitreous humour is regarded by many surgeons as likely to lead to shrinking of the eyeball. Such a loss is, therefore, generally dreaded. Yet this does not result from even a considerable loss of vitreous humour, which is quickly replaced, but rather from the choroiditis which may supervene, with considerable disturbance of the circulation, leading to changes in the nutrition.

If the conjunctival blennorrhœa has become chronic, the treatment,

apart from the hygienic precautions already indicated, is summed up in the regular use of astringent lotions and caustics.

If the secretion is moderate in quantity, the acetate of lead may be used (1 or 2 to 100 of water); if it is more abundant, a lotion of the nitrate of silver (1 to 3 to 100 of water), or the mitigated pencil may be employed. Solid sulphate of copper should be preferred in those cases where, the secretion having ceased, we wish to prevent permanent hypertrophy of the papillæ. But if the mucous membrane after some time becomes accustomed to the action of the same remedy and it loses its effect, it is advisable to alternate the nitrate of silver pencil with sulphate of copper or acetate of lead.

The two forms of purulent conjunctivitis to which we give a special place in the classification of conjunctivites, *ophthalmia neonatorum*, and *gonorrhœal conjunctivitis*, present the same series of symptoms, and the principles of treatment are also the same.

Ophthalmia neonatorum (of new-born children).—In regard to this we would only remark that sometimes it assumes, especially in the early stages, the appearance of a catarrhal conjunctivitis, and then requires the attention proper to that affection. Sometimes the form it takes is freely purulent. Sometimes again the secretion shows a tendency to plasticity, approaching to diphtheritic conjunctivitis, which latter affection will occupy our attention in the next chapter. But the true diphtheritic is never seen in newly-born children. What we find in such cases is not, as in true diphtheritic, the infiltration of the mucous membrane with fibrinous matter, but the deposit of fibrinous exudation on the surface of the conjunctiva in the form of a membrane. Nevertheless, this state of matters warns us to be somewhat cautious in using caustics, and indicates antiseptic lotions, the prolonged application of ice-cold compresses, and, if the plasticity of the secretion continues, the administration to the little patient of very minute doses of calomel.

Catarrhal conjunctivitis of new-born children can be ascribed to different causes in isolated or combined action, such as a too irritating light, cold, uncleanliness. But the ætiological element in blennorrhœa neonatorum is direct infection, by leucorrhœal discharge of the vagina or cervix uteri finding its way into the infant's eye during the act of birth, or, later, by means of soiled linen or sponges. Thus it is important to use rigid prophylaxis by careful disinfection of the vagina before and during parturition, and to strongly recommend extreme cleanliness in the linen and sponges used, and as regards the hands of all those who come in contact with mother and child. Considerable diminution in the frequency of cases of ophthalmia neonatorum (from 10 to 0·2 per cent.) has been obtained by taking these precautions, together with the minute cleansing of the face and eyes of the child with carbolised

water (1 or 2 per cent.), and instillation of some drops of a solution of nitrate of silver (2 per cent.) between the eyelids immediately after birth. A child with blennorrhœa must be isolated and treated according to the rules given above.

We also frequently meet with purulent conjunctivitis in little girls affected with leucorrhœa, or children living near them. The frequency and the danger of this contagion should lead medical men to a serious investigation of such cases, in order that they may guide those who have charge of the children, and recommend hygienic measures, as well as the local treatment required.

In **gonorrhœal blennorrhœa** the infection takes place by direct transmission of the discharge with the fingers. Sometimes we observe simultaneously severe arthritis, which may attack several joints at the same time or successively. The inflammatory process, generally very intense, runs a very rapid course. The tumefaction of the lids is considerable, the palpebral conjunctiva is greatly swollen, and that of the eyeball is the seat of a bright injection and of a deep chemosis. The secretion is rapidly established and very abundant.

It is especially in these cases that we must not forget to take the precaution of thoroughly protecting the eye which is not affected, on account of the exceedingly contagious nature of the discharge, of which we must warn the patient and those around him. If the disease run a very acute course we must apply ice-cold compresses of antiseptic solution (sublimate) day and night, deplete by scarifying or by the repeated application of leeches, give large doses of calomel, and even make use of mercurial frictions, especially when there is a tendency to plasticity. As soon as the purulent character of the ophthalmia is declared, we must begin cauterisation, which may have to be repeated once or twice a day, because the eschar becomes detached so much the more quickly as the congestion is greater.

II.

Diphtheritic Conjunctivitis.

Diphtheritic Conjunctivitis, one of the most terrible of the affections of the eye, observed in true epidemics in some of the northern regions (*e.g.*, in North Germany), is exceedingly rare in other countries, especially Britain and France.

It is true that supposed cases of it have been often reported, but this is due to the disease having been confounded with the *croupous* form of ordinary conjunctivitis, in which the conjunctiva is covered

with a slight white or greyish membrane, which may sometimes be removed *en masse* or in pieces, exposing the underlying mucous membrane very much congested, turgid, bleeding and of a brilliant red colour. It is thus we observe it, for example, in little children, as a variety of ophthalmia neonatorum, and in more advanced age sometimes as an epidemic form of catarrhal conjunctivitis or blennorrhœa. Its prognosis is far from being so serious as in diphtheria, and the treatment is that of catarrh or blennorrhœa (*vide supra*), with the restriction that we have to abstain from cauterisation as long as there is any tendency to the formation of false membranes.

True diphtheritic conjunctivitis presents altogether different symptoms. It is characterised by a fibrinous infiltration throughout the entire thickness of the mucous membrane, which interferes with the circulation, and gives a peculiar tinge to this membrane.

Diphtheritic conjunctivitis begins with a feeling of heat and acute pain, accompanied by increased secretion of tears. Shortly after, the upper lid becomes swollen, the cutaneous markings disappear, the skin becomes smooth, shining and of a pale rose tint which spreads over the lid from the free margin. The patient finds it difficult, and soon impossible, to raise the eyelid. It falls down and overlaps the other, and he becomes excessively afraid of its being touched when any one approaches him to raise it.

The ocular conjunctiva presents a large vascular network, but is not of a bright red colour. The chemosis, which is then rapidly developed, is of a yellowish appearance, intermixed with a great number of red points, each of which is a small apoplectic spot. Incision of the chemosis does not permit of the escape of any serum, the subconjunctival tissue being infiltrated with coagulated, gelatinous fibrin.

It is very difficult to evert the superior eyelid, not only because of the pain, but because the lid offers great resistance. After everting, we see that the surface is smooth and yellowish. This is due to the thick, fibrinous exudation which deeply infiltrates the conjunctiva, stopping almost entirely the circulation of the mucous membrane, and menacing with total destruction the conjunctiva and the entire eye. If we remove a layer of this exudation we invariably find the same smooth yellow surface—that is to say, the conjunctiva thus curiously infiltrated. The most striking feature is the absence of vessels, and if an incision is made, even to a considerable depth, scarcely a drop of blood is shed. This gives to the mucous membrane a lardaceous appearance, which is still better seen in the part covering the cul-de-sac. The lower lid presents the same appearances.

In children, well-defined white diphtheritic patches are often found on the external skin at the angles of the eye. Amongst them also the

diphtheritic affection does not always involve the whole surface of the conjunctiva, but may occupy only limited portions of the membrane.

The secretion is sanious, greyish, and mixed with numerous detached flakes of the diphtheritic matter; there is also great lachrymal catarrh, producing a feeling of excessive heat.

This combination of symptoms is characteristic of the first period of the disease, the so-called **period of infiltration.** It is during this first period—which may be of very short duration, but may last for six, eight, or even ten days—that the safety of the eye is especially threatened by complications of the cornea. If corneal affections supervene only during the second stage, or if the second stage begins before the cornea is seriously involved, the danger is much less.

At the beginning of the second period—the **period of purulent discharge**—the lids begin to lose their stiffness, and there is a copious discharge of fibrinous masses. Vessels reappear on the surface of the mucous membrane, and the circulation is re-established at several points, so that there only remain isolated white patches, which are surrounded with a mucous membrane, resembling that of purulent conjunctivitis. Whilst these white patches gradually lose the characteristic physiognomy of the diphtheritic infiltration, the rest of the conjunctiva, still deprived of its epithelium, is covered with papillary excrescences which ultimately invade the entire surface, so that in the end we find ourselves in the presence of a well-defined purulent ophthalmia. At the same time, the chemosis loses its yellow appearance and its stiffness, and resembles more the ordinary chemosis. Unfortunately, the disease does not end as does blennorrhœa of the conjunctiva, but enters a third stage—the **period of cicatrisation.**

We are then in the presence of a regressive modification of the conjunctival tissue, which becomes transformed into cicatricial tissue, producing, according to the intensity of the disease, more or less extensive adhesions between the palpebral conjunctiva and that of the eyeball.

When the infiltration has been moderate, the cicatricial alteration may be confined to a simple shrinking of the conjunctival sac, but in more pronounced cases there is a true xerophthalmia, followed by the loss of the eye.

The ultimate condition of diphtheritic affections varies according to the duration of each period. After a prolonged first period, the purulent stage is generally rapid, whilst the process of cicatrisation occupies a considerable time. The inverse takes place when the first period is short, and it may be so short as to pass almost unobserved.

The greatest danger of this destructive disease arises from affections of the cornea, and unfortunately these complications are only too frequent.

It is easy to understand that such a complete interruption of the circulation in the conjunctival and subconjunctival tissues as accompanies the period of infiltration cannot last long without seriously affecting the nutrition of the cornea. In short, this membrane is very readily altered if the period of infiltration lasts for more than thirty-six or forty-eight hours. And if this period lasts for a long time the loss of the eye is only too certain.

There is a great difference according as the cornea becomes affected in the first period or during the purulent stage.

In the first case, the cornea, till now in a normal state, and even of an exceptional brilliancy, becomes all of a sudden the seat of a slight exudative opacity, which extends more and more; the epithelium which covers it is destroyed, and an ulcer is formed which increases in size and in depth, and the bottom of which is covered with an opacity sometimes yellow, sometimes transparent. The margins of this ulceration have the appearance of being "punched out," and we are liable to be deceived as to its depth when the bottom of the ulcer, yielding to the internal pressure, rises up nearly to the level of the rest of the cornea. Perforation may then take place, which, if involving a considerable surface, is followed by rupture of the capsule and panophthalmitis. If the perforation is less extensive, the prolapsed iris which fills up the wound of the cornea becomes covered with a thick exudation, and the disease follows its destructive course on this membrane.

If an attempt be made to prevent perforation by paracentesis, the opening is immediately closed, and if a portion of the cornea is excised in order to form a permanent fistula, our object is not easily attained, because the great plasticity of the secretion immediately obliterates the opening, and covers the prolapse of the iris with exudation.

The affection of the cornea does not always assume the same form; it sometimes begins with facets which are almost transparent, at other times by general yellowish infiltration. The result of either is a widespread ulceration, which tends to perforation.

If the purulent period supervenes during the course of the corneal affection, there is a much greater chance of its becoming limited, and we may then hope to preserve part of the vision.

The affections of the cornea are the same as we have described in speaking of purulent ophthalmia.

Prognosis.—We have already said that diphtheritic conjunctivitis is perhaps the most dangerous affection from which the eye can suffer, because it only too often terminates in the loss of the eye, and because any treatment hitherto tried has been quite inadequate.

It is more serious in the case of an adult than of a child. Cases

where the affection only partially reaches the conjunctiva, and to no great depth, naturally allow a more favourable prognosis. But it is always doubtful until the purulent stage is reached.

During the first period, we judge of the gravity of the case by the amount of infiltration in the parenchyma of the tissue, which may be estimated by the degree of stiffness of the lid, by the more or less complete suppression of the circulation, and by the greyish colour of the chemosis.

The state of the cornea decides the future of the eye; the earlier the affection of this membrane, the graver is the prognosis. If the keratitis begins about the commencement of the second period, the prognosis is much more favourable. The pre-existence of a vascular affection of the cornea is a very beneficial circumstance, for reasons sufficiently obvious. We must also take into account the general character of the epidemic.

Experience shows that the cases caused by direct contagion are much the more serious.

Ætiology.—The causes of this disease are very obscure; all that can be said is, that it is very contagious, and is generally present as an epidemic. It should be considered as the expression of a general condition, as is manifest from the simultaneous appearance of diphtheritic affections in other parts of the body, and from the general symptoms which accompany it, such as violent fever, with periodical exacerbation, loss of appetite, and considerable general weakness.

Corroborative evidence is found in the fact that the other eye, although protected from direct contagion, often becomes attacked. The undoubted influence of systemic remedies points to the same conclusion. During an epidemic, we observe that children of weak constitution are oftenest smitten, and amongst them we find a relatively large number who are the subjects of congenital syphilis.

Under the influence of a diphtheritic epidemic, inflammations and traumatisms of the eye readily assume the special character of the disease. It thus happens that a too active use of irritating remedies, especially of caustics, aids its development, especially in cases where there is a predisposing plasticity of the secretion.

Although the diphtheritic disease is eminently contagious, it must be kept in mind that inoculation does not always produce the same disease, but perhaps a catarrhal or purulent affection of the conjunctiva; whilst, on the other hand, inoculation of purulent matter may produce diphtheritic conjunctivitis. Newly-born children are never affected with diphtheritic conjunctivitis; it sometimes, although rarely, occurs between the ages of six months and a year. Then its frequency

increases progressively till the third year, after which it diminishes till the eighth year. Diphtheritic conjunctivitis rarely attacks adults.

Treatment.—If a specific treatment for diphtheritic conjunctivitis remains to be discovered, we can at least indicate, on the one hand, treatment which is undoubtedly injurious, and, on the other, those remedies which seem to act favourably on the progress of the disease.

During the first period of the disease, the use of caustics must be entirely proscribed; they unquestionably destroy the eye. The local treatment consists in the use of ice-cold compresses made with freshly prepared aqu. chlori., or with a solution of sublimate (1 per 5,000), which should be changed whenever they become hot, and continued day and night till near the beginning of the second period. Active blood-letting (which cannot be obtained by scarifications, since they do not allow any blood to escape) is best effected by applying leeches in the region of the internal angle over the nasal bone. By renewing the leeches as often as they fall off, we maintain a continuous and even an increasing escape of blood during the first period of the disease.

We must prescribe for the patient a strict diet and a mercurial treatment, giving 5 centigrammes ($\frac{3}{4}$ grain) of calomel to an adult, and from $\frac{1}{2}$ to 2 centigrammes ($\frac{1}{12}-\frac{1}{3}$ grain) to a child, every two hours night and day. At the same time we make mercurial inunctions every day, using the compound ointment—2 to 4 grammes (ʒss to ʒi) for an adult, $\frac{1}{2}$ to 1 gramme (gr. 6 to gr. 15) for a child. This active treatment must of course be stopped as soon as the danger diminishes.

The affected eye should be frequently washed with a disinfecting fluid mixed with milk or boroglycerine, which is beneficial in taking up the isolated flakes of the secretion. If the second eye is not affected, it must be protected from direct inoculation by the protecting glass (already described), or, if that cannot be obtained, by a bandage, avoiding, however, any kind of pressure which might become dangerous by impeding the circulation.

For the same reason, the use of the protecting bandage must be stopped as soon as the slightest tumefaction of the lids appears.

As soon as the purulent period seems imminent, it must be promoted by stopping the cold compresses, and they may then even be beneficially replaced by hot aromatic compresses.

During the last few years, an attempt has been made to check diphtheritic conjunctivitis at its commencement, by hot compresses moistened with a disinfectant solution of permanganate of potassium or of benzoate of soda (5 to 100). The results of this treatment seem to be so satisfactory that the method deserves to be imitated.

Moreover, we must remember that all enfeebling treatment in ordinary diphtheria meets an increasing number of adversaries; so that

we may also doubt the utility of mercurial treatment and of blood-letting in diphtheria of the conjunctiva. Undoubtedly, any energetic treatment must be carried out with due regard to the condition of the individual.

If we notice that change in the appearance of the mucous membrane which characterises the second period, we may apply slight cauterisations to the red and bleeding points, closely watching the effect. To avoid the friction of the slough in the cornea, it is well to begin with the inferior eyelid. If the slough is quickly and easily detached, we may make a second and somewhat stronger cauterisation, followed by deep scarification, which accelerates the circulation and promotes the separation of the slough.

On the other hand, we must abstain from repeating these preliminary cauterisations if the fibrinous exudation returns.

If once a freely purulent condition is declared, the treatment is similar to that which we have recommended for purulent conjunctivitis, with a few necessary modifications, such as a certain amount of prudence in cauterising, and the restricted use of cold compresses, which are only of transient utility after cauterisation.

During the period of cicatrisation we must cease to use caustics, and as far as possible palliate the desiccation of the eye by instillations of milk, boroglycerine, carbonate of soda lotion (30 grains of the carbonate of soda in 1 ounce of water).

Corneal complications demand the use of pilocarpine, and paracentesis of the anterior chamber, performed in the bottom of the ulcer, of a considerable size, so as to establish if possible a fistulous opening.

During the process of recovery and after its completion the general health of the patient requires, in the majority of cases, strengthening diet and tonics.

III.

Pustular, Phlyctenular Ophthalmia.

This disease, which only exists on the ocular conjunctiva, is characterised by well defined and very limited exudations, which elevate the epithelium, and form pustules containing a perfectly transparent gelatinous liquid. Various forms of the disease are distinguished by the seat, development and complications of these phlyctenulæ.

1. In the most simple form, there appears on the ocular conjunctiva, a little raised above its level, a triangular injection, its summit, which is directed towards the cornea, presenting a phlyctenula as large as a pin head or millet seed. There may be several of them at different parts of the conjunctiva. At first the injection increases, but after-

wards the vascular swelling flattens, becomes pale and disappears along with the phlyctenula, the contents of which are absorbed without leaving any trace.

At other times the small phlyctenula bursts, allowing the contents to escape, and forming a small ulcer, which is soon covered with a layer of epithelium, and heals in a short time.

This entire process is completed in a few days, and the more quickly the farther the phlyctenula is removed from the cornea.

Very often the injection advances in the form of little bands, always pushing the infiltration before it. On reaching the margin of the cornea it assumes a horse-shoe shape, or divides into two. Sometimes many injections with their exudations affect the cornea in this manner.

If the disease is arrested at this point the injection grows pale and disappears, but the grey exudation of the cornea is for a long time visible as an opacity of the membrane. At this period the vessels of the conjunctiva sometimes encroach on the cornea, causing a superficial vascular corneitis, which has received the name of *phlyctenular* or *scrofulous pannus*.

2. At other times the conjunctival or subconjunctival injection is much more extensive. The hyperæmia and infiltration are localised in the neighbourhood of the conjunctival ring, and thus form a slight swelling round the cornea. On it we sometimes find, not without difficulty, a great number of very small transparent phlyctenulæ, which cover the conjunctival ring like fine sand. In a few days the injection fades, the pericorneal swelling falls and the small pustules disappear without leaving any traces. Very rarely they excoriate and form little ulcers, which, in any case, quickly heal up, becoming covered with a layer of epithelium. This form is almost never complicated with pustular corneitis.

3. A very pronounced injection accompanies the formation of large sub-epithelial exudations of the conjunctiva situated in the neighbourhood of the cornea, on the conjunctival ring itself, and sometimes partly on the cornea.

These flattened exudations may be formed several at a time or successively. Their epithelial layer excoriates, and they then present large ulcerations from 1 to 2 millimetres in diameter, which do not heal for some weeks. If the ulceration gain in depth it may give rise to perforation at the margin of the cornea, which, if not attended to, may be the starting-point of partial staphyloma. More rarely the disease is accompanied with circumscribed infiltrations in the cornea (yellow infiltration), which become changed into an abscess by the purulent transformation of the infiltrated tissues.

4. Large phlyctenulæ are formed on the ocular conjunctiva. The

inflammation gains in depth, and is communicated to the sclerotic. We then find a large prominent pustule, of a violet-red colour, clearly defined, the injection of which disappears on pressure. This phlyctenula very often ulcerates, and the duration of the disease may be prolonged, but the inflammatory process only affects the superficial layers of the sclerotic.

Phlyctenular conjunctivitis is occasionally unaccompanied by any subjective sensations; but at other times the patient suffers from excessive secretion of tears, very violent pain and intense photophobia, associated with blepharospasm. This last symptom is met with especially and almost exclusively when the cornea is affected. When, by means of elevators, and even then not without difficulty, we separate the lids to examine the condition of the eye, there is a gush of hot tears, and the patient turns up his eyes to avoid the light. Photophobia and blepharospasm disappear momentarily, so that the inspection of the eye becomes easy, after the application of some drops of cocaine between the eyelids. The secretion is not altered unless the affection is complicated with catarrhal conjunctivitis.

A characteristic feature of phlyctenular ophthalmia is its predisposition to frequent relapses.

Prognosis.—The prognosis is very good in the case of small phlyctenulæ on the conjunctiva and on the conjunctival ring, if the cornea is not affected. Even corneal complication in the form of bands makes the prognosis worse only in so far that the consequent opacity does not easily yield. In the case of pustular conjunctivitis with episcleritis, we must not forget the longer duration of the disease, which, *per se*, is not an element of danger. The large phlyctenulæ of the conjunctival ring last for a long time; but, if carefully watched, they pass off without leaving any trace.

Where we have yellow infiltration of the cornea, the prognosis depends on the amount of inflammation which accompanies this condition. If it is entirely absent the prognosis is bad; it is much better if the inflammation is acute.

Ætiology.—Phlyctenular ophthalmia specially attacks children, and may be considered as amongst the most frequent of the conjunctivites of this period of life.

We find it in healthy children, as well as in those who are badly nourished and scrofulous. The term "scrofulous," as applied to it, is therefore not justifiable.

It may arise from any of the irritating influences which induce the other forms of conjunctivitis. The concurrent appearance, either before or after its commencement, of cutaneous erruptions of the eyelids or of the surrounding skin, such as eczema or zona, seem to

point to phlyctenular conjunctivitis as an exanthematous disease of the mucous membrane depending on the ciliary nerves. Hence it has been called *conjunctival herpes.* Yet many of the forms of this affection which we have described bear but a slight resemblance to a cutaneous herpes.

Dr. Martin (of Bordeaux) pays great attention to the frequency of astigmatism, and considers the use of cylindrical glasses as calculated to prevent the relapses.

Treatment.—Very often, specially in the slighter forms which do not involve the cornea, the cure is spontaneous; accordingly, care must be taken not to interpose needlessly with an irritating local treatment, which can only increase the evil. Above all, three remedies much in favour with the public and even with medical men—viz., vesicants, leeches and nitrate of silver—must be proscribed. The first increase the nervous irritability of the little patients; the second do not, in the majority of cases, meet any indication, and they needlessly enfeeble the patient; the third may, at most, be employed when the affection is complicated with catarrhal conjunctivitis, and even then, for fear of causing too strong irritation, it may be replaced by solutions of alum or of borax.

On the other hand, a concentrated solution of nitrate of silver may be beneficially used to paint the mucous membrane of the nose, when it is ulcerated, as it very often is in scrofulous children.

The principal and, so to speak, specific remedies for phlyctenular ophthalmia are the local application of pure calomel dust and of oxide of mercury. The first should be applied by means of a very dry brush handled in the following manner:—The lids are everted, and the powder is thrown on the unhealthy conjunctiva by a sharp stroke of the index finger against the brush held between the thumb and middle finger.

A very fine layer of calomel is thus deposited on the cornea and conjunctiva. After a short time, the calomel is found rolled into filaments in the conjunctival cul-de-sac, whence it is easily removed by means of a brush moistened with water.

These insufflations are repeated daily until the phlyctenulæ disappear, then at increasingly longer intervals for several weeks.

The method in which the calomel acts is difficult to explain. It may, mechanically, destroy the epithelial layer of the pustules, and thus assist in their rupture. Yet experiments have shown that other powders do not produce the same effect. Its chemical action could only be explained by its transformation into the bichloride, for calomel itself is insoluble. Its action then would be to diminish the calibre of the vessels and even to obliterate the smallest branches.

In cases of ulcer of the cornea, we must prescribe hot lotions with chlorinated water, and the sub-orbital region must be rubbed with the following ointment :—

White precipitate, ...	50 centigs. (gr. 7).
Extract of belladonna, ...	1 gramme (gr. 16).
White vaseline, ...	8 grammes (3ij).

When the first irritation has passed off, and the cornea has become vascular, we use with great advantage an ointment of the oxide of mercury, so justly praised by *Pagenstecher*.

It may be prescribed in the following proportions :—

Yellow oxide of mercury (prepared by the moist method), ...	25 to 50 cs. (gr. 4 to 7).
Vaseline, ...	5 grammes (3i).

We introduce a piece the size of half a pea into the conjunctival sac by means of a small brush; it is allowed to remain there for a few minutes, and is then removed by carefully washing the conjunctiva and inferior cul-de-sac with a moist brush.

The photophobia has been treated in a special manner by painting tincture of iodine on the forehead and shut eyelids, but this symptom often disappears with the treatment just described. While it lasts, we must not encourage the tendency shown by children to hide their faces and to seek out dark corners. It is better to apply a protective bandage, which moreover has the advantage of preventing the little patients rubbing their eyes.

It is necessary to change the bandage often, to clean the eyes, and to replace the bandage, as soon as the condition permits, with dark-coloured glasses.

When the keratitis is in the form of little bands, we may cut short the progress of the disease by gently touching the small exudation with a pointed mitigated nitrate of silver pencil, followed immediately by washing with salt water, or by dividing the vessels near the margin of the cornea. This small operation is performed by means of an ordinary scarifying knife. Since the circulation is easily re-established in the vessels thus divided, we prefer to destroy them with the galvano-cautery or to excise a piece; this is done by lifting up a small fold containing the vessels, and snipping it off with curved scissors. We must abstain from excision in scrofulous pannus, which yields readily to yellow oxide of mercury ointment.

Ulcers and abscesses of the cornea do not permit the use of calomel or *Pagenstecher's* ointment; their treatment will be discussed in the chapter on corneitis.

When intense blepharospasm prevents thorough treatment, or is

injurious from the pressure exercised on the cornea, we must relieve the eye by section of the external palpebral ligament, adding thereto if necessary, after the method of *Agnew*, incision of the tarso-orbital fascia. Section of the external palpebral ligament is performed by dividing the external commissure horizontally for from 10 to 15 millimetres with a pair of straight-pointed scissors. To divide the fascia, we draw the lid upwards and outwards, slip one limb of a pair of scissors between the skin and tarso-orbital fascia, and run the other into the superior cul-de-sac. We then divide the fascia, made tense by the dragging on the lid, by a sharp stroke of the scissors for about 4 or 5 millimetres.

For the excoriations of the skin, so frequent about the nostrils and lips, we use glycerine, a solution of nitrate of silver, and later an ointment of lead or zinc. We must also attend to the nasal mucous membrane by injecting or otherwise locally applying an astringent or caustic lotion.

General treatment must not be neglected, because the constitution of the patient often requires it, and it is then indispensable in warding off relapses, so common in this disease. Of suitable hygienic precautions, residence in a pure atmosphere and plenty of exercise form a considerable part. Light purgatives are often necessary, but especially an alterative. We may give some such powder as the following:—

Antimonii sulphuratis, . .	āā gr. 15-30.
Pulv. Rhei., ...	
Sodæ Bicarb., ...	

Divided into twenty powders. One thrice daily.

We may add to this, if necessary, small doses of calomel.

We have seen benefit derived from prolonged rubbing of the whole body with salt water, and, according to the nature of the child, from cod-liver oil, or from stimulants, such as alcohol in small spoonfuls after food.

Spring Catarrh.

A somewhat rare variety of conjunctivitis has been described under the name of *spring catarrh*. It is characterised by phlyctenoid eruptions on the conjunctival limb, which becomes transformed into a swollen ring more or less large, pinkish, and resembling gelatine. The greatest width of the swelling is in the space left bare by the opening of the eyelids, where also the injection is most distinctly marked. This alteration is less frequent at the superior and inferior margins of the cornea. The mucous face of the eyelids seems pale, as if it were

covered with a thin layer of milk, and in the region of the tarsus we find swollen papillæ and small round white spots which are not prominent on the level of the conjunctiva.

This variety most frequently affects young persons of from seven or eight years to the age of puberty. A return of the disease generally takes place each spring, and it almost entirely dies away towards autumn. It has no other serious inconvenience than preventing the children from attending to their regular studies for several months. With the exception of slight photophobia, they do not complain of pain unless through inflammatory exacerbation, which may also bring on some discharge. The prognosis is good; this disease terminates in recovery without any damage to the cornea. We must abstain from all irritating treatment, contenting ourselves with calomel or iodoform insufflations, at the same time acting on the constitution of the patients by suitable hygienic and therapeutic agents (change of air; iron and arsenic). If the hypertrophy of the conjunctival limb is very considerable, we may, without inconvenience, cut it off to the level of the surrounding conjunctiva.

IV.

Granular Conjunctivitis.

Experience has shown that granular ophthalmia presents itself in two forms—1st, **acute granulations**, often accompanied with severe inflammation; 2nd, **chronic granulations**, where the inflammation is entirely absent or supervenes at a later period. It is true that, in a certain number of cases, both forms appear in combination, but nevertheless it is necessary to maintain the exact distinction, because of the important differences in the treatment required.

1. Acute Granulations.

The disease begins with swelling of the upper lid, accompanied by conjunctival and sub-conjunctival injection, which extends over the entire ocular conjunctiva to the conjunctival ring and even beyond it. On the palpebral conjunctiva, we find increased vascularity, as also turgescence of the mucous membrane from the presence of small prominent papillæ, red and tumefied as in catarrhal conjunctivitis. Between the papillæ we find whitish round spots, about the size of a pin head, non-vascular, which do not rise above the level of the conjunctiva. These spots, scattered over the mucous membrane, form the characteristic symptom of acute granulations. The secretion is at this period relatively scanty, but the affection is often accompanied

with lachrymation and photophobia, so that the patients are not able to open their eyes. A flood of scalding tears escapes if we separate the margins of the lids. At the same time there is considerable pain in the eye and forehead, even extending to half the head.

Any subconjunctival injection indicates a disposition of the inflammation to extend to the cornea. In fact, we often see greyish opacities below the epithelium, with superficial vascularity, which takes its origin from the vessels of the conjunctival limb spreading over the cornea, a condition easily recognised by focal illumination. At other times, the disease produces superficial ulcers at the margin of the cornea.

The **progress** of the disease is as follows:—After eight or ten days there supervenes an inflammation of the conjunctiva, which becomes swollen; at the same time the papillæ become turgid. The vascularity hides the little white spots, which are reabsorbed, and finally disappear. The disease then assumes the characters of catarrhal conjunctivitis, with a puro-mucous secretion, and progresses rapidly enough towards a favourable termination. This form of granular conjunctivitis, which lasts altogether for about three or four weeks, is that which we classify under the name of *Egyptian ophthalmia.*

Unfortunately, the disease does not always end so quickly and so favourably. The inflammatory process, necessary for the reabsorption and extermination of the granulations, may deviate in two opposite directions.

The inflammation may become so acute as to constitute a purulent ophthalmia, which is then substituted for the acute granulations, and from which we must fear the most serious consequences. At other times, it is not sufficiently intense to produce absorption of the granulations, which are more and more developed, become prominent on the surface of the conjunctiva, and take the characteristic form of trachomatous granulations.

The termination of this disease is thus very variable; sometimes the granulations pass off without leaving any trace; sometimes, when they become chronic, and when the eye has frequently been affected with the same disease, they give rise to superficial cicatrices, which, by suppressing a portion of the conjunctival secretion, cause a dryness of the eye. This condition predisposes to chronic catarrh, and renders the eye more liable to be affected by all those atmospheric influences which are apt to set up acute inflammations. Again, the corneal complications may become the starting point of various changes, which may pass off with the granulations or pursue an independent course.

Prognosis.—In simple cases, when the secondary inflammation is kept within the limits necessary for the reabsorption of the granulations, the prognosis is good, especially if the cornea is not involved, or

only slightly so. Cicatrices are much less to be feared when the first period—*i.e.*, the period which precedes the inflammatory reaction, has been short, and when the number of granulations has been very limited.

The granulations, *per se*, being free from danger, the gravity of the prognosis depends entirely on the complications. It may be that a purulent ophthalmia supervenes, it may be that the disease passes into the chronic stage.

Ætiology.—The precise causes of acute granulations are difficult to determine. The affection developes under all the noxious city influences which occasion catarrhal and purulent conjunctivites. It is often developed in an epidemic form in prisons, barracks, &c., that is to say, wherever there are dirt and bad hygienic conditions. What is important to know is, that it is contagious, and is propagated by the contents of the granulations and by the secretion.

Von Graefe admits contagion by the atmosphere. The disease appears to be readily developed amongst persons who are weakly, scrofulous, tubercular, &c. Inoculation does not always produce the same disease, but sometimes other forms of conjunctivitis. On the other hand, acute granulations may arise from contagious matter taken from catarrhal or purulent ophthalmia.

Treatment.—We have seen that acute granulations are sometimes cured spontaneously under the influence of an inflammatory reaction; hence we have an indication to abstain from all active therapeutic interference in the early stages of the disease.

The use of astringent lotions or of caustic, remedies which habit suggests to medical men in the presence of such a conjunctivitis as this is, may have in the case of acute granulations a most disastrous result, by thwarting the means which nature has provided for the cure of the disease, or by inducing transformation into other and more dangerous forms.

It suffices, then, in the beginning of this affection, to isolate the patient so as to keep the contagion from spreading, to keep him at rest in good hygienic conditions, and to advise him to employ from time to time moderately cold compresses to relieve the sensation of heat from which he suffers. Where there is great tumefaction of the lids we interfere only by painting the external integuments with a solution of nitrate of silver, acetate of lead, or tincture of iodine. If this first period is prolonged, and the inflammation necessary for the absorption of the granulations is delayed, we may promote its formation by hot compresses or by using hot chlorinated water.

Whenever the purulent discharge shows itself, it becomes necessary for us to watch the case very closely; and if this discharge becomes

excessive, we must check it by compresses of ice water, and, generally, by those remedies which we have advised for purulent ophthalmia. At the same time we must not forget that a certain degree of purulence is necessary for the absorption of the granulations. If it is deemed prudent to intervene with caustics, we must, with the greatest care, at first use solutions of acetate of lead, sulphate of copper, or nitrate of silver of medium strength, closely watching their effect before applying the mitigated pencil as in true purulent inflammations. In most cases the application of caustic every forty-eight hours is sufficient.

If the inflammation seems to be too feeble, we must try to produce an artificial hyperæmia by means of hot compresses and other stimulating agents, such as caustics, used superficially and repeated as often as is necessary. We generally employ sulphate of copper, a concentrated solution of acetate of lead, or the mitigated pencil of nitrate of silver.

In the case of relapse we must be guided by the same principles, always bearing in mind that the cure of acute granulations demands a certain degree of hyperæmia, which must therefore be promoted when deficient, and checked when excessive. It is well also to associate with the local treatment systemic remedies tending to improve the constitution of the patient.

2. Chronic Granulations—Trachoma.

The affection described under the name of chronic granular or trachomatous ophthalmia passes through diverse phases, now to be described in succession—phases whose aspects are so varied that an inexperienced observer might imagine them to be as many different diseases. Experience has shown that in reality these different appearances are due to the various evolutions of the same pathological process, the symptoms of which are combined with those of the inflammation that accompanies and complicates the primary disease.

In the first period of this disease, which is developed in an insidious manner, the inflammatory symptoms may be completely absent, or they may be so slight that the eyes of the patient may have contracted granular ophthalmia without his suspicions being aroused. At most the eyes are sensitive to the action of light and other irritating agents, such as dust, smoke, &c.

Sometimes the margins of the lids are glued together in the morning, or the eyes may appear slightly smaller on account of the sinking of the upper eyelid. If we evert the lids, the conjunctiva in general appears glistening, white, but, on the whole, normal. Only we find on it whitish or greyish vesicular granulations, varying in size according to

their stage of development, from small points scarcely visible to the naked eye, and only rising slightly above the level of the conjunctiva, to the size of millet seeds.

They are semi-transparent, and appear either disseminated or arranged in rows parallel to the tarsal margin, on the palpebral conjunctiva in the neighbourhood of the cul-de-sac, or in the sinus itself. We much more rarely see them on the ocular conjunctiva, near the angles of the eye.

The anatomical nature of these granulations is not yet determined. Of the numerous suppositions which have been made as to their origin we shall only repeat the two most important. According to some authorities, they are formed by a circumscribed hyperplasia of the lymphatics, which in the normal condition are embedded in the reticulated connective tissue of the conjunctiva. They thus form true lymphoid follicles.*

Others consider them as really new growths, and this hypothesis is specially defended by our Belgian *confrères*,† whose great authority and experience as regards this matter cannot be denied. They see in the vesicular granulations which we have just described the peculiar and special pathological character of the ophthalmia of armies, which, under the influence of intercurrent inflammations, assumes the aspect of a catarrhal, purulent, or granular ophthalmia.

It is no cause for surprise that the form of the disease described under the name of vesicular granulations should have long remained unknown, or been considered very rare, because we seldom see the chronic granulations in their first stage, since they may exist for a long period without any inflammatory symptom, and without evoking any complaint from the patient, who feels so little inconvenience that he is ignorant of their existence.

In the second stage, the granulations, having increased in size, become covered with a vascular plexus, and thus form a great number of reddish projections on the palpebral mucous membrane, whence they extend to the palpebral sinus, the ocular conjunctiva, the semilunar fold and the caruncle. At the same time the conjuntiva becomes red and infiltrated; it secretes a muco-purulent liquid; and, if this condition lasts for any length of time, we find papillary granulations, consequent on the serous infiltration of the papillæ of the conjunctiva, making their appearance along with trachomatous granulations (mixed granulations of *Stellwag*).

The third stage is occupied with the development of fresh granulations,

* Consult an article in *Archiv. d'Ophthalmologie*, 1869, by Dr. Paul Blumberg: "Du Trachome au Point de Vue Cellulo-Pathologique."

† For details, see article in *Annales d'Oculistique*, Feb., 1870, by Dr. Herion, of Louvain: "Des Granulations Palpébrales."

while those of the previous stage lose their round and circumscribed form and become diffuse. The papillæ swell and increase in size, blending with the granulations. Thus we find on the mucous membrane red gelatinous or fleshy masses, in which we are no longer able to distinguish granulations from papillæ, and which assume very variable aspects.

Sometimes we find pediculated, conical, or polypoid excrescences, forming isolated villi, or united in close and parallel columns, separated by deep furrows, which only become visible when the mucous membrane is moved about. Sometimes they appear as condylomatous fungoid masses, covering with patches or longitudinal bands the mucous membrane of the lids; the palpebral sinuses, and the neighbouring ocular conjunctiva, as also the semilunar fold and the caruncle.

The membrane itself during this period undergoes a fibroid degeneration. It atrophies, and presents the appearance of cicatricial tissue (greyish-white, shining, and without vessels). Thus we see in the palpebral conjunctiva several cicatrices parallel with the free margin of the lid, and others radiating towards the cul-de-sac. If the mucous membrane which covers the cul-de-sac is similarly affected, the palpebral sinus diminishes in depth, contracts more and more, and finally is obliterated, so that the tarsal mucous membrane is a direct continuation of that of the eyeball, which has undergone analogous alterations.

If, in the early stages of granular ophthalmia, the patient is so little annoyed that he ignores the state of his eyes, he will not be long, whenever the granulations have acquired a certain development, or enter into the second stage, in complaining of a disagreeable sensation as if of foreign bodies in the eyes and of an increased sensibility to light and to irritants, and will find it impossible to use his eyes over any work. The secretion, even when insignificant in quantity, causes some disturbance of vision as it descends from the superior cul-de-sac over the cornea. These symptoms increase if the disease affects the cornea, and are then accompanied with violent ciliary pains. Should the condition be complicated with purulent ophthalmia, we again meet with the series of symptoms already described as accompanying that malady.

Complications. — The rugose condition of the conjunctiva causes important alterations in the cornea, especially if the lids are naturally tight and closely applied to the eyeball. There is first of all superficial vascularity, then a proliferation of epithelial cells between the epithelial layer and *Bowman's* membrane (*pannus of the cornea*). These alterations, and the consequent opacity, occupy the upper part of the cornea, and this so generally that the very aspect of the pannus permits of our diagnosing at once granular ophthalmia. Later the

affection invades the entire membrane, which is softened, loses its resistance, and more readily yields to the pressure of the anterior chamber.

At other times the cornea participates directly in the trachomatous affection; granulations are formed in it as small greyish lumps, surrounded with vessels which extend over the entire cornea.

We shall have to speak in detail of pannus of the cornea, when speaking of the affections of that membrane.

The granular affection may, under bad hygienic or atmospheric conditions, be further complicated with catarrhal conjunctivitis or with acute or chronic purulent ophthalmia, and the cornea may then suffer from ulcer or abscess, as it is liable to do in such conditions.

If, at the period of these complications, the cornea is already covered with a pannus, it seems to be protected more or less, according to the extent of the pannus, from the dangers to which the purulent condition exposes it. (It is on this observation, and on that of the resolution of the granulations by purulent inflammation, that the rational treatment of old standing pannus by purulent or *jequirity* inoculation depends.)

Progress and Termination.—Chronic granulations are developed in an insidious and almost imperceptible manner, as we have already seen. If the disease is arrested in this slight form, it may heal spontaneously, the granulations being absorbed by a slow inflammatory reaction, which, however, sometimes assumes the character of an acute inflammation; but, in the majority of cases, the disease runs a chronic course in passing through its various stages. The transformation of all the granulations does not take place at the same time, and we may frequently meet on the same eyelid granulations in all stages of development, finding in some parts a fresh crop of granulations, when in others the inflammatory reaction has already produced infiltration of the mucous membrane and hypertrophy of the papillæ, or the conjunctiva in places has even undergone the fibrinous transformation, which changes it into cicatricial tissue. From time to time slight inflammatory attacks intervene, which for the moment increase the secretion and then gradually disappear.

During the second period, the disease may also be cured by resolution, if the patient be placed in good hygienic conditions and submit to appropriate treatment. But, in the majority of cases, cicatrices of the palpebral conjunctiva are left. According as the cornea has been more or less affected, we shall find on it opacities, which often defy all treatment. If the affection has been of long duration, or the masses of granulations considerable, there frequently remains a relative feebleness of the levator palpebræ superioris which causes a certain degree of drooping of the eyelid, even after the disease is cured.

Again, after the third period, we find more or less complete opacities, and sometimes even staphylomatous distensions of the cornea. At the same time, the contraction of the tissue substituted for the conjunctiva may produce deformity of the eyelid, inversion of its margin, and incurvation of the tarsus. The simultaneous obliteration of the ducts of the lachrymal gland may cause a dryness of the eye which brings on a progressive xerosis. We refer to the chapter on purulent ophthalmia for the ultimate result of this latter complication.

Prognosis.—The prognosis varies with the development of the disease, the conditions in which the patient is placed, and the facilities which he possesses for taking care of himself.

In the first period, the disease, if properly treated, generally terminates in a short time by resolution. The duration of the treatment is much longer if the affection has entered the second period, and a cure is not always obtained without leaving traces on the cornea and conjunctiva.

Later, the disease is still more stubborn; its duration is, so to speak, unlimited, and even when our treatment succeeds in arresting the development of fresh granulations, and in causing those which already exist to disappear, the changes in the lids and cornea produce more or less serious disturbances of vision, sometimes even amounting to blindness.

Ætiology.—Chronic granulations rarely attack children or old people. Statistics show that they more frequently affect men than women. It is not generally believed that granular conjunctivitis is developed from a constitutional condition of the organism. Indeed, it is observed in persons who are perfectly healthy, whilst the unhealthy and cachectic appearance of persons affected for a long period with chronic granulations is due to the injurious influence which the lengthened duration of the affection exercises on the health and spirits of the patients.

The contagious nature of granular ophthalmia is no longer disputed. It may be propagated by the medium of the atmosphere, charged with germs, but, without doubt, direct contact with the contagious secretion produces either granulations or some other form of conjunctival inflammation.

The disease appears endemically, or in epidemics where people are crowded together under bad hygienic conditions. The special micrococcus found by *Sattler* in granular ophthalmia, whose inoculation by him on a sound conjunctiva produced the same disease, has not been found by other observers.

Treatment.—The rational treatment of granulations, which de-

mands much tact and prudence, ought to be directed to the local state, and to the general and hygienic condition of the patient.

In treating the local condition, the use of caustics holds an important place. The surgeon must not forget, however, that he ought not to destroy the granulations directly by the use of caustics, but only excite by this means the inflammatory condition sufficient for their absorption. In several places we have insisted on the fact that nature herself provokes the inflammatory reaction necessary for the cure of the granulations. The surgeon's duty is to aid the *natural* process, if the inflammation is insufficient, and to moderate it if it becomes excessive. The caustic should be applied only to the affected portions, sparing the healthy conjunctiva, the conservation of which is of the first importance. For this reason solid caustic, such as the mitigated nitrate of silver pencil and bluestone, are preferable for isolated granulations, solutions of the same substances are applicable only for diffused granulations.

Sulphate of copper is best used when there is no catarrhal discharge. When we observe some secretion, or when the patient complains of its existence during the night, we prefer to employ nitrate of silver or acetate of lead. This last remedy excites very persistent reaction and ought only to be used where the cornea is perfect, otherwise it may form deposits and incrustations on the cornea in spite of the most careful use. Nitrate of silver, too continuously or too strongly employed, may produce a greyish and indistinct coloration (*argyrosis*) of the conjunctiva.

Glycerine, with tannin, has a very mild action, but it has this advantage that it can be used by the patient himself; we therefore use it when the patient can be seen only occasionally.

In such circumstances we may prescribe one or other of the following remedies :—

Tannin, ...	gr. vij.
Glycerine, ...	ʒijss.
Cupri sulphatis, ...	gr. i.
Glycerine, ...	ʒijss.

Moreover, it is necessary, when the affection is of long duration, to vary the choice of remedies, substituting aq. chlori., alum, borax, salicylate of soda for those we are employing, because the conjunctiva becomes accustomed to their action.

Sometimes it becomes advisable to stop all active remedies, restricting our treatment to hygienic measures only.

The immediate effect of any application of caustic may be very acute, and may require to be checked by cold compresses or douches,

in which case care must be taken not to reapply the caustic till the irritation produced by the previous application has disappeared. Strong cauterisations, following quickly on each other, increase the inflammation, producing complications, and rendering the diseased parts indifferent to the action of the remedies, which must then be increased in strength. When the granulations are dry, indolent, and without inflammatory reaction, we may beneficially substitute, according to *von Graefe's* advice, hot compresses, about 100°F. for the caustics, which compresses should be kept on for a longer or shorter period, in proportion to the difficulty we have in exciting the necessary inflammation.

The *jequirity* treatment requires a freshly made infusion of half an ounce of dicorticated seeds macerated for twenty-four hours in 1½ lbs. of cold water and then filtered. This has to be applied directly to the mucous membrane three times a day for a few days, till it produces an ophthalmia characterised by considerable swelling of the lids, croupous membranes on the conjunctiva, and a copious muco-purulent discharge. The pain is sometimes very severe; there may also be œdema of the face and neck and even partial necrosis. In the course of ten or twelve days the inflammation subsides; and, severe as it seems to be, it is generally without danger to the cornea. Nevertheless, as destructive ulceration has been observed, we have to be careful in cases where the cornea is sound. The curative effect of this treatment upon the granulations is much questioned, but seems indisputable as regards pannus of the cornea, in which case it is preferable to the inoculation of blennorrhœal pus.

Scarifications may be useful where we have diffuse granulations, with swelling of the mucous membrane; but it would be an error to make them routine practise in chronic granulations, for dangerous cicatrices would form, especially if caustic were applied after the scarifications.

Instead of scarifying, we often make use of energetic friction on the unhealthy mucous membrane with a somewhat hard sponge. The result, as regards the escape of blood, is almost the same, and we think that by thus removing the epithelial layer, we stimulate the circulation which favours the absorption of the granulations.

Excision of the granulations is admissible only in a few well-defined cases, *i.e.*, where the granulations are isolated and pediculated, in a word, where we can extirpate them without fear of injuring the conjunctiva.

At other times the conjunctiva, and more frequently the caruncle, are covered with a thick fungoid or gelatinous layer, which disappears with the most exasperating slowness under the influence of ordinary

caustics. In these cases, it is admissible to remove this layer, always taking care not to remove too much, and specially avoiding the removal of any healthy portion of the mucous membrane.

Thus, it is preferable to make a deep incision through the conjunctiva and the subconjunctival tissue of the fornix conjunctivæ when they are much swollen and stretched, or to incise each granulation and bring out its gelatinous contents by compression between the nails of the fingers or by means of a sharp spoon. The galvano cautery has been proposed for the same purpose. *Dr. Galezowski* years ago proposed excision of part or of all of the fornix conjunctivæ with the granulations it contains, and he employs this method in a great number of cases with advantage. Recent communications of *Jacobson's* practice (*Heisrath et Vossius*) suggest the same operation with sutures applied to the conjunctival wound. This operation being rather long and painful requires chloroform.

As the disease progresses favourably, the more active remedies must be abandoned for those with a milder and more gentle action. We should gradually increase the interval between two successive applications, and finally stop all local treatment.

Diseases of the cornea complicating granular ophthalmia, unless they are provoked by an irritating treatment, require continuation of the remedies employed against the disease of the conjunctiva.

As to pannus of the cornea, its treatment will be discussed with the affections of that membrane.

The cicatricial alteration of the conjunctiva and the consequent dryness of the eye should be treated with milk lotions, the application of fresh oil and of glycerine, and a solution of carbonate of soda (1 part to 30 of water).

It is necessary, in treating chronic granulations, to bear in mind the close connection of the lids to the eyeball. The mechanical action of the friction of the internal surface of the lids, when they are firmly applied to the eye, as also the irritation of the hairs when the margins are inverted, are amongst the most frequent causes of corneal complications. The pressure of the eyelids may be diminished by enlarging the palpebral fissure. This operation is called *cantoplasty*, and will be described in connection with diseases of the eyelids. We may often prevent inversion of the lid by performing this operation, or by the more direct methods which will be discussed in the chapter on *entropion*.

If there remains, after the patient is cured, a drooping of the upper eyelid, caused by feebleness of the levator muscle, we may try at first regular exercises suited to correct the defect.

Thus we should make the patient look upwards, whilst the other eye is closed, and make him do so for a few seconds, repeating the

exercise several times a day. If necessary, this condition may also be remedied by a simple operation, which will be described when we treat of *ptosis*.

General treatment should take account of the constitutional conditions and any existing diathesis. In every case, it is of importance to free the secretions, and to increase the action of the skin (by dry friction, slight diaphoresis, Turkish baths, &c.) The contagious character of the disease demands the isolation of the patient, especially when there is secretion, which circumstance must not be overlooked after the patient returns to his family. It is true that granulations, when unaccompanied with secretion, do not seem able to spread the contagion; but we must not forget that the secretion may be established at any moment, and that we must protect the patient and those who are around him.

We share in the opinion of those who think that good hygiene is often more advantageous in the treatment of granulations than any other means. Fresh air is one of the conditions indispensable to recovery. Still further, the disease, already cured, is apt to recur if the patient be exposed to unfavourable atmospheric influences. Change of air, or removal to another country, have been known to exercise a beneficial influence on the disease.

Amyloid Degeneration of the Conjunctiva.

A very rare affection of the conjunctiva, and one which presents certain resemblances to granulations, has been described under the name of *amyloid degeneration of the conjunctiva*. It is developed most commonly in the upper half of the cul-de-sac and of the semilunar fold, and produces so great an hypertrophy of the mucous membrane that it may cause a projection beyond the palpebral fissure. The conjunctiva is thus transformed into a thick tissue—soft, gelatinous, and of a yellowish colour—which contains a few transparent grains larger than ordinary granulations. The rest of the conjunctiva is absolutely healthy.

The only treatment recommended in this degeneration is the removal of the hypertrophied parts of the conjunctiva.

Conjunctivitis from Use of Atropine.

To complete the series of the various forms of conjunctivitis, we must mention that form which follows the use of *atropine*, *duboisine*, or *eserine*. It appears sometimes as a catarrh, with a puro-mucous secretion and swollen papillæ and lymph follicles, sometimes as a hyperæmia

of the palpebral conjunctiva, which takes on a yellowish tint, and becomes thicker. The skin of the eyelids at the same time wrinkles, becoming rugose, and of an erysipelatous red. The patient suffers from lachrymation, which obliges him constantly to wipe his eyes.

This conjunctivitis, comparatively rare, sometimes makes its appearance after the first application of atropine or duboisine, and ought then to be attributed to an idiosyncrasy of the mucous membrane; in other cases it supervenes only after a prolonged use of these alkaloids, especially when the pharmaceutical preparation is defective.

In all cases we must at once stop their application, and prescribe hot lotions of acetate of lead. In such cases, also, we may use without inconvenience the extract of belladonna or of duboisine for those patients who cannot bear atropine.

ART. II.—Pterygium.

The name of *pterygium* is given to a highly vascular triangular thickening of a more or less extensive portion of the conjunctiva, whose base corresponds to the circumference of the eyeball, and whose apex is directed towards the cornea, upon which it may more or less encroach (Fig. 27). It is very mobile on the sclerotic, and is generally situated in the direction of the internal rectus, more rarely in that of the external, and exceptionally we find several on the same eye.

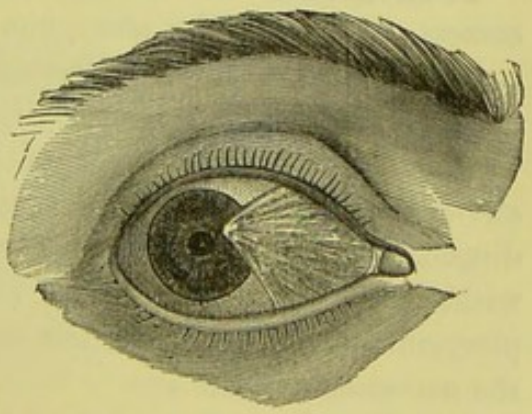


Fig. 27.—Pterygium.

At first we may find at the summit of the pterygium the small ulceration which excites this cicatricial formation, and which, by advancing over the cornea, may draw the pterygium to the centre of the cornea, and even beyond the pupil. It may become the seat of inflammation, and then appears injected and swollen (fleshy, sarcomatous pterygium), although normally it is pale, thin and semi-transparent (thin, membranous pterygium). The pterygium, which never disappears spontaneously, may remain stationary for an indefinite period, or may be continuously or periodically progressive.

It is only when it is inflamed or thickened that it gives rise to the sensation as of a foreign body between the eyelids. When it occupies

a large extent of the conjunctiva, it may considerably incommode the movements of the eye.

Again, if it affects, or extends beyond, the centre of the cornea, it causes considerable disturbance of vision.

Prognosis.—Pterygium is perfectly harmless *per se;* we must consider in our prognosis its extent on the cornea and its tendency to progress. On the other hand, it must not be forgotten that, even after operation, the part of the cornea affected by the pterygium remains more or less opaque; and that the pterygium is apt to recur.

Ætiology.—The pterygium is formed in the following manner:—In consequence of small ulcers at the margin of the cornea, the cicatricial process drags on the surrounding epithelial tissue. That of the cornea, being firmly attached to its membrane, cannot yield, and therefore the cicatricial contraction acts chiefly on the conjunctiva, which is very mobile and easily displaced. The portion thus drawn towards the seat of cicatrisation is folded on itself, and becomes inflamed and vascular, and thus the pterygium is formed (*Arlt*).

At other times the formation of the pterygium is preceded by that of a pinguicula, which is a conjunctival thickening produced by the friction of small foreign bodies, which have entered the palpebral fissure and raised the epithelial layer of the mucous membrane. Between this projection of the swollen conjunctiva and the corneal margin there then exists a small hollow. In this hollow small foreign bodies may be lodged, which are very liable to cause ulceration at the corneal margin. The consequent cicatrisation draws the pinguicula on to the cornea (*Horner*).

Treatment.—An attempt has been made, but generally without success, to destroy the pterygium by cauterising it with sulphate of copper, nitrate of silver, or laudanum. *Decondé* has published several good results obtained by covering the entire pterygium from time to time with a thick layer of finely powdered lead acetate. He allows it to remain on for a few seconds, then removes it with a brush dipped in water. As a rule, we cannot relieve the eye of a pterygium without surgical interference, which is not advisable unless the pterygium extends beyond the margin of the cornea, or incommodes the movements of the eye.

The methods of operation which are in vogue are ligature, transplantation, and excision.

Ligature.—A thread with a needle at each end is introduced below the pterygium in the following manner:—The operator, having raised the pterygium with a pair of forceps, passes one of the needles from above downwards below the pterygium near the margin of the cornea; the other needle is passed in a similar manner near the base of the

pterygium. The thread is then divided between the needles, and three ligatures are thus obtained. The external and internal are intended to embrace the apex and base of the pterygium, and the third is used to detach it from its posterior surface. Having firmly tied the ligatures, we may cut short the ends of the thread. In about four days the strangulated part is easily removed (*Szokalski*).

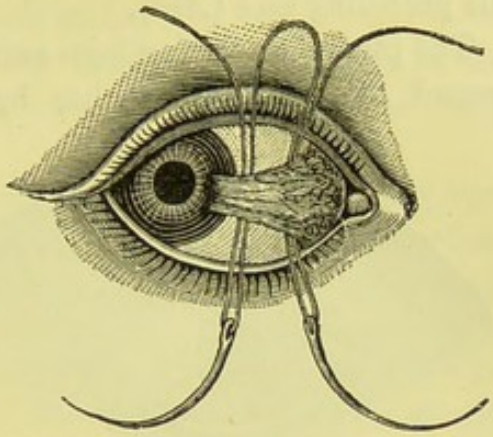


Fig. 28.—Ligature of Pterygium.

Transplantation or *deviation* is performed in the following manner:—Having detached the pterygium from the cornea and sclerotic, so that it adheres only by its base, an incision is made, commencing at the inferior margin of the conjunctival wound, four millimetres from the corneal margin and parallel with it, of sufficient length to receive the free extremity of the pterygium. The pterygium should then be fixed into the conjunctival incision by a few points of suture.

When very large, the pterygium may at first be divided in two through its whole length, and each half transplanted upwards and downwards in the way we have just described.

Excision of the Pterygium.—Having separated the lids, the surgeon takes hold of the pterygium with a pair of forceps, then raising it, he carefully detaches with a pair of scissors first the corneal portion, beginning with the apex (Fig. 29), and continues to separate the membrane from the sclerotic for three or four millimetres from the margin

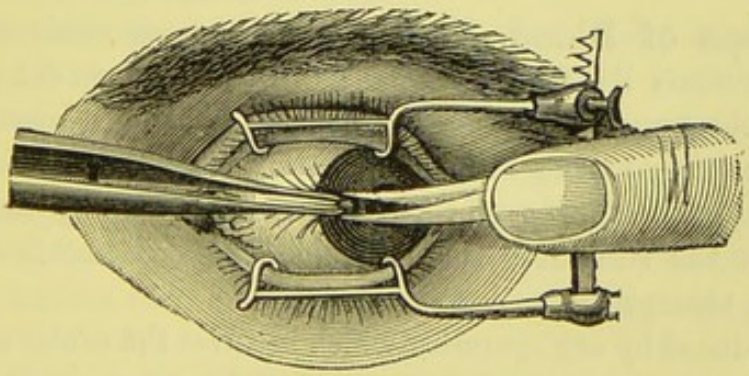


Fig. 29.—Excision of Pterygium.

of the cornea. The membrane thus detached should be entirely removed by two cuts of the scissors converging towards the base.

It may also be excised by the following method:—The surgeon, raising up the pterygium from the surface of the sclerotic, passes a

cataract knife behind it, the cutting edge being turned towards the cornea, and the flat resting on the sclerotic. He then separates the pterygium up to the apex from the subjacent tissue, after which he takes hold of it with a pair of forceps and continues the operation as in the preceding case (*Arlt*).

The pterygium having been removed, the edges of the conjunctival wound are brought together by one or two sutures; the mucous membrane in its vicinity is, however, previously loosened to facilitate their approximation.

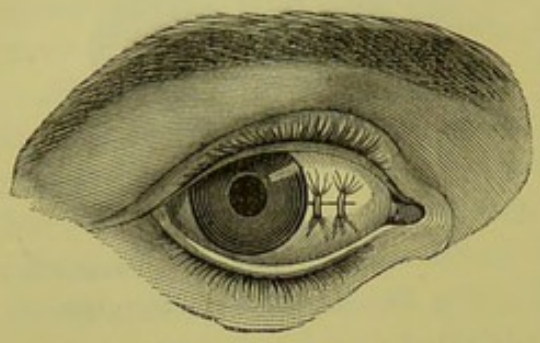


Fig. 30.—Suture of the Conjunctiva after Excision of Pterygium.

It is never necessary, or even desirable, to remove the pterygium from its very base, and the length of incision which we have indicated generally suffices.

Pagenstecher, after detaching the pterygium from the cornea and sclerotic, even allows it to remain adhering by its base. He turns it back, and unites the edges of the conjunctival wound by one or two sutures.

The pterygium thus everted speedily atrophies, especially when a tightly-tied ligature is passed round its base, as we are in the habit of doing.

ART. III.—Subconjunctival Effusions.

Effusions of Blood, Ecchymosis.—Ecchymosis of the conjunctiva presents itself in the form of a patch or deep red ring which surrounds the cornea, and gives to the eye an alarming appearance out of all proportion to the insignificance of the lesion. In fact, it does not present any other symptom, and gradually disappears, passing through all the successive shades which any ecchymosis does when undergoing absorption.

It is produced by any operation which involves the ocular conjunctiva (Strabotomy), by blows on the eye, or by the general conditions which cause cranial congestion, such as lifting heavy weights, vomiting, coughing, &c. Again, it is found as one of the symptoms of a scorbutic condition or of a degenerated state of the vessels in certain diseases of the heart. It is also found after fractures of the orbit or base of the skull. With the exception of their symptomatic signification, ocular effusions in themselves are of no importance. Their absorption,

although very slow, sometimes occupying several weeks, is spontaneously accomplished.

In order to accelerate this absorption we may advise soft massage through the lids, and compresses dipped in a little water, to which a few drops of tincture of arnica have been added.

If the effusion is very great we may make a few punctures in the conjunctiva, and apply a compressive bandage permanently or only during the night.

Serous Effusion, Subconjunctival Œdema.—This appears as a semi-transparent swelling of the otherwise healthy conjunctiva, which swelling may be so great as to cover the cornea and project between the margins of the lids.

This œdema is not of itself painful, but is almost always a symptom of an inflammatory process, either of the internal membranes of the eye, or of the eyelids or surrounding parts (chalazion, erysipelas, inflammation of the lachrymal sac, phlegmon of the orbit). Sometimes it supervenes along with serous effusions of other portions of the body, as in the case of anæmic or chlorotic patients, and persons affected with cardiac or renal diseases.

The best treatment for simple non-complicated ecchymosis, when it is thought expedient to interfere, is incision of the effusion, as already indicated.

Subconjunctival Emphysema.—This state is characterised by a puffy condition of the conjunctiva, a peculiar sensation of crepitus on pressure, and the readiness with which pressure causes the swelling to disappear. It is produced when fracture of the orbital wall opens a communication between the subconjunctival and the nasal fossæ, the frontal sinuses, or the ethmoidal cells.

It may also arise from any rupture of the lachrymal sac or tear passages, which allows air to enter the subconjunctival tissue when the patient blows his nose. The emphysema of itself is unimportant, and disappears when pressure is made with a bandage on the closed eyelids.

Purulent effusions near the internal angle of the eye have also been observed under the conjunctiva in scrofulous children (*Arlt*). Their cause has not been ascertained, and they disappear spontaneously.

ART. IV.—Lesions of the Conjunctiva.

Injury of the conjunctiva may arise—1, from penetration of a foreign body; 2, from wounds by a sharp instrument; 3, from chemical reagents.

1. **Foreign bodies,** in penetrating the conjunctiva, may cause a sudden lesion, or may excite progressive irritation by their prolonged stay. They are most frequently lodged in the folds of the superior cul-de-sac, often in the palpebral conjunctiva, rarely in the ocular. When they remain for any length of time in the cul-de-sac the patient feels that they are present, and there is hyperæmia, with catarrhal conjunctivitis, and sometimes partial hypertrophy of the papillæ in their neighbourhood. Often the pain is very acute, increasing with every movement of the eye, and accompanied with lachrymation, photophobia, and sometimes with blepharospasm.

We should begin treatment by searching for and removing the foreign body. With this object we must evert each lid separately, using, if necessary, focal illumination, and carefully exploring the folds of the superior cul-de-sac. Foreign bodies are generally loosely attached to the conjunctiva, and easily removed by forceps, a piece of linen, or a small curette. If they are firmly embedded in the conjunctiva and cannot be removed by forceps or a curette, the small fold of conjunctiva in which they are embedded should be excised. Some drops of cocaine render these little operations quite painless. After the extraction we must check any irritation by the application of cold compresses or slight astringents.

2. **Wounds of the Conjunctiva** which do not involve any other structures of the eye are without importance and readily heal. When they are very extensive we may unite their edges with one or two sutures, and, if necessary, we may first of all remove the contused portions with a pair of scissors. Cold compresses and a bandage effectually counteract any consecutive irritation.

3. **Burns and cauterisms** by chemical reagents cause the formation of whitish patches, which are thick and project above the mucous surface, and are accompanied with inflammatory reaction and *cauterism* in acute pain. The danger of a burn increases with its extent.

Their gravity, besides, is increased by their influence on the cornea, and by the cicatrisation, which often causes irremediable adhesions between the lids and the eyeball, destroying in whole or in part the eyeball's power of rotation (vide *Symblepharon*).

The *treatment* demands the speedy removal of the reagent. For this purpose we use injections of milk or oil when the reagent is alkaline; carbonate of potash in tepid water when it is acid. Frequent instillations of oil, repeated applications of vaseline with boracic acid between the eyelids, fresh lotions, or cold compresses to relieve pain, complete the treatment. The eschars which separate ought to be carefully removed, as their presence becomes a new source of irritation.

While cicatrisation is progressing, we must be on our guard to

prevent the formation of adhesions, if necessary operating with the view of covering the wound with previously detached neighbouring conjunctiva, or having recourse to a true conjunctival graft (vide *Symblepharon*).

ART. V.—Atrophy and Xerosis of the Conjunctiva. Xerophthalmia.

The name of *xerosis* is given to the dryness of the eye which arises from atrophy of the mucous membrane, and specially from atrophy of the secreting glands. Limited to the surface, we call it *epithelial;* if it affects the conjunctiva through and through, *parenchymatous.*

When this atrophic process involves only a part of the mucous membrane, it is called *xerosis glabra;* if it occupies the entire structure, *xerosis squamosa,* and, as in this case the cornea equally participates in the disease, the condition has received the name of *xerophthalmia.*

In partial xerosis we find on the conjunctiva whitish, greyish patches, of a satin-like lustre, presenting all the characters of cicatricial patches. In complete xerosis, we find the conjunctiva perfectly dry and pale, covered with small powdery scales, formed by the destruction of the epithelial layers. The folds of the cul-de-sac disappear, and the semilunar fold is effaced, as is also the caruncle; the palpebral conjunctiva is then directly continuous with the ocular, which is also retracted. The cornea is opaque, atrophied, and diminished in all its diameters.

The Meibomian glands are atrophied, as well as the surrounding tissue; the ducts of the lachrymal gland are obliterated, as are also the puncta lachrymalia. The absence of all secretion produces extreme dryness of the eye, the movements of which are very much limited by the retraction of the mucous membrane, and by the adhesions, which may even prevent the lids being closed.

Xerosis, as has already been seen, originates in the ophthalmiæ which are followed by atrophic degeneration of the mucous membrane (granulations, &c.), and also arises from extensive burns. Occasionally, xerophthalmia is brought on by pemphigus of the conjunctiva in connection with pemphigus of the face. We have seen one of these cases from the beginning to the end, and observed the same alterations in leprous patients in the special hospitals of Norway.

There is no cure for xerosis; our treatment aims at relieving the patient's sensations of dryness, by frequent washing with tepid water, milk, glycerine, or a solution of carbonate of soda.

Epithelial xerosis is nearly always found on that part of the ocular conjunctiva which remains uncovered when the lids are open. We there observe on both sides of the cornea a nearly triangular white spot, its point directed to the canthus, slightly prominent, and covered with very small white patches or a frothy discharge. When we take this off with a brush, the conjunctiva under it is dry and not brilliant. All the conjunctiva is normal, but so relaxed that it gets folded as the eye moves. Bacillæ have been found in the discharge, but the same may be found in normal conjunctiva and in catarrhal discharge without xerosis. These white spots have been observed in epidemics of hemeralopia (*Bitot*), in Russia during the time of fasting, and in isolated cases in anæmic and weak people. They are not permanent, and pass with the return of good health. In Brazil this disease is rendered more serious by necrosis of the cornea which is apt to occur in the sickly children of negro slaves, and is sometimes found even in adults (*Ophthalmia brasilianis*).

ART. VI.—Tumours of the Conjunctiva.

1. **Pinguicula.**—This name is given to a little whitish-yellow tumour, varying in size from a pinhead to a small pea, situated near the margin of the cornea, and parallel with the horizontal diameter of the globe. It most frequently occurs on the nasal side, rarely on the temporal, sometimes simultaneously on both. Notwithstanding its name, fat does not enter into its composition. It is formed of cellular tissue, with elastic fibres and a few vessels, and is covered with a thick epithelial layer. It does not cause the patient any annoyance, and remains, as a rule, stationary. It is supposed to arise from small erosions, produced by contact with minute foreign bodies, which reach the eyes through the palpebral fissure.

The cicatrisation of the erosions leads to the junction of the neighbouring folds of conjunctiva, and thus to the formation of the pinguicula.

This little tumour does not require any treatment. If by excessive development it hinders the movements of the eye or becomes a deformity, it can be removed with curved scissors, the margins of the wound being brought together with a point of suture.

2. **Lipomata.**—These tumours are rarely found on the conjunctiva. When they do occur, they are usually situated in the space bounded by the superior and external recti muscles, at a short distance from the corneal margin (*von Graefe*). They are of a yellowish puffy appearance,

and are covered with healthy conjunctiva. They are congenital, and correspond with the fatty tissue of the orbit. It is only when there is progressive enlargement, or when they become a source of conjunctival irritation, that these tumours require to be removed, which is done by incising the conjunctiva which covers them. Having removed the tumour, the edges of the wound may be brought together with a few suture points.

3. **Polypi.**—These are small pediculated, nipple-shaped, rose-coloured tumours, situated in the region of the semilunar fold and caruncle. Their cause is obscure. Fleshy excrescences or vegetations, secondary to wounds, have also been observed on the conjunctiva (after tenotomy of the internal rectus). They also become pediculated, and may easily be snipped off with scissors. In the same way we may operate on a polypus, stopping the excessive hæmorrhage, which sometimes follows this small operation, by touching the wound with nitrate of silver. The application of the caustic diminishes the great tendency to recur which polypi possess. With the same object in view, we may also remove with scissors the portion of conjunctiva in which the polypus is inserted.

4. **Dermoid Tumours.**—These are small yellowish-grey tumours, varying in size from that of a lentil to that of a small hazel-nut, always situated at the margin of the cornea, and most frequently at its inferior external margin, encroaching more or less upon it. Their surface is smooth, with a great number of sinuosities, and they are sometimes furnished with hairs. The structure of these tumours is analogous to that of the skin; consisting of undulating non-nuclear cellular tissue, containing elastic fibres, sometimes follicles, and even groups of fat cells (*von Graefe*). The whole is covered with a thick layer of epithelium. Dermoid tumours are congenital, tending to increase, and recurring if they are incompletely enucleated. They have been attributed to a defect in development (*Ryba*) when accompanied with other affections of the same kind, such as coloboma of the lids. The gradual encroachment of the dermoid over the cornea requires the removal of the tumour. We may best perform the operation by taking hold of the tumour at its most prominent part with sharp pointed forceps, and detaching it by means of a cataract knife, first from the cornea, afterwards from the sclerotic. As it penetrates very deeply into the cornea, it would be imprudent to attempt to remove it in all its thickness. It suffices in practice to excise it at the natural level of the cornea (*von Graefe*). If the cicatrisation leaves a very visible mark it may be masked by tatooing.

5. **Cysts.**—These present themselves as round and circumscribed rose-coloured tumours, semi-transparent or yellow, varying in size, but sometimes reaching that of a bean. Their membraneous envelope

is more or less resistant, and their contents are liquid or thickish. These cysts are almost always congenital, but they have been seen to follow a blow on the eye.

Complete enucleation is the best way to operate on them. But since, from its weakness, the containing wall is apt to burst, and as, in trying to detach them from the conjunctiva to which they adhere closely, they are liable to be wounded, we do not always succeed in the enucleation. When, therefore, the contents are liquid, and the cyst wall very thin, it suffices to incise it, lightly cauterising after the evacuation of the contents.

6. **Erectile Tumours.**—When these occur on the conjunctiva, they are always an extension of similar tumours of the eyelid. They should be completely destroyed, and that as soon as possible, by excision, galvano-cautery or electrolysis.

7. **Pigment Spots.**—These are very common, and are free from danger. However, as they have sometimes been the starting point of sarcomatous degeneration, we excise them, uniting the edges of the wound with suture.

8. **Lupus.**—This may be primarily developed on the conjunctiva, or, starting on the cheeks or lids, may extend to the mucous membrane. It presents itself as small transparent pimples, resembling in colour *café au lait*, which ultimately ulcerate, and in cicatrising produce symblepharon or trichiasis. When the eyelids are involved we may have ectropion, narrowing, or even occlusion, of the palpebral fissure. Simultaneously the cornea may become the seat of lupous eruptions or of a thick pannus. The disease, if left to itself, in one way or another leads to total blindness.

The treatment consists in scraping the diseased tissue with a small sharp steel curette. By performing this operation carefully, and as often as the pimples reappear, we may succeed in arresting the disease and in preserving the vision. The cornea stands the scraping of the pimples extremely well.

We have seen *Lepra* in the Norwegian hospitals, producing alterations of the conjunctiva, so much resembling those of lupus that very often they could only be distinguished from one another by the general disease.

9. **Syphilitic Ulcerations.**—Syphilitic ulcerations have been described as occurring on the surface of the palpebral conjunctiva and in the culs-de-sac. Their hard base, resistant and indurated margins, and the presence of a general syphilitic condition, comfirm the diagnosis. Several times we have observed on the eyeball gummata under the conjunctiva in the form of small elastic tumours; in one case there was at the same time a large and profound phagedænic ulcer-

ation on the inner face of the inferior eyelid. The gumma, situated between the cornea and canthus, prevented the normal adduction of the eyeball and produced diplopia. There were also gummata on the corresponding part of the other eye. In addition to the appropriate general treatment, the local treatment of the ulceration consists in the application of a solution of the perchloride of mercury (1 to 10), insufflation of iodoform, the application of nitrate of silver, and scraping with a sharp steel spoon. The gummata only require general treatment.

10. **Epithelioma and Sarcoma.**—These rarely begin with the conjunctiva, and when either does make its appearance in the neighbourhood of the cornea as a small papule, it may be confounded with a phlycten, all the more so that it is accompanied with a similar injection. However, the epitheliomatous pimple has sharper margins, is covered with a smooth epithelium, and presents a papillary surface on being examined with a lens.

When the affection is more advanced it takes the appearance of a puffy tumour, sometimes ulcerated, varying in its course, invading sometimes slowly, sometimes quickly, the cornea, which it ultimately destroys. Sarcoma generally is pediculated and may cover the whole cornea without penetrating it. We should excise it as soon as possible, not hesitating, if the disease has made some progress, to sacrifice the eye in the interests of the general state. We may first try the local application of a more or less saturated solution of chlorate of potash (beginning with the strength of 1 to 50), using daily two spoonfuls of this solution of the strength of 1 to 20 (*Bergeron*).

11. **Medullary and melanotic cancers** rarely begin with the conjunctiva, but may frequently extend to it from neighbouring structures. Melanotic cancer has, however, been observed arising in the neighbourhood of the cornea.

12. **Entozoa.**—Cysticercus of the cellular tissue has been noticed (*Sichel*), and in subtropical countries the filaria medinensis (*Schœne*). The cysticercus appears as a whitish or yellowish vesicle, about the size of a large pea, surrounded by a sufficiently pronounced conjunctival injection. The diagnosis can only be made certain by microscopical examination.

The filaria medinensis appears as a blackish filament, endowed with very rapid movements which cause the patient great pain and give rise to a marked inflammation of the conjunctiva.

Both the cysticercus and filaria should be extracted by incising the conjunctiva which covers them.

13. **Lithiasis.**—By this is meant a calcareous desiccation or alteration of the secretion of the conjunctival glands, more especially those

of Meibomius (infarction of the glands). It appears in the conjunctiva as small, white, round concretions, about the size of pin heads. As a rule, there are several scattered on the tarsal conjunctiva, and near the margin of the eyelid. These concretions are a source of irritation, and, if they rub against the cornea, may cause infiltration or ulceration of that membrane. A small incision having been made in the conjunctiva which covers them, they may be removed with the point of a cataract needle, or with a curette.

CHAPTER III.

DISEASES OF THE CORNEA AND SCLEROTIC.

Anatomy.—These two membranes, so different in external appearance, are structurally only one.

They are directly continuous with each other, and form a completely closed envelope for the media of the eye, being perforated only by the optic nerve.

The **sclerotic** is a fibrous membrane, composed of bundles of fibres which anastomose with each other, and interlace perpendicularly. Some of the fibres run in a direction parallel with the meridian of the eye, others parallel with its equator. The tissue is traversed by a great number of elastic fibres and connective-tissue corpuscles (*corpuscles de tissue cellulaire*). Where the optic nerve enters the eyeball, the fibres of the sclerotic divide into several layers, the outermost of which, being folded almost perpendicularly on themselves, surround the nerve, thus forming its external envelope; whilst the innermost layers penetrate the optic nerve, forming a fenestrated membrane which gives passage to the bundles of nerve fibres (*membrana cribrosa*). The middle layer, separated from the external by cellular tissue, unites with the sheath of the optic nerve. At the place where the optic nerve penetrates, the sclerotic attains its greatest thickness, 1·25 millimetres, and it gradually diminishes in thickness towards the cornea, where it is only ·3 or ·4 of a millimetre. It is considerably strenghtened by the insertions of the recti and obliqui muscles.

The sclerotic has no *nerves*, and has only a few *vessels* which come from the ciliary vessels and form a large meshed network on the external and internal surface of the membrane. The posterior portion of this network forms a vascular circle round the optic nerve, giving off branches which penetrate the optic nerve and choroid. From the anterior portion of the network there arise, in a similar manner, perforating branches, which supply the ciliary muscle.

The sclerotic is, moreover, perforated at points by small canals, which run more or less obliquely, and give passage to the vessels and nerves of the choroid. The great number of these canals near the optic nerve and cornea perceptibly diminishes the consistence of the membrane in these situations. Near the junction of the sclerotic with the cornea, but rather behind it, is found the canal of Schlemm; it

contains a plexus of vessels receiving some small veins from the ciliary muscle, and giving off numerous vessels which join the veins that come to the external surface of the sclerotic (*Leber*).

The **cornea** is the direct continuation of the sclerotic, and owes its transparency to the perfect homogeneousness of its intercellular substance. In form and appearance it resembles a watch-glass, closing in the anterior opening of the sclerotic, which covers the corneal margin for 1 millimetre nearly, but a little more above and below than at the sides. The greatest thickness of the cornea is at the periphery (1·12 millimetres), and it gradually diminishes towards the centre (0·9 millimetre). We can distinguish, from before backwards, three distinct superimposed layers, which may be easily separated from each other.

1. The **epithelial layer** is the direct continuation of the conjunctival epithelium. It is stratified, and the most superficial cells are flat, while those immediately beneath are round, and the deepest are cylindrical. The epithelial layer is separated from the true corneal tissue by an elastic lamina (*Bowman's membrane*), the independent existence of which is disputed by some observers, who regard it as a layer of condensed corneal fibres.

2. The **tissue proper** of the cornea is composed of fibrillæ disposed in lamellæ, parallel to the surface of the membrane. Between these lamellæ, which are not easily separated, as they are more or less connected with each other, is found a system of star-shaped cells without membrane, but possessing nuclei and nucleoli (corpuscles of the cornea). Each cell gives off a number of prolongations (six to twenty) of variable length, which anastomose with others in their neighbourhood so as to form a network or canalicular system, traversing the membrane in all directions. Other smaller cells, destitute of cell-wall, have also been observed in the corneal tissue, scattered among the fibrillæ (migratory cells) in the midst of the canalicular network.

3. The **membrane which lines the posterior surface of the cornea** (*Descemet's* membrane), is a transparent, homogeneous, elastic membrane, and on its posterior surface is covered with a layer of pavement epithelium, which gradually modifies towards the circumference. In this situation the membrane becomes thicker, and divides into a series of fibres, some of which lie against the internal wall of *Schlemm's* canal, whilst others are reflected on the iris (ligamentum pectinatum). The modified epithelium is continued over the ligamentum pectinatum to the iris.

The cornea is non-vascular; its nerve supply is derived from the ciliary nerves. As each nerve-fibre enters the cornea, it loses its

sheath and white substance, and is thus reduced to its axis-cylinder, which becomes transparent. In the anterior portions of the cornea, the nerves divide dichotomously, forming a great number of superimposed filaments, having nuclei at the points of division.

Opinions are divided as to their termination. According to some, they form a network situated very superficially in the cornea (*His*); others believe that there are still smaller divisions (*Saemish*). Others again have observed that the nervous plexus, situated near *Bowman's* membrane, gives origin to some bundles of fibrillæ of single contour, which divide into very small ramifications, forming a nerve fibre network at the base of the epithelial layer. From this network several exceedingly fine fibrillæ arise, which penetrate the epithelium and terminate freely in a small swelling (*Cohnheim*).

Chemical Character.—The corneal tissue gives on maceration chondrin, which redissolves in an excess of the reagents that precipitate it (*His*), whilst the sclerotic, like all other cellular tissues, gives gelatine.

ART. I.—Keratitis.

A. SUPERFICIAL KERATITIS.

1. Superficial Vascular Keratitis, Pannus.

Diagnosis.—We see supervening, generally in the course of conjunctival affections, a pericorneal injection of the subconjunctival vessels, which extend to the border of the cornea but no further, anastomosing with the conjunctival vessels, a few branches of which pass over to the cornea, where they may be followed to a certain distance from the margin.

Occasionally the vessels also develope beneath *Bowman's* membrane, or between it and the epithelium (*Donders*).

At the same time, the surface of the cornea is slightly tarnished, and becomes the seat of ulcerations or of greyish infiltrations. According to the extent and amount of the vascularisation, the aspect of the cornea may vary considerably. Sometimes the vessels are isolated; sometimes they are so numerous that the cornea thus vascularised gives a general diffused rose or ruddy reflection, in which it is impossible any longer to distinguish individual vessels.

At other times, we see a vessel advancing from the margin of the cornea to the centre, where it divides into many branches in the midst

of an opacity. This vascularisation may exist at different parts of the cornea, or it may even invade the whole membrane. The superficial infiltration sometimes only produces slight opacity; sometimes it causes more pronounced irregularity of surface, being accompanied by excoriations of the epithelium, or by little facets.

When the superficial vascular keratitis passes into the chronic stage (*pannus*), it forms an opaque vascular layer, which is at first thin, and still allows the iris and pupil to be recognised (*pannus tenuis*), but it may become very thick, absolutely opaque, or even fungoid (*pannus crassus, sarcomatous pannus*). When the affection reaches the greatest intensity, the cornea appears to be covered with fleshy pimples. When the turgescence has disappeared, the cornea becomes of a dirty-grey colour, perfectly opaque, and furrowed with vessels.

The ocular conjunctiva participates more or less in the inflammation, being injected and infiltrated.

The affection may be unaccompanied by pain, or there may be acute ciliary pain, with lachrymation and photophobia. Vision suffers more or less according to the amount of alteration in the transparency of the cornea.

Superficial keratitis is caused by an abundant formation of new cells and vessels, which may take place between the epithelial layer and Bowman's membrane, or behind Bowman's membrane. According to *Iwanoff*, the disease is the result of a proliferation of cells at the level of the conjunctival limb, which cells, by their migratory movements, become infiltrated between the epithelium and Bowman's membrane. In the early stages the blood seems to circulate freely amongst the forming cells, while the vascular walls are almost imperceptible, and do not appear till later. The new cells mix freely with the epithelial cells, which increase in size, so that the epithelial layer is much thicker. A tendency to the production of cellular tissue then becomes manifest, and Bowman's membrane disappears.

Progress and Termination.—The disease may disappear with the exciting cause; but, when it is secondary to granular ophthalmia, the pannus may remain, even after the original disease has disappeared. The duration naturally depends on the cause, and may be protracted for some months, or even years. Often the pannus is cured, but permanent opacities are left. At other times the prolonged infiltration softens the membrane, which yields to the pressure, and thus increases in curvature. Again, the pannus may excite a deep inflammatory process in the cornea, with deep ulcerations, which lead to perforation, and heal only after leaving a leucoma adherens. The most disastrous termination is when the cornea participates in a xerophthalmia, consequent to trachomatous atrophy of the conjunctiva.

Prognosis.—This depends on the extension and cause of the mischief; it is especially good when the cause can be removed before the pannus has entered upon an independent course. The superficial parts of the cornea are then regenerated, especially in young people, with perfect transparency. After trachoma the prognosis is much less favourable, and depends on the state of the mucous membrane. The greater its vascularity and capability of furnishing a copious secretion, the more favourable is the prognosis. If the cornea is changed into cicatricial tissue and desiccated, recovery is impossible.

Ætiology.—Superficial vascular keratitis most frequently occurs after conjunctival affections, rarely after catarrh with papillary hypertrophy, often after trachomatous granulations; the cornea itself either becoming the seat of granulations, or being altered by the mechanical effect of the friction of the rough surface of the palpebral conjunctiva.

Pannus may also supervene as a consequence of phlyctenular conjunctivitis, and then assumes the form which we have described as scrofulous pannus (see page 68).

In fine, pannus is the result of mechanical irritation of the cornea; by cilia (in entropion); by concretions in the palpebral conjunctiva (infarction of the Meibomian glands); or by external irritations, when the cornea is insufficiently protected by the lids, which may not completely cover it (ectropion, lagophthalmus).

The name "pannus" can scarcely be given to the vascularisation of the cornea which supervenes after other forms of keratitis during the period of tissue regeneration.

We look on this vascularisation as a fortunate circumstance, because it is the precursor of recovery; for this reason it is sometimes called "regenerating pannus."

Treatment.—The treatment has for its first indication the removal of the exciting cause, which is effected by curing the trichiasis, entropion or ectropion, and by removing concretions, &c. Trachomatous pannus requires careful treatment of the palpebral granulations (*vide* p. 80, *et seq.*)

If the pannus persist after the cause is removed, the remedies employed will vary with the degree of its intensity.

In slight cases success may often be attained by dusting with calomel or by using the yellow oxide of mercury ointment. In more pronounced cases we use stronger remedies, such as glycerine with tannin, a solution of nitrate of silver, or, when the cornea is covered with true granulations, we cauterise them lightly with the mitigated nitrate of silver pencil, or sulphate of copper.

When the conjunctiva is dry and shows little tendency to secretion, excellent results may be obtained by the prolonged use of hot com-

presses. Speaking generally, it is necessary to begin with mild remedies, gradually passing to the stronger, varying the medication, sometimes stopping all treatment, and restoring by hot compresses the power of reaction to the tissues which have become insensible to irritants.

Where there is great vascularity, when the above-mentioned remedies have failed, we may scarify and even excise the conjunctival and subconjunctival vessels which lie near the margin of the cornea and extend to its surface. Following out this idea, *Furnari* has recommended, in cases of obstinate pannus, section of the conjunctival and subconjunctival tissue around the cornea (*syndectomy* or *peritomy*).

This little operation is performed in the following manner:—After sufficient use of cocaine, and having separated the eyelids by means of a speculum, we make with a scarifier a circular incision in the conjunctiva at 6 millimetres from and concentric with the margin of the cornea; then, with the same instrument, we detach the conjunctival band, thus marked off, from the sclerotic up to the corneal margin, where it is cut away. This done, we remove for a like extent, by small snips of the scissors, or by scraping with the scarifier, the subconjunctival tissue, so as to completely denude the sclerotic.

Furnari's further recommendation, however, to cauterise the sclerotic surface thus exposed, or to make an abrasion on the cornea, is not without serious inconvenience, and should *not* be put in practice. Cold compresses and the use of the compressive bandage suffice, as a rule, to check any reaction.

Finally, in those cases where the cornea is entirely covered with a thick pannus layer, we may practise inoculation of blennorrhagic pus, so as to set up a purulent conjunctivitis, in the course of which the corneal affection is dissipated. This process is only applicable when both eyes are affected, and ought not to be attempted when the pannus does not cover the entire cornea.*

The pus which is to be inoculated is taken from an eye affected with purulent ophthalmia, and a small quantity of it is placed by a brush on the mucous membrane of the inferior eyelid. This inoculation does not always succeed, or it may produce only an insufficient catarrhal conjunctivitis, in which case it must be repeated.

When the inoculation succeeds, after a few days the lids swell and the purulent secretion is established. If the inflammation is now too great, it must be treated by the remedies specified under purulent ophthalmia.

The other eye, although affected with pannus, ought to be properly

* Inoculation should only be performed on one eye at a time.

protected, so as to avoid a simultaneous purulent condition of both eyes.

In countries where diphtheritic conjunctivitis is common, purulent inoculation presents another danger, as it is liable to set up diphtheritic conjunctivitis with all its sequelæ.

The great danger of this mode of treatment lies in the possibility of its causing a too violent reaction, which may lead to perforation and destruction of the cornea. It might, however, be possible to obviate this danger more certainly by previously performing syndectomy (*Lawson*).

Jequiritic ophthalmia produced by means already described (p. 82), seems most advantageous for the cure of pannus, and preferable on account of its action being less destructive than inoculation of blennorrhagic pus.

2. Circumscribed Superficial Keratitis.

Diagnosis.—This affection is characterised by slight greyish or yellowish circumscribed opacities, situated at the centre or periphery of the cornea. As the disease advances, the epithelium participates in the infiltration, and becomes excoriated. A superficial ulcer is thus formed, which has for its base the greyish opacity.

Sometimes the epithelial destruction seems to precede the infiltration. A small facet makes its appearance on the surface of the cornea, near its periphery or centre, as if the epithelium had been removed by the stroke of a claw. In a few days we see a slight whitish opacity at the base of the ulcer, and the appearance of the diseased cornea is now the same as in the preceding case.

In this disease, there is only a slight superficial injection of the conjuntiva, which is sometimes entirely absent. On the other hand, this form of keratitis is often accompanied by more or less severe ciliary pain and very pronounced photophobia, especially when the epithelial excoriation has laid bare the nerve plexus of the cornea, thus exposing it to the action of the air, the friction of the eyelids, and the irritation of the secretion of the conjunctival sac. These symptoms, however, almost entirely disappear when the epithelium begins to grow again.

The changes just described, especially when their situation is near the periphery of the cornea, may escape observation, which is, moreover, made difficult by the blepharospasm of the patients (which may be momentarily removed by application of cocaine), and some observers have been led, though wrongly, to believe in an idiopathic scrofulous photophobia, without perceptible alteration in the eye.

Progress and Termination.—If the disease is situated near the periphery, and there is a loss of epithelium, we perceive in a few

days that it has been renewed, leaving a slight superficial opacity, which soon disappears. The morbid products are absorbed, and the cells which have been destroyed are replaced by new ones. The conjunctival limb is often at this time injected.

If the disease is situated at a greater distance from the periphery, we can (by focal illumination) distinguish a greyish streak, which extends from the border of the cornea to the seat of the disease. Before long this becomes vascular, and a channel is thus prepared for the absorption of the inflammatory products.

Prognosis.—In the great majority of cases the disease terminates favourably, although slight opacities remain for a length of time. It is only occasionally, or in consequence of an irritating treatment, that it extends to the tissue proper of the cornea, and that the diseased foci multiply, and are transformed into deep ulcers or abscesses.

In general, it may be stated that the affection heals more rapidly the nearer it is to the margin of the cornea; the prognosis, however, must take into account the frequency of relapses.

Ætiology.—Circumscribed superficial keratitis proceeds from direct injury of the cornea; scratches, burns, or foreign bodies are often the cause of this disease.

In other cases, it is caused by the presence of a blennorrhagic conjunctivitis or chronic catarrh, especially in elderly subjects. It frequently accompanies phlyctenular ophthalmia, and has thus been called pustular keratitis. In trachoma, it sometimes precedes the formation of pannus.

It is most frequently observed in children, from twelve to fourteen years of age, and this has been attributed to a lymphatic or scrofulous diathesis (scrofulous keratitis).

Finally, this affection has been observed in the course of some diseases of the lachrymal sac, being due in such cases to the contact of pus.

Treatment.—If the conjunctival injection is very great—which it rarely is—we may recommend a few cold compresses, but we must not prolong their application, because the cold seems to retard the regeneration of the epithelium. The treatment chiefly consists in hot fomentations made with infusion of chamomile or with the following lotion :—

Laurel water, ...	℥ss.
Distilled water, ...	℥xl.

a tablespoonful of this solution in a large bowl of water, kept at a temperature of 95° or 100° by means of a chafing dish. These fomentations ought to be kept on for three-quarters of an hour, and should be repeated from four to six times a day. Where there are multiple foci, and a tendency to extend, we instil every morning and

evening a drop of a solution of eserine or pilocarpine; at the first symptom of iritis, atropine has to be applied.

When there is excoriation of the epithelium with photophobia, the best remedy is the application of a compress and bandage, because the friction of the lids on the eye prevents the formation of the epithelium, as the new layers are removed as speedily as they are formed.

When the regeneration of the epithelium is slow, and if there is no conjunctival injection, we may stimulate the circulation by hot compresses. After the reconstruction of the epithelial layer, and as soon as the vascularity has reached the cornea, we may use calomel dust, or an ointment of the yellow oxide of mercury, or we may prescribe the following lotion :—

Tinct. opii (Sydenham),*	āā ℥ss.
Aqu. distil., ...	

of which a few drops are to be instilled morning and evening.

In the general treatment, which is of great importance in preventing the relapses so frequent in this disease, we must abstain from purgation, vesication, and blood-letting. Varying with the constitution of the patient, our treatment should be directed according to the principles already laid down.

Phlyctenular and Fasicular Keratitis have been already treated (p. 68) under Diseases of the Conjunctiva.

3. Superficial Vesicular Keratitis.

(Corneal Herpes.)

The characteristic symptom of this somewhat uncommon disease is the sudden formation of a number of vesicles (five to twenty) on the cornea. They are about the size of a pin's head, quite transparent, and their limpid contents are quickly renewed whenever they are evacuated by puncture of the vesicle. The disease is accompanied by anæthesia of the cornea, and at the same time by acute ciliary pain, lachrymation, and photophobia. These last symptoms disappear with the vesicles, and reappear with each fresh crop, of which there are sometimes several at short intervals. The normal tension of the eye seems often considerably diminished. The affection passes off without leaving any trace. It has been seen to follow catarrhal affections, accompanied by herpes of the lips or nose (*Horner*).

The evacuation of the pustules seems to us to be of no use. We best succeed by putting a layer of calomel dust, about a millimetre

* Sydenham's Tincture of Opium is a vinous preparation—strength 1-8.

thick, on the cornea, for it destroys the vesicles by friction. Having removed the calomel, we apply a compress and bandage. Acute ciliary pain, which deprives the patient of sleep, may be checked by subcutaneous injections of morphia.

On eyes lost by glaucoma or chronic irido-choroiditis, we observe sometimes on the cornea a large fluctuating vesicle (*Keratitis cullosa*), its anterior wall being formed by the epithelium or the superficial layers of the true cornea, and its contents a slightly turbid or even sanguineous serum. There is sometimes severe pain, sometimes none at all. This vesicle may last a long time, or burst after some days' existence. In case of severe pain, we may rupture the vesicle and cut off its anterior wall, and apply afterwards iodoform powder and a well-fitting antiseptic bandage. Frequent recurrence of this affection, when painful, sometimes requires cauterisation of the eyeball to be performed.

B. PARENCHYMATOUS KERATITIS.

Parenchymatous keratitis is sometimes circumscribed (interstitial), with or without vascularity, and sometimes diffused.

1. Interstitial Keratitis.

(*a.*) Vascular Interstitial Keratitis.

This disease begins with a thick network of vessels, which originate in the subconjunctival tissue, passing on to the cornea, and there terminating abruptly. This vascular network, composed of fine parallel vessels, gives to the part of the cornea which it occupies a reddish appearance, of such a kind that we might suppose it, at first sight, to be an extravasation of blood at the margins of the cornea.

Soon, however, we observe between the vessels the presence of a greyish exudation, and at the margin of the vascularity a deep yellowish opacity. The entire portion affected with the vascularity protrudes above the level of the cornea, whilst the yellow exudation does not present any swelling. This last fact is explained by the pathological process, which consists in the transformation of the corneal cells, without segmentation of the nuclei or proliferation of new cells—in short, without purulent formation. Sometimes above the infiltration we observe an alteration of the epithelium, which assumes a peculiar stippled appearance, due to a hyperplasia of its cells.

When the disease begins to abate, we at first find that the vessels disappear, the elevated portion of the cornea becomes flat, and the infiltration assumes a greyish tint. At the same time, it is limited in

the form of a round opacity, towards which several superficial vessels extend (pannus of regeneration). The clearing of the cornea progresses from the periphery towards the centre, which sometimes does not regain complete transparency, or only regains it after a longer or shorter period.

A special form of vascular interstitial corneitis is a deep-seated variety of the fascicular keratitis. It is consecutive to phlyctenular conjunctivitis, and has already been described (see p. 68).

The symptoms which distinguish these two forms are as follows:—

In the interstitial form, we find a deeper infiltration, and a great number of closely-packed vessels, which do not always extend to the infiltrated portion of the cornea; whilst in the other, the phlycten is situated on the surface of the cornea, and is always found at the extremity of the little vascular band.

The subjective symptoms, which accompany interstitial keratitis, are very variable. Sometimes very slight, in the majority of cases they are more or less violent. Patients complain of great heat in the eye, lachrymation, ciliary pain and photophobia. The visual acuteness is naturally much diminished.

Progress and Termination. — The duration of interstitial keratitis is very long. Two months pass before it has attained its full development, when it may remain stationary for several weeks. Finally, the absorption of the infiltration and the disappearance of the vessels take four or five months. Complications are of rare occurrence; and it is only as a consequence of irritation of the eye, either from the fault of the patient or by irrational treatment, that abscess or deep ulcerations supervene with all their consequences.

The participation of the conjunctiva by its hyperæmia and catarrhal swelling, if it is not excessive, ought to be regarded as a circumstance favourable to the reabsorption. Rarely do we find iritis or cyclitis as complications. This last, when it does occur, is due to the extension of the inflammatory process to the ciliary body, through the medium of the vessels. The chief symptoms are exacerbation of the signs of irritation, intense photophobia, violent and persistent pain, diminution of the tension of the eyeball and of the acuteness of vision.

Prognosis.—Notwithstanding the long duration of the disease, the prognosis is, as a rule, favourable, because there is no tendency to suppuration. The most aggravating circumstance, so far as vision is concerned, is when the seat of the infiltration is at the centre of the cornea, because it leaves a more or less troublesome opacity, which, however, gradually clears, especially in young patients. Cyclitis as a complication, which is of rare occurrence, renders the prognosis very grave.

Ætiology.—Interstitial keratitis often supervenes among children in the course of phlyctenular conjunctivitis, or idiopathically in consequence of external irritations, especially in badly nourished and weakly persons.

Treatment.—In the treatment of interstitial vascular keratitis, we must, at least during the first period, be content to preserve the diseased eye from the baneful influences of strong light, of wind, dust, &c., carefully watching the progress of the inflammation.

Astringent lotions and caustics ought to be entirely set aside, for they only make matters worse. The pain should be checked by fomentations made with an infusion of chamomile or a solution of belladonna, prepared after the following formula :—

Extract. belladon., ...	gr. 45.
Aqu. distil., ...	℥vj.

a tablespoonful of this solution in a cup of hot water.

Instillations of atropine or eserine have no effect, because the remedy is not absorbed. Besides, the use of eserine has the great inconvenience of easily exciting in children a follicular conjunctivitis. Pilocarpine is therefore preferable.

When the cornea begins to clear, we may use calomel dust, and if it is well borne, it may be applied daily or replaced by the yellow oxide of mercury ointment, which should be tried in small quantity at first and gradually increased.

Paracentesis of the anterior chamber has also been recommended for this form of keratitis (*Hasner*). The treatment of fascicular keratitis has been already explained (*vide* p. 71).

A general strengthening treatment ought to accompany the local appliances, and should be suited to the patient's constitution—*i.e.*, tonics in the form of iron, quinine, and iodine preparations, salt water bathing, nourishing food, residence in the country.

(*b.*) Non-Vascular Interstitial Keratitis.

At some point on the cornea a greyish opacity makes its appearance, at first nebulous, but after a time concentrated in one place, where it forms a saturated whitish opacity, surrounded with a greyish ring. Several of these opacities may appear on the cornea at the same time, and they do not sensibly rise above its level. The circumscribed infiltrations are not accompanied by any symptom of irritation, and annoy the patient only by disturbing the vision. The disturbance is much greater than the condition of the cornea would lead us to expect, and may even cause blindness for the period during which the affection lasts, if both eyes are affected at the same time.

The opacity may disappear without leaving any alteration in the structure of the cornea; but sometimes it persists and increases in thickness, so that the epithelium which covers it is raised above the level of the cornea.

Then a partial necrosis of the affected tissue supervenes, which involves the formation of an ulcer with its consequences. A more fortunate termination results from the appearance of a few vessels which proceed from the conjunctival ring towards the opacity and favour its absorption. If this takes place, we also observe a greater amount of pericorneal injection, and the patient complains more of sensitiveness to light and to external irritants.

The aspect of the cornea varies with the extent and intensity of the affection. Sometimes the infiltration only shows itself in the form of a slight cloud; sometimes as whitish opacities about the size of a pin head; sometimes it forms a very dense opacity, which raises the epithelial layer, and extends to the interior of the tissues.

Progress and Termination.—The affection is of long duration, but ends favourably, leaving an opacity which is persistent in proportion to the depth of the infiltration and the age of the patient.

Prognosis, upon the whole, is favourable, except in cases of deep ulceration where there is a risk of perforation. The greatest danger lies in an irrational treatment.

Ætiology.—Often we cannot ascribe the affection to any special cause; at other times it supervenes in the course of phlyctenular or purulent conjunctivitis, or as a complication of superficial vascular keratitis.

Treatment.—The chief remedy to be employed in this affection is the application of hot compresses to the eye (*von Graefe*). The temperature of the compresses should be higher, and their application more prolonged, in proportion as the disease shows itself to be devoid of irritation. The only precaution to be taken is to moderate, or even stop, the use of these compresses when the conjunctiva becomes hyperæmic, or when there is secretion, or when the cornea becomes more infiltrated and manifests signs of an inflammatory action. We should then replace the compresses temporarily by lotions of carbolised water (1 to 200), repeated several times daily, until the disease has regained its initial character.

Such, then, are the general principles of treatment in this affection, which demands the most careful attention on the part of the surgeon, and an exact appreciation of the results of his treatment. If, however, we are threatened with iritic complications, atropine must be used till the pupil is dilated, and the dilatation must be maintained; belladonna ointment may be rubbed on the forehead, and, generally, iodine prepar-

ations may be given with mild laxatives, while vesicants may be applied repeatedly when the general condition of the patient permits it.

2. Diffuse Parenchymatous Keratitis.

Diagnosis.—A slight opacity extends over the entire surface of the cornea, in the early stages so immaterially altering its appearance, that at first sight we may believe there is only a discoloration of the iris, and not a disease of the cornea. By degrees the opacity becomes thicker, the cornea loses its brilliancy, and its epithelial surface appears as if pricked with the point of a needle. Often this form of keratitis at first only affects a portion of the cornea, and gradually, sometimes very slowly, invades the whole membrane.

The subconjunctival injection is ill-developed, or may be entirely absent, and the only symptoms of which the patient complains are disturbance of vision, dread of a strong light, and slight lachrymation. Yet, in the course of the disease, ciliary pain sometimes intervenes, which, owing to some irritating cause, may be at times very violent.

In a certain number of cases the opacity may be denser at one or several points of the cornea, and if it should happen to be so in front of the cornea, vision may be reduced to the distinction of day and night. When the cornea begins to clear, vessels are developed which originate at the conjunctival ring, and are sometimes so numerous and closely packed as to cause a reddish reflection from the cornea.

Progress and Termination.—The course of diffuse keratitis is most provokingly slow. In a few weeks it may affect both eyes, and its duration varies from a few months to two years. It generally, however, terminates favourably, the cornea regaining almost perfect transparency. Complications of the iris and choroid are not rare, but may be prevented by rational treatment.

We have several times observed a recurrence of this disease after an interval of months and years.

Prognosis.—Exception made for the long duration of the disease, the prognosis is, as we have just seen, favourable. We must not, however, forget that any imprudence on the part of the patient—*e.g.*, exposing his eye to cold air, intense light, &c., or irritating treatment on the part of the surgeon, may produce very serious complications.

Ætiology.—In the majority of cases the cause of the disease is to be looked for in the patient's general condition, although we meet it also in perfectly healthy-looking people. Children and young adults of weak constitution are more liable than others to be attacked. Sometimes it is accompanied with other manifestations of a scrofulous rhachitic or syphilitic diathesis. It has been also connected exclusively

with the presence of inherited syphilitis (*Hutchinson*), manifested by cicatrices at the angles of the mouth, chronic swelling of the knee, deafness, and the peculiarities of the incisor teeth, so well known from *Mr. Hutchinson's* description.

Treatment.—We do not know of any remedies which will rapidly cut short the progress of the disease. The continued use of hot compresses and cataplasms best succeeds in promoting the vascularisation, which is necessary for cure. At the same time, we keep the pupil dilated by instillations of atropine (1 grain to 1 ounce) morning and evening. We have observed some cases of tolerably rapid recovery in patients who, besides the local and general treatment, had a small seton applied in the scalp over both ears.

When the cornea begins to clear, daily insufflation of calomel, or the application of the yellow oxide of mercury powder, or of tincture of cantharidis (with equal parts of olive oil), every third or fourth day, hastens the restoration of transparency in the cornea. If this be too long in being established, we may practise peritomy (*vide* p. 102).

To this local treatment we add a general tonic course, and where there is a syphilitic diathesis, iodides or bi-chloride of mercury.

C. DEEP KERATITIS (PUNCTATA).

This is the name which is applied to the parenchymatous variety of the disease, when it affects the deep layers of the cornea. The affection begins with inflammatory symptoms, and the formation of circumscribed isolated opacities. When it extends to Descemet's membrane, it gives rise to the special form which has received the name of *keratitis punctata.*

This disease is characterised by the presence of small spots on the posterior surface of the cornea. These are sometimes due to changes in the epithelium of Descemet's membrane, and sometimes to deposits precipitated by the aqueous humour, in which case they are more numerous on the inferior aspect of the cornea. By focal illumination we are specially enabled to see the details and situation of these slight opacities, which sometimes project into the anterior chamber, and can be observed also on the capsule of the lens. The disease is almost always accompanied with changes in the appearance and function of the iris, and with opacities of the vitreous, which proves that *descemetitis* only supervenes as a consequence of disease of the uveal tract.

The affection of Descemet's membrane being only a sequence of parenchymatous keratitis, or much oftener of serous iritis, its course depends on the progress of these diseases, as do also the prognosis and treatment.

D. SUPPURATIVE KERATITIS.

When the products of corneal suppuration remain shut up between the lamellæ of the cornea, we have to deal with an abscess; when, however, they escape freely on the surface, we have a corneal ulcer. Another distinction, very important from the clinical point of view, as on it depend great differences in treatment, is to be drawn from the fact that suppurative keratitis is sometimes accompanied with a greater or less amount of inflammation (inflammatory ulcer and abscess). Sometimes there is an entire absence of inflammation (non-inflammatory, indolent, or torpid abscess and ulcers of *von Graefe*).

1. Circumscribed Infiltration and Abscess of the Cornea.

(*a.*) Inflammatory Abscess.

This, from its beginning, is accompanied with heat, photophobia, lachrymation, and ciliary pain. We find a partial or complete peri-corneal subconjunctival injection. If it is complete, the cornea is surrounded by a rose-coloured zone, sometimes slightly infiltrated. Soon there is formed, either at the centre of the cornea, or towards its periphery, a small *circumscribed infiltration*, which may extend by slow degrees without altering the level of the cornea if it is deeply situated, whilst it raises the layers of the membrane if situated superficially.

Sometimes, several infiltrations are formed, which rapidly coalesce to form one. Its colour, at first grey, becomes yellowish, the *abscess* is surrounded with a greyish cloud, and frequently we see greyish rays deeply seated stretching from its margin to the periphery of the cornea. When it occupies the centre of the cornea, it is generally round in form; if it is situated near the margin, it coincides with its contour, but is round towards the centre. The epithelium above the abscess only becomes irregular or rough when the abscess is superficial and exercises a greater or less amount of pressure on the epithelial, which it elevates above the level of the cornea.

The abscess is formed by the destruction of the cellular elements and intercellular substance of the cornea, and along with this we find that the cells in its neighbourhood are swollen, and that their nuclei have undergone segmentation.

The abscess contains infectious matters (micrococci and bacilli), pus corpuscles, mixed with fat and the debris of the corneal tissue, more or less altered. According to the relative quantity of these elements, the contents are sometimes so thick, that the abscess is not evacuated on puncture; sometimes they are more liquid.

The pus enclosed in the abscess may spread between the lamellæ of the cornea, and extend to the lower portions of the membrane. It then assumes the form of an arc, more or less elongated, with the concavity turned upwards, and is known as an *onyx* (Fig. 31, 6).

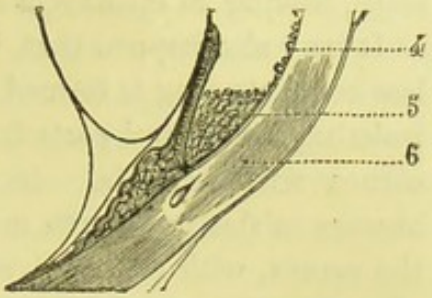


Fig. 31.—Onyx and Hypopyon.

The inferior border of this effusion always remains at some distance from the sclerotic, and the pus does not change its position when the patient moves his head. This characteristic distinguishes onyx from hypopyon. By focal illumination, we can easily see that the pus is effused in the lamellæ of the cornea, and sometimes we can distinguish small greyish or milk-like streaks, which connect the abscess with the onyx.

Progress and Termination.—The abscess may be very rapidly evolved, taking only a few days or hours. But when it is small and situated superficially, it developes much more slowly.

We sometimes see, after a short time, the epithelium excoriating, and then the anterior wall of the abscess bursts, leaving us to deal with an ulcer, the base of which, at first yellowish, soon becomes greyish, is re-covered with epithelium, and heals up more or less quickly, leaving a slight opacity. Generally, the subconjunctival injection increases during the period of regeneration, and we may even find a few vessels crossing the corneal margin, and going towards the seat of the disease.

It may also happen that the infiltration or the contents of the abscess are gradually absorbed, without any destruction of the epithelium. Its yellow tint is changed to grey, but, for some time after, we may still recognise its situation by the more or less persistent opacity which ensues.

In the more serious cases the abscess extends, invades the different layers of the cornea, and terminates by approaching one or other, or perhaps both, surfaces of the membrane.

If it bursts anteriorly, we have an ulcer with all its consequences. If it is Descemet's membrane which yields, the pus escapes into the anterior chamber, and is collected in its lower part, forming a *hypopyon* (Fig. 31, 5).

The opening in Descemet's membrane, by which the pus has escaped, is sometimes so small that it cannot be seen, even on focal illumination. At other times a whitish or greyish streak clearly shows the path by which the abscess communicates with the anterior chamber. Until the work of regeneration has begun, the abscess may be repeatedly emptied and refilled; the opening in Descemet's membrane then closes, the

pus in the anterior chamber is absorbed, and the morbid process stops, leaving an opacity to mark the position of the abscess.

It may also happen that, by the union of several abscesses, a more or less complete ring is formed near the periphery of the cornea, which, by isolating the central parts from their source of nutrition, threatens the cornea with necrosis. In the same way, the extension of a single abscess in size and depth may cause partial or complete destruction of the cornea, with consecutive loss of the eye, or at least the formation of an indelible opacity.

It should also be observed that abscess of the cornea may be complicated with iritis, which, on its part, may give rise to an effusion of pus in the anterior chamber, although the abscess has not burst internally. Lastly, when the early stage of suppurative keratitis is very acute—as, for example, after violent injury of the cornea—the inflammation may extend to the choroid, and involve the entire organ in a general suppuration.

(*b.*) Non-inflammatory Infiltration and Abscess.

Without any inflammatory symptom, such as photophobia or pain, a yellowish spot appears, as a rule, at the centre of the cornea, and rapidly extends in depth and size. Its margin is distinctly separated from the healthy tissue, and it is not surrounded with the greyish ring. It is sometimes situated in the deep layers, sometimes superficially, in which case it protrudes beyond the level of the membrane.

Progress and Termination.—When the disease tends to recovery, the aspect of the abscess changes, assuming the characteristics of the inflammatory variety. It is surrounded with a greyish cloud, pericorneal injection is established, the eye becomes very sensitive, and the patient suffers from photophobia, ciliary pain and a sensation of intense heat. The abscess does not extend deeper, and the yellow portion becomes grey. Recovery takes place either by absorption or by the abscess bursting externally and being converted into an ulcer, in which case it becomes covered with epithelium, vascularises and heals, leaving a greater or less amount of opacity.

Unfortunately in the large majority of cases the disease is much more troublesome. The indolent abscess increases in depth till it reaches Descemet's membrane, which participates in the disease, and from which the inflammation extends to the iris; hence, we have *iritis* with *hypopyon*.

Lastly, if the epithelial layer and anterior wall of the abscess are destroyed by the suppuration, we have, as a consequence, the formation of a large ulcer, which may lead to perforation of the cornea, and the keratitis may end in the formation of a large staphyloma or extensive leucoma.

In the worst cases, the inflammation attacks the deep structures of the eye, and determines the atrophy of the organ.

Prognosis.—In suppurative keratitis, complete restoration to the original condition is only seen when the infiltration is circumscribed and in young persons. In other cases we cannot hope for more than the conservation of the cornea, and the formation of a cicatricial opacity. The prognosis in other respects depends on the situation, the extent, and the special character of the abscess.

As a rule, indolent abscesses must be considered as the more dangerous, because, from their insidious and rapid course, they may easily involve a large portion of the cornea. Once they become vascular they are no longer distinguishable from the other variety of corneal abscess, so far as the prognosis is concerned. The greater their extent the more have we to fear an unfortunate termination, either from perforation of the cornea with its sequelæ (prolapse of the iris, staphyloma, atrophy of the cornea, panophthalmitis and atrophy of the eyeball), or from iritic complications.

Even in successful cases, the extent of the abscess determines to some extent the size of the opacity, and the amount of difficulty in vision, which will result from it. Things being otherwise equal, a central abscess will cause us more apprehension than a peripheral one. First, because the opacity which remains after the disease has passed off will be situated in front of the pupil; and also, because regeneration of the tissue is much more difficult when the abscess is at some distance from the periphery, for all nutriment to the cornea comes from its margin. An exception to this prognosis is only to be taken for multiple peripheral abscesses, which are very serious, because they separate the cornea from its source of nutrition, and expose it to the risk of necrosis.

We shall speak in a separate chapter of the prognosis of abscesses which have become ulcers.

Ætiology.—These suppurative keratites are usually connected with infectious diseases of the conjunctiva (purulent or diphtheritic ophthalmia) or of the lachrymal sac. The infectious influence is more powerful when there is a trauma of the cornea, be it only a slight abrasion of the epithelium. Circumscribed infiltration has its origin in local circumstances, such as palpebral granulations, or it depends on general weakness—for instance, in infants or in women debilitated by prolonged nourishing. It has also been observed after small-pox, at the period of desiccation, or after cicatrisation of the pustules. Abscess of the cornea has also supervened after chills, or after diseases which very greatly lower the general health—*e.g.*, typhoid fever, scarlet fever, puerperal fever, diabetes, &c.

Von Graefe has mentioned suppuration of the cornea in children of from two to four months of age, who generally die very speedily without exhibiting cerebral symptoms, but in whom an autopsy nevertheless shows the presence of an encephalitis.

Finally, there is a form of suppurative keratitis which follows lesions of the fifth intercranial pair, and which has received the name of *neuro-paralytic keratitis.* In this case there is complete insensibility of the cornea, which is apt to be injured by external irritants, the eye being no longer protected against these by the closing of the lids. This phenomenon has also been observed in a more restricted degree, when the branches of the fifth pair in the orbit and in the eyeball are exposed to too great pressure, as in glaucoma, exophthalmus, &c.

Treatment.—When the circumscribed infiltration is accompanied by conjunctivitis or dacryocystitis, with or without discharge, this disease has to be treated first. If there is hyperæmia of the iris, or iritis, atropine is needed. Infiltration without complication requires warm antiseptic fomentations and lotions, compresses, and a pressure bandage, provided that it produces a good effect and does not hurt the patient. When once ulceration has taken place, the treatment is that of the ulcer (*vide infra*). The basis of treatment of corneal abscesses consists in the application of antiseptic lotions and a bandage, instillations of eserine or pilocarpine (*Weber*), and paracentesis.

Myotics and the antiseptic bandage must be employed from the very beginning to the end of the treatment. In spite of the bad influence myotics exercise on iritis, we cannot spare them till the conservation of the cornea is quite sure. After this we can apply atropine in their stead. If the pain is very acute, we must have recourse to morphia injections in the temple.

When the disease begins as the indolent variety, hot fomentations must be used until it becomes vascular, and till a greyish ring surrounds the purulent focus. When once the abscess is formed, whatever be its nature, it must be treated in accordance with general principles —*i.e.*, it must be opened by paracentesis, performed with a needle, or, if the purulent focus is very large, with a small linear section knife. We conclude that pus is present by the duration of the inflammation, and by taking into account its more or less rapid development, by the deeper colour of the pericorneal injection, by the more distinct appearance of the yellowish tint of pus, and especially we ascertain whether pus is present or not by touching the focus with a sound or with the convexity of a Daviel's curette (*Arlt*).

If the abscess is superficial, it suffices to open it by piercing its anterior wall with a cataract knife. If the matter which it contains does not readily flow out, it may be carefully removed with a curette.

If the abscess is deep, it is better to introduce a paracentesis needle at its base, thrusting it obliquely through the abscess into the anterior chamber, taking care, by properly inclining the needle, not to injure either the iris or lens. We must also avoid a too rapid evacuation of the aqueous humour, and rather open up the abscess little by little with Daviel's curette. With a pair of fine forceps we can withdraw any coagulated pus from the lips of the wound. Paracentesis has a twofold advantage—1st, The aqueous humour, in escaping, takes along with it the matter pent up in the abscess and thus washes out the cavity; 2nd, The operation at the same time diminishes the tension, which, arising from the anterior chamber, acts on the cornea, the resistance of which is diminished by the morbid process.

The diminution of the tension always favours the work of repair, which should be our object in treating this affection. It is sometimes necessary to repeat the paracentesis at intervals, and we should always thereafter apply a compress and bandage.

As to general treatment, if, in the first stage of inflammatory purulent keratitis, the prescription of mild laxatives should be indicated, it is in general much more necessary to keep up the patient's health by a nourishing diet, by tonics, such as quinine and iron, and by light stimulants.

The treatment of the hypopyon, ulcers and opacities, which may be secondary to an abscess, will be explained further on.

2. Ulcers of the Cornea.

(*a.*) Inflammatory Ulcer.

This disease begins with very acute ciliary pain, lachrymation, photophobia, and intense pericorneal injection. Together with these symptoms the ulcer is developed at the centre or near the periphery of the cornea, either as a loss of substance showing a greyish base, or as an infiltration, at first appearing below the epithelial layer, which it soon destroys.

At first, the greyish tint of the ulcer is best seen at its margin, which is slightly swollen and surrounded by a greyish ring, due to the infiltration of the adjacent corneal tissue; but the base of the ulcer remains almost perfectly empty. As the ulcer developes, it becomes yellowish, and increases in depth and extent, invading the various layers one after the other. When regeneration of the tissue begins, the ulcer regains its greyish colour, the opaque ring which encircles it is more pronounced, and the epithelial layer is renewed from the periphery towards the centre. The base of the ulcer is covered with

greyish lymph, which becomes organised, and the new tissue thus formed may in time regain perfect transparency, or a more or less pronounced opacity may remain.

Vessels come from the periphery towards the ulcer and hasten the process of repair. This process is sometimes very slow, and may last for several months. When the regeneration of the epithelium has once begun, the symptoms of irritation, especially the pain and photophobia, soon disappear.

There is a special variety of ulceration which takes place near the margin of the cornea. It is in the form of a crescent, and extends along the margin like a furrow, more or less completely encircling the central parts of the membrane. The nutrition of these portions being thus compromised, they may undergo changes and suffer necrosis, involving the destruction of almost the entire cornea.

(*b.*) Non-inflammatory (Indolent, Torpid) Ulcer.

With scarcely any symptom of irritation or inflammation, this sometimes begins as a rather small ulcer, retaining perfect transparency on its base and around. It is in the form of a facet, and may remain so for a long while; sometimes, but without changing its appearance, it strikes into the deeper layers of the cornea and even perforates through it. Another and much more serious variety shows a great tendency to extend, at first superficially, but afterwards into the substance of the cornea. It begins generally near the centre, and presents a greyish translucid base, and on one part of its margin a yellowish-white curvilinear and somewhat raised, but rather narrow, infiltration, surrounded by radiating yellow lines or small spots. In this direction the ulcer extends rapidly. Hypopyon is almost always present from its beginning, or when it reaches a certain stage. It may come from the ulcer itself, the pus finding its way through the lamellæ of the cornea, or it may be formed by the epithelial cells which line Descemet's membrane on the side of the anterior chamber; or, again, it may be caused by an iritis, which is a frequent complication of the disease. Thus, we have simultaneously contraction of the pupil, loss of mobility, discoloration and vascularisation of the iris. The ulcer which we have just described has been called by *Roser ulcer with hypopyon*, and by *Saemisch ulcus serpens*.

Less frequently the ulceration begins near the margin of the cornea in crescentic form, and slowly spreads over the surface (*ulcus rodens*), being always surrounded by small greyish spots which unite to form the margin of the ulceration. The margin is undermined and somewhat raised, so that the base of the ulcer seems deeper in its neighbourhood and looks exfoliated. The process stops sometimes for a

time, but begins afresh, and leaves after it an extensive white opacity. There is generally no hypopyon or perforation.

Progress and Termination.—Whatever be the form of the ulcer, when it tends to heal, we find it assuming a greyish tint; the loss of substance is then replaced by newly-formed cells, which, if developed quickly, remain opaque, but, if slowly formed, may acquire perfect transparency. The vascularisation of the ulcer, while necessary to the process of repair, also favours the formation of an opacity, for if the vessels be very numerous, the cells are rapidly developed. This restitution of the destroyed tissue takes place below the epithelial layer, which also is quickly restored from the periphery of the ulcer towards the centre.

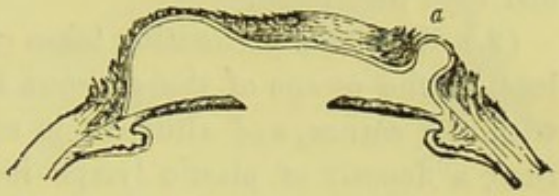


Fig. 32.—Hernia of the Cornea.

When the ulceration extends to the deep layers of the cornea, affecting those near Descemet's membrane, the intraocular pressure may push the base of the ulcer forward, forming what is known as a "hernia" of the cornea, or *keratocele* (Fig. 32, *a*).

Descemet's membrane, being very elastic, may make an external hernia, rising above the level of the cornea, as a transparent vesicle, enclosing the aqueous humour. Sometimes this condition persists for a long time; the Descemet's membrane and the remaining corneal tissue may become thickened, and so afford a basis for the cicatricial tissue which is substituted for the lost corneal substance. The form of the cicatrix is often staphylomatous; but it may gradually become flatter.

As a rule, the keratocele bursts, but may collect again and burst afresh, and the *fistula of the cornea* which results may last for a considerable time.

Deep and extensive ulcers, when they, owing to the pressure of the aqueous humour, give rise to keratocele, may involve the entire cornea, thus causing an ectasia of the whole membrane. In other cases, the cicatricial tissue, by its contraction, may draw in the surrounding tissue, so that the cornea becomes flat.

The most disastrous terminations arise from perforation of the cornea, especially when the rupture is extensive. This perforation, if the ulcer is very deep, may be due to simple intraocular pressure, or to violent muscular contractions, as in coughing, sneezing, vomiting, lifting weights, &c.

According to the seat and extent of the perforation, we may have one or other of the following terminations:—

(1.) If the perforation is linear, and the base of the ulcer not too thin, the margins of the wound touch each other, and may immediately unite. The aqueous humour is re-secreted and pushes the iris and lens back to their normal position; and although the perforation may have occurred repeatedly, the cornea may ultimately heal as if it never had been perforated.

(2.) When the perforation takes place in the centre of the pupil, the lens, on the escape of the aqueous humour, comes into direct contact with the cornea, and although it remains in contact for a very short time, a deposit of plastic lymph is formed on the capsule. After a while the corneal opening cicatrises, and as the aqueous humour re-gathers, the lens is pushed backwards and becomes detached from the point of rupture. A filament of plastic exudation, connecting the capsule with the posterior surface of the cornea, may be left for some considerable time; but, in most cases, a small central opacity of the capsule (capsular cataract), with a slight corneal opacity at the seat of perforation, is all that remains. The opacity of the cornea may so entirely disappear in the course of time, that even with focal illumination it is no longer visible.

(3.) When a small perforation takes place at some distance from the centre of the cornea, as soon as the aqueous humour escapes, a portion of the iris, either marginal, central or intermediate, comes into contact with the cornea (Fig. 33). The diminution of the intraocular pressure favours the cicatrisation of the ulcer, so that the corneal opening is soon filled up, the aqueous humour is re-accumulated, and aided by muscular action, the iris is restored to its original position. If the adhesion between the iris and the cicatrix has already become firm, it is not broken up, but forms what is called *anterior synechia.*

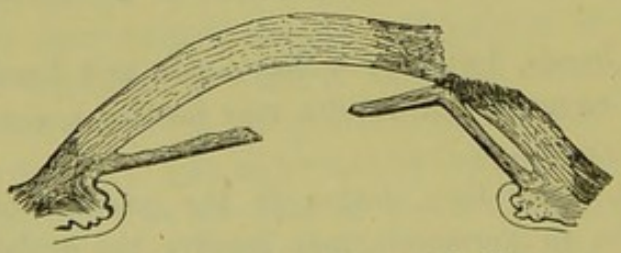


Fig. 33.—Perforating Ulcer of the Cornea, Adhesion of Iris (Anterior Synechia).

(4.) When the perforation has been very extensive, and the iris has prolapsed between the margins of the ulcer, it can no longer be disengaged, but the prolapsus becomes covered with plastic lymph which unites the edges of the perforation, and becomes the basis for the cicatricial tissue. The cicatrix fills up the loss of substance, and in it we may, by a deeper colour, for a long time afterwards detect portions of the iris. The anterior chamber in such cases is irregular in form, being deeper at the side where the iris is *in situ*, than on the other where it is drawn towards the cornea.

When the adhesion is formed near the periphery, leaving the

sphincter of the iris intact, the pupil may be normal so far as its mobility and position are concerned (Fig. 33).

On the other hand, the pupil will be displaced towards the seat of the perforation, when a part of the iris near the free margin is adherent,

Fig. 34.—Perforating Ulcer of the Cornea, Adhesion of the Iris by its Pupillary Margin (Anterior Synechia).

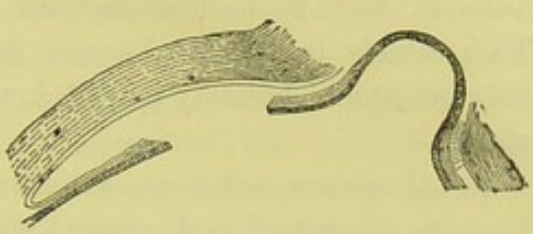


Fig. 35.—Prolapse of Iris after Extensive Perforation.

and especially if a portion of this margin has been caught in the cicatrix (Fig. 34) (*leucoma adherens*). If the entire pupil has been caught, the iris is tensely drawn towards the cicatrix, and the anterior chamber is very shallow.

(5.) If the perforation is extensive and takes place suddenly, the prolapsed piece of iris may be very large, and, subjected to the pressure of the aqueous humour, may protrude beyond the cornea, forming a vesicle of the size of a large pea (Fig. 35). If the prolapsus does not burst, and in bursting become flattened, it will give rise to partial staphyloma of the cornea and iris (Fig. 36). In some cases, the lens

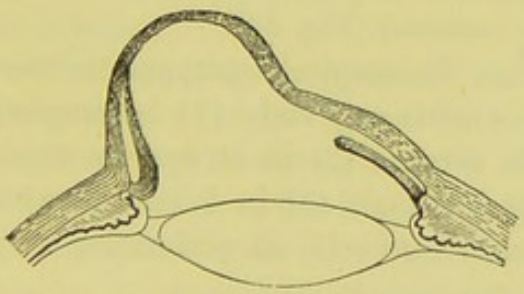


Fig. 36.—Partial Staphyloma of the Cornea and Iris.

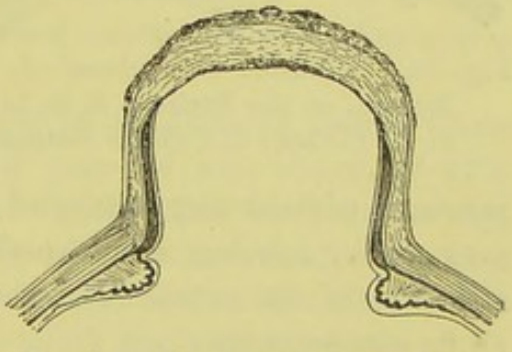


Fig. 37.—Total Staphyloma of the Cornea and Iris.

capsule may be ruptured, which will give rise to cataract, or the lens may start out of the eye, the zonule of Zinn may be torn, and some vitreous humour escape. In consequence of this accident, we may have intraocular hæmorrhage, separation of the retina, or general inflammation with shrinking of the ball.

(6.) After the partial or total destruction of the cornea, the iris is found immediately behind the opening thus produced. The pupil is contracted, and soon closed by an effusion of plastic lymph. The entire iris is also covered with an opaque tissue, and is united to the

margins of the perforation. The cicatrix, which is at first prominent, in time becomes flat from the contraction of the tissue. Following fresh inflammatory attacks in the interior of the eye, the cicatrix, if as yet not very solid, is unable to withstand the pressure of the aqueous humour, and is pushed forward into a staphylomatous projection. This ectasia may burst, become flat, and, after several such attacks, may become completely solidified, whilst the eyeball undergoes atrophic changes.

In other cases, after an extensive perforation of the cornea, the iris becomes thickened and covered with an opaque cicatricial tissue, and the pupil being occluded, the entire membrane is pushed forward by the aqueous humour, which collects behind the cicatrix, and distends it more and more till it forms that variety of ectasia which is called *total staphyloma* (Fig. 37). The lens, in such cases, may have been expelled at the time of perforation, but more frequently it is retained in the eye.

The distension of the staphyloma is sometimes irregular, either from the iris having contracted adhesions with the lens, or from the cicatricial tissue which covers the iris yielding unequally to the pressure of the aqueous humour. In this case, the staphyloma seems nodulated, and is called racemose staphyloma (*staphyloma racemosum*) (Fig. 38).

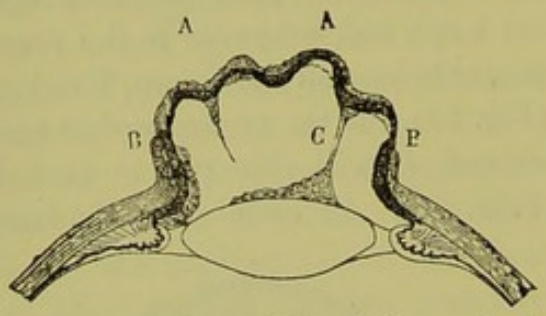


Fig. 38. - Nodulated Staphyloma—A, A, Nodules on the Surface; B, B, Limit of the Cornea; C, Cellular Filament.

To recapitulate, suppurative corneitis may end—(1) in complete recovery without any opacity of the cornea; (2) in an opacity which may or may not clear away (speck or leucoma); (3) in keratocele with alteration of the curvature of the membrane; (4) in perforation with all its consequences.

Prognosis. — If the ulcers are small, superficial, greyish, the inflammatory symptoms well-marked, and the patient young, the prognosis is very favourable. Atonic ulcers are much less hopeful as regards their prognosis, because they tend to increase in size, and we are often unable to prevent extensive destruction of the corneal tissue. The visual disturbance which ensues after the ulcer has healed depends on the extent and seat of the opacity. Moreover, adherent leucomata expose the patient to the same dangers as synechia, either directly from the dragging of the iris, or indirectly from displacement of the lens.

Again, when there is a staphylomatous cicatrix the prognosis is

always grave, as there will be alterations in curvature of even the healthy portions of the cornea, and as, after the lapse of years, there may be complications involving loss of vision.

Finally, very extensive perforation may lead to blindness from atrophy of the ball or the formation of a total staphyloma.

Ætiology.—Ulcer of the cornea is to be attributed to the same causes as abscess. The *ulcus serpens* occurs most frequently in subjects who are affected with some disease of the lachrymal sac, in consequence of superficial injuries of the cornea—as, for example, during harvest operations. It is considered to be of infectious origin.

Treatment.—With inflammatory ulcer, the object of local treatment is to diminish the inflammation, to stay the progress of the ulceration, and to hasten the process of repair. These indications are best met by giving the eye rest, by instilling pilocarpine or eserine (atropine only when there is iritis, and the conservation of the cornea quite sure); or by the use of iodoform in the form of a strong ointment (gr. xxx ad. ℥i) or powder dusted on the base of the ulcer; or, again, by employing a pressure bandage or performing paracentesis corneæ. When there is acute pain, we may have recourse to an ointment containing morphia—say 6 grains to ℥ij of white vaseline—rubbed on the forehead and the temple; or subcutaneous injections of morphia may be administered. We must carefully avoid all astringent or caustic lotions; but, on the other hand, benefit may be derived from frequently cleansing the eye with an antiseptic solution. The greatest attention has to be paid to the lachrymal sac and to any other source of infection.

The spreading or infective ulcer should be cleansed several times daily with a brush dipped in freshly prepared aqu. chlori. or in a solution of sublimate (1–2,000). The actual cautery (galvano-cautery, thermo-cautery, or red-hot probe) is an excellent means of destroying the infiltrated parts at the margin and on the base of the ulcer, but it has to be managed with prudence, to avoid perforation, or even a too great thinning of the cornea, which predisposes to staphyloma.

When the ulcer is indolent, the best treatment is to use hot boracic lint compresses, moistened with sublimate or carbolised water (5–1,000). Along with this myotics must be employed, for myosis helps the cornea to sustain the intraocular pressure. This pressure is one of the chief causes in keeping back the normal nutrition and the reparative process in the cornea, and often requires repeated paracentesis of the anterior chamber.

When perforation of the ulcer is impending, it is of the utmost importance to forestall it by performing paracentesis at the thinnest part, by doing which an irregular rent of the tissues, with its pernicious

consequences, may be prevented. Where there is hypopyon (and especially if it be large), we are obliged to evacuate the purulent masses, by making an incision at the inferior margin of the cornea, close on the sclerotic, with an iridectomy knife. The pus often re-accumulates, and demands either the re-opening of the wound with a probe-pointed stylet, or a fresh paracentesis.

In this case, some advise iridectomy, which, moreover, often becomes necessary at a later stage, to establish an artificial pupil, on account of the central opacities of the cornea, which are secondary to the disease (see the article on *Iridectomy*).

Saemisch recommends, in cases of indolent ulcer with great tendency to destruction of tissue, a transverse incision through the cornea, extending from one side of the ulcer to the other, which may be best made with Graefe's linear section knife. He also recommends that the wound should be kept open for some time after—perhaps for weeks. Although we are able to testify to the salutary effect of this operation, it has the great disadvantage of causing a whitish cicatrix, which is so much more injurious to vision, the more it is situated in front of the pupil. Sometimes, also, the iris becomes engaged in the wound, and remains caught in the cicatrix. *Saemisch's* operation ought, therefore, never to be performed without a previous trial of the antiseptic treatment and the actual cautery, as indicated above.

When, in consequence of a small perforation, we have an adhesion of the iris to the cornea, we may use with advantage mydriatics and myotics alternately, so as to stimulate the muscles of the iris, now in one direction, now in the other. We may also try, by the same means, to reduce any recent prolapse of the iris. But when the prolapse has already become distended, we must repeatedly puncture the hernia, and if that does not suffice, it must be divided with Graefe's cataract knife, and carefully removed with curved scissors. We may also try with a hard rubber spatula to separate the iris from the corneal wound, or to push it back into the anterior chamber. It is a mistake to cauterise the prolapsed iris with nitrate of silver, for the proceeding is somewhat dangerous, and does not fulfil the end in view.

The application of caustic (we prefer the galvano-cautery) is only admissable when the prolapse has already begun to become vascular and to increase in thickness, when it may be used to hasten the cicatricial process.

If the lens has followed the iris, we cannot hope to preserve it, and, in the interest of cicatrisation, it is better, if the lens be seen in the wound, to remove it from the eye by opening its capsule.

Where there is a large and solid adhesion between the iris and a cicatricial staphyloma of the cornea, we must make an iridectomy,

partly because the central pupil can no longer be useful for vision, but more especially because in such cases the gradual increase of the intra-ocular pressure threatens the eye ultimately with blindness.

In cases where the papillary margin only is adherent to the cornea, or in any case of anterior synechia where a small, narrow knife can be introduced between the synechia and the periphery of the anterior chamber, we use this mode of operating in order to cut the adhesion. When the synechia is somewhat larger, we do it with small forceps-scissors, placing the synechia between the two blades, introduced through an incision in the cornea like that for iridotomy.

Persistent fistulæ of the cornea, which periodically close, only to open afresh, are exceedingly difficult to cure. We must at first try pilocarpine, with a pressure bandage. If unsuccessful, we may touch the fistula with caustic, introducing into it a needle dipped in nitrate of silver or a red-hot platinum wire. These remedies, however, are rather dangerous, for we are liable to wound the capsule or the iris.

We shall speak of the treatment of staphylomata when we come to treat of anomalies in the curvature of the cornea.

The general treatment is the same as that already indicated as appropriate in corneal abscess.

ART. II.—Opacities and Specks on the Cornea.

Opacities of the cornea owe their existence to those permanent alterations of the tissue which are a consequence of inflammations of this membrane, or of a loss of substance or disturbance of its nutrition.

These alterations may take place in the epithelial layer, in which situation they consist of an increase in the number and size of the cells forming the layer, intermixed with fatty and calcareous matter; or they may occupy several layers of the substance proper of the cornea, and are then formed by an accumulation of nuclei in the cells, by masses of fatty cells, by calcareous deposits, or by imperfectly developed cells, which are proliferated to repair a loss of substance. In the surrounding parts, we also find imperfectly developed corneal corpuscles and fusiform cells.

Opacities vary in extent and density, from a slight cloud (*nebula*) to absolutely opaque cicatricial spots (*leucoma*). The intermediate degrees have received the name of *albugo*. Leucomata have a bright, silky reflection, and, if they be the result of perforation, their centres are white like chalk, for the opacity then involves the entire corneal thickness.

Not infrequently do we see opacities due, to some extent, to deposits

of metallic salts (acetate of lead and nitrate of silver), which result from the misdirected application of these salts as remedies.

A special form of corneal opacity proceeds from a loss of conductivity in the nerves which enter at the margin of the membrane. Thus, in some varieties of irido-cyclitis and glaucoma, or in sclerotic staphyloma, where the ciliary nerves are dragged upon or exposed to an abnormal pressure, we find a cloudy opacity developing near the margin of the cornea, and extending towards the centre of the membrane. After some time it becomes whiter. If this opacity be formed simultaneously at several parts of the periphery, only the central portion of the cornea remains transparent. In some cases it is formed at the same time on the nasal and temporal sides, thus separating, as by a whitish ribbon, the inferior and superior thirds of the cornea which remain transparent.

We also see temporary opacities of the cornea when the internal pressure of the eye increases or is suddenly diminished.

In the first case the opacity seems to be due to alterations in the arrangement of the elements which compose the cornea, although they themselves remain normal. In the second case it is composed of parallel striae, which are easily seen by focal illumination, and which are the optical expression of a folding of Descemet's membrane.

Finally, we meet with partial opacities in the periphery of the cornea, which by their situation and appearance seem to be a direct continuation of the sclerotic. These are sometimes due to phlyctenular affections; sometimes they exist at birth, and these will receive further attention when we come to speak of congenital affections of the cornea. Again, they may follow certain forms of parenchymatous keratitis, of anterior sclero-choroiditis, or episcleritis. These *sclerotic* opacities may appear at different places near the corneal margin, and slowly advance to the centre, stopping sometimes in their advance, or affecting by-and-by the whole cornea. They may recede, leaving only slight traces near the margin.

The disturbance of vision arising from an opacity of the cornea varies with its position and density and the state of its margins. A small, well-defined, but perfectly opaque opacity, even although situated at the centre of the pupil, if it only partially covers it, disturbs the vision much less than semi-transparent opacities, which give rise to diffusion of the light, and destroy the clearness of the retinal image. We can easily understand this if we remember how perfectly we can see through a glass when there are only a few points perfectly transparent, whilst we can scarcely distinguish anything through an opaque glass. The disturbance of vision is in all these cases much more considerable when the eye is directly opposed to the light, and the patients see much better if they turn their backs to the light, or can protect their eyes against it.

Another cause of disturbance in vision, which is found in conjunction with corneal opacity, is the alterations in the curvature of the membrane, which are due to the morbid process in the neighbourhood of the cornea, or in the entire membrane itself.

To remedy these visual defects, the patient, with the view of obtaining very large retinal images, brings the object at which he looks as near his eyes as possible. This can only be done with considerable effort of his accommodation, giving rise to congestions of the deep membranes of the eye (sclerotico-choroiditis), which may be the starting point of a greater or less amount of myopia and amblyopia.

When the opacity exists only in one eye, we often find that this eye deviates (strabismus). The patient, annoyed by the diffuse image which he receives on this eye, gives up binocular vision, and uses only his good eye, and the other eye then follows the natural tendency of its muscular equilibrium. It deviates inwards, when the rectus internus muscle is more powerful than the externus, which is most commonly the case, and *vice versâ*.

Prognosis.—The prognosis depends on the age and constitution of the patient, and on the duration, extension, situation, and nature of the opacity. Thus, in children and young persons of good constitution, even extensive opacities, resulting from deep keratitis or from ulcer, may gradually clear up and entirely disappear. We have already noticed the same thing in speaking of the small perforations which give rise to capsular cataract. As to opacities which are occasioned by alterations of the tissue, accompanied by vascularity, the more superficial, the less extensive, and the more recent they are, the more readily and perfectly do they disappear. There is, however, no chance that a leucoma formed by cellular tissue, or calcareous or metallic deposits, will disappear. Opacities due to an alteration of the epithelial layer, even although somewhat extensive, have a much more favourable prognosis, for we can act on them directly, either with remedies or by surgical interference.

Ætiology.—Opacities of the cornea, as we have already seen, arise from infiltration of the cornea, or from loss of substance of the membrane. They are also due to epithelial alterations, produced by direct and prolonged irritation of the mucous membrane of the conjunctiva or irritation from the cilia (entropion and trichiasis). Again, these opacities may be due to the impaction of foreign bodies, to deficiency in the nervous supply of the cornea, and to the sudden increase or diminution in the intraocular tension.

Treatment.—The treatment should aim at promoting the local circulation, and hastening the nutritive functions of the parts, thus giving an impulse to the absorption of the opacity. For this reason

most of the remedies recommended for corneal opacities are irritants (calomel, tincture of opium, red precipitate, sulphate of copper, sulphate of soda, iodide of potassium, &c.)

When we have to deal with an opacity which we can foresee will clear away gradually, it is useless to interfere; it is only when it becomes stationary that we try the effect of insufflations of calomel or of the yellow oxide of mercury ointment, used every day or every second day. If these remedies fail, we may try the much more irritating instillations of tincture of opium, or of cantharides, or of terebene, pure or mixed with olive oil.

If we wish to produce a still stronger irritation, we may touch the opacity lightly with sulphate of copper or nitrate of silver.

Electricity, so often recommended, acts also as an irritant, but hardly deserves the eulogies which have been pronounced in its favour.

Dr. Rathmund, of Munich, has obtained good results in cases of dense opacity by injecting a tepid solution of common salt (from 1–30 to 1–10) under the conjunctiva, a few millimetres from the corneal margin. A certain amount of chemosis is caused, which disappears on applying a compress and bandage.

When the opacity is due to alterations in the epithelial layer or to deposits of metallic salts, it may be removed with a scarifying or cataract knife. The result, however, is very uncertain, for often the newly-formed tissue gives rise to a fresh opacity.

When an indelible opacity is surrounded with a semi-transparent circle, it is of great importance to remove it, if possible, for by dispersing the rays of light, it very seriously impedes vision. We may sometimes succeed by carefully touching the margin of the perfectly opaque spot with the point of the mitigated pencil. The use of hot vapour has also been highly recommended.

Sometimes we may promote the removal of corneal opacities by dividing the conjunctiva by means of a peritomy performed according to the method already described (see p. 102). This operation is specially indicated in progressive sclerotic opacities.

Another indication is afforded when we find ourselves in the presence of an indelible opacity. We must then, in the interests of the patient's vision, so act as to reduce as much as possible the optical defects. For this purpose, we at first use stenopaic spectacles, made of an oval-shaped metallic diaphragm, like a common spectacle glass, and provided with a small opening or very narrow slit. Thus, only those rays which are near the optical axis reach the retina, and all the peripheral light, which by its diffuseness would impair the clearness of the retinal image, is excluded. Such glasses are of great service in reading, writing, &c.; but they are of no use in walking, because they greatly

diminish the visual field, as must always be the case when the patient looks through a small opening.

Another method of obtaining a somewhat similar result is to make an artificial pupil behind the transparent part of the cornea. In the chapter on iridectomy, we shall speak of this operation in detail.

The often-repeated experiment of replacing an opaque by a transparent cornea begins to give encouraging results (*Power, Hippel*). Having removed a round portion from the entire thickness of the cornea with a guarded trephine, we replace the loss of substance by a similar morsel of transparent animal or human cornea also obtained by trephining. The implanted cornea becomes completely ingrafted, and although at first it loses its transparency, it regains it after some time, and the patient has sufficiently good sight to count fingers at several metres from the eye.

Again, in tattooing the cornea, we possess a means of removing the disagreeable expression which white indelible spots always give to the physiognomy. At the same time, tattooing counteracts the inconvenience of semi-transparent spots, and increases the acuteness of vision in such circumstances. This operation should be performed as follows :— Having separated the lids with a speculum, the leucoma is covered with a thick layer of Chinese ink rubbed into a thin paste, and numerous punctures are made in it with an instrument provided with five needle points (Taylor's needles) to permit of the ink penetrating into the tissue. The surface is again rubbed with a spatula, *ad hoc*, and having waited for a few seconds, the cornea is cleaned with a moist sponge, so as to ascertain the effect; if necessary, the operation is repeated. If the degree of coloration is sufficient, a final layer of Chinese ink is applied, and gently rubbed in with the spatula. The speculum is allowed to remain *in situ* for five or ten minutes, so as to prevent the movements of the lids interfering with the effect. Fixation forceps must not be used at any part of the operation, because the ink would be introduced into the conjunctiva and leave a permanent black mark. The operation ended, a compress and bandage must be applied.

Tattooing cannot be performed where the iris has recently been included in the cicatrix, or where there is a tendency to ectasia, because the eye is then liable to a glaucomatous attack, which the operation may suffice to set up. With this exception, however, a carefully performed tattooing is free from danger. We have successfully performed it many times without the slightest accident.

We cannot finish this chapter without mentioning the congenital opacities of the cornea, which will be described when we come to speak of the congenital anomalies of the membrane; and a senile physiological opacity known as the arcus senilis.

ART. III.—Arcus Senilis.

This opacity appears first at the superior margin of the cornea as an arc; it is of a greyish colour, from 1 to 2 millimetres broad, and is separated from the conjunctival ring by a transparent portion of the cornea of nearly the same breadth. At a later stage it becomes more of a yellowish colour, and appears at the inferior aspect of the cornea, extending by slow degrees entirely round, till it forms a ring, the superior and inferior portions of which are always larger than the lateral, which sometimes can scarcely be said to be present.

The opacity is the outcome of a fatty degeneration of the corneal cells, which takes place at a more or less advanced period of life, and seems to be connected with atheromatous degeneration of the vessels; it is rarely seen in young adults. This disease is never the object of treatment; besides, it so little alters the properties of the corneal tissue, that incisions made in the parts affected (say, for extraction of cataract) heal up perfectly.

ART. IV.—Anomalies in the Curvature of the Cornea—Staphylomata.

1. Transparent Staphyloma.

(*a.*) **Conical Cornea—Keratoconus** (Fig. 39).

When this disease reaches a certain degree of development, the conical distension of the cornea may be easily seen. Its rounded and blunt point, generally formed by the centre of the cornea, very rarely by the periphery, projects forwards, and in a certain number of cases is slightly opaque.

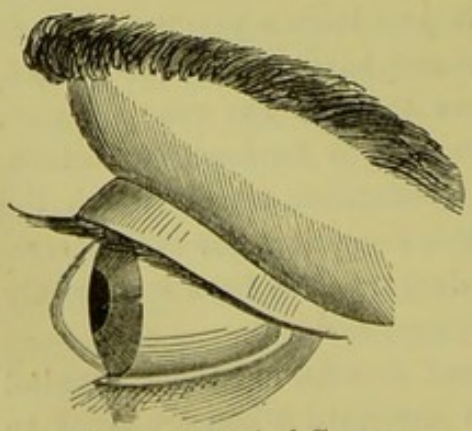


Fig. 39.—Conical Cornea.

This change in the form of the cornea is accompanied with considerable impairment of vision, which, in part, depends on the extraordinary elongation of the antero-posterior axis of the eyeball, and in part on the irregularity of the refraction, which is much greater at the summit than near the base of the cone (irregular astigmatism). Hence, we have a high degree of myopia, and such an

amount of polyopia and amblyopia, that the acuteness of vision is diminished to a thirtieth or fiftieth of the normal. The patients, who soon perceive that they can decidedly improve the state of their vision by contracting the palpebral fissure so as to exclude a portion of the luminous rays, acquire the habit of partially closing their eyelids.

If the disease when it has reached this stage in its development be easily recognised at the first glance, it is not so in the early stages. The patients complain of a dimness in vision, which has come on very gradually, and is accompanied with myopia, which can only be very imperfectly corrected by concave glasses; but the change of corneal curvature is sometimes so slight, that we must, with the keratoscope (p. 6), compare the reflections from the cornea with those of a normal eye before we can be sure.

By throwing a beam of light obliquely on the cornea with an ophthalmoscopic mirror we are also able to come to a precise diagnosis. If there be conical cornea, a very visible shadow is thrown on the opposite side of the ectasia, and the shadow changes its situation if we alter the direction in which the light falls on the cornea. Again, in examining the fundus of the eye with the ophthalmoscope, we find a considerable and characteristic deformity of its image. The exact curvature of the cornea can be ascertained only by an ophthalmometer.

Progress and Termination.—The ectasia, as a rule, developes insensibly, but cases have been recorded where it supervened suddenly. Having attained a certain degree of development, it may remain stationary, or after a short time it may begin to increase again, without ever causing rupture. The disease often attacks both eyes successively, and never passes off spontaneously.

Prognosis.—Till recently the remedies employed, either to improve the vision or to arrest the progress of the disease, yielded results so imperfect, as far as vision was concerned, that the prognosis of keratoconus was undoubtedly bad. Special glasses, and a new method of operation having for its object the flattening of the cornea, the advantages of which seem to be well ascertained, have, however, recently become valuable remedies against the disturbance of vision produced by this affection.

Ætiology.—The cause of this affection certainly rests in a disturbance of the equilibrium between the intraocular pressure and the resistance of the cornea, which is much diminished in thickness. This equilibrium seems to be interrupted, not by an increase of the ocular tension, but by an atrophic process in the central portions of the cornea.

Treatment.—Stenopaic apparatus, cylindrical lenses, and hyperbolic

glasses improve the vision very considerably; but instillations of eserine and the application of a pressure bandage continued for several months, repeated paracentesis of the anterior chamber, or iridectomy performed for the purpose of diminishing intraocular tension, have *not* succeeded either in effectually stopping the progress of the ectasia, or in flattening it.

Fig. 40.—Meyer's Needle for the Operation of Conical Cornea.

Much more favourable results have been obtained by *von Graefe's* operation, which has for its object the formation of a small ulcer with circumscribed infiltration, which, by its cicatrisation, produces retraction of the surrounding substance, and so indirectly flattens the cornea. The method of operation is as follows:—With an iridectomy knife or a special needle (Fig. 40), we remove from the corneal surface, a little to the outside of the summit of the cone, a small portion of the corneal substance, about 3 millimetres in length, *taking care not to penetrate the anterior chamber*. The day after this small operation we begin to cauterise the wound with the point of a solid mitigated nitrate of silver pencil, and this application is repeated every two or three days. Having thus procured a small limited infiltration, we perform paracentesis at the bottom of the ulcer, repeating it daily for a week. These small operations can be also performed with the galvano-cautery.

We then leave the cicatricial process to nature, and, as the cicatricial tissue contracts, the cornea slowly becomes more flattened, and the staphyloma disappears. Throughout the treatment we must apply a compress and bandage, and instil atropine.

With the same end in view some have proposed superficial cauterisation with the galvano-cautery, the excision of a small corneal flap with or without consecutive suture of the edges of the wound (*Bader*), or the trephining of the conical cornea (*Bowman*) with iritomy (*Abadie*). All such methods should be avoided, because the proximity of the lens renders them dangerous, and because they give rise to more or less complete adhesion of the iris to the cornea; besides they leave far more apparent cicatrices than are left by *von Graefe's* method, without any compensating optical advantage.

(*b.*) Globular Cornea, Keratoglobus, Hydrophthalmus of the Anterior Chamber (Fig. 41).

This disease is characterised by a general spherical distension of the cornea in all its diameters. The distension, however, often does not stop at the cornea; the sclerotic, at its junction with the cornea, becomes also distended, reduced in thickness, and of a bluish tint. The entire anterior half of the eyeball may, at length, thus be increased in size, and sometimes to such an extent that the cornea protrudes beyond the palpebral fissure, so as to prevent the closing of the eyelids (buphthalmos). The cornea, in these cases, may remain transparent or it may be more or less opaque; the anterior chamber is very deep, and the aqueous humour generally clear.

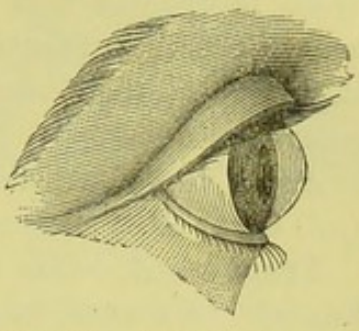


Fig. 41.—Globular Cornea, Hydrophthalmos.

The iris is tarnished and is separated from its ciliary attachment by the distension; sometimes it is tremulous when it has lost the direct support of the lens. If the suspensory ligament of the lens has been torn by the distension of the ball, the lens may be displaced.

The pupil is slightly dilated, almost immobile, and sometimes presents a few isolated adhesions with the capsule.

The movements of the eyeball thus distended are curtailed. The visual acuteness is considerably reduced, according to the degree to which the disease and its complications in the deep structures of the eye (glaucomatous excavation) have developed. Thus, whilst in one case the patient may still be able to see letterpress of a certain size, in other cases vision is reduced to the distinction of light and darkness, or may be completely abolished.

Concave and stenopaic glasses seem to be of no benefit.

Progress and Termination.—The disease, except when of congenital origin, which we must treat of separately, is developed slowly. It may remain stationary at any of its stages, or may reach the extreme development of buphthalmos. As it progresses, it is often complicated with affections of the iris and choroid, or with glaucomatous cupping of the papilla. Spontaneous perforation has not been observed. In certain cases, as, for example, when the affection is due to pannus of the cornea, and when the distention is not great, the cornea may regain its normal condition. In most cases, however, the distension remains after the keratitis is cured, and it may even increase.

The prognosis is very unfavourable, because, even in cases where the disease is stationary, vision is imperfect; and, moreover, in its

development, the disease, against which all treatment is of little avail, leads to almost complete blindness.

Ætiology.—This disease is due to a diminution of the corneal resistance, such as takes place in extensive inflammations of the membrane in diseases with vascular pannus. The secretion of a greater quantity of the aqueous humour, which was formerly supposed to be the cause of the disease, is secondary to the increased size of the anterior chamber.

Again, the disease has been recognised as a congenital condition (*vide infra*) often affecting both eyes, but in different degrees.

Treatment.—Our resources as to treatment in this affection are limited. We must, in the early stages, check the inflammatory state of the cornea which causes the ectasia, and increase the resistance of the membrane by means of a pressure bandage, and must also diminish the intraocular pressure by repeated paracentesis, by sclerotomy or by a large iridectomy. Drainage of the anterior chamber, puncture of the vitreous body, and section of the ciliary muscle, have all been tried without any satisfactory results being obtained. It may even happen, in advanced stages of the disease, that a bad cicatrix, following such attempts at operation, leads to atrophy of the eyeball.

When the ectasia is so great that it impedes the movements of the lids, if the eye be exposed to a constant irritation, and if such an amount of deformity result that the patient wishes to be delivered from it, we must have recourse to those methods of operation which are employed for staphyloma, and which we shall describe in the next chapter.

2. Opaque Staphylomata.

(*a.*) Partial Staphyloma (Fig. 42).

The cicatricial ectasia, which only occupies a portion of the cornea, may be situated at the centre of the membrane or towards the periphery. Its colour varies from white to dark blue. We can often see blackish spots in the ectasia, due to the iris pigment, when the iris forms part of it. When the staphyloma is very prominent, and is exposed to the friction of the lids, it often becomes irritated and covered with vessels.

Vision is disturbed in proportion to the amount of alteration in front of the pupil and the central parts of the cornea. The disturbance of vision is frequently in great part due to the irregular curvature of the cornea in the neighbourhood of the staphyloma.

When the iris remains free, the anterior chamber is increased in depth by the ectasia. Where there is anterior synechia, the iris is drawn forward with the cornea; and in this case any dragging on a

membrane so abundantly supplied with nerves as the iris, causes every now and again an inflammatory attack, accompanied with ciliary pain.

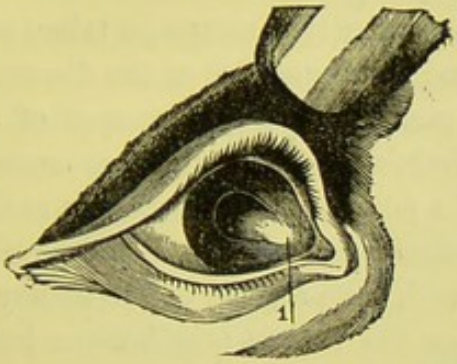


Fig. 42.—Partial Lateral Staphyloma.

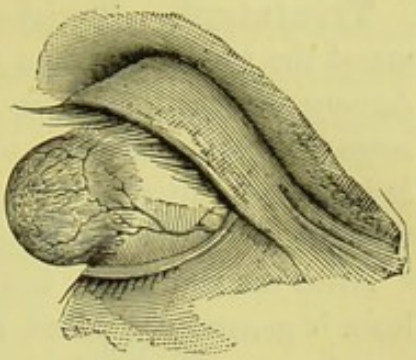


Fig. 43.—Complete Staphyloma.

During these inflammatory exacerbations, the intraocular tension increases, the ectasia may become more developed, or the pressure on the optic nerve may cause glaucomatous cupping of the papilla, and gradual loss of sight.

(*b.*) **Complete or Total Staphyloma** (Fig. 43).

Complete staphyloma forms a well-marked projection, sometimes of a conical form, sometimes resembling a very irregular blister, the base of which occupies the entire periphery of the cornea. This staphyloma may attain the size of a walnut, and prevent the eyelids closing. It is formed of cicatricial tissue of a bluish or whitish tint, and presents the various aspects which we have already described in speaking of perforations of the cornea.

Vision is always reduced in these cases to the perception of light, which takes place chiefly by the light reaching the retina through the sclerotic.

In cases of partial staphyloma, when the iris remains free, the ectasia is formed by the cicatricial tissue of the cornea which has yielded to the pressure of the aqueous humour. When there has been prolapse of the iris, and when the hernia forms a part of the cicatricial ectasia, it is at its summit composed of iris tissue covered with newly-formed tissue. Its base is formed by the portions of the cornea which were at the margin of the perforation, and which are united to the prolapsed iris by plastic lymph. In such cases, especially when the prolapse of the iris has been considerable, the lens may be partially displaced forwards.

In complete staphyloma, the walls of the ectasia are formed by the iris, covered with a more or less thick cicatricial tissue, and near the base we find the portions of the corneal tissue which remained after the destruction of the greater part of that membrane. If the lens has not been expelled at the time of perforation, as a rule it remains in its normal situation, but becomes opaque. The interval between the lens and the posterior surface of the staphyloma is filled with an albuminous fluid.

Ætiology.—Staphylomata are due to ulceration of the cornea or to perforation secondary to suppurative keratitis. We have already described their mode of formation (see p. 121).

Treatment.—Partial staphylomata require that means be taken to arrest the progress, and to prevent the evil consequences of the disease. Among the most important we would mention the performance of a large iridectomy, for the purpose of diminishing intraocular pressure. It is always indicated when the state of a portion of the cornea is such that the vision will be improved by the formation of an artificial pupil.

After the iridectomy has been performed, the progress of the staphyloma is generally arrested, and sometimes the ectasia may become less prominent. If at a later stage the tension increases anew, we must again interfere, either by renewing the operation, or by repeated paracentesis of the cornea, or by sclerotomy.

Abadie advises the division of the base of the staphyloma in the cornea-sclerotic margin, with a cataract knife gliding before the lens. In finishing the incision a very small bridge can be left undivided, when the staphyloma is very large.

When a staphyloma assumes considerable dimensions, or when it becomes a permanent cause of irritation, we must have recourse to one of the following proceedings :—

(*a.*) *Incision of the Staphyloma* is especially indicated, when the wall of the staphyloma is thin, for the purpose of causing the ectasia to collapse, by the evacuation of the aqueous humour and a portion of the contents of the eye. The two halves of the incised staphyloma then come together, the one on the top of the other, and thus form a flat cicatrix. Taking a cataract knife, the back of which is turned towards the centre of the eye, the point is introduced near the base of the staphyloma, and pushed through its greatest diameter, from without inwards, so as to divide the staphyloma at its greatest height into two equal parts (see Fig. 44)

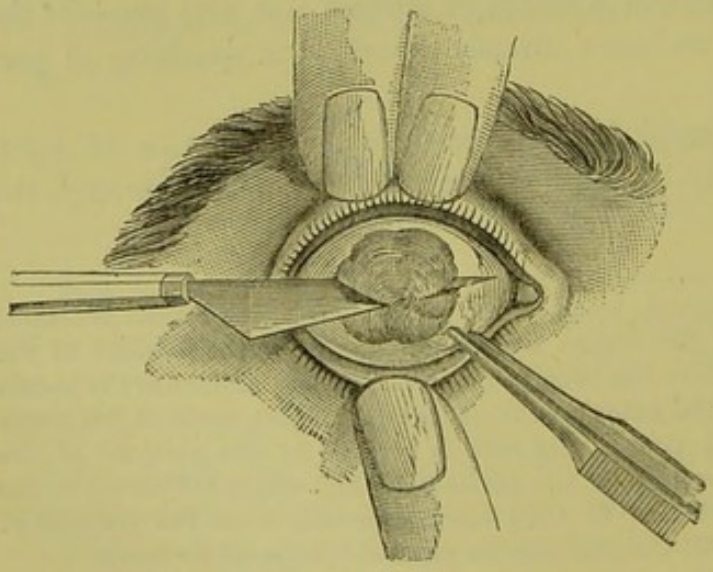


Fig. 44.—Incision of Staphyloma.

The aqueous humour, the lens if it is still present, and a portion of the vitreous humour escape at once by the opening. The compress

and bandage should be kept on till the flat corneal cicatrix is firmly formed; otherwise there is a risk of the ectasia recurring.

(*b.*) *Excision of the Staphyloma.*—Excision has for its object the removal of the staphyloma in whole or in part, and the formation of a resistant flat cicatrix. Complete excision is performed in the following manner:—The patient being placed on a couch and the lids properly separated, the surgeon transfixes the base of the staphyloma with a cataract or staphyloma knife, from without inwards, a little above the transverse diameter, with the blade of the knife turned upwards (Fig. 45). By pushing the knife onwards towards the nose, he detaches the superior half of the ectasia from its base; he then takes hold of it with toothed forceps, and finishes the excision with curved scissors.

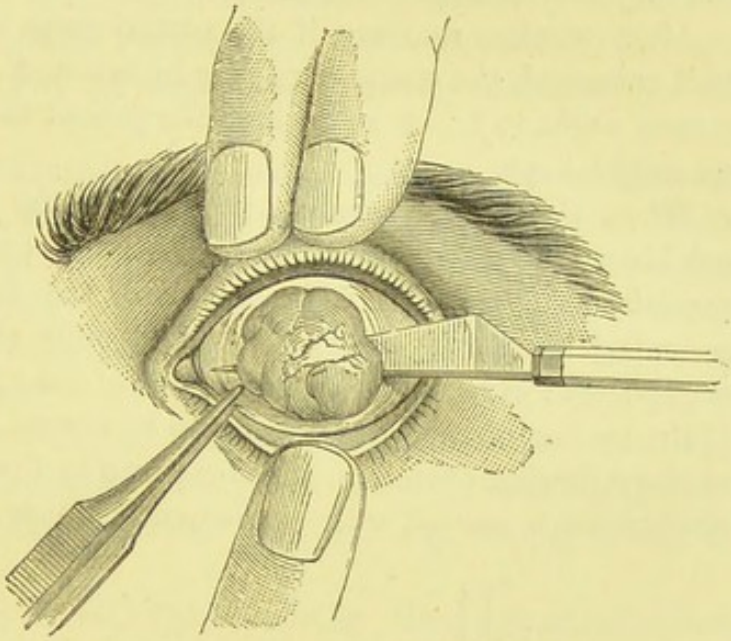


Fig. 45.—Excision of the Staphyloma.

If the lens is still *in situ*, and does not escape spontaneously, he must open the capsule so as to allow it to escape. After the operation a compress and bandage are applied.

There is generally little hæmorrhage at the time of operation, except in cases where the intraocular tension of the eye is perceptibly increased. But a few hours afterwards a considerable hæmorrhage may take place into the cavity of the eye, detaching the membranes and pushing them towards the wound. In such cases, suppuration of the eye and atrophy of the ball usually follow.

When the case progresses steadily towards recovery, the lips of the wound become covered with granulations and fleshy growths, and at the same time, the portion of the vitreous which occupied the opening assumes a greyish colour, and is reduced to a muco-purulent mass. By degrees the opening is closed in with cicatricial tissue, which, at first highly vascular, flattens down, and contracts into a whitish cicatrix.

In every case of total staphyloma entirely limited to the cornea, it is very advantageous to close the wound which remains after the excision with a few conjunctival sutures (*Knapp*). The operation is

then begun by detaching the conjunctiva from the margin of the cornea up to the equator of the eye. The mucous membrane thus detached is pierced by four sutures (made with different coloured threads). Two of them are turned over the bridge of the nose, and two over the temple, so as to leave the field free for operation. The staphyloma is then excised, according to the method described, and the conjunctival sutures are united.

After complete recovery, if the normal shape of the eye is tolerably well preserved, the conjunctiva may be tattooed at the place where the cornea ought to be, so as to save the patient the necessity of wearing an artificial eye.

When the ectasia involves not merely the cornea, but also the neighbouring parts of the sclerotic, the tension of the eyeball must be carefully examined. If it be increased, the danger of immediate or secondary hæmorrhage forces us to give up all idea of excising the staphyloma; evisceration or enucleation of the eyeball is then indicated. If the tension of the eyeball seems to be normal, we may have recourse to the following operation, which we owe to *Critchett*. The base of the staphyloma is pierced with semi-circular suture needles, threaded with

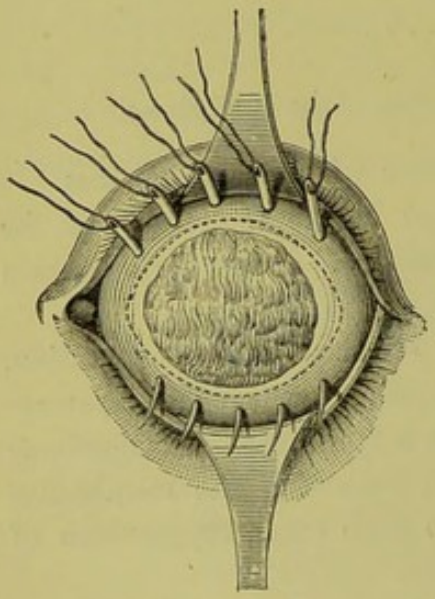


Fig. 46.

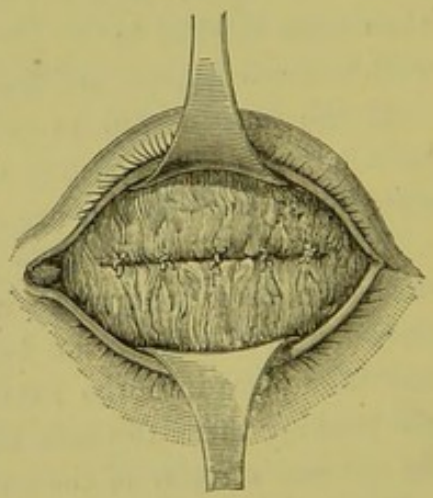


Fig. 47.

silk. These needles, to the number of four or five, according to the extent of the ectasia, should be inserted at equal distances and introduced into the eye from above downwards (Fig. 46). The needles being so placed that their two extremities pierce the sclerotic at equal distances from the margins of the staphyloma in front of the muscular insertions, the staphyloma is excised. A small horizontal incision is made from the insertion of the external rectus towards the nose, and then, with small probe-pointed scissors, two semi-elliptical flaps are

excised, always keeping at 2 millimetres from the points at which the needles are inserted.

Having thus excised the staphyloma, the needles are drawn through and the threads carefully tied, so as to bring the margins of the sclerotic wound into as close approximation as possible (Fig. 47). If the points of suture do not come away spontaneously, they may be removed as soon as cicatrisation is complete, generally after a few weeks. The stump which remains after this operation is sometimes angular, and there may be then some difficulty in fitting an artificial eye.

Partial excision of the staphyloma, which has special advantages when our patient is a child, may be done in the following manner:—With a cataract knife a flap is cut at the base of the staphyloma, care being taken to detach two-thirds of its periphery. The lens and a portion of the vitreous being expelled, the detached portion of the staphyloma is cut with a pair of curved scissors so as to leave a flap, which in form and size corresponds with the base of the staphyloma. This being done, the apex of the flap is attached to the corresponding point of the sclerotic. The suture separates spontaneously, leaving a flap and strong cicatrix.

In buphthalmic eyes, *von Graefe* advises that a partial atrophy should be obtained. This may be accomplished as follows:—A double silk thread is passed through the vitreous, so that a portion of the sclerotic, say about 10 or 12 millimetres, is enclosed in the ligature. It is well to introduce the thread parallel to the periphery of the cornea, and to avoid any thin portion of the membrane, in which our thread might encounter partial atrophy of the choroid, and which would, therefore, not afford suitable material for suppuration. The suture is tied, but not tightly; the ends are cut off near the knot, and an ordinary bandage is applied.

At the first symptom of panophthalmitis (chemosis, slight protrusion of the eye, and restriction of its movements), the thread is withdrawn and hot compresses applied.

In a fortnight or three weeks the stump loses its sensibility, and the atrophy is determined.

Enucleation of the Eye.—When the staphyloma is accompanied with intense ciliary pain, and when the eye is the seat of a low inflammation from which the other eye seems to suffer, it is better at once to enucleate the eyeball by *Bonnet's* method.

The patient having been placed on a couch, and some anæsthetic administered, the surgeon takes hold of a fold of conjunctiva near the cornea, above the insertion of the internal rectus muscle, and incises it with curved scissors; then introducing the scissors beneath the con-

junctiva, he frees the subjacent cellular tissue very completely. He next slips a strabismus hook beneath the muscular insertion, and cuts the tendon at a short distance from the sclerotic. Having done so, he continues to divide the conjunctiva, keeping near the cornea, till the next muscle is reached, which is detached from the sclerotic in a similar way, and so he proceeds till all the recti muscles are cut.

With a pair of strong forceps he then takes hold of the eyeball in the sclerotic by the tendinous extremity of the internal or external rectus muscle, which has purposely been cut somewhat long, and drawing the eye as far as possible forwards and to the side, introduces a pair of scissors, kept shut, along the eyeball till the optic nerve is reached, which he divides by a single cut (Fig. 48).

If the operator be standing behind the patient, he may prefer to divide the optic nerve of the right eye from the temporal side of the orbit, and that of the left from the nasal side.

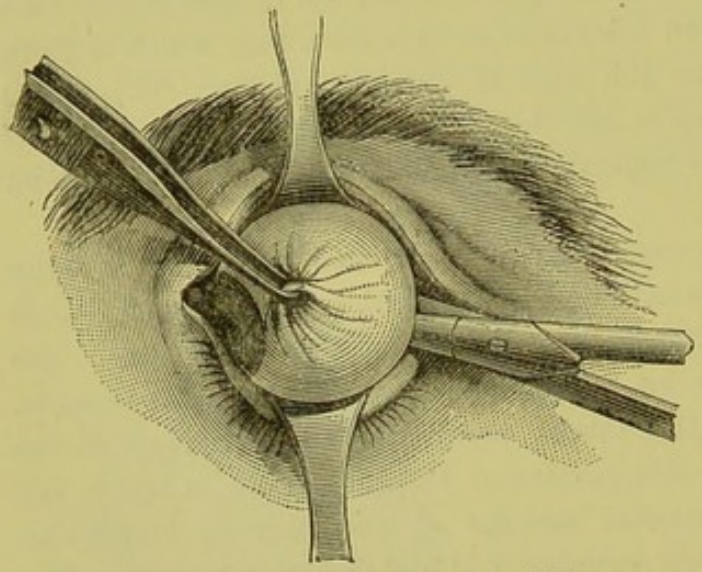


Fig 48.—Enucleation of Eyeball.

As soon as the optic nerve is divided, it is very easy to dislocate the eyeball and completely detach the oblique muscles. Some surgeons draw the edges of the conjunctival wound together with a suture drawn circularly through it, and tied like the strings of a purse.

The hæmorrhage in this operation is insignificant; we apply an antiseptic dressing (lotion of sublimate, iodoform in powder dusted over the wound), and a pressure bandage. Cicatrisation is generally completed in a few days.

Evisceration of the Eyeball.—In the place of enucleation and to prevent the danger of fatal meningitis, which has occurred exceptionally after this operation, evisceration of the eyeball has lately been performed, an operation that was first suggested by *Noyes*, and recommended as a general method by *Alfr. Graefe*. The conjunctiva has to be detached round the cornea at 1 or 2 millimetres distance from its margin. We then perform excision of the cornea with the narrow scleral ring that surrounds it, and with a small blunt-edged spoon we remove all the contents of the eyeball, leaving only the sclerotic. The slight hæmorrhage once arrested by a stream of iced sublimate solution, we dust iodoform in powder on the inner surface of the sclerotic,

draw the edges of the conjunctival wound together with catgut, and apply an antiseptic pressure bandage. We have several times seen very severe and lasting inflammatory reaction with great pain, but always an ultimately good result in a week or two, without any serious complication. The stump is indolent and well suited to an artificial eye. Nevertheless, we still prefer our classic enucleation with its simple and rapid healing, and consider it not more dangerous, provided we use the same antiseptic precautions.

ART. V.—Tumours of the Cornea.

Tumours of the cornea are very infrequent, and, when they do occur, almost always originate in the conjunctival limb, developing in the epithelium or extending to the cornea from a tumour in another portion of the eye. Moreover, the tissue proper of the cornea does not generally participate in the primitive alteration. In this situation cancers and melanotic tumours have been seen, which can only be treated by excision if they are somewhat circumscribed; if otherwise, by the enucleation of the eyeball. In speaking of tumours of the conjunctiva, we have already indicated the course and treatment of dermoid tumours situated partly on the cornea and partly on the conjunctiva (see p. 93).

ART. VI.—Lesions of the Cornea—Foreign Bodies.

The most frequent lesion of the cornea is that produced by the penetration of foreign bodies, as splinters of metal, glass, stone, wood, &c. They may penetrate no farther than the surface of the membrane, but may also bury themselves more or less deeply in its surface, or again pierce it and penetrate the deeper parts of the eye.

If a portion of the foreign body projects outwards, the friction of the lids causes great irritation, lachrymation, and very acute pain.

When the foreign body remains in the substance of the cornea, it causes a circumscribed suppuration, so that it may suppurate out of the cornea, anteriorly if situated superficially, or into the anterior chamber if it has gone deeper. Should we experience some difficulty in detecting the presence and exact seat of a foreign body we

must use focal illumination and a magnifying glass, the pupil being previously dilated, for the opaque foreign body is more easily detected against the red fundus of the eye.

When the foreign body has not gone farther than the cornea, and if we have succeeded in extracting it, the prognosis is absolutely good; if it has gone into the eye, the prognosis depends on the situation in which it may be lodged.

The extraction of foreign bodies from the eye has become very easy since the introduction of cocaine. When the patient is deficient in courage and does not hold his eye steady, it is, however, advisable to steady the eye at once with fixation forceps. As a rule, it suffices to hold the patient's head against the back of a chair and to separate the lids with the thumb and index finger of the left hand, and to steady the eye by making moderate pressure on it with the fingers holding the lids. When the foreign body is lodged in the anterior portion of the cornea, it can easily be removed with Daviel's curette.

If the splinter is iron or steel, we may try to remove it with a magnet. When the foreign body is strongly fastened in the substance of the cornea, the best method is to introduce a small gouge or cataract needle behind it, and remove it from behind forwards. If it already project into the anterior chamber, so that it cannot be taken hold of with forceps without a risk of pushing it still farther, it becomes necessary to enter the anterior chamber with an iridectomy knife, avoiding as far as possible any escape of aqueous. The flat of the knife is then brought behind the foreign body, and after it has thus been fixed, we can remove it with a cataract needle or fine forceps.

After the extraction we use iodoform in ointment or powder, and a pressure bandage is applied. If, notwithstanding these precautions, the foreign body should fall into the anterior chamber, we must wait till the aqueous humour re-accumulates. Then an incision, a few millimetres in length, is made at the margin of the cornea with an iridectomy knife. Sometimes the aqueous humour, whilst rapidly escaping, takes the foreign body along with it. If, however, it still remains in the eye, we may try at first the use of the magnet, and failing that, a pair of iridectomy forceps must be introduced into the anterior chamber, with which we take hold of the portion of iris on which the foreign body rests, and drawing it out of the eye, we excise it with curved scissors.

Wounds of the cornea are sometimes merely superficial abrasions, going no deeper than the epithelial layer, such as may be caused by scratches, contact with a branch of a tree, or very superficial burns, as from cigar ash. There is always very great irritation accompanied with lachrymation, ciliary pain and intense pericorneal injection. After

superficial burns of large extent, the alteration has a very startling appearance; but, nevertheless, admits of complete recovery without any cicatrix, especially in young patients. If the tissue of the cornea itself has been reached by a deeper burn, or by the action of some caustic, and if the inflammation is not arrested, it may be followed by suppuration with all its sequelæ.

We must, first of all, ascertain whether any portion of the foreign body remains on the cornea. We must check the inflammation by cold compresses, or if necessary by a few leeches applied to the temple; we must use atropine, apply iodoform in powder or ointment, and keep on a pressure bandage till the lost tissue has been replaced.

Injuries with a cutting instrument generally heal up rapidly, leaving at most a small opacity, if the wound be linear and has not been followed by prolapse of the iris.

The lesion is much more dangerous if the wound is irregular, if there is prolapsed iris, and if the instrument has entered the lens. In this last case, traumatic cataract will ensue, the danger of which varies with the age of the patient. If we do not succeed in reducing the hernia of the iris at once, by exciting contraction of the pupil by rubbing on the upper eyelid, or by using atropine and pilocarpine alternately, we must excise it with a small knife or pair of scissors.

We should then keep the eye at rest by a compress and bandage, continuing the instillation of myotics; and if the inflammatory reaction is very strong we must put some leeches on the temple, anoint the forehead with mercurial and belladonna ointment, and if necessary prescribe a purgative. The various complications—iritis, traumatic cataract, &c.—require special treatment, which shall be described when we speak of these affections.

ART. VII.—Congenital Anomalies of the Cornea.

1. A cornea too small in all its diameters is found only when the entire eye remains in a more or less rudimentary condition (microphthalmos).

2. In excessive development of the cornea, forming what is known as *congenital globular cornea*, the membrane seems to be more convex, because the anterior chamber is deeper. But, in reality, the radius of curvature of the cornea is more nearly that of the sclerotic.

The iris is enlarged, the pupil is dilated and sometimes displaced

inwards, upwards or downwards. The cornea is so large that the white of the eye is scarcely to be seen in the palpebral fissure. The transparency of the membrane is as a rule imperfect, and the vision is considerably injured, chiefly by complications of the choroid, opacities of the vitreous body, and excavation of the optic nerve. The cause of this affection is not precisely known. It has been ascribed to intra-uterine iridokeratitis, with increased ocular pressure (glaucoma), and diminished resistance of the cornea.

3. The sclerotic opacity, instead of stopping at the conjunctival ring, sometimes encroaches on the cornea, so that the centre is the only transparent portion of this membrane. (Sclerosis of the cornea, sclerophthalmia.) The rest of the eye may be normal. This condition must be attributed to an arrest of development, the cornea, up to a certain period of intra-uterine life, being as opaque as the sclerotic.

A congenital defect in the transparency of the cornea is also observed in the form of milky spots situated towards its centre, which at a later period disappear more or less completely. They are probably due to intra-uterine affections of the cornea, similar to those which are observed later, and which are the cause of opacities of this membrane.

4. We have also congenital dermoid tumours of the cornea, which have already been described along with the tumours of the conjunctiva (see p. 93).

DISEASES OF THE SCLEROTIC.

ART. I.—Scleritis and Episcleritis.

Formerly it was thought that the subconjunctival injection was localised in the sclerotic, and we distinguished, under the name of rheumatismal or gouty ophthalmia, the pericorneal hyperæmia, formed by a loop of very fine vessels, which radiated around the margin of the cornea. On the other hand, the possibility of a sclerotic inflammation was denied. We now know that the pericorneal injection is situated in front of the subconjunctival tissue, and that the sclerotic may also become the seat of an inflammation, although in the redness which accompanies this inflammation we may not be able to distinguish the isolated vessels.

The inflammation of the sclerotic, called **scleritis** or **episcleritis**, presents the following features:—A limited portion of the white of the eye, most frequently on the external side of the cornea, becomes of a reddish-violet colour, which, in the first stage, resembles an ecchymosis. This spot, whose colour depends on a hyperæmia of the sclerotic, covered by the semi-transparent conjunctival tissue, is accompanied later with a subconjunctival injection. In slight cases the patient does not suffer from any symptom of irritation, and the redness may disappear after a few weeks, usually to reappear in the neighbouring parts, and thus in time to extend right round the cornea.

In other cases the injected portion does not remain at the level of conjunctiva, but rises above it, either in the form of a large and red papule, or as a yellowish swelling on the red base formed by the spot. The disease then shows a great tendency to be complicated with opacities of the cornea, or the inflammation may extend to that membrane; or, from secondary compression of the ciliary nerves, there may be disturbance of the innervation of the cornea. In fact, that membrane loses its sensibility in the portions affected. It then becomes opaque, the opacity beginning at the margin next to the diseased sclerotic, and extending considerably towards the centre. In severe cases the patients complain of headache and of pressure in the eye; but vision is affected only when the disease is complicated by affections of the cornea, iris, or choroid.

Progress and Termination.—The disease always lasts several months, and may be of still longer duration if the affection attacks different points of the sclerotic. Generally after a few months the swelling falls, the injection becomes pale, and the affected part takes a

slate colour, due to the pigment deposited in the sclerotic tissue. The corneal opacities gradually disappear, and only occasionally become permanent.

Prognosis.—It is absolutely good as long as the scleritis is not complicated by other affections. We should warn the patient of the probably long duration of the disease, which our treatment as a rule does little to shorten.

Ætiology.—The cause of this affection is almost always rheumatic. It is often met in conjunction with rheumatic pains in other portions of the body. Again, it sometimes seems to depend on a scrofulous or even syphilitic diathesis (*Mooren*).

According to statistics, a third of the cases occur at the age of puberty or immediately thereafter. The disease is more frequent in women than in men; it affects them also at the period of the change in life, and then seems to be connected with anomalies of menstruation and general affections of the circulation.

Treatment.—As to local treatment, we have found that all astringents, such as nitrate of silver and red precipitate, are irritating, and therefore to be avoided. In recent years, massage through the eyelids (*Pagenstecher*) and multiple incisions in the affected part, extending even to the sclerotic (*Adamueck*), have been recommended. Calomel seems useful in cases of superficial injection.

Hot aromatic compresses, protection and subcutaneous injections of morphia sufficiently check the pain from which the patient suffers. We must advise rest for the eye, protection from the action of cold and moist air on the eyes and the head, especially during the night, and from variations in temperature. When the iris is complicated we must have recourse to atropine.

In most cases the ocular affection being dependent on a rheumatic diathesis, we may succeed in shortening its duration by keeping up active transpiration for a few hours twice or thrice weekly, and by the internal administration of iodide of potassium or of salicylate of soda.

The affections of the sclerotic, known under the name of *sclerotico-choroiditis anterior* and *sclerotico-choroiditis posterior*, or anterior and posterior staphyloma of the sclerotic, depend entirely on diseases of the ciliary body and choroid, and will be described along with these.

ART. II.—Lesions of the Sclerotic.

1. **Foreign bodies** which wound the sclerotic, but remain between the lips of the wound, may be at once removed with forceps, the wound being enlarged if necessary to admit of our so doing.

2. **Wounds of the sclerotic** are of importance only when there is simultaneous rupture of the choroid with escape of vitreous, or other serious complications, as intraocular hæmorrhage, detachment of the retina, &c. Simple wounds heal perfectly and easily; they only require a pressure bandage, and, if extensive, to be drawn together with a suture.

When the wound is near the cornea, there is almost always a prolapse of the iris, which should be excised and a bandage immediately applied. If there is a hernia of the vitreous humour in the wound, it may be touched with the mitigated nitrate of silver pencil, so as to hasten the cicatrisation (*Mooren*).

3. **Ruptures of the sclerotic** are more dangerous, not as regards the sclerotic itself, which heals perfectly, but because they are produced by severe contusions, which bring about more serious lesions of the eye. Ruptures always take place in the neighbourhood of the cornea, and cause prolapse of the iris and escape of the lens and of a portion of the vitreous, although sometimes the conjunctiva is not torn. Again, we may have as a result of such a contusion internal hæmorrhage, detachment of the retina, &c. In such cases the vision is much impaired, and the disease may end in panophthalmitis and atrophy of the eyeball. The prognosis, always grave, thus depends entirely on the nature of the lesions which accompany the rupture of the sclerotic. If it seem prudent to interfere, the conjunctiva must be incised above the spot where the rupture has taken place, the prolapsed iris should be snipped off, a bandage applied, and any consecutive inflammation checked by blood-letting. When the injury has involved the ciliary body, or if cyclitis be set up, danger to the other eye from sympathetic ophthalmitis may arise.

CHAPTER IV.

IRIS—CILIARY BODY—CHOROID.

Anatomy.—The second envelope surrounding the media of the eye is formed by the choroid, lining the sclerotic and continued in the ciliary body and iris. Indeed, embryologically and histologically considered, these three portions of the eye should be viewed as forming a single membrane, which has been called the *uvea* or *uveal tract.*

1. The **choroid** is situated between the sclerotic and retina, clearly separated from the latter membrane by an elastic layer. The choroid is united to the sclerotic only very loosely, except in the neighbourhood of the optic nerve, where the two membranes are very firmly joined (as will be described shortly). The choroid is composed of the following four layers :—

(*a.*) *The outermost layer,* which unites the choroid to the sclerotic (suprachoroidea), is composed of coarsely-meshed cellular tissue, mixed with elastic fibres, lymph corpuscles, oval nuclei which belong to the

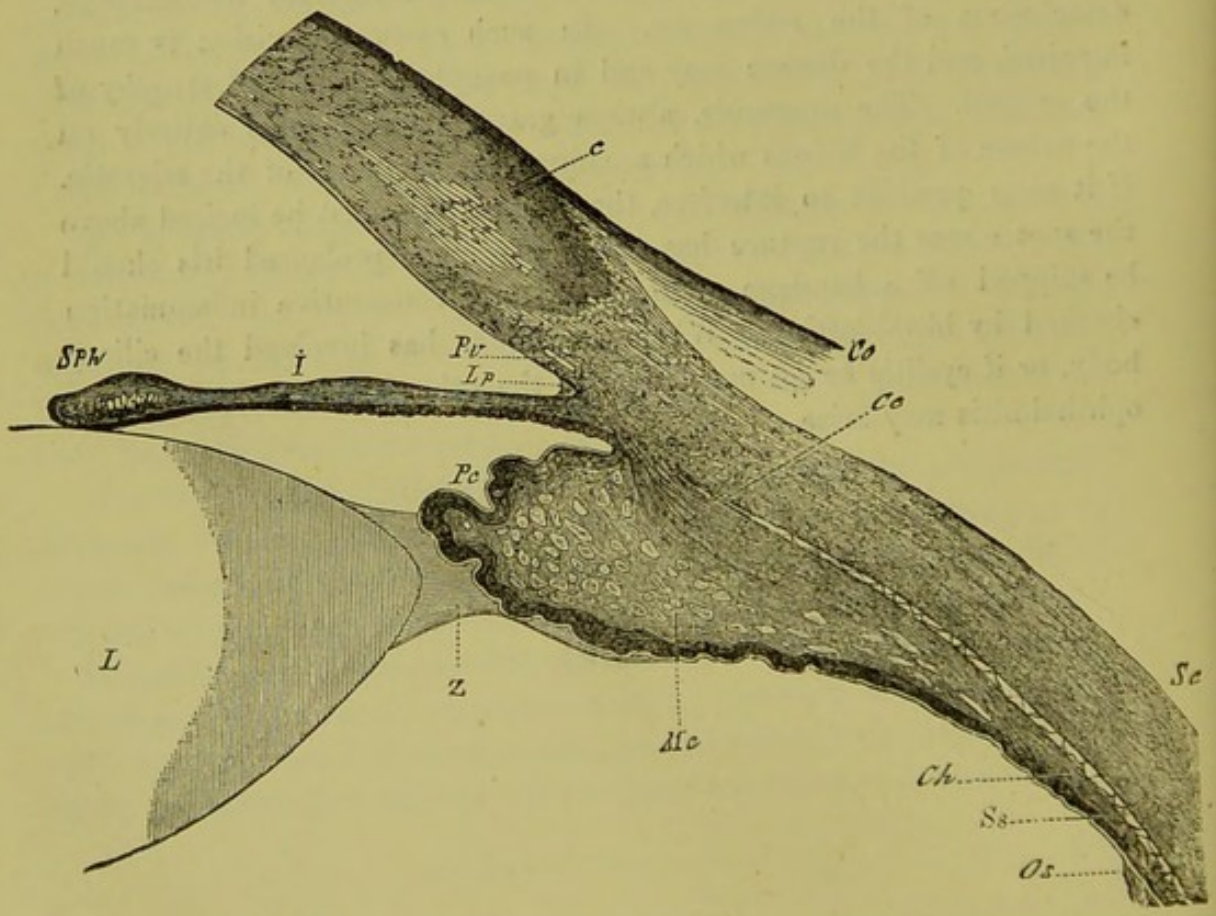


Fig. 49.—Theoretical Section of the Anterior Segment of the Eye (after *Merckel*). *C*, Cornea ; *Sc*, Sclerotic ; *Co*, Conjunctiva ; *I*, Iris ; *Sph*, Sphincter ; *Pv*, Venous plexus ; *Lp*, Ligamentum pectinatum ; *Pc*, Ciliary processes ; *Mc*, Ciliary muscle ; *Ch*, Choroid ; *Os*, Ora serrata ; *Z*, Zonule of Zinn ; *Ss*, Supra choroidal space ; *L*, Lens.

endothelium, and a great number of pigment cells, sometimes round, sometimes furnished with multiple prolongations, which anastomose with each other. The whole are united together by a very fine, homogeneous and perfectly structureless intercellular substance. This external layer of the choroid, the *lamina fusca* of the older authors, contains the vessels and nerves which supply the iris.

(*b.*) *The second layer* is that containing the large vessels of the choroid (*vascular layer*). The veins are situated to the outer side, the arteries to the inner, and they lie in a tissue analogous to that which forms the

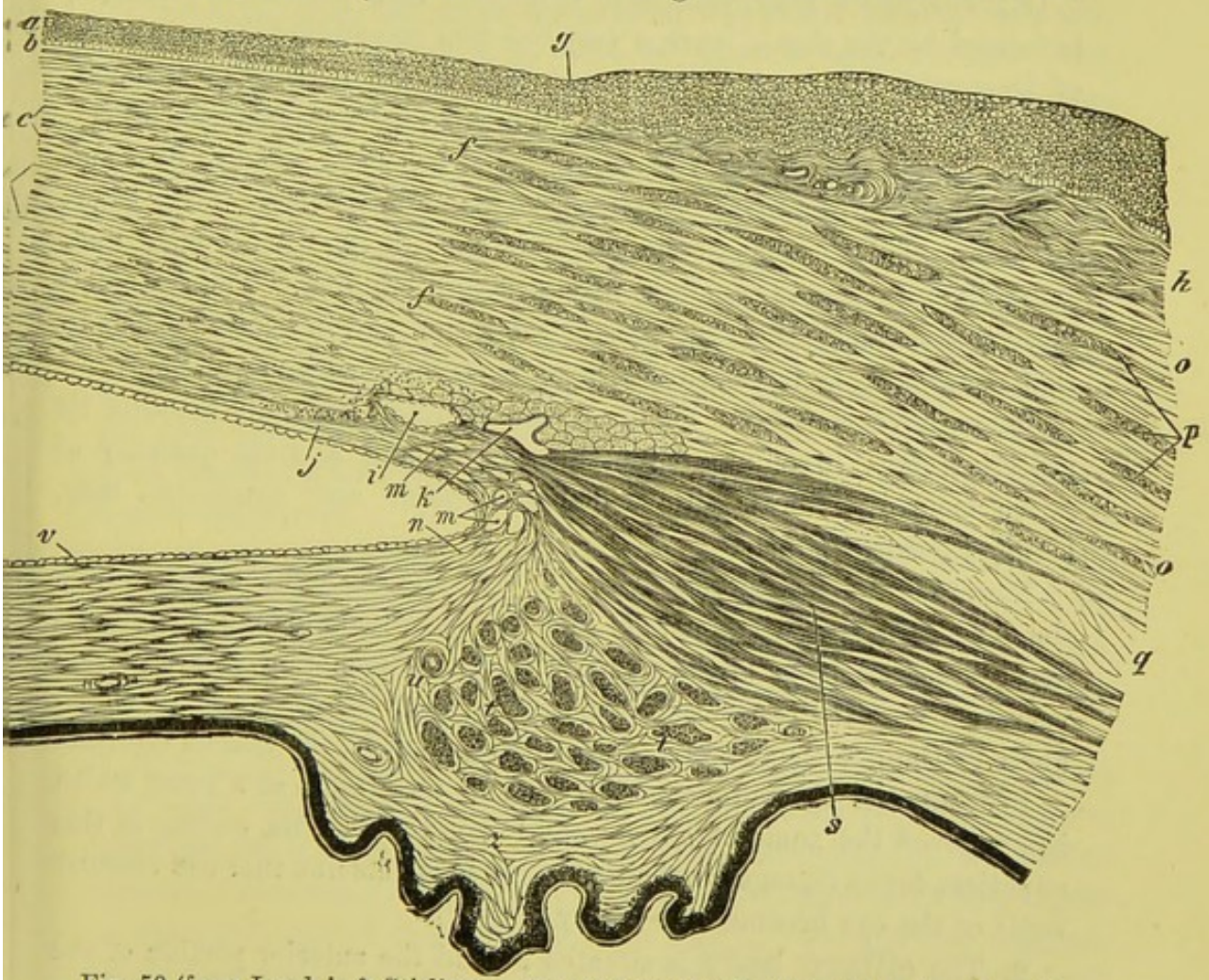


Fig. 50 (from Landois & Stirling).—Antero-posterior Section at the junction of the Cornea with the Sclerotic.

a, Anterior corneal, or conjunctival epithelium; *b*, Bowman's lamina; *c*, corneal corpuscles lying in the juice canals; *l*, corneal lamellæ (the whole thickness lying between *b* and *d* is the substantia propria corneæ); *d*, Descemet's membrane; *e*, epithelium covering it; *f*, junction of cornea with the sclerotic; *g*, limbus conjunctivæ; *h*, conjunctiva; *i*, canal of Schlemm; *k*, Leber's venous plexus (is regarded by Leber as belonging to *i*); *m*, *m*, meshes in the tissue of the lig. iridis pectinatum; *n*, attachment of the iris; *o*, longitudinal, *p*, circular (divided transversely) bundles of fibres of the sclerotic; *q*, perichoroideal space; *s*, meridional [radiating], *t*, equatorial (circular) bundles of the ciliary muscle; *u*, transverse section of a ciliary artery; *v*, epithelium of the iris (a continuation of that on the posterior surface of the cornea); *w*, substance of the iris; *x*, pigment of the iris; *z*, a ciliary process.

subjacent layer. The adventitious tunic of the vessels is very strong, and contains, according to *H. Müller*, involuntary muscular fibres. The pigment cells in this situation are less numerous, smaller, furnished with very short prolongations, and mixed with other non-pigmented cells. Beneath this layer is found—

(*c.*) *The layer of the capillaries*, united into a very close network, forms what is called the *chorio-capillaris* (*membrana Ruyschiana*). The capillaries are embedded in a homogeneous, structureless tissue.

(*d.*) *The fourth layer*, intimately connected with the chorio-capillaris, is formed by the elastic layer, a very fine film resembling the membrane of Descemet, but much thinner, and, like all the vitreous membranes, homogeneous, and without structure. It is provided, on its internal aspect, which touches the retina, with an epithelial layer composed of flattened cells very rich in pigment (tapetum). This pigment varies in intensity, but is especially present in the neighbourhood of the macula lutea, and, generally speaking, is abundant in newly-born children. The epithelial layer serves as a basis for the rods of the retina, and in reality belongs to that membrane, as has been shown by embryological investigations.

There have also been found in the choroid, especially towards its posterior part, involuntary muscular fibres and a great quantity of nerve elements, fibres with a double contour and ganglionic cells. (*Müller, Schweigger*).

Towards the posterior pole of the eye, the choroid terminates in a slender and narrow ring, cellular and elastic, which surrounds the optic nerve. As we have already said, the membrane is in this situation very firmly united to the sclerotic, and supplies a few fine and isolated fibres to the neurilemma of the optic nerve, and to the lamina cribrosa.

In front, the choroid properly so called terminates at a point which has received the name of *ora serrata*, because the retina, ending at this situation, forms zigzags denticulated. It is at this line that the vascular tunic of the eye becomes the ciliary body.

2. The **ciliary body** is situated behind the anterior portion of the sclerotic, and is composed of two parts; the one external, the *ciliary muscle;* the other internal, the *ciliary processes.* The latter, seventy or seventy-two in number, are generally parallel with the direction of the meridian, and are formed by folds of the choroid. They arise near to the ora serrata, and increase rapidly in height, extending to the neighbourhood of the equator of the lens, which they do not seem to touch. Having reached this situation, they abruptly curve towards the insertion of the iris, leaving a deep grove between them and the insertion of this membrane. The tissue of the ciliary processes is analogous to that of the choroid; it is composed of cellular tissue, which encloses a few masses of pigment and a great number of vessels.

The chorio-capillaris no longer exists in these organs; the elastic lamina is here changed into a paler tissue, less persistent and more difficult to detach from the subjacent layer, and presenting on its internal surface prominences and furrows, from which it has received the name of *reticulum*. Pigmentary epithelial cells are also found on the surface of the ciliary processes; there they are of irregular shape and very dark.

The external portion of the ciliary body which directly touches the sclerotic is formed by the ciliary muscle (tensor muscle of the choroid). Its unstriated fibres arise from the internal wall of the canal of Schlemm, by an insertion rendered more solid by some fibres which come from the membrane of Descemet (ligamentum pectinatum) and from the sclerotic. In this situation the fibres form a tendinous ring, which is strengthened by a layer of cellulo-elastic tissue. The muscular fibres follow different directions; the most external are parallel with the sclerotic, and become lost in the choroid; those of the innermost layer are circular; the intermediate fibres are directed towards the ciliary processes; so that the muscle, when viewed as a whole, is in the form of a triangle, of which the base is towards the ciliary processes, and the apex towards the canal of Schlemm. These smooth fibres form small bundles, which are separated from each other by cellular tissue, vessels and nerves.

3. The anterior portion of the uveal tract is formed by the **iris**. Its origin is at the junction of the sclerotic with the cornea; it arises from the internal wall of the canal of Schlemm, along with the ciliary muscle. From thence, this membrane is directed inwards, and is spread over the convexity of the lens.

It presents a ring of variable size, the opening in which is called the pupil. Its greatest thickness is very near the pupillary margin, although the margin itself is thin. We can distinguish, on its anterior surface, a somewhat irregular circular line concentric with the border of the pupil, and at about a millimetre from it. In this line originate other lines and bands, which are circular near the margin of the pupil, but radiating near the ciliary attachment. The position of the line corresponds to the small arterial circle of the iris.

The **colour** of the iris depends on the quantity of pigment enclosed in its tissue. When it contains little or no pigment, the iris appears by interference to be blue; whilst a dark shade of iris is caused by a great quantity of pigment being enclosed in the tissue proper. This is composed of cellular tissue, forming undulating fasciculi, which sometimes take a radiating direction, sometimes a circular. It encloses cells which may or may not contain pigment, and surrounds the very numerous vessels with which the iris is supplied.

The **muscles** of the iris are situated near its posterior surface. We distinguish near the margin of the pupil circular fibres concentric with the margin. These constitute the sphincter of the pupil. The dilator of the pupil is represented by a thin layer of straight and radiating fibres, which seem to arise near the ciliary ring, and are directed towards the sphincter, where, curving on themselves, they become lost in the circular fibres. The existence of a dilator muscle in the iris has been denied by several histologists.

The anterior surface of the iris is formed by a very thin endothelium, which covers a layer of anastomosing cells and lymphatics (*Michel*). Near to its ciliary insertion, we can distinguish elastic fibres which come from the ligamentum pectinatum of Descemet's membrane. The posterior surface is formed by a hyaloid elastic membrane, and is covered with a thick layer of pigment enclosed in round cells and of an amorphous intercellular substance. It is the continuation of the pigmented epithelial layer of the choroid which we have seen to pass over the ciliary processes, and which, likewise, covers the iris to the pupillary margin, in the neighbourhood of which it increases in thickness, and beyond which it sometimes extends, so that we then see the pupil to be bounded by a very dark border.

Circulation of the Choroid, Ciliary Body and Iris.—The following details of the circulation of the choroid and iris and ciliary body are those enunciated by *Leber*, whose researches have thrown new light on many points.

The structures which have just been described (choroid, ciliary body and iris) receive their **arterial blood** from the ciliary arteries, which are classed as posterior ciliary arteries (direct branches from the ophthalmic artery), and anterior ciliary arteries (arising from the arteries of the recti muscles). The short posterior ciliary arteries, about twenty in number, perforate the sclerotic near the entrance of the optic nerve. They divide dichotomously in the choroid, and distribute themselves rapidly over it till in the neighbourhood of the ora serrata.

Starting from their entrance into the choroid, they send branches to the capillary layer, in which, finally, all their ramifications are lost, with the exception of a few branches which pass the ora serrata to anastomose with branches of the anterior ciliary arteries and with the long posterior ciliary arteries. The direct transformation of these arteries into veins does not exist. The anterior portions of the choroid, situated beyond the ora serrata, receive their arterial blood from the long posterior ciliary arteries, and from the anterior ciliary arteries. Those arteries (long posterior ciliary), having pierced the sclerotic very obliquely near the optic nerve, follow a course in the external layer of the choroid (membrana supra choroidea), until they reach the ciliary

muscle, where they divide into two branches, which, diverging from each other, pierce the muscle, and, at its anterior border, assist in the formation of the great arterial circle of the iris.

The anterior ciliary arteries, five or six in number, reach the sclerotic by piercing the insertions of the recti muscles. On the sclerotic they are directed towards the margin of the cornea, and in their course send some branches into the interior of the eyeball. These branches perforate the sclerotic, and, in the ciliary muscle, unite with the long posterior ciliary arteries to form the great arterial circle of the iris, at the margin of the ciliary muscle, and a second arterial circle situated in the midst of the substance of the muscle itself. From these arterial circles arise:—(1) Arteries for the supply of the anterior part of the choroid, recurrent branches which anastomose with the short posterior ciliary arteries, and finally form the capillary system; (2) the arteries of the ciliary muscle — these are in the form of a very fine capillary network, the meshes of which run parallel with the muscular fibres of this structure; (3) the arteries of the ciliary processes—these pierce the ciliary muscle before reaching the processes, and divide into a great number of ramifications, which form anastomoses, and terminate in the

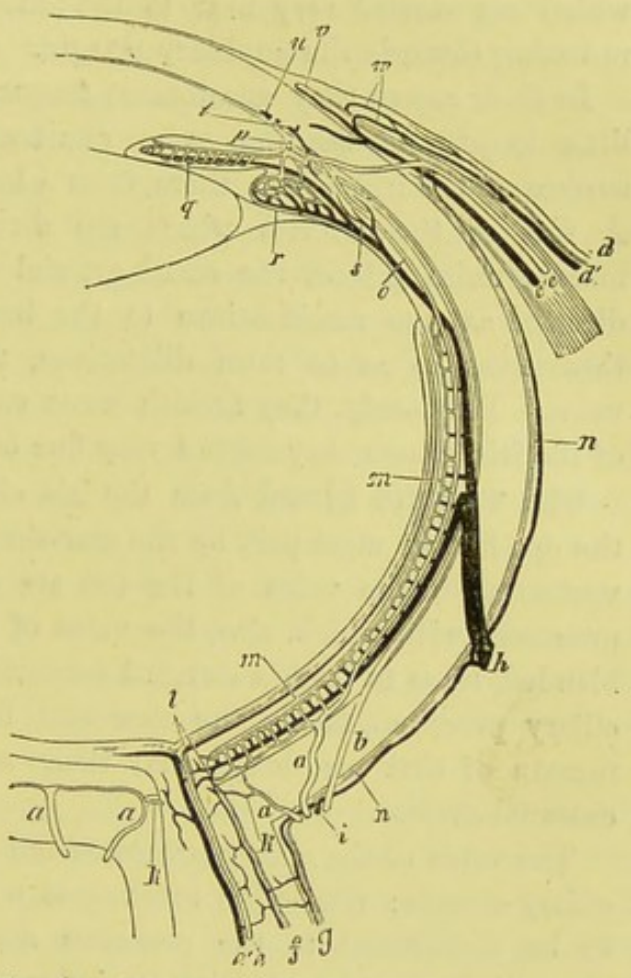


Fig. 51.—Diagrammatic representation of the blood-vessels of the eye, according to *Leber*.

Horizontal view, veins black, arteries light, and with a double contour—*a*, *a*, short posterior ciliary; *b*, long posterior ciliary; *c'*, *c*, anterior ciliary artery and vein; *d'*, *d*, artery and vein of the conjunctiva; *e'*, *e*, central artery and vein of retina; *f*, blood-vessels of the inner, and *g*, of the outer optic sheath; *h*, vorticose vein; *i*, posterior short ciliary vein confined to the sclerotic; *k*, branch of the posterior short ciliary artery to the optic nerve; *l*, anastomosis of the choroidal vessels with those of the optic; *m*, choriocapillaris; *n*, episcleral branches; *o*, recurrent choroidal artery; *p*, great circular artery of iris (transverse section); *q*, blood-vessels of the iris; *r*, ciliary process; *s*, branch of a vorticose vein from the ciliary muscle; *t*, branch of the anterior ciliary vein to the ciliary muscle; *u*, circular vein; *v*, marginal loops of vessels on the cornea; *w*, anterior artery and vein of the conjunctiva.

veins at the free margin of the processes, although, as yet, we are unable to decide whether they are transformed directly into veins or undergo the capillary transformation; (4) the arteries of the iris, which are carried very near to the anterior surface of the membrane, radiating towards the pupillary margin.

In their course they anastomose frequently with each other, forming little loops, and sending some ramifications towards the posterior surface of the iris, which there form a large meshed capillary system. A few of the arteries which are directed towards the pupillary margin unite to form the small arterial circle of the iris; others are directed as fine ramifications to the border itself, where, curving on themselves so as to form dilatations, they assume the character of veins. Previously, they furnish some small branches to the sphincter of the iris, where they form a very fine capillary network.

The **venous blood** from the iris, ciliary body and choroid, leaves the eye for the most part by the star-shaped veins of the choroid (vasa vorticosa). The veins of the iris are united to those of the ciliary processes, with which, also, the veins of the ciliary muscle are in part blended, so as to form a serrated network on the internal surface of the ciliary processes, facing the choroid. It is only when they reach the margin of that membrane that their veins dip so as to come to the external surface.

The veins of the ciliary processes and of the iris do not traverse the ciliary muscle; whilst the arteries, as we have already seen, pierce it, to be distributed to the processes and iris. Thus, contractions of the ciliary muscle exercise an influence only on the arterial circulation, and, during accommodation, the ciliary processes diminish in size, but become swollen when accommodation is at rest. After the veins of the iris and ciliary body have united in the choroid, they run from before backwards to the star-shaped veins, by which all the venous blood of the choroid leaves the eyeball. These star-shaped veins, situated near the equator of the eye, thus receive, in addition to the veins already mentioned, those of the anterior parts of the choroid, of which a certain number are united to the veins of the ciliary processes, and to those of the posterior part of the choroid. These last are situated between the short ciliary arteries, so that these vessels exercise a mutual pressure on each other, from which it may be presumed that they regulate the supply of blood in these parts. Thus, the stream of blood following the same direction from before backwards, in both the arteries and the veins, the distension of the arteries will accelerate, by consecutive compression, the circulation in the veins, whilst the distension of these latter will retard the current of blood in the arteries.

All the veins of the choroid thus converge from different points, and terminate in a branch which perforates the sclerotic. It is by this arrangement that the star-shaped veins are formed; of these we generally find four or six, which anastomose by tolerably large branches.

A portion of the venous blood from the ciliary muscle leaves the eyeball by another route than that which we have just described. A dozen or fourteen small veins perforate the sclerotic near the margin of the muscle, and, while dividing so as to anastomose, run towards the ciliary venous plexus (canal of Schlemm), with which a large proportion are incorporated, whilst a few join the anterior ciliary veins of the subconjunctival tissue. From the canal of Schlemm, several veins, having previously perforated the sclerotic, go towards the margin of the cornea; others spread out in the venous episcleral network.

There are thus two ways by which the venous blood from the iris, ciliary body and choroid is brought to the surface; a posterior passage by the star-shaped veins, which is much the larger, and an anterior passage, which has just been described. In the case of hyperæmia, or of intraocular pressure, such as to compromise the star-shaped veins at the point where they pierce the sclerotic, the blood by preference takes the anterior passage, and we then see an increase in number and size of the anterior ciliary veins.

The **nerves** of the choroid, ciliary body and iris come from the ophthalmic ganglion, and from the naso-ciliary nerve. Arising from the ganglion, ten to twenty nerves (short ciliary nerves), having perforated the sclerotic near the optic nerve, enter the choroid; there they supply the nerve elements which we have already described, or run between choroid and sclerotic to the ciliary body. The nerves coming from the naso-ciliary (long ciliary nerves) perforate the sclerotic near the insertion of the superior oblique muscle. They go to the ciliary muscle, where they divide and anastomose with the short ciliary nerves. It is from this network that the nerves of the iris come, which follow almost the same course as the vessels; their mode of termination is not exactly known.

ART. I.—Hyperæmia of the Iris.

The first symptom which hyperæmia of the iris produces is congestion of the episcleral tissue, the vessels of which are, as we have seen, closely connected with those of the iris. Hence, we find a more or less intense pericorneal injection. Another symptom consists in the impaired effect of atropine on the contraction of the pupil; it dilates it, but with

difficulty, and for a shorter time than in a normal eye. If we find this condition, we must make sure that it does not depend on an affection of the cornea preventing or retarding the action of the remedy, or on the presence of adhesions of the pupillary margin (posterior synechia).

The third symptom of hyperæmia of the iris consists in a change in the coloration of this membrane, due to the circumstance that a yellowish-red tint is added to its natural colour. Thus a blue iris becomes slightly yellowish; a brown iris takes on a rose tint. This discoloration is so much the more apparent in simple hyperæmia of the iris, that the aqueous humour preserves its transparency, and that the tissue composing the membrane is not the seat of exudations as in iritis. In cases of very chronic hyperæmia (for example, after the operation for solution of cataract), the change of coloration of the iris depends also on alterations of the pigmentary cells of the iris stroma, accompanied with atrophy of the pigment which forms the extreme margin of the pupil, the contour of which thus loses its regularity and appears dentated. Advancing years also produce an analogous alteration, and cause the iris to lose its usual brilliancy, without any symptom of inflammation.

Hyperæmia of the iris passes off with the removal of the exciting cause, without leaving any trace; or it may lead to iritis, either spontaneous or secondary to an irritating course of treatment—as, for example, the use of a nitrate of silver lotion.

Ætiology.—Hyperæmia of the iris always precedes and accompanies inflammation of this membrane. It is also found in hyperæmic or inflammatory affections of the structures in vascular connection with the iris. Thus hyperæmia of the iris is formed as a consequence of excessive and prolonged efforts of vision, and in inflammations of the anterior parts of the choroid and ciliary body. It is also observed in ulcerative or traumatic affections of the cornea, and in inflammations of the conjunctiva, acute granulations, and phlyctenular ophthalmia, especially if these affections have been carelessly treated with irritants.

Our **treatment** ought to be directed to the cause of the hyperæmia, as well as to the local congestion. We should recommend absolute rest for the eyes and the avoidance of everything which is likely to increase the congestion; for example, a too brilliant light and general congestions to the head. We should also recommend the prolonged use of atropine or duboisine, so as to give complete rest to the internal muscles of the eye.

ART. II.—Iritis.

Inflammation of the iris adds to the symptoms of hyperæmia already described that of the production of an exudation. This exudation may be formed :—

(*a.*) At the margin of the pupil and on the posterior surface of the iris, where it is very apt to produce adhesions between the iris and the capsule of the lens (posterior synechia).

(*b.*) On the anterior surface of the iris, in the aqueous humour and on the membrane of Descemet.

On the anterior surface of the iris, it assumes the form of a very thin fibrinous structure, which destroys the brilliancy of the membrane, giving to it the appearance of an unpolished surface; it also often extends to the pupillary field. In the aqueous humour, it produces either general haziness, or flocculi, or small floating membranes, which may gravitate to the bottom of the anterior chamber (hypopyon).

Finally, this exudation may affect the membrane of Descemet, there forming a slight cloud or punctate deposits.

(*c.*) In the parenchyma of the iris itself, increasing the volume of the membrane or producing pupillary excrescences.

We shall have to distinguish several forms of iritis—Simple or plastic iritis, serous iritis, parenchymatous iritis, and, as a special form of this last variety, syphilitic iritis.

A. Simple or Plastic Iritis.

The pericorneal injection in this form is more or less pronounced according to the intensity of the inflammation. In severe cases, it is even accompanied with œdema of the subconjunctival tissue, producing a chemosis, which to some extent masks the injection around the cornea. The aqueous is somewhat muddy; the iris itself is more or less deficient in brilliancy and changed in colour; and the pupil, generally contracted, is perfectly immobile, or excessively sluggish in its movements.

When the affection has already led to the formation of adhesions between the margin of the pupil and the lens, the outline of the pupil is irregular; or, if at first sight it seems normal, its irregularities become apparent by focal illumination or by using atropine. By this remedy the as yet feeble adhesions are often at once torn asunder, and the pupil then regains its circular form.

In such cases we often see the debris of these synechiæ and of the pigment of the iris on the capsule, where they indicate the position of the adhesions. Again, deposits of exudation, varying in their size and in their form, may exist in the pupillary field itself. In other cases,

the synechiæ resist the action of atropine, which then only dilates those portions of the iris which are still non-adherent, and this irregular dilatation may cause the pupil to assume the most varying forms.

These adhesions are sometimes limited, sometimes large, isolated and more or less numerous; or the margin of the pupil may adhere to the capsule throughout its entire extent. To this condition the term *complete* or *annular synechia* has been applied.

When at the same time the exudation completely fills the pupillary field, it produces occlusion or obliteration of the pupil.

B. Serous Iritis.

Instead of the plastic exudation, which characterises simple iritis, we observe here a hypersecretion of the aqueous humour, which is at the same time muddy, and which precipitates deposits of variable size and form on the posterior surface of the cornea and on the capsule of the lens. The pericorneal injection is often very slight, and the appearance of the iris is apparently changed by the haziness of the aqueous and of the cornea.

The anterior chamber is deeper, the intraocular pressure increases, and, in consequence of the disturbance of the nerves thus produced, the pupil is semi-dilated, and remains nearly immobile. In slight cases, the haziness of the aqueous humour and Descemet's membrane is often so inconsiderable that it is discovered only on very careful examination. We then find a general cloudiness produced by the suspension of solid particles in the aqueous humour, or, in more pronounced cases, flakes which float in the humour, and gravitate to the bottom of the anterior chamber. This haziness disappears if we permit the deposit to escape by paracentesis.

The posterior surface of the cornea presents a slight general opacity, intermingled with greyish points, varying from a very fine point to the size of a pin head, or even larger. The alterations of the membrane of Descemet, which, in addition to these deposits, may consist in modifications of its epithelial layer, are frequently accompanied with opacities of the vitreous (*Irido-choroiditis*).

The deposits on the membrane of Descemet, and on the capsule of the lens, were formerly considered as the origin of the disease. It was believed that the disease consisted in inflammation of a hyaloid membrane which was thought to line the anterior and posterior chambers as a serous sac connected with the envelope of the vitreous. This disease was then called *Aquo-capsulitis*, *Hydromeningitis*, *Descemetitis*.

C. Parenchymatous Iritis.

In this variety of iritis the inflammation and exudation affect the elements of the tissue composing the membrane, which increases in thickness either throughout its entire extent or partially.

Thus we have a swelling and a hypergenesis of the cellular elements, in addition to which there is a disturbance of the circulation, followed by the appearance of tortuous vessels on the anterior surface of the membrane. This swelling is further increased by a plastic or purulent effusion in the parenchyma, at the margin or on the surfaces of the iris. These exudations unite the pupillary margin to the capsule, in the form of pigmented synechiæ, rendering the pupil immobile. The space which separates the posterior surface of the lens from the iris, as also the pupillary field, is filled with greyish or yellowish material; effusion into the anterior chamber likewise takes place, and can give rise to an extensive hypopyon.

The aspect of the anterior surface of the iris varies according as the disease is general or more definitely localised. It always appears tarnished, discoloured and swollen, with isolated pigment spots due to the hypergenesis of the cells of the stroma. But in the first case this appearance is general; in the second it is seen near the free border or in the continuity of the membrane, either as deeply-coloured papilliform excrescences, or as small yellowish tubercles surrounded with vessels. These nodosities rise above the level of the iris, and are insensibly lost in its tissue.

This condition of the iris is accompanied, especially in the primary stages of a severe case, with a well-marked pericorneal injection, with conjunctival congestion and with chemosis. The lids even may participate in the irritation, especially the superior eyelid, which becomes red, shining and œdematous.

D. Syphilitic Iritis.

Syphilitic iritis may present itself in the form of any of the varieties of iritis which we have just described. Nevertheless, there exists a form of partial parenchymatous iritis, which is very often met apart from any specific manifestation, but yet so frequently in conjunction with constitutional syphilis, that it may be considered as characteristic of this diathesis.

In syphilitic iritis only a small portion of the membrane changes its colour, becomes swollen and vascular, and takes on a red, yellowish or brownish tint. This small tumour, of variable dimensions, extends sometimes considerably beyond the level of the iris, and resembles in its structure a gummatous tumour in its early stage. Several may be observed at the same time. They rarely undergo a fatty or purulent degeneration; in most cases they disappear as do the nodosities of parenchymatous iritis, generally by absorption, and the tissue of the iritis atrophies at the affected spots. In this variety of partial iritis the pericorneal injection also appears most quickly towards

the portion of the corneal margin which is nearest to the seat of the alteration.

In the different forms of iritis which have just been described, the subjective sensations, such as pain, photophobia, disturbance of vision, &c., are present with very variable intensity.

Pain is sometimes entirely absent; it is, as a rule, more acute in parenchymatous and simple iritis than in the serous form, and probably arises from compression of the ciliary nerves by the hyperæmic tissue or by the exudation. Thus in slight cases there is often only a sensation of heat and of heaviness in the eye; in other cases the patients complain of lancinating pains in the suborbital region, in the forehead, and in the parts supplied by the contiguous branches of the fifth pair.

The pain, as a rule, increases towards the evening and during the night, so as entirely to deprive the patient of sleep. The lachrymation and photophobia vary with the intensity of the ciliary pain, without ever being so pronounced as in keratitis.

Disturbance of the vision depends essentially on the affection of the aqueous humour and on the effusions which are formed in the pupillary field. Therefore, when we find a greater diminution of the acuteness of vision than is accounted for by these alterations, or defects in the pupillary field, our attention should be directed to the complications which so frequently occur in certain forms of iritis (choroiditis and opacities of the vitreous body).

When the invasion of iritis is very acute, in a feeble or irritable subject, it may be accompanied by a general febrile reaction, by gastric disturbance, and even by vomiting.

Progress and Termination.—When iritis follows an acute course, it soon attains its maximum intensity, and imperceptibly disappears at the end of three or four weeks. The pericorneal injection grows pale, the conjunctiva becomes white, the pupil is dilated, regaining its circular form, and the effect of atropine is increasingly strong. The exudations are absorbed, and the iris assumes its normal condition.

Traces of synechiæ are sometimes seen to remain on the capsule of the lens, as small pigmentary spots, which even after the lapse of years indicate the existence of a previous iritis. Notwithstanding this complete cure, there remains for a certain time a great liability to relapse, especially if the muscles of the iris have not been kept at rest by the prolonged use of atropine.

This favourable course of iritis may take from a few weeks to a few months. Serous iritis, although more chronic, often passes off without leaving any trace; simple iritis much more frequently causes synechiæ, which do not yield readily to treatment; parenchymatous iritis, if it

be developed in conjunction with or after a simple iritis, rarely admits of perfect repair of the affected tissue.

In a second series of cases the iritis is cured; but posterior synechiæ have been formed, which are too strong to yield to the action of atropine. If they are not numerous and isolated, they may exist without any serious consequences; but these adhesions often exercise a most baneful influence on the eye, because they produce incessant dragging of the membrane, during the movements to which the iris is constantly subjected by the action of light and of accommodation; they thus disturb the circulation and innervation. This danger is so much the greater in proportion as the synechiæ are large and numerous. Indeed, they explain the frequency of relapses, which formerly were by common consent ascribed exclusively to a general diathesis. In each of these new attacks, the disease becomes worse, because the synechiæ already existing hinder the action of the atropine, and because additional synechiæ are formed each time, thus rendering the communication between the anterior and posterior chambers of the eye more and more difficult, a communication which is essential to the equilibrium of the intraocular pressure and to the normal nutrition of the media of the eye. Again, when a complete posterior synechia is formed, with or without the obliteration of the pupil, this communication is entirely stopped; the aqueous humour and liquids secreted behind the iris push that membrane forwards towards the cornea, and, as it is retained at its pupillary margin by adhesion to the capsule, the peripheral portions of the membrane alone can yield to this pressure; hence the iris assumes a funnel-shaped appearance.

In these cases, the inflammation spreads to the ciliary processes and to the choroid, the tension of the eye increases, and glaucomatous symptoms are produced (hardness of the eyeball, venous congestion, anæsthesia of the cornea, characteristic retraction of the visual field). Later, the iris and choroid atrophy, the hypersecretion ceases, the eyeball gradually softens, and at the same time a calcareous cataract is formed. We shall have to revert in greater detail to this complication to which the name *irido-choroiditis* has been given, and which often takes the inverse order, that is to say, beginning with an affection of the choroid, the disease extends to the iris.

In a certain number of cases iritis assumes an essentially chronic form; here the inflammatory symptoms are greatly in abeyance, only the pupil is seen to be sluggish in its movements and sometimes slightly contracted; and, when examined by focal illumination, or after using atropine, isolated adhesions to the capsule are seen to exist. From time to time there is slight muddiness of the aqueous humour, and by small degrees the iris loses its bright reflection, becomes dis-

coloured and grows thinner, and the tissue gradually atrophies. Often, in the course of this chronic form, an acute exacerbation, with characteristic symptoms, supervenes.

Prognosis.—The gravity of this disease depends on the cause of the iritis, and on the alterations which it has already produced in the eye. If we get the disease in its early stage before the formation of synechiæ, or if these still yield to the action of atropine, the prognosis is absolutely good; it becomes serious with the existence of numerous adhesions which resist the action of mydriatic. It is on this account that the chances of cure are much greater in simple or serous iritis as compared with parenchymatous or suppurative. Again, the prognosis must take account of the various complications which may arise in the other membranes of the eye; and, in traumatic iritis, of the simultaneous existence of other lesions.

Ætiology.—Iritis may be observed as a consequence of any of the causes which produce a prolonged congestion of the scleral tissue—*e.g.*, the presence of foreign bodies for a long time in the conjunctival sac, or the imprudent and prolonged application of caustics. It may also be produced in consequence of persistent irritation of the iris itself, as by foreign bodies, by portions of the lens exercising pressure on it, by the dragging which results from anterior or posterior synechiæ. Again, the inflammation, after having its origin in the cornea, may be communicated to the iris, especially if the deep layers of this membrane are the seat of disease, or it may arise from inflammation of the anterior portions of the choroid. As a special cause there should be noted the sympathetic influence which an eye, injured in the region of the ciliary body, exercises over its fellow. In this last case there may be developed an ophthalmia, so called sympathetic, which sometimes begins with the iris.

Idiopathic iritis occurs seldom in elderly people, it chiefly attacks children before the age of adolescence. It has been observed in consequence of menstrual irregularity, and chronic diseases of the uterus and its appendages.

Amongst the diatheses which produce iritis, syphilis is the most important—almost three-fourths of the persons affected with iritis show syphilitic symptoms—besides, iritic symptoms in early life have been attributed to congenital syphilis. As to the rheumatic diathesis, it is true that iritis often results from exposure to cold, and is accompanied with rheumatic pains in other portions of the body; but it would be inaccurate to say that this variety of the disease has any special form. Undoubtedly, tubercles may appear in the iris before any other symptom of general tuberculosis, but generally the effects of tuberculous and cancerous dyscrasiæ are only felt in the iris after they

have attacked other organs. The same remark holds true for metastatic or embolic iritis, observed in the course of septicæmia, after puerperal fever, suppurating wounds, &c.

Treatment.—The first indication to be fulfilled in inflammation of the iris is to prevent the continual functional use of the muscles of this membrane, which contract incessantly under the influence of light and of accommodation. Our object is best attained by using atropine, or duboisine, which, in addition, by dilating the pupil, have the advantage of preventing the formation of posterior synechiæ, and of assisting the intraocular circulation.

Mydriatics thus diminish the hyperæmia of the internal structures of the eye, and act favourably on the tension of the globe. We must use, in the early stages of iritis, a concentrated ointment or solution (2 or 4 grains to ʒi of water or vaseline) as an instillation two or three times a day, six drops in the course of half an hour (putting in one drop every five minutes). This method of using the remedy is preferable to instillations continued throughout the day, which, by the passing but often-repeated irritation consequent on the application of the remedy, deprive the eye of the necessary rest. In the majority of cases, this remedy, if pure and carefully prepared, is very well borne by the eye; yet it sometimes causes considerable irritation of the conjunctiva (see p. 84). We must, then, substitute duboisine in similar doses, or, if this remedy be not better supported by the conjunctiva, cocaine, hyoscyamine, or a carefully filtered lotion consisting of—

Extract of belladonna, ...	gr. 15
Distilled water, ...	♏ 150

It is absolutely necessary to dilate the pupil, and it is only when this object has been attained that we may diminish the frequency of the instillations and employ a less concentrated solution, but still a sufficiently strong one to maintain the dilatation.

Along with the mydriatics, we should recommend hot poultices kept on the eye for two hours at a time, and repeated four times a day. We may replace the poultices by hot lotions made with an infusion of camomile, of belladonna, or of laurel water (1 : 15 distilled water).

The use of atropine and absolute rest for the eye, which must be protected from too strong a light and from cold, are indispensable, whatever may be the form of iritis with which we are dealing. At the same time, it is well to prohibit all heating food.

When we see that the inflammatory symptoms are very acute, and especially if we find pronounced ciliary pain which persists in spite of the employment of atropine, it is beneficial to apply a few leeches to the temple in the evening (the number varying according to the consti-

tution of the patient and the intensity of the inflammation), to incise, if necessary, the chemosis, and to rub the forehead with mercurial and belladonna ointment.

In addition, it is necessary to procure sufficient rest for patients deprived of sleep, by subcutaneous injection of morphia, or by the administration of chloral.

In cases of serous iritis the use of atropine has seemed to determine, in persons predisposed to glaucomatous attacks, an acute exacerbation of the disease; it must therefore, in such cases, be used with care. When the pain seems to depend on the hyper-secretion of the aqueous humour, otherwise implicated, and on the tension of the eye, great advantage may be derived from paracentesis of the anterior chamber, which, if performed with the requisite precautions, may be repeated several times without danger to the cornea, and with great benefit as far as the disease is concerned. It is also in this variety of the disease, if it be prolonged, or if there have been relapses, that we must act on the bowels by repeated saline purgatives, and on the secretions of the kidneys and skin by the acetate of potash and by subcutaneous injection of pilocarpine, or hot sarsaparilla drinks taken in the morning while in bed, so as to cause a few hours diaphoresis. Again, we must, if the general health of the patient permit of it, establish counter-irritation by cutaneous derivatives, such as vesicants to the neck, issues, and even a seton.

It must not be forgotten that this affection, if accompanied by a serous choroiditis, may assume a glaucomatous character, and if we observe its distinctive symptoms (hardness of the eyeball, contraction of the visual field, venous congestion, anæsthesia of the cornea), we are forced to perform iridectomy.

The presence of a plastic exudation furnishes an indication for mercurial preparations; if the amount of exudation be not great, it suffices to prescribe a small dose of calomel ($\frac{1}{6}$ or $\frac{1}{3}$ grain) taken every two hours, and inunction of the forehead with mercurial and belladonna ointment. According to the quantity and rapidity of the exudation, the mercurial treatment must be more or less active.

When plastic iritis takes the character of parenchymatous iritis, or if the disease assumes this form at first, being accompanied with violent inflammatory symptoms and with the rapid production of a great quantity of exudation, it is better to use at once $\frac{3}{4}$ grain doses of calomel every two hours, and inunctions with 15 to 45 grains of mercurial ointment, repeated several times a day with the usual precautions to avoid salivation. During this treatment the patient should be confined to bed, or at least to his room, so as to avoid sudden variations of temperature.

Under the influence of this treatment we often see plastic exudations softened and gradually absorbed.

If the disease is the effect of syphilis, this treatment must be followed by the administration of bichloride and opium pills, or by proto-iodide of mercury, combined with iodide of potassium. In rheumatic iritis we have to employ salicylate of sodium or iodide of potassium.

In every case of iritis, when, notwithstanding the therapeutic agents, complete posterior synechia is formed, with or without occlusion of the pupil, we must have recourse to iridectomy. This operation has also been recommended whenever there is a well-marked hypopyon. But in this case paracentesis of the anterior chamber, made with a small linear section knife at the junction of the sclerotic with the cornea, near its inferior margin, is sufficient to relieve the anterior chamber of its contents, which may be again very speedily renewed and necessitate repetition of the paracentesis.

It is often useful to employ hot compresses in such cases, which also seem to be very beneficial for the inflammatory symptoms of parenchymatous iritis, as they aid in the absorption of nodosities and gummatous tumours of the membrane. When a gummatous tumour is developed to a great size, a portion of the iris so affected may be advantageously excised.

In traumatic iritis, caused by the presence of a foreign body in the anterior chamber, our treatment should begin by removing it according to the rules already laid down (p. 142), and the secondary inflammation of the iris must be treated according to its nature and intensity. When the inflammation arises from the swelling of a traumatic cataract, we must, under all circumstances, extract the cataract by the linear method.

In cases of prolapsed iris, caused by a perforating wound of the cornea, we must carefully excise the portion which projects beyond the level of the cornea, use atropine, put on a compress and bandage, and, if the inflammatory condition of the eye requires it, apply a few leeches to the temple.

Iritis supervening after the extraction of cataract may have various causes. It requires a special treatment according to its form, and according as it results, either indirectly from an inflammatory condition of the wound, from injury of the membrane during the operation, or from the action of cortical pieces remaining in the eye, or again from some individual condition of the person operated on (anæmia and senile marasmus). In the great majority of cases, antiphlogistic treatment is undoubtedly prejudicial. A well-fitting compress and bandage, hot compresses, atropine, mercurial treatment, and a strengthening and tonic diet should be resorted to, according to special indications which

we shall explain in the chapter on accidents following the operation for cataract.

The treatment of sympathetic iritis will be indicated when we come to consider the sympathetic affections of the eye.

After recovery from iritis, we must take precautions against relapses by using atropine continuously for a few weeks longer, even although a cure has been effected without leaving any synechiæ.

If such exist, we must try first of all to destroy them by instillations of atropine and of pilocarpine. In cases where we do not succeed, relapses, and perhaps the ultimate loss of the eye, can be avoided only by performing the operation of corelysis or of iridectomy. This last operation is always indicated in cases of complete posterior synechia; and in such cases surgical interference should not be abandoned or delayed.

Moreover, in all cases of iritis where the cause is not some passing influence, the constitution of the patient should be studied, so as to prevent relapses by administration of appropriate remedies. Besides the special indications furnished by the presence of a diathesis, menstrual affections, &c., we should recommend the regular application of counter irritants to the skin, such as dry cupping at the nape of the neck or mustard to the limbs, freeing of the urinary secretion by diuretics, *e.g.*, mineral waters, and that of the skin by diaphoretics. All these remedies, combined with a moderate diet, are of utility in preventing relapses, in retarding the spread of the chronic inflammation to the surrounding parts endangered, and often in arresting the progress of this disease so destructive to vision.

ART. III.—Wounds of the Iris.

Wounds of the iris are caused by the penetration of a foreign body, or a sharp-pointed or cutting instrument; or, again, by general contusion of the eye. In the first case, the body implanted in the iris may become encysted by effusion of plastic lymph, and may remain for a long time in the parenchyma without exciting inflammation. But in the great majority of cases, it is followed by an immediate and continuous irritation, which may give rise to a suppurative inflammation. It is then necessary to extract the foreign body, either directly, or by excising the portion of iris which envelopes it.

In searching for its situation, we may be guided by the cicatrix of the wound of the cornea, by which the foreign body entered the eye, and which is not always easily found without a careful examination by focal illumination. Again, the pericorneal injection is often greatest

near the part of the corneal margin which corresponds to the position of the body in the iris.

Punctured wounds, incisions, and rents in the structure of the iris are almost always accompanied by escape of blood into the anterior chamber, which may make the examination of the affected parts exceedingly difficult.

The wound may be a simple fissure in the iris, or a loss of substance more or less considerable, rupture of the adherent border, or a rent in the pupillary border only.

This last kind of injury, which, from the lesion of the sphincter of the iris, produces great dilatation, is less frequent than rupture of the ciliary margin (irido-dialysis). It is very easily recognised, especially when we use an ophthalmoscopic mirror. A second peripheral pupil is formed, which to ordinary inspection appears black, and through which the fundus of the eye may be illumined as by the normal pupil. Similar cases have been recorded in which there was even monocular diplopia.

A simple lesion of the iris alone is not followed by serious symptoms; it often passes off, like incisions or excisions of a portion of the iris in operations, with scarcely a symptom of irritation. At other times, the signs of inflammation are very slight, and yield to the use of atropine, moderate antiphlogistic treatment, and a compress and bandage.

Yet a serious inflammation of the iris, complicated by an affection of the ciliary body, may be the result, especially in cases of extensive rupture of the ciliary margin. It is, however, rare that the lens is not injured at the same time as the iris by such serious wounds. It may be dislocated or its capsule opened, in which case we have a traumatic cataract, with more or less swelling of the cortical substance. The iris, exposed to the danger of contact with these masses when they fall into the anterior chamber, or to prolonged pressure, may become the seat of a more or less serious inflammation. We are therefore obliged to extract the lens immediately, making also, in the majority of cases, an iridectomy.

When the wound in the cornea by which the instrument has entered the iris is irregular, there may be a prolapse of the iris in it. Attempts at reduction of these herniæ of the iris are almost always unsuccessful, and are specially dangerous, from the irritation which they produce. It is better at once carefully to excise the portions of the iris which project into the wound.

Changes in the iris, produced by general contusion of the eye, may be confined to a simple paralytic dilatation of the pupil (mydriasis), or we may find tremulous iris when the violence of the blow has caused dislocation of the lens. At other times, we may find the iris torn away

from the ciliary body (irido-dialysis), with escape of blood into the anterior chamber. These contusions may be followed by glaucomatous tension, which requires eserine, paracentesis of the anterior chamber, or iridectomy.

As a curious and exceedingly rare result of such injuries, there has been observed the inversion backwards of the pupillary margin; in which case the iris is driven backwards, and a variable portion of it thus becomes invisible in its entire extent. At the same time, the lens is generally moved from its normal position. In violent contusions, other portions of the eye are also more or less affected (rupture of the choroid, separation of the retina, escape of blood into the vitreous body), and the safety of the eye is endangered by other lesions than that of the iris. Inflammations of this membrane which follow injury should be treated by antiphlogistic remedies, according to the rules already laid down.

ART. IV.—Tumours of the Iris.

Tumours of the iris are infrequent. CYSTS, on focal illumination, appear as round semi-transparent tumours, which increase more or less slowly in size. The signs of irritation which accompany them (pericorneal injection, lachrymation, ciliary pain) are sometimes very acute, at other times they are entirely absent. Cysts are found in consequence of wounds where a hair has penetrated into the anterior chamber, and it seems probable that in these cases the development of the cyst is intimately connected with the presence of epidermis cells near the root of the hair (*Schweigger*). When they give rise to pain or other inconvenience by their size, they have to be removed along with the piece of iris in which they are situated; recurrence is frequent. Cases of TUBERCULOUS and more rarely LIPOMATOUS, PIGMENTED tumours have been noted, as also TELEANGIECTIC tumours of the iris. Condylomata and gummatous tumours have been described with parenchymatous and syphilitic iritis.

As to SARCOMA, it has been observed in the iris most frequently as an extension of the disease from other structures of the eye, generally from the choroid, yet MELANOTIC tumours have also been seen originating in the iris in the form of a red or yellowish pigmented neoplasm, which soon fills the anterior chamber and produces ulceration and perforation of the cornea. At other times the tumour penetrates beyond the circumference of the cornea, and extends into the episcleral tissue. In any such case, whenever we have arrived at a sure diagnosis, we must enucleate the eyeball.

ART. V.—Functional Diseases of the Iris.

Movements of the iris are either dilatation or contraction of the pupil; it is contracted (*a*) under the influence of light; (*b*) when the vision is adapted for near objects; (*c*) when the internal rectus contracts; (*d*) on irritating the sensory branches of the fifth pair, especially those which supply the eye. Again, the pupil of one eye, even of a blind eye, contracts when that of the other eye contracts from any of the specified causes. It is, therefore, necessary to examine the pupillary movements of each eye separately, whilst the other eye is kept shut.

The affections of the mobility which we shall have to describe here are characterised by permanent dilatation (*mydriasis*) or contraction (*myosis*) of the pupil, or by the rapid succession of contraction and dilatation, known under the name of *hippus*.

1. Mydriasis.

The dilatation of the pupil varies in degree and is sometimes irregular. When the mydriasis is very marked, the pupil, instead of remaining black, has a greyish appearance, due to the reflection in the lens of the greater quantity of light which enters the eye.

The difficulties of vision which ensue in great part depend on the dazzling produced by the too great quantity of light which enters the eye; they consequently disappear as soon as the patient looks through a small circular stenopaic opening (Fig. 52). Sometimes they are caused by the simultaneous paralysis of accommodation, for paralysis of the ciliary muscle often accompanies that of the sphincter of the iris. We can satisfy ourselves that the difficulty in vision proceeds from defective accommodation by using biconvex glasses, which cause it to disappear.

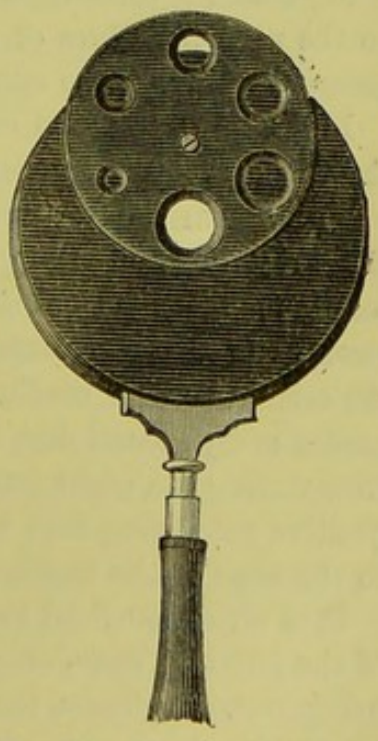


Fig. 52.—Circular Stenopaic Openings.

The details of these symptoms vary with the state of the refraction of the affected eye; they will be explained along with the anomalies of refraction and accommodation.

Mydriasis is present often in one eye only; nevertheless, it is very annoying to the patient, because the retinal image of the affected eye differs in intensity of illumination from that of the other eye.

According to the cause which has produced it, mydriasis comes on more or less rapidly; sometimes it disappears spontaneously, at other times under the influence of treatment; but it may return, and even persist throughout life.

The **prognosis** also depends on the cause; it is perfectly favourable when our treatment can reach the exciting cause, or when it is not a nervous symptom indicating the presence of a serious lesion. The prognosis is very serious when the mydriasis is a symptom of organic disease of the nervous centres.

Functional affections of the muscles of the iris may be **caused**—1, by a more or less complete paralysis of the third pair, of rheumatic, syphilitic or central origin; 2, by irritation acting on the great sympathetic; for instance, in spinal diseases, in telminthiasis, hypochondria, hysteria, as a forerunner of certain forms of monomania, and, though not constantly, in irritable persons, after frights, gastric disturbances, &c.

Mydriasis is also often observed in the course of cerebral affections, such as encephalitis, meningitis, hydrocephalus, &c.

In absolute amaurosis, the dilatation of the pupil is due to insensibility of the retina to light. It has also been seen to persist after excessive use of atropine where the iris has become atrophied.

Mydriasis of one eye is caused by contusion of the eyeball, syphilis of old date, madness (general paralysis), and has been observed also in patients who were afterwards found to have cerebral or spinal disease.

Mydriasis is sometimes due to the direct action of a swollen cataract on the muscular fibres of the iris, or again to an increase of intraocular pressure acting on the ciliary nerves (glaucoma).

In the last-mentioned case, the mydriasis may affect only a portion of the pupillary margin, when a few ciliary branches alone are injured.

Treatment.—We must ascertain the cause, and if it lies outside the eye, use appropriate remedies. Locally, contraction of the pupil may be obtained by instillations of pilocarpine or of eserine of the strength of 5 centigrammes to 10 grammes of water (1 to 200). At the same time, the continuous current should be employed for a short period every second day, or a weak current may be employed for a long time during the night (one or two cells of Trouvé or of Leclanché; the positive pole being kept to the eyelids by a bandage, the other applied to the nape of the neck).

It is often beneficial to arouse indirectly the action of the sphincter of the pupil by exercising the vision on near objects, and by regularly using convex glasses, the choice and use of which will be explained along with the treatment of paralysis of the accommodation.

Cases in which the mydriasis has been cured by administration of

mercurials and of iodide of potassium are explained by the existence of a syphilitic or rheumatic diathesis as the primary cause of the paralysis of the third pair, and demand a close examination of the general condition of each patient.

2. Myosis.

Myosis consists in the contraction of the pupil, which may be reduced to the size of a pinhead; less light then enters the eye, the retinal images are less brilliant, and thus vision is impaired, especially in the evening. The presence of myosis has little effect on the extent of the visual field; consequently, by itself, it does not cause much disturbance of vision. When that exists, it should be attributed to other concomitant alterations.

The **causes** of this affection may be ranged into two classes—those which cause spasmodic contraction of the sphincter of the iris, and those which produce paralysis of the fibres of the dilating muscle. To the first class of causes, we must assign myosis resulting from the continual application of the eyes over very fine and brilliant objects (this form is apt to occur amongst jewellers, watchmakers, engravers). To this class we must also refer the myosis produced by the reflex action which the sensory branches of the fifth pair exercise on the common motor oculi, which explains the sluggish pupil in ciliary neuralgias, when a foreign body or other irritating influence acts on the cornea or conjunctival sac. Lastly, central irritation of the third pair may cause spasm of the sphincter (meningitis in its early stage, congestion of the encephalon from alcoholic excess, opium, nicotine, &c.)

Pilocarpine and eserine, by an influence directly opposite to that of atropine, produce myosis by their effect on the nerves of the iris.

Myosis due to a paralysis of the dilating fibres indicates an alteration in the sympathetic—as, for example, in the form of spinal amaurosis, which accompanies locomotor ataxy. In this affection, the diameter of the contracted pupils does not vary with illumination, but continues to be modified with convergence and the accommodation (*Robertson*). Myosis has also been seen to follow compression of the cervical sympathetic, from a tumour or an aneurism.

The **treatment** of myosis should vary with its cause, which, as we have just seen, is often at a considerable distance from the eye. As local treatment, we should mention the use of atropine; but the effect of this remedy only lasts for a short time, and it should be considered as a rational remedy only for spasm of the sphincter of the iris, for which it should be employed systematically.

3. Hippus.

Hippus is characterised by incessant changes in the size of the pupil, which contracts and dilates successively, and independently of such physiological causes as light, accommodation, &c. It is observed during recovery from paralysis of the third pair (analogous to the irregular contractions of other muscles during the regressive period of paralysis), as a consequence of albinism, and most frequently as an accompaniment of the chronic convulsions of the extrinsic muscles of the eye, known as *nystagmus*.

The **trembling of the iris** (tremulous iris, iridodoncrosis) is purely a passive movement of the membrane, produced during the movements of the eyeball whenever the iris has lost its natural support —viz., the anterior convexity of the lens. This trembling may also be seen to affect a portion of the iris only, in cases of partial dislocation of the lens. Most frequently this phenomenon supervenes after the extraction of cataract, after complete displacement of the lens, either from its falling down, or from injury. Again we find it when the lens has perceptibly diminished in volume, by partial absorption (in cataracts more than ripe, or after operations by discission).

It is also seen in cases of anterior hydrophthalmia, when the iris is drawn forwards by the distension of the anterior portion of the eye, and separated from the lens by a layer of fluid.

Contrary to the hitherto generally received opinion, we do not think that fluidity of the vitreous alone can produce tremulous iris, for with the ophthalmoscope we have seen many cases of complete liquefaction of the vitreous, where there was no movement of either the lens or iris from before backwards.

ART. VI.—Congenital Anomalies of the Iris.

1. **Colour.**—Various anomalies in the *colour* of the iris are seen, in the iris of one eye not being of the same shade as that of the other, without there being the least disturbance of vision. We must take care not to confound this condition with the discoloration produced by iritis. Again, the iris may not be of the same colour throughout, and the difference of shade may be confined to a section of the membrane or to the small circle. Besides, we may notice pigmentary spots on

the iris, varying in number, in size, and in their generally very dark colour. All these peculiarities are without pathological importance.

2. **Irregularity in Form of Pupil.**—Another variety of congenital anomaly consists in *irregularity in the form of the pupil*, which is often nearly oval. In many cases also the position of the pupil is markedly eccentric. Moreover, in most eyes the centre of the pupil is not situated exactly behind the cornea, but rather to the inner side, at the point corresponding to the visual axis of the eyeball, and in such cases the displacement of the pupil may pass unobserved. But the pupil may be situated very far from the centre (*ectopia*), in which case it is separated from the adherent border of the iris only by a narrow band of that membrane. The lens may also be similarly displaced. Ectopia is often found in both eyes symmetrically and in several members of the same family.

3. **Multiplicity of Pupils** (*polycoria*) is very rare. The abnormal pupils may be in the neighbourhood of the normal pupil, separated the one from the other by narrow bands of iris tissue (probably in connection with persistence of the pupillary membrane). At other times there is a complementary opening near the ciliary margin (most likely due to a congenital irido-dialysis), in which case the margins of the pupil are not free. As a rule, there is no difficulty of vision arising from this anomaly, which may, however, cause diplopia.

4. **Persistence of the Pupillary Membrane** is less infrequent; it is usually incomplete, in so far as only a greater or smaller number of fibres are seen, arising from the anterior surface of the iris, and crossing the pupil; or they unite to form a pigmented membrane in front of the capsule.

They do not at all impede the normal action of the pupil, and afford the luminous rays a passage sufficiently great to prevent any alteration in vision.

5. In **Coloboma of the Iris** we have a fissure of the membrane almost invariably directed downwards and inwards. It may extend across the whole iris (complete coloboma), or stop short at a certain distance from the ciliary margin (incomplete coloboma). In the latter case (Fig. 53), the margins of the coloboma sometimes contract with the pupil, although they do so more slowly.

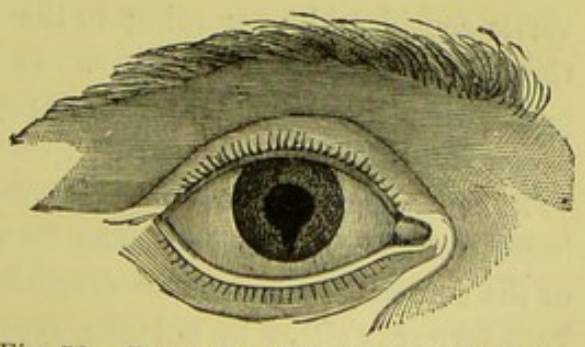


Fig. 53.—Incomplete Coloboma of the Iris.

The fissure of the iris often extends to the ciliary body and choroid. Sometimes, in connection

with a coloboma of the iris, we find microphthalmia, congenital cataract, and other fissures which should have closed during intra-uterine life (coloboma of the eyelids, hare-lip, cleft palate, &c.) Coloboma of the iris may be found in one or in both eyes; it has been often noticed in several members of the same family.

When the iris alone is affected, vision is almost always normal; cases of amblyopia occur along with the complications which we have mentioned.

Coloboma is due to an arrest of development of the eyeball.

6. **Absence of the Iris** (*Trideremia* or *Aniridia*) may be complete or incomplete. If the latter, we find irregular portions of iris tissue, of variable size, absent; or the small circle only may be wanting, which gives the appearance of a pupil dilated with atropine.

When there is complete absence of the iris, the lens can be seen in its entire extent, and the eye has a strange aspect. If cataract supervene, vision may be sufficiently good, in consequence of light passing between the margin of the lens and the ciliary body.

In general, the patients suffer only from dazzling, and any greater disturbance of vision depends rather on complications (buphthalmos, cataract, microphthalmia, &c.)

When the ciliary muscle is also absent, accommodation is impossible.

Absence of the iris has been observed in both eyes, and seems to be hereditary in some families; it also is due to an arrest of development in the eyeball. In cases of dazzling, we may advantageously prescribe smoked glasses and stenopaic spectacles.

ART. VII.—Anomalies in the Form and Contents of the Anterior Chamber.

1. Even in the normal state, the **depth** of the anterior chamber varies considerably, according to the age of the person and the condition of the refraction of the eye. It is shallower in infants and in old people than in adults, deeper in myopic eyes, in which the eyeball is elongated, than in hypermetropic.

In consequence of pathological conditions, the anterior chamber may become *shallower* or *deeper*. The first modification is due to flattening of the cornea (consequent on cicatricial contraction) or on the iris being kept forwards either by anterior synechiæ or by exudations accumulating behind an iris affected with complete posterior synechia. The peripheral part of the anterior chamber may be deeper than the central,

when fibrous bands bind the great circle of the iris to the ciliary processes. Again, the anterior chamber is greatly diminished in depth when there is an increase of the intraocular pressure (glaucoma) pushing the lens forwards towards the cornea, or when the lens itself, increasing in size by the softening of its substance, pushes the iris nearer the cornea.

The anterior chamber increases in depth in cases of staphyloma of the cornea, or by the distension of the anterior portion of the eyeball (hydrophthalmia), or again when the lens is displaced in the eye or removed from it.

2. The **contents of the anterior chamber** may be mixed with blood, with pus, with foreign bodies, with lens tumours, cysticercus, &c.

Effusion of blood into the anterior chamber has been called **hyperæmia.** When the anterior chamber is entirely filled, we perceive a more or less deep uniformly red reflection which hides the iris. If the effusion only occupies a portion of the chamber, we may displace its usually horizontal level, by moving the head, so long as the blood is liquid. Above the blood, we see a layer of aqueous humour of a rose colour. The portion of the iris which remains visible seems at first to be of its normal colour, later it becomes discoloured, as in hyperæmia. The pupil is sometimes dilated by the pressure which the blood exercises on the iris.

The disturbance of vision, always very great when the anterior chamber is filled with blood, depends in partial effusions on the amount of difficulty with which the light still penetrates the eye, and on the causes to which the effusion is due.

It is due in most cases to injury, contusion of the eye, or detachment of the iris from wounds or operation. It is, as a rule, quickly absorbed, and without any other treatment than the application of a compress and bandage. But we also observe persistent hæmorrhages, or hæmorrhages which are renewed several times during a fortnight, the clot which closes the torn vessel of the iris being always again detached by the action of the aqueous humour. We can then recognise the recent effusions by the fresh appearance of the blood, whilst the absorption leaves on the iris very dark coloured red spots.

When the quantity of blood effused is very great, and is acting on the iris like a foreign body, producing symptoms of irritation (pericorneal injection, ciliary pain, &c.), we are obliged to remove it from the anterior chamber by performing paracentesis at the lower margin of the cornea. But this small operation requires great care, as the withdrawal of pressure may cause fresh hæmorrhage, arising from the vessels torn in the primitive lesion. The contents of the anterior

chamber should be allowed to escape very slowly; whilst slight digital pressure is made on the eyeball through the superior eyelid.

This pressure should be maintained by a tight bandage, applied immediately after the evacuation of the anterior chamber. It may be gradually slackened after a quarter of an hour, but the pressure should be continued by the application of an ordinary bandage for several days.

A second cause of effusion of blood is certain internal inflammations of the eye, such as chronic choroido-iritis, with occlusion of the pupil and commencing atrophy of the eyeball. In these cases, the hæmorrhage may return, and is with difficulty absorbed. Here, while paracentesis is useless, a bandage promotes absorption; but our treatment should be directed to the deeper disease of the eye.

We must also notice isolated cases of spontaneous effusion of blood, due to disturbance of the general circulation, connected with dysmenorrhœa, purpura hæmorrhagica, &c., and, again, those curious instances of patients who at will can produce an effusion of blood into the anterior chamber (*Weber*, *Mooren*).

The effusion of *plastic lymph* or of *pus* into the anterior chamber, termed **hypopyon,** is most frequently connected with affections of the cornea (three times out of every four), or of the iris, or of the ciliary body.

We have already described the symptoms and peculiarities of this affection, when speaking of suppurative keratitis and iritis. It only constitutes a symptom, consequently its treatment is closely connected with that of the affection to which it is due.

Portions of the lens may fall into the anterior chamber, in consequence of rupture of the lens capsule by operation or by injury. Cases have also been recorded where the complete lens, loosened from its attachment by rupture of the suspensory ligament, has, on dilatation of the pupil, fallen into the anterior chamber. (See dislocation of the lens.) In the majority of cases, the portions of lenticular matter are rapidly absorbed, and do not cause any injury. It suffices to keep the pupil dilated by atropine. If the entire lens has fallen into the anterior chamber, it must sometimes be removed by an incision made in the periphery of the cornea.

Foreign bodies may enter the anterior chamber through the cornea; their influence on the iris and the method of extracting them have already been explained *apropos* of the cornea and iris (see p. 142).

Cysticercus has been seen in the anterior chamber, and more than twenty cases have been published. In general, the first symptoms are those of a circumscribed iritis, then a white spot makes its appearance, and increases in size till the parasite pierces the membrane and floats in the aqueous, or is attached to a portion of the iris.

The anterior chamber then encloses a small semi-transparent, yellowish vesicle, endowed with undulating movements, and projecting from time to time a small filament, the extremity of which is furnished with an enlargement, representing the head and neck of the cysticercus (Fig. 54). The presence of this foreign body often produces a disturbance of the aqueous, and symptoms of iritis, which necessitate its removal by a linear incision in the periphery of the cornea. If the removal of the cysticercus be followed by prolapse of the iris, which ordinary manipulation does not reduce, it is better to exise the prolapsed portion.

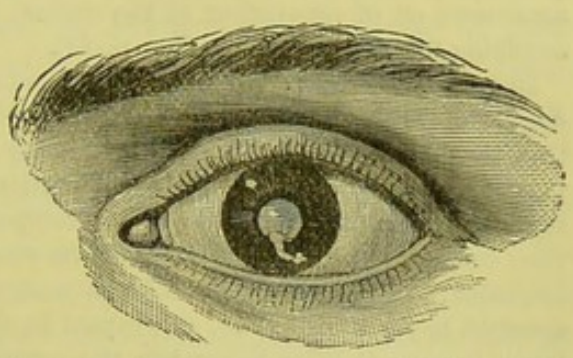


Fig. 54.—Cysticercus in Anterior Chamber.

ART. VIII.—Operations on the Iris.

1. Iridectomy.

Indications.—Iridectomy is performed for a double purpose; sometimes to form an artificial pupil, sometimes in certain inflammatory conditions of the membranes of the eye as an antiphlogistic agent.

For *optical purposes*, iridectomy is resorted to in the following circumstances:—

1. In central opacity of the cornea;
2. In occlusion of the normal pupil;
3. In stationary central capsular cataract;
4. In zonular cataract or other stationary central cataracts;
5. In certain cases of dislocation of the lens.

As an *antiphlogistic*, iridectomy is performed—

1. For glaucomatous affections;
2. In a certain class of affections of the cornea;
3. In cases of iritis or irido-choroiditis accompanied with adhesion of the iris;
4. For complete posterior synechia, or for multiple and large synechiæ, which are not broken up by atropine.

Before making an artificial pupil we should always examine the state of the vision, so as to be sure that its impairment is entirely due to the opacities which are seen on direct inspection. For this purpose the pupil must be dilated with atropine, and the visual acuteness measured by test types; we must also employ

stenopaic slits and glasses adapted to the state of the patient's refraction and accommodation. When we are dealing with a leucoma adherens, which prevents our dilating the pupil, we estimate the state of the vision by finding the distance at which a luminous point is still seen as such. We should also examine the visual field by a lamp, so as to prevent our making an optical iridectomy in cases of amaurosis or of separation of the retina, when the patient cannot possibly gain anything from the operation (see p. 25).

In eyes where there has existed a leucoma from infancy, we often find a certain degree of insensibility of the retina. When we examine such patients we find that they do not distinguish the luminosity of an ordinary lamp, and specially that they do not indicate exactly the direction of the luminous source. They often refer all luminous impressions to the temporal side, no matter from what direction they come. It is in such cases that the examination of the phosphenes is of great importance. We must also take into account the time that has elapsed since the eyesight has not been used, and repeat at short intervals our examination with the lamp, because it helps to awaken the retinal sensibility. We can operate in those cases with confidence in the result, for we know from experience how much the vision will be improved by systematic exercise, as soon as luminous rays reach the retina, through the artificial pupil.

In answer to the question, should an artificial pupil be made in one eye if the other be perfect, we must reply in the affirmative (*von Graefe*). In a certain number of cases the operation re-establishes normal binocular vision, and at any rate it increases the visual field, and makes it easier for the patient to go about.

Choice of Situation for Artificial Pupil.—When we perform iridectomy for optical purposes, as, for example, in cases of leucoma, for obvious reasons we must select the most transparent portion of the cornea, bearing in mind that each perfectly opaque spot is surrounded with a semi-transparent zone. If the opacity is central, and if the cornea is of equal transparency in all portions of its periphery, the operation should be performed inwards and somewhat downwards, so that the artificial pupil may occupy the position of the normal visual line. If the internal part of the cornea is occupied with an opacity, the iridectomy should be made from below; if the inferior and inner portion is affected, it must be made from the outside; and if the upper portion alone is transparent, we must make it from above, although we run a chance of seeing the pupil obscured by the superior eyelid.

In cases of occlusion of the pupil, central cataract, &c., if the cornea is perfectly transparent, we always select its internal and inferior aspect.

If we perform the operation on both eyes, we always make, if possible, the artificial pupils in the same position—that is to say, both downwards and inwards, &c.

When the iridectomy is made to diminish intraocular tension or for posterior synechiæ, it is better to make it at the superior part of the cornea, because it is not so easily noticed and causes less dazzling.

Yet, as it is rather more difficult to perform the operation above, an inexperienced operator will prefer to choose the inferior or internal

portion of the cornea. The same position should also be chosen when the fear or indocility of the patient renders the administration of chloroform necessary. The cornea has then a great tendency to rotate upwards, and when we draw it down with fixation forceps to the palpebral fissure, we run the risk of rupturing the zonule of Zinn. This danger is most to be feared when the eye is very tense from excess of intraocular pressure, at the moment when we are about to excise the iris, after making an incision in the cornea.

Extent of the Iridectomy.—The size of the portion of iris to be excised depends essentially on the object of our operation.

When it is a question of artificial pupil, it is important that the iridectomy be not uselessly large. A small opening suffices for the passage of luminous rays, a large one causes the patient troublesome dazzling. On the other hand, when we wish to diminish intraocular tension, or to establish communication between the anterior and posterior chambers of the eye, we must excise a large portion, involving the extreme periphery.

The size of the portion to be excised is determined by the situation and dimensions of the incision through which the iris is to pass.

Fig. 55.

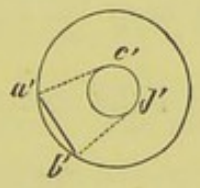


Fig. 56.

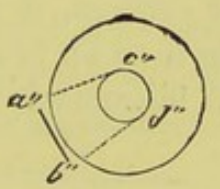


Fig. 57.

Thus, for example, if the incision in the cornea be situated at the place marked a, b (Fig. 55), and if its length be equal to the distance a, b, the size of the artificial pupil will be the area a, b, c, d.

If the incision be as a', b' (Fig. 56), the artificial pupil will occupy the area a', b', c', d'.

Again, if the incision be made in the sclerotic (Fig. 57), and be represented by the length a'', b'', the new pupil will be bounded by the figure a'', b'', c'', d''.

In the diagrammatic figures which we have just given, we have supposed that the incision is perpendicular to the surface incised, but in reality the instrument passes more or less obliquely through the tissue, so that it is necessary to distinguish the internal wound (Fig. 58), a', b', which opens into the anterior chamber, from the external wound, a, b, on the external surface. It is evident that it is the size and position of the internal wound which determine the size of the artificial pupil, since the iris, stopped by the margin of the wound, cannot come farther out of the anterior chamber. It is for this reason that we must

make the incision in the sclerotic, if we wish to excise the iris up to its

Fig. 58.

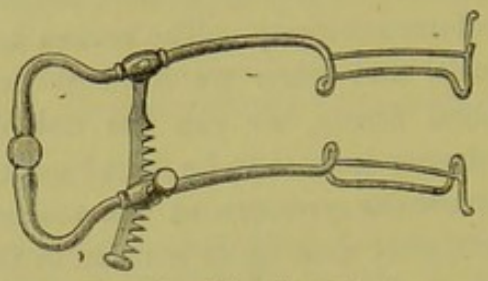


Fig. 59.—Eye Speculum.

ciliary attachment. The operation of iridectomy does not require any previous preparation of the patient. Anæsthetics are required only for

Fig. 60.—Fixation Forceps.

timid and unmanageable persons or for children. We use cocaine to render the conjunctiva and cornea insensible.

For children, it is well to keep the legs and arms perfectly still by rolling them up in a shawl.

The instruments necessary for the operation are—

Fig. 61.

1. Eye speculum (Fig. 59);
2. Fixation forceps (Fig. 60);
3. Straight or bent keratome (Figs. 61 and 62);
4. Iris forceps (Figs. 63 and 64);
5. Curved scissors (Fig. 65).

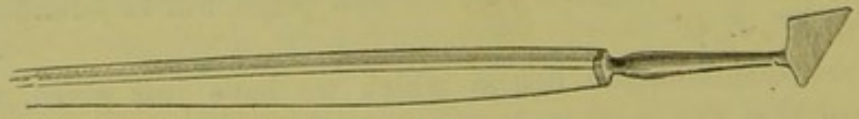


Fig. 62.

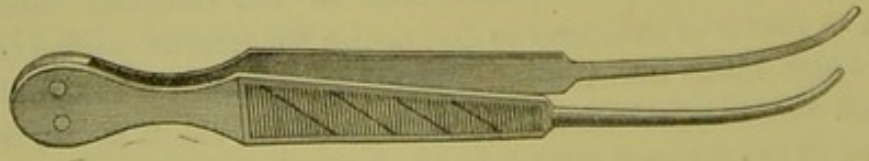


Fig. 63.—Iris Forceps.

It is also well to have in readiness, in case they should be required,

a probe-pointed knife and a small straight spatula (rubber, tortoise-shell, or silver).

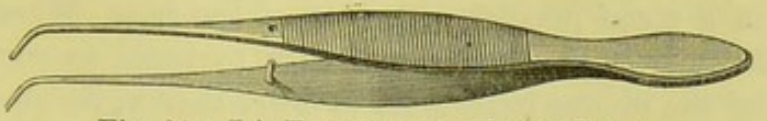


Fig. 64.—Iris Forceps with Abrupt Curve.

For elevators we use the spring speculum, or, if the patient is under the influence of chloroform, or restless, two ordinary elevators. When the patient is quiet, it is better to hold the lids separate by means of the fingers of an experienced assistant. This greatly diminishes the inconvenience suffered by the patient during the operation, which inconvenience is due in great part to the pressure of the elevators.

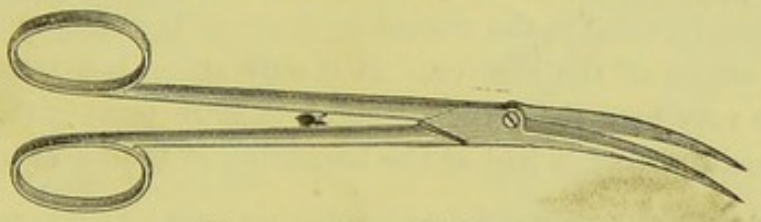


Fig. 65.—Curved Scissors.

Bent or straight keratomes are used; the latter only when we make an iridectomy from the temporal side.

In every other situation, because of the nasal and orbital prominences, we must choose bent knives, the angle at which they are bent varying with the amount of prominence. The same considerations must determine the curvature of the forceps.

Description of the Operation.—In the description of the various steps of the operation, we suppose that the operator is making an iridectomy on the right eye at its internal aspect.

First Stage: Incision of the Cornea.—The patient being placed on a couch, and his head fixed by the hands of an assistant, the operator, having sufficiently separated the lids, lifts with the fixation forceps, held in the left hand, a fold of conjunctiva near the margin of the cornea, just opposite to the place where the coloboma is to lie, and, directing the eyeball to the temporal side, he introduces the knife into the anterior chamber, at the place previously determined in accordance with the special features of

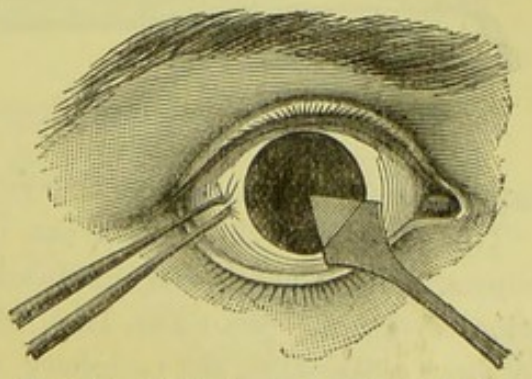


Fig. 66.—Iridectomy, Incision of the Cornea.*

* In this Fig. the fixation forceps is not on its right place: it ought to be higher up, opposite to the point of the knife.

the case. As soon as the point enters the anterior chamber (Fig. 66), it should be directed towards the centre of the pupil, so that the knife is always in a plane parallel with that of the iris. When we have made a sufficiently large opening, and wish to begin to withdraw the knife, it is of the utmost importance to lower the handle of the instrument, so that its point is directed towards the cornea. This precaution is necessary, because this is the time at which the aqueous usually escapes; the lens and iris are pressed forward, and if the knife maintained its original position, its point would inevitably injure the lens. When we have given the knife the position indicated, it is slowly withdrawn from the anterior chamber, care being taken by lowering the handle always to keep the knife towards the cornea. At the same time, we may, if necessary, enlarge the wound by drawing the cutting edge along one of the angles of the incision. It is only at the last moment, when the point is very near the corneal wound, that we must give the knife the same position that it had at the beginning of the operation.

If we have selected the cornea for our incision, we must take care not to run the knife too far between its lamellæ. Also, the advice is generally given to make the point of the knife enter perpendicularly to the surface of the cornea; in which case the handle of the instrument must be lowered as soon as the point enters the anterior chamber, so that the knife may be parallel with the iris when in the anterior chamber.

It is better to give the knife the direction which it should have in the anterior chamber, even from the beginning of the incision; we then select a spot for the puncture a little farther back, and, before puncturing, we make a slight depression on the cornea with the point of the knife.

It has been sometimes advised to withdraw the knife abruptly, but the sudden diminution of intraocular pressure may cause congestion of the vascular tissue. It is therefore preferable to withdraw the knife slowly, so that the aqueous may escape as gently as possible from the anterior chamber.

Fig. 67.—Bent Knife with Blunt Point.

When the incision is not sufficiently large, it may be increased by means of a small blunt-pointed knife (Fig. 67), or with scissors. Considerable caution and great dexterity are required in using scissors for this purpose.

The section of the cornea can be performed also by puncture and counter-puncture with von Graefe's knife in the same way as in the operation of cataract (see Chap. IX.), when the anterior chamber is narrow. In these cases, when the periphery of the cornea has to be spared for optical purposes—as, for instance, in large central leucoma—*Gayet* performs the incision of the scleral margin with a scarificator, cutting in a horizontal line the layers until the anterior chamber is opened; then he passes the blunt-pointed knife or scissors to enlarge the opening.

Second Stage: Section of the shred of Iris drawn out through the Wound.—The surgeon, laying aside the keratome, but still keeping the eye steady with the fixation forceps, takes hold of the iris forceps, and keeping them firmly closed, exercises slight pressure with their point on the external lip of the wound, and thus introduces them into the anterior chamber.

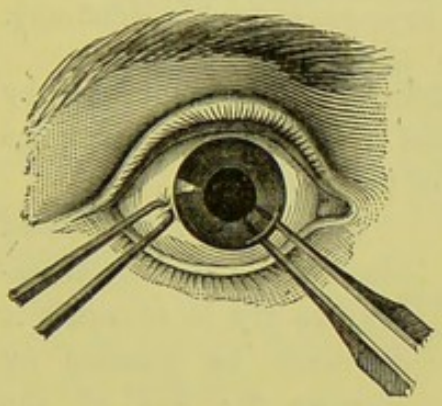


Fig. 68.—Forceps seizing the Margin of the Pupil.

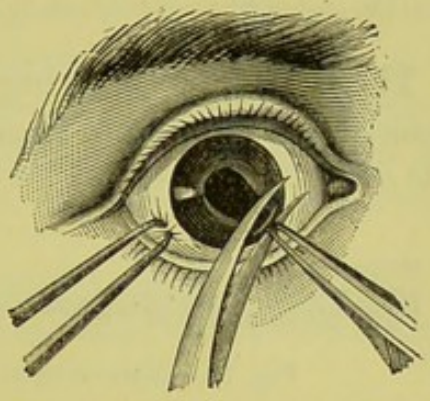


Fig. 69.—Section of the shred of Iris drawn out through the Wound.

He directs the point towards the pupillary margin, taking care by slight lateral movements to prevent the instrument from becoming entangled in the folds of the iris. Having got to the margin of the pupil, the surgeon should steady the forceps, and having opened them he should seize hold of the margin of the iris and draw it out.

An assistant then takes a pair of curved scissors, and gently laying their convex side against the eyeball, cuts off the prolapsed iris as near to the cornea as possible (Fig. 69).

Often the iris becomes spontaneously prolapsed in the wound, at other times prolapse may easily be produced by slight pressure on the sclerotic margin of the incision; in either case we do not require to introduce the forceps into the anterior chamber.

If the surgeon cannot avail himself of the services of an experienced assistant, to whom he may entrust the cutting of the iris, he is obliged to make over to his assistant the fixation of the eye, whilst he himself takes the iris forceps in his left hand, and uses the curved scissors to cut the iris with his right.

However the iris may be cut, it is necessary that it be cleanly cut at the level of the cornea. If otherwise, a piece of prolapsed iris may be left in the wound, which will be drawn into the anterior chamber by the contractions of the iris, or will remain in-

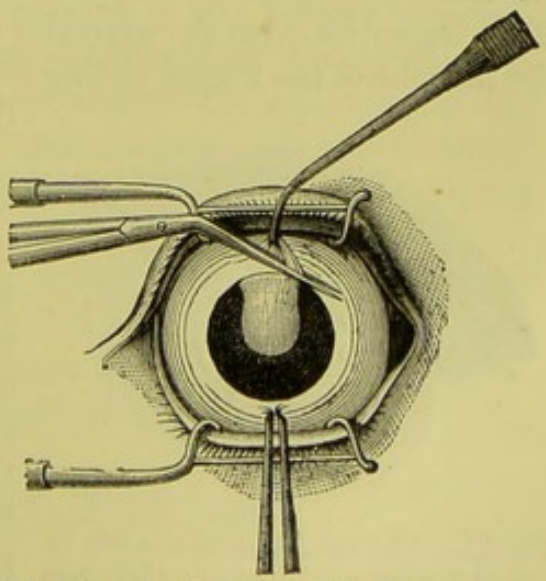


Fig. 70.—Section of the Iris by two cut of the Scissors.

cluded between the lips of the wound. In the first case, the new pupil will not be of the size which we wish; in the second case, a synechia will be formed.

The necessity of carefully excising the iris from its ciliary attachment in glaucomatous affections, obliges the surgeon himself to make the excision by several successive cuts with the scissors. He begins by excising the shred of iris at one angle of the sclerotic wound (Fig. 70), then he draws the iris gently towards the opposite angle, detaches it from its insertion, and finishes by a last cut with the scissors at the other angle; but he has to take care not to draw the iris strongly into the angles, where it gets entangled and cannot be pushed back without difficulty.

Third Stage: Clearing the Wound.—This is accomplished by management designed to remove any effusion of blood, and to disengage the sphincter of the iris from the margins of the wound.

Fig. 71.—Narrow Spatula.

When there is effused blood in the anterior chamber, we try to evacuate it as much as possible by opening the lips of the wound with a narrow spatula (Fig. 71), at the same time making light pressure on the sclerotic margin of the wound.

The aqueous humour which thus escapes from the anterior chamber carries the blood along with it; this delicate manipulation may be repeated several times at intervals.

Yet, if the blood show no tendency to come out, or if there be a renewal of the hæmorrhage, it is better to put cold-water compresses on the eyelids, and to refrain from any further attempts at evacuation, for the absorption of blood takes place in a very short time (almost always during the first twenty-four hours).

In clearing the wound, we remove with small forceps the little blood clots which are formed on the conjunctiva at the incision, then any particles of iris pigment retained between the lips of the wound. For this purpose we cause the convexity of the curved scissors to glide over the margins of the wound, sliding the instrument from the periphery of the cornea towards the sclerotic.

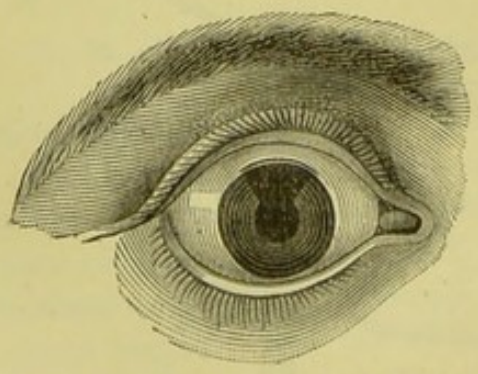


Fig. 72.—The Sphincter of the Iris in the Anterior Chamber after Iridectomy.

In the last place we must assure ourselves that the margins of the iris are not between the lips of the wound. We may detect their presence in the anterior chamber by seeing the margin of the artificial pupil formed by the extremities of the cut sphincter. In cases where the extremities of the sphincter have not entered the chamber, we must cause the spatula or the back of a

caoutchouc curette (Fig. 73) to slide over the sclerotic to the cornea, making slight pressure at the margins of the wound, or we may gently push them into their place with the spatula. This manipulation should not be stopped till we have obtained the desired result.

Fig. 73.—Caoutchouc Curette.

When we are satisfied as to the condition of the wound, we refresh the eye on which we have operated by applying cold compresses for a few minutes, or sponging it with cold water; we then apply a compress and bandage.

As a rule, all pain ceases with the application of the bandage, which should be changed for the first time not sooner than twenty-four hours after the operation.

A few drops of atropine the day after the operation, ensure, by dilating the pupil, that the edges of the newly-cut sphincter do not contract any adhesions with the capsule. The tendency to the formation of posterior synechiæ may be inferred if the corners of the cut sphincter take the form of projecting angles. If this feature be absent, and if the progress of the eye be favourable, atropine is not used till the third day after the operation.

We seldom have any great reaction in the eye after iridectomy, so that it suffices to continue the application of the bandage for a few days, and to keep the patient in bed in a dark room till the small incision is completely cicatrised. Whenever this takes place the patient may wear a loose bandage, and gradually accustom himself to broad daylight, protecting his eyes, when he begins to get out, from excessive light by smoked glasses. If there be a pronounced reaction, it may become necessary, when the irritation appears in the neighbourhood of the cicatrix, and when the cicatrix is still very thin, to continue the application of the bandage for a longer period. If the aqueous humour is muddy, and if there are symptoms of iritis, we must follow the course indicated when speaking of this disease, especially insisting on the use of atropine.

When there is pain or sleeplessness we must have recourse to chloral or subcutaneous injections of morphia, and if the pain persists, we apply several leeches behind the ear of the same side. All such complications naturally indicate a prolonged period of rest in a darkened room.

2. Substitutes for Iridectomy.

Iridotomy.—In cases in which the lens is absent—*e.g.*, after cataract operations, when there is occlusion of the pupil in consequence

of iritis, even in cases where there has been an irido-cyclitis, with disorganisation of the iris tissue and flattening of the cornea—*von Graefe* substituted iridotomy for iridectomy. He followed one of two methods in performing this operation. The first method consists in pushing a small double-edged and very sharp-pointed knife through the cornea and newly-formed tissues, till it reaches the vitreous humour, and then immediately withdrawing it in such a way as to enlarge the opening in the plastic membranes without increasing the corneal wound. According to the second method, he introduces a small sickle-shaped knife through the margin of the cornea, piercing the iris and vitreous humour. He then divides the iris from behind forwards, and withdraws the knife. The opening thus made in the iris is enlarged by the retraction of the tissues and penetration of the vitreous; it shows less tendency to be obliterated than after iridectomy performed under the same conditions, which is no doubt due to the greater simplicity of the operation, iridotomy almost never causing effusion of blood or dragging of the tissues involved.

Bowman has proposed iridotomy for optical purposes even in presence of the lens—for example, in zonular cataract. He punctures the cornea near its external margin with a narrow iridectomy knife, and introduces through this opening a small convex probe-pointed knife of the same size as the iridectomy knife. The point should traverse the pupil between the iris and the lens, and be carried on till it reaches the ciliary attachment of that membrane. He then turns the blade towards the iris, which he cuts at its pupillary border in withdrawing the knife. It is difficult to avoid incising the posterior surface of the cornea at the same time; but the greatest danger is the chance of opening the capsule of the lens in introducing the knife between it and the iris.

De Wecker's forceps-scissors are very useful in performing iridotomy. Should the lens be absent, we make a small incision with the iridectomy knife near the margin of the cornea, piercing both it and the iris. Having introduced one of the blades of the scissors behind the iris, and the other between it and the cornea, reaching to the opposite margin of the cornea, one or two incisions are made (iridotomy simple or double), according to the ease with which the tissues retract so as to form a sufficient pupil.

Fig. 74.—Sichel's Iridotome.

As we cannot always use this instrument without a considerable loss of vitreous, and as the action of the scissors involves a certain degree

of contusion, it is better in most cases to use Sichel's iridotome (Fig. 74), which incises the iris from before backwards, according to the original proposal of *von Graefe*. The special indications of these operations will be explained in greater detail when speaking of secondary cataract.

Another method of forming an artificial pupil for optical purposes (in cases of central opacity of the cornea or lens) is that of *Carter*. Having made a small incision at the corneal margin, he introduces into the anterior chamber a pair of scissors, the blades of which are shut. On opening them a small fold of iris gets between them, which is excised by closing them. The small piece of iris often remains on the scissors, and may be removed by withdrawing them from the anterior chamber; if not, it must be extracted by iris forceps.

Iridorhexis.—When the iris, in consequence of chronic inflammation, is very brittle, if there be adhesions of the pupillary border, these synechiæ are sometimes tougher than the iris tissue itself.

If, then, we perform iridectomy, on taking hold of the iris with the forceps, it often happens that we find the iris tearing in its continuity, rather than its pupillary margin separating from the capsule. An experienced observer can, by careful examination with focal illumination, to a certain extent foresee this state of matters. The surgeon who would then free the margin of the pupil from the capsule, might by too great traction tear the capsule, and thus run the risk of traumatic cataract.

To prevent this accident, *Desmarres* invented a process for tearing the iris, rupture of which is inevitable in these cases.

Iridodesis, Iridenkleisis.—When we make an iridectomy in the usual manner, we excise the sphincter of the iris, and the artificial pupil is of course deprived of its mobility at the spot where the sphincter is cut. This condition is not without inconvenience to the patient, when the iridectomy is made for optical purposes.

On this account various attempts have been made at displacing the normal pupil, so as to intercept as much as possible the luminous rays traversing the defective portions of the cornea and lens, at the same time preserving for the new pupil all the mobility of the old.

This desideratum has been obtained by the following process devised by *Critchett*:—A very narrow incision is made with a narrow iridectomy knife, or with a special instrument, the *broad needle*, at the margin of the cornea, or, better still, in the sclerotic. A thread noose previously prepared, and kept open, either by the ingenious forceps of Waldau or those of Förster, or by means of a somewhat large pair of ordinary forceps, is then placed over the incision in such a manner that the surgeon may pass a pair of very fine iris forceps through the noose and incision, so as to take hold of the iris at some distance from the margin of the pupil.

He then draws out the iris, taking care to leave the sphincter in the anterior chamber, and the noose is closed round the small prolapse of the iris, either by means of the forceps or by tightening the ends of the thread. In this way the iris is ligatured (iridodesis). The surgeon then cuts the ends of the thread at a little distance from the noose, and applies the ordinary compress and bandage.

After two days, when the small wound has cicatrised, the prolapsed portion of iris is cut off along with the noose, which strangles it.

Snellen has simplified this operation by passing, previous to making his incision, a thread through the conjunctiva, parallel with the margin of the cornea, and as near as possible to the point of puncture. The thread being so arranged, it only remains after the incision to make the noose, through which the forceps are passed, and to tie it tightly over the small prolapse.

Stellwag and *de Wecker* have proposed to replace ligature of the iris by simply causing it to be embraced in the cicatrix of the wound of the sclerotic (iridenkleisis).

For this purpose, an incision is made a little farther from the margin of the cornea, piercing the slerotic very obliquely, so as to obtain a sufficiently long canal. The prolapse of the iris is effected by gentle pressure on the external lip of the wound, or if necessary the iris is drawn out by very fine iris forceps as in iridodesis. When once the iris has prolapsed, it is not touched, but a compress and bandage are put on, and left untouched for twenty-four hours, at the end of which time, the small portion of iris which protrudes beyond the sclerotic is cut off with curved scissors.

A more simple means of obtaining the same result consists in fixing the iris in the sclerotic wound, finishing the operation at one sitting.

For this purpose, a peripheral incision is made in the sclerotic, the iris is drawn out so as to leave the sphincter in the anterior chamber, and the portion of iris which protrudes beyond the sclerotic wound is immediately resected with a pair of scissors.

If the canal of the wound be narrow and sufficiently long, the iris remains caught in it. As soon as the section of the prolapse is completed we apply a pressure bandage.

Notwithstanding the considerations which have led to the invention of displacement of the pupil, this operation has never been generally adopted, because there is a danger that the dragging on the iris, caught in the sclerotic wound, will at a later period become the starting-point of chronic inflammations. Several cases of irido-choroiditis, arising from this operation, have been published, some of which have ended in the loss of the eye.

Corelysis.—In cases of synechia, it has been attempted to free the

iris from its adhesions by detaching the pupillary margin from the lens by means of an operation (*Streatfield* and *Weber*).

It has been proposed to do so in the following manner:—

First Stage: Puncture of the Cornea.—A small incision is made in the cornea, at about 4 millimetres from its centre and in its external portion, by means of a paracentesis needle or a broad needle. This incision should be about 4 millimetres in breadth.

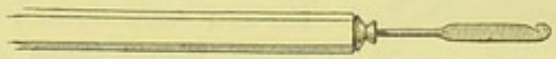


Fig. 75.—Streatfield's Spatula.

Second Stage: Freeing the Pupillary Margin from the Lens.—We may use for this purpose Streatfield's spatula (Fig. 75) or Weber's hook (Fig. 76). The spatula is introduced through the corneal incision into the anterior chamber, laid flatly on the lens, and gently pushed forwards between the iris and the capsule, at the side of the synechia which we wish to destroy (Fig. 77). Slight lateral movements are then made with the spatula in the direction of the synechia,

Fig. 76.—Weber's Hook.

taking the cornea as the point of support, and holding the handle of the instrument in the horizontal plane. As a part of the synechia yields, the spatula should be made to advance farther on the pupillary margin.

In this way we may, by moving the instrument in different directions, detach almost the whole of the border of the pupil, with the exception of the parts beneath the section and in its immediate neighbourhood. Therefore, we must make the corneal incision in front of that portion of the pupil which is most free.

If circumstances allow a choice, we should make the corneal incision by preference in the external portion of the cornea, there being no bony prominence to interfere with the necessary manipulations. Having finished the operation, we must immediately dilate the pupil, and maintain the dilatation by frequent instillations of a strong solution of atropine or duboisine.

Another method of performing **corelysis** has been proposed by *Passavant*. He makes a small incision with an iridectomy knife near the margin of the cornea just above the synechia.

The size of the incision is such as to easily admit iris forceps; he

introduces a pair of small forceps, without sharp points, into the anterior chamber, and takes hold of the iris; he then destroys the synechia by gently withdrawing the instrument. As soon as the synechia is destroyed he opens the blades, so as to let the iris go, and carefully withdraws the instrument from the anterior chamber. He can only detach one synechia at a time, and if there are more than one he must repeat the operation, which he does after a few days. If there be prolapse of the iris in the corneal wound, he attempts to reduce it by the ordinary methods.

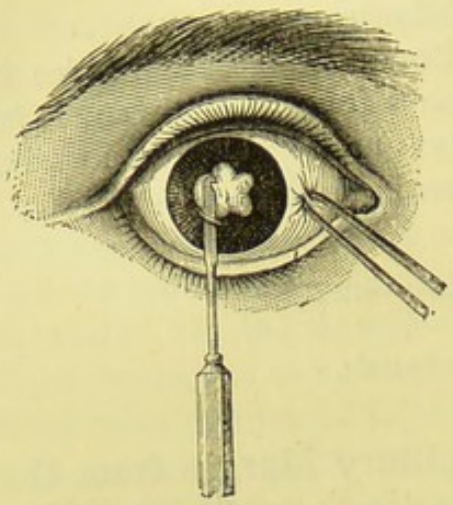


Fig. 77.—Corelysis.

Förster detaches the synechia by pressing with the finger and the margin of the eyelid through the cornea upon the pupillary margin, and pushing it back towards the periphery of the anterior chamber, having first let out the aqueous humour by paracentesis.

DISEASES OF THE CILIARY BODY.

ART. I.—Cyclitis.

Inflammation of the ciliary body, frequently an extension from neighbouring structures (iris and choroid), occurs also idiopathically.

The general symptoms of this affection are—

(*a.*) Considerable hyperæmia of the subconjunctival arteries, forming a very bright pericorneal injection.

(*b.*) Ciliary pain, especially great sensibility on touching the ciliary region.

(*c.*) Formation of inflammatory products, either as opacities in the anterior part of the vitreous or as hypopyon in the anterior chamber.

The turgescence of the diseased tissue soon becomes the source of disturbance of the circulation in the iris, as is manifest from the swelling of the distended and tortuous veins, especially in the periphery of the membrane, although it presents no other inflammatory symptom than the change of colour which accompanies the venous stasis.

As we are unable to see the ciliary body, it is only by touching the ciliary region and by the indirect symptoms that we can be certain of the diagnosis. But, again, these symptoms (subconjunctival hyperæmia, opacities in the vitreous, and hypopyon) are characteristic of cyclitis only when we have carefully excluded every other cause of their production.

Cyclitis presents three different forms, which must be distinguished from each other.

(*a.*) **Simple or Plastic Cyclitis.**—Here the pericorneal injection is very considerable, and the vessels of the iris are dilated and tortuous. Hence arises a slight discoloration of that membrane, the tissue of which is not otherwise altered.

The anterior chamber seems deeper, the iris being drawn backwards, especially at its periphery, by the plastic exudation, which forms in the ciliary body at the ciliary attachment of the iris. The pupillary margin is free from exudation, as is also the pupillary field; the pupil is dilated.

The venous engorgement may give rise to inflammation of the iris (irido-cyclitis). The inflammation may extend also to the choroid, producing effusion in the vitreous body. These complications, as a rule, pass away with the primary lesion, but they may persist after it has

disappeared. This variety of cyclitis is accompanied with very acute ciliary pain.

(*b.*) **Serous Cyclitis.**—The pericorneal injection in this case is much less pronounced than in the former, and the veins of the iris are not distended and tortuous. The pupil is somewhat dilated, the anterior chamber, at first deeper, becomes shallower, and at the same time there is increase of the intraocular pressure.

A very characteristic symptom is the rapid formation of very fine opacities in the anterior part of the vitreous humour, which more or less interfere with vision. The disease is often combined with serous iritis, but, on the other hand, it may spread backward to the choroid and assume the character of glaucoma.

(*c.*) **Purulent Cyclitis.**—In this variety the pericorneal injection is very great, and is accompanied with hyperæmia of the internal structures. Thus we find on ophthalmoscopic examination that the veins of the retina are dilated and tortuous.

The stasis in the choroidal veins, which also exists, cannot be directly seen. At the same time, opacities appear in the vitreous, at first flaky, but ultimately membranous, which account for the visual disturbance from which the patient suffers. A characteristic feature in this disease is the sudden formation of hypopyon, which disappears and reaccumulates in the course of a few days. The ciliary pain is very great, and increases when the eyeball is touched.

The disease is apt to become complicated with parenchymatous iritis, or with purulent infiltration of the choroid.

Progress and Termination.—The affection may be arrested at any period of the inflammation; the inflammatory symptoms gradually disappearing, and the opacities of the vitreous and hypopyon being absorbed. If, on the other hand, the disease advances, serous cyclitis becomes glaucoma, simple cyclitis becomes purulent, while the surface of the ciliary body, choroid and posterior portions of the iris are covered with plastic exudations. These exudations become organised, forming false vascular membranes, often of considerable thickness, which produce a certain traction on the ciliary insertion of the iris, so that the anterior chamber is deepened at its periphery. The compression and obliteration of the ciliary arteries cause atrophy of the iris and choroid, and interfere with the nutrition of the vitreous body, which becomes the seat of organic opacities, and undergoes atrophy; as a consequence of the contraction of its dimensions we have separation of the retina. The lens loses its transparency; and the whole eyeball gradually atrophies, but is liable to periodical inflammation, with severe pain, so that even the other eye during these inflammations is affected.

Prognosis.—Cyclitis is always a serious affection. Of the three forms just described, the serous and purulent in their early stages are the least dangerous, at least when the purulent is not caused by a foreign body or a dislocated lens, because in such a case the irritation is maintained and the resolution of the hyperæmia and inflammation prevented.

Again, purulent cyclitis is very dangerous if it supervene after an operation—for example, after the extraction of cataract—for it then extends rapidly to the deep structures, and brings about the purulent liquefaction of the entire eye.

The most serious prognosis is that of plastic cyclitis which has attained a certain degree of development. This affection so greatly disturbs the nutrition of the important structures of the eye that it almost always involves atrophy of the organ.

Ætiology.—Inflammation of the ciliary body may follow an iritis or choroiditis. But the affection is often traumatic, and may then be caused by wounds in the ciliary region, the presence of a foreign body in the eye, or again by the sympathetic action which, in certain circumstances, one inflamed eye exercises on the other. This last form (sympathetic ophthalmia) will be the subject of a separate chapter.

Treatment.—The great hyperæmia, indicated by a bright pericorneal injection, demands antiphlogistic treatment, atropine and the internal administration of opium. Violent pain and sleeplessness should be checked by morphia or chloral.

In the plastic and purulent forms we must employ mercurial treatment, administered in the same way as in serious cases of iritis (regular inunction). The serous form should be treated, like serous iritis, with purgatives, diaphoretics (injections of pilocarpine), diuretics and derivatives acting on the skin. If the aqueous humour be muddy, and if there be increased tension of the eye, we must perform paracentesis of the cornea, which should be repeated if necessary, and if the symptoms persist we must have recourse to iridectomy. When purulent cyclitis is the result of an operation—for example, after removal of cataract by section—the general condition of the patient often does not admit of active antiphlogistic remedies, or any debilitating treatment. Hot compresses, tonics, in certain cases a tight compress and bandage, give the best results. An eye entirely lost by cyclitis, and still painful, ought to be enucleated, unless opto-ciliary neurectomy (*vide infra*) permanently checks pain and inflammation, as we have frequently observed.

The presence of a foreign body in the eye demands as the first condition of success its extraction. If we do not succeed, the eye is almost always lost, and the only question then is to preserve the other from sympathetic inflammation.

ART. II.—Lesions of the Ciliary Body.

Wounds which involve the ciliary region are—either clean-cut wounds made with a sharp instrument, or irregular wounds made by foreign bodies (splinters of metal, glass, thorns, &c.) These agents may produce a wound without penetrating the eye, or they may penetrate, or again they may be stopped between the lips of the wound. In this last case they are easily removed by a magnet or forceps. If the foreign body has penetrated the eye, the possibility of surgical interference depends on its special position. (See the remarks on foreign bodies in the lens and vitreous humour.)

Clean-cut wounds of the ciliary region, when they are not very large and not very deep, often heal very rapidly under a compress and bandage. If there be prolapse of the iris or of the ciliary body, the hernia should be snipped off.

If there be escape of vitreous, and if the wound be large, it may be necessary to unite it by a suture. To avoid penetrating the eye with the needle while suturing, which might happen if the patient were to move suddenly, we use a thread provided with a needle at each end, which needles are made to pierce the lips of the wound from within outwards.

The chief danger to be feared in a wound involving the ciliary region is a sympathetic inflammation in the other eye.

Tumours of the ciliary body are described with those of the choroid.

ART. III.—Irido-Choroiditis.

We must distinguish two varieties of this disease.

1. In the first the disease begins with **iritis,** following which, posterior synechiæ keep up a chronic inflammation, which extends to the anterior parts of the choroid. In cases of complete posterior synechiæ, the equilibrium of the internal fluids of the eye is interrupted by the stopping up of the communication between the anterior and posterior chambers. The fluids then accumulate behind the iris, driving it towards the cornea; but it can only yield to the pressure at the periphery, the pupillary margin being adherent to the lens. The pushing forward of the iris at first only appears at certain places, giving it an indented appearance; later it becomes general.

The iris in the early stage is only tarnished and discoloured, but now it is distended and shows symptoms of atrophy. If the pupil be in such a condition as to admit of ophthalmoscopic examination, we find opacities in the anterior part of the vitreous humour, which are fine and filamentous.

The eyeball is at first hard, but afterwards softens.

The pain is often insignificant.

Vision is in the early stage little altered, but later sensibly diminishes, owing to opacities in the vitreous, and it decreases in proportion as the nutrition of the choroid is involved.

2. In the second variety the disease begins **in the choroid**, in which membrane inflammation with its consequences has already produced considerable alterations in the visual acuteness before the iris is affected.

Thus we may already have numerous opacities in the vitreous, effusion between the choroid and retina, disturbance in the nutrition of the lens (albuminoid infiltration), and it is only after these changes that the inflammation extends to the iris, and that plastic exudations form posterior synechiæ.

The lens and the iris are now pushed forward towards the cornea, so that the anterior chamber is almost entirely obliterated; and lastly, the disease presents the same combination of symptoms as has already been described in the first form.

When the irido-choroiditis has attained a certain development, it is often very difficult to say in which of the two ways it began; in such cases we must be guided by the following considerations:—

When the inflammation has begun in the iris, the patient will remember the different exacerbations of the inflammation in this membrane, and its structure will be found considerably altered (synechiæ, change of colour, atrophy).

The lens is more rarely affected in this form than in the other, and when it does become opaque it is at a later period. Decrease of visual acuteness is at first inconsiderable, and chiefly depends on deposits of plastic lymph in the pupil; later there are opacities of the vitreous humour and of the lens.

In cases in which the inflammation begins in the choroid, there is considerable diminution of vision from the beginning, owing to the formation of opacities in the vitreous humour. Often we have detachment of the retina occurring early in the disease, with its characteristic influence on the visual field. The intraocular tension then perceptibly decreases, the lens becomes opaque, and later undergoes calcareous transformation.

The iritis which complicates the choroiditis does not present any marked inflammatory symptom, but is insidious in its course.

Progress and Termination.—Both forms of irido-choroiditis are generally chronic, and are accompanied with periodical exacerbations of the inflammatory symptoms.

In the course of the disease, the increase of the internal pressure may bring on glaucomatous symptoms or atrophy of the retina.

In other cases, an effusion of serum or of blood on the internal surface of the choroid produces separation of the retina, which complication is manifested by special symptoms, to be explained when we speak of the diseases of the choroid and retina. As a rule, if the morbid process be not arrested, neoplastic masses fill the posterior chamber, and the irido-choroiditis, after involving the ciliary body, and giving rise to cyclitis, terminates in atrophy of the eyeball.

Prognosis.—The prognosis is grave, but varies with the period and special form of the disease.

In slight cases of irido-choroiditis without any great alteration of the choroid, where there is no complication of the retina or lens, and when the plastic matter behind the iris is not great, judicious treatment may arrest the progress of the disease, maintaining and even improving the state of vision. On this account the prognosis is less grave when the irido-choroiditis has begun with the iris.

In this form, we must not despair even when atrophy of the eyeball has already begun, if this atrophy entirely depend on nutritive changes in the vitreous, without definite alteration in the tissues, and if the central and peripheral visual perceptions are still tolerably good. Treatment arrests the progress of this atrophy.

The prognosis becomes absolutely bad when there is separation of the retina, or when the ciliary body is included in the morbid process (as shown by sensibility to touch, peripheral retraction of the iris, &c.)

Ætiology.—The majority of cases of irido-choroiditis originate in posterior synechiæ formed during an iritis, or in the presence of foreign bodies, *e.g.*, a dislocated lens, which, even although encysted, may become dangerous after the lapse of a longer or shorter period from displacements in the interior of the eye. Again, cases which begin with choroiditis may often be connected with the rheumatic or syphilitic diathesis or alterations in the general health, for example in women at the change of life, or in young women from sixteen to twenty in consequence of irregularities of menstruation.

Treatment.—In every case of irido-choroiditis where there are posterior synechiæ, it is of the first importance to liberate part of the pupillary margin, or to establish the communication between the anterior and posterior chambers by an iridectomy.

Whenever the communication is established the vision improves, the state of the choroid is ameliorated, as is also the nutrition of the

vitreous, in which the opacities are gradually absorbed; consequently this re-establishment of the communication between the two chambers should be got at any cost, even should it be necessary to repeat the iridectomy. Once the desired result is obtained, we often see eyes which have already begun to atrophy regain their normal volume and tension.

This condition does not therefore forbid operation, but it need not be said that operation may be useless if the atrophy have reached a certain stage and be the result of choroidal atrophy with obliteration of the vessels.

There are many difficulties in performing iridectomy when false membranes closely connect the posterior surface of the iris with the capsule of the lens and with the ciliary processes. Besides the difficulties of seizing the iris, it is important in such cases to remove at the same time, as far as possible, the neoplastic masses.

There is besides, in these cases, a very great tendency to occlusion of the opening thus obtained by new plastic effusion.

Consequently it is of the greatest importance to be able to remove a large flap of iris to its very periphery, and along with it the subjacent false membranes.

In a great number of cases, this result can only be obtained by simultaneously extracting the lens, which moreover is often found altered in its nutrition and more or less opaque. The ordinary iridectomy, as already described, only partially answers our purpose, and the following method should be substituted. The incision is made with von Graefe's straight knife, such as is used for linear extraction of cataract. We pierce the inferior margin of the cornea, and go behind the iris with the point of the knife; then, carrying it along behind the iris to the point where we wish to make the counter-puncture, we again pierce the iris and cornea, and finish the section.

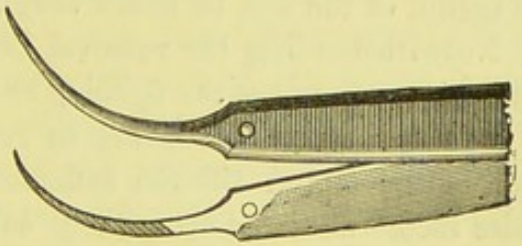


Fig. 78.—Capsular Forceps.

This incision resembles the peripheral incision made in the extraction of cataract by *von Graefe's* method, with this difference, that the knife at the same time cuts the iris at its ciliary insertion, and opens the capsule of the lens, so that as a rule a little lenticular substance escapes by the wound. We then introduce a special form of capsular forceps (Fig. 78) in such a way that one of the blades is placed between the iris and the cornea, and the other behind the iris and false membranes. This latter blade will therefore penetrate the lens itself. Having pushed the forceps firmly forwards, we draw out all that we can take hold of

between the blades, and if any resistance is met we must disengage the mass by a few strokes of very finely bladed scissors (Fig. 79).

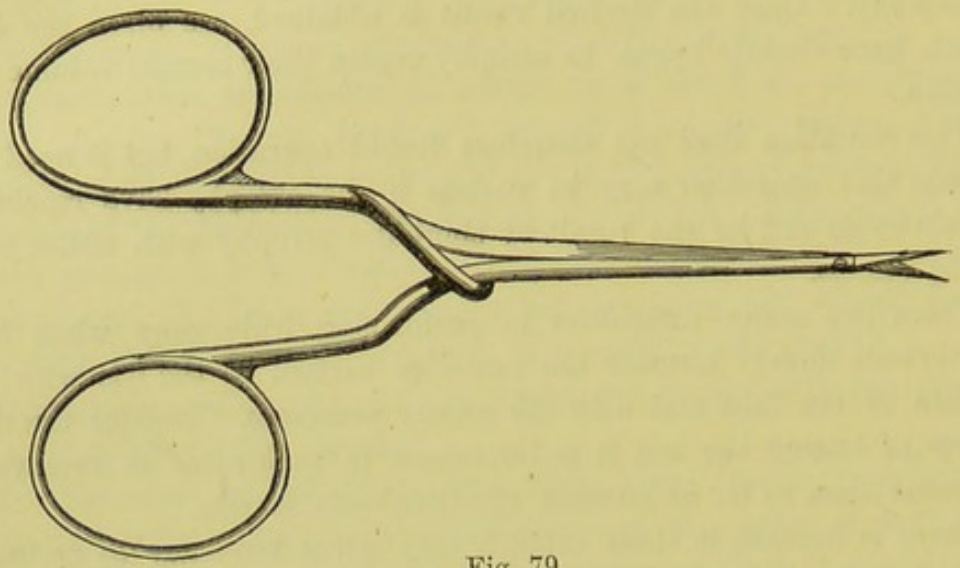


Fig. 79.

Generally this manipulation suffices to produce the simultaneous escape of the lens; if, however, it does not follow the iris and false membranes, the capsule must be torn with the cystitome, and extraction performed in the usual manner (see article on cataract).

It is of importance also to remove as completely as possible all the opaque portions of the capsule which can be removed without any great dragging of the iris, to which they adhere.

Notwithstanding the removal of a large portion of the false membranes, we often see the opening reclosed by fresh neoplastic formation.

It then becomes necessary to repeat the operation, but this should not be attempted till the inflammatory process which produced the false membranes has completely subsided. When the time comes for repeating the operation, if the lens have already been removed, it may suffice to rupture the false membranes with a sharp crochet, after the corneal incision, and to remove as much of them as possible. At other times it is better to perform iridotomy, or capsulotomy, or a combination of the two operations (see operation for secondary cataract). Besides, it is necessary to institute constitutional treatment in accordance with the principles already enunciated, and to take into account the special indications furnished by menstrual affections, by the sudden arrest of a hæmorrhoidal discharge or by habitual constipation. Again we have seen good results obtained by the prolonged use of potassium iodide and small doses of corrosive sublimate. Only, we must steadily bear in mind the fact, that no medication can have a salutary influence on the eye until surgical interference has given to the organ the conditions essential for the nutrition of the diseased structures.

ART. IV.—Sympathetic Ophthalmia.

When an eye is affected with traumatic irido-choroiditis, we often find that a similar affection springs up in the other eye, and it is this which has received the name of *sympathetic ophthalmia*. It presents itself, however, under various forms.

1. **Sympathetic irido-cyclitis,** the most dangerous and most common form, begins with diminution of the visual acuteness, lachrymation, photophobia, and pericorneal injection.

Contemporaneously, exudations are formed at the pupillary margin and on the posterior surface of the iris. These exudations are rapidly organised, and form solid false membranes.

The pupil is then retracted, and, in consequence of the complete posterior synechia, immobile and insensible to the action of atropine. The iris at first appears more stretched and discoloured, but the tissue is swollen by effusion into its parenchyma, and the anterior chamber is shallower. Soon to these symptoms are added those of cyclitis, sensibility to pressure on the ciliary region, effusions into the vitreous, and gradual softening of the eyeball.

The visual acuteness is now greatly reduced, and the visual field contracted. As the disease progresses, the pupil becomes filled with plastic material, the periphery of the iris is drawn backwards by false membranes, which unite its posterior surface with the ciliary body; consequently at the periphery the anterior chamber is increased in depth. The lens grows opaque, the retina becomes detached, and the eyeball atrophies. In the most favourable cases the affection stops before attaining this ultimate phase; in which case a certain amount of visual perception remains, which a suitable surgical operation may increase.

2. **Sympathetic serous iritis** is much less dangerous than the preceding form. Its symptoms are those of serous iritis in general; slight subconjunctival injection, muddiness of the anterior chamber, and greyish deposits on the posterior surface of the cornea, normal appearance of the iris, dilatation of the pupil, and increase of the intraocular pressure.

3. **Sympathetic chorio-retinitis** has till now been observed only by *von Graefe*, who has seen two cases. One of the cases followed the linear extraction of a calcareous lens, which had fallen into the anterior chamber, with consequent irido-cyclitis and great sensibility to pressure in the eye which had undergone the operation.

Six weeks after the operation the patient complained of his other eye, which had up till this period been in a normal condition; and in it was found a sudden diminution of the acuteness of vision, with a defective visual field.

On ophthalmoscopic examination the retina was seen to be hazy, and the retinal veins dilated and tortuous. Simultaneously slight symptoms of serous iritis appeared.

Under treatment (blood-letting, corrosive sublimate, iodide of potassium), and at the same time as the eye operated on ceased to be sensitive, the vision of the sympathetic eye gradually improved, and it regained its normal sight.

The second case is that of a person who had lost an eye in youth from separation of the retina, with calcareous deposits in the choroid. At the age of twenty the other eye became affected with the symptoms of retinitis which we have just described, and at the same time the impaired eye became sensitive to pressure. The latter having been enucleated, the phenomena of the sympathetic affection disappeared.

4. **Sympathetic neurosis.**—The fourth form of sympathetic affections is distinguished from the others in not being accompanied with any material change in the structure of the eye.

It has been called *sympathetic neurosis*, and is characterised by great photophobia, with secondary spasm of the orbicularis, lachrymation, and slight pericorneal injection, which is present especially after efforts of vision. At the same time there is a want of visual power, and an enfeeblement of the accommodation.

In addition to the sympathetic affections which we have just indicated, various forms of conjunctivitis, corneitis, choroiditis, &c., have been described as following traumatic lesions of the other eye. Still, it is scarcely accurate to place these affections in the same category with sympathetic diseases.

Progress and Termination.—The time which may elapse between the affection of the first eye, and the manifestation of the sympathetic disease in the other, is very variable. If it sometimes supervenes in the course of a few weeks, it has been observed in other cases to occur only after twenty or thirty years, always preceded by the characteristic painful sensibility of the ciliary region of the eye first affected.

If the sympathetic ophthalmia assume the form of irido-cyclitis, it does not come on suddenly, but follows rather an insidious course, resisting all treatment, and gradually destroying vision by producing atrophy of the ball. Yet it sometimes stops spontaneously, leaving a certain amount of luminous perception.

Sympathetic serous iritis does not expose the vision to serious

danger; it is a very mild form of serous iritis, and is easily controlled by treatment.

Again, sympathetic neurosis, whilst preventing the patient from using his eyes, never produces any important alteration in structure.

Prognosis.—It is very good for neurosis, favourable for serous iritis, very bad for irido-cyclitis, for the cases are rare in which, notwithstanding active interference, we succeed in preserving any useful amount of vision.

Ætiology.—Sympathetic disease is to be expected when one eye has been injured so as to involve the ciliary region, either immediately or secondarily, when at a later stage the process of cicatrisation produces a dragging on this region, as, for example, in cases of prolapsed iris being caught in the wound.

Foreign bodies which have penetrated the eye, even although they remain quiescent for several years, may suddenly become a source of irritation, probably in consequence of small displacements in the interior of the eye. Operations rarely give rise to sympathetic affections of the other eye; they have been seen after extraction of cataract, and after iridodesis.

Calcareous cataracts or calcareous deposits on the choroid, which occur after irido-choroiditis, or irido-cyclitis, even in atrophic stumps, may keep up a state of chronic irritation which may at any moment excite a sympathetic affection in the other eye.

The appearance of the disease in the second eye is often preceded by pain, sometimes very acute, which is always elicited on touching the ciliary region of the eye first affected. This characteristic symptom tells of imminent danger, or, if the disease has already begun, indicates its true nature.

The means of transmission of the irritation from one eye to the other are—

1. The ciliary nerves, some of which may preserve their conductility even in an atrophied eye, the neurilemma and fibrous envelope resisting the degenerative and atrophic process for a length of time (*von Graefe*).

2. Much more rarely, the optic nerve (*Mooren*), and the intravaginal space (*Knies*) which communicates by the arachnoidal space with the other eye.

3. The vessels; in a case of sympathetic choroiditis, with the ophthalmoscopic appearance of neuroretinitis, the autopsy did not show any other way of transmission (*O. Becker*).

Micrococci found in the intravaginal space by *Snellen* and *Leber*, as well as by *Deutschmann*, who, after repeated injections of microbes into the eye of a rabbit, established an inflammation of the other one,

propagated through the optic nerve and its envelopes, prove that sympathetic ophthalmia can be of an infectious nature.

Treatment.—The great danger of sympathetic ophthalmia, and the impossibility of foreseeing which form the disease will take, indicate the necessity of anticipation and active intervention, whenever the condition of one eye causes us to fear for the other. This fear may always be entertained when there is pain on touching the ciliary region. The only certain means of preventing the development of sympathetic ophthalmia lies in the enucleation of the injured eyeball. Some cases of sympathetic ophthalmia, in which the disease appeared a short time after the enucleation, do not prove anything more than that the operation came too late, the pathological processes having already advanced beyond the enucleated eye.

When the sympathetic disease is already present, and is in the form of irido-cyclitis, the enucleation of the first injured eye is no longer of any avail in arresting the evil. Yet it must not be neglected, when there is a foreign body in the eyeball, if the eye be painful to touch and deprived of all vision.

An eye which is affected with sympathetic irido-cyclitis is rarely influenced by the remedies recommended for that disease. Hot fomentations without interruption during 8 to 10 hours daily, energetic application of atropine, mercurial inunctions and diaphoresis, obtained by giving pilocarpine subcutaneously, are the best remedies. On the other hand, experience has shown that any operation is productive of harm.

At the very beginning of the disease, some have believed that they saw good results from an iridectomy, made with a von Graefe's linear section knife in the extreme periphery. But we must abstain from all surgical interference if the inflammation has already reached a certain intensity, if the yellowish exudation products fill the pupil, attaching the iris to the capsule, if the iris be furrowed with large vessels, &c. Attempts at iridectomy made at this period are not only without benefit, but are very detrimental, because they are a source of new irritation which increases the inflammation, rendering the loss of the eye almost inevitable.

Thus it is now recognised that we must wait till the inflammatory symptoms have disappeared, the development of vessels in the iris stopped, the visible false membranes assumed a greyish appearance without vascularity, till the ciliary region has ceased to be painful to the touch, and, finally, till the tension of the eye, always considerably diminished, does not notably vary from the normal.

The time necessary to wait is from three to four months, but as a rule it is well to wait as long as possible, so that the eye may have

regained a state of perfect quiescence. We must not be entrapped into premature interference by the dread of atrophy of the eyeball and loss of vision.

As soon as all irritation has passed off, we should perform iridectomy, with extraction of the lens and false irido-retinal membranes, in the manner already described.

If the pupillary opening thus obtained afterwards becomes closed, we should excise another portion of the iris. Perhaps in such cases it would be better to perform iridotomy, which operation shall be described when we speak of secondary cataract.

For sympathetic serous iritis, it suffices to use the remedies which have been mentioned for the ordinary form of the disease as soon as the eye which causes the sympathetic affection has been removed.

The enucleation of the first affected eye always suffices to cure sympathetic neurosis, and it does so almost at once.

Following up an idea of *von Graefe's*, we have employed section of the anterior ciliary nerves behind the point where palpation produces acute pains, instead of enucleation, not only in manifest sympathetic neurosis, but in every case where we have entertained fears of a sympathetic affection.

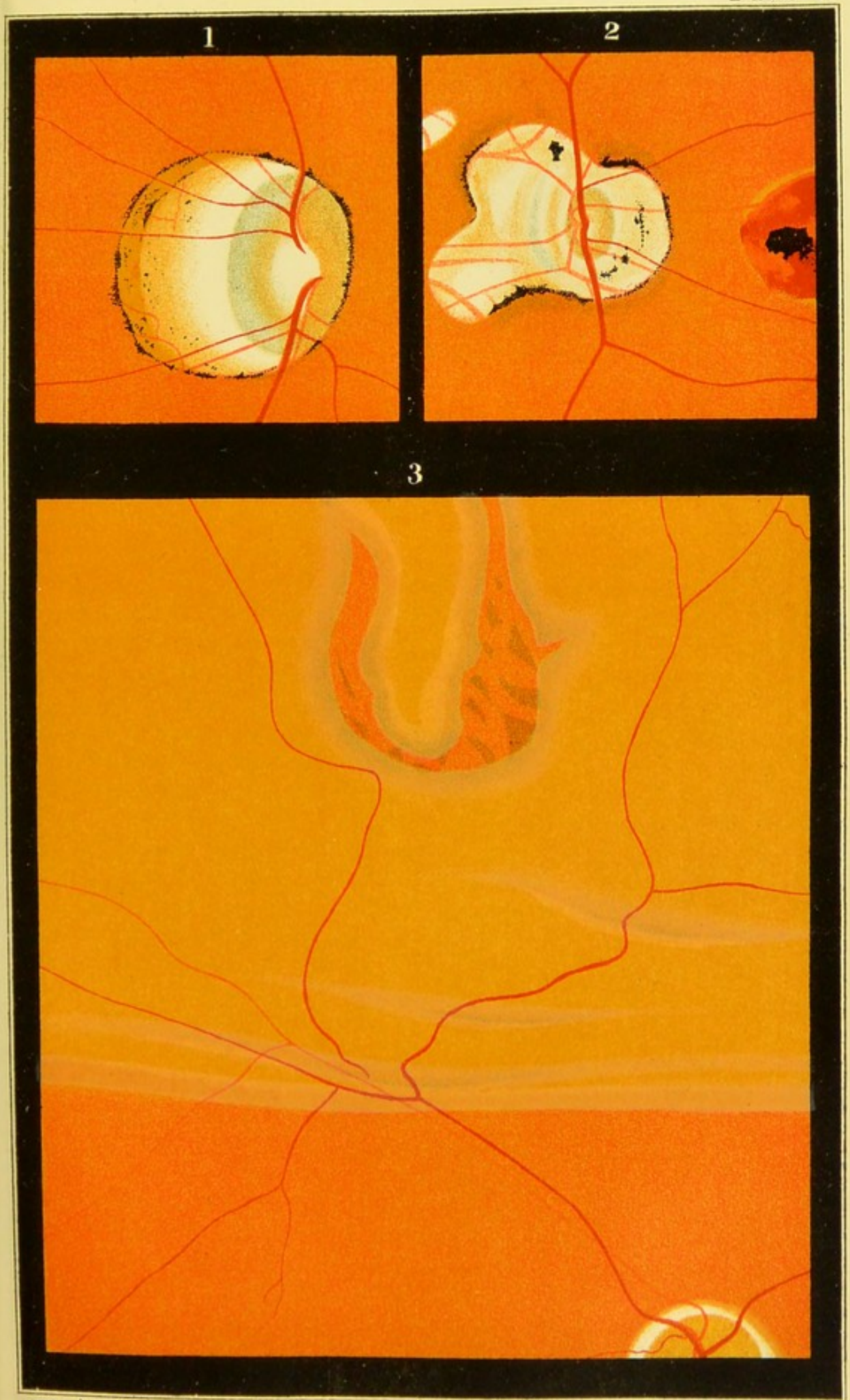
Following out a similar idea, section of the ciliary nerves has also been performed in the posterior segment of the eyeball, the section either leaving out the optic nerve (*Snellen*), or including it (*Boucheron, Schoeler*). This latter method is to be preferred, because we are surer of cutting all the ciliary nerves, and thus there is a greater chance of attaining the desired effect. The operation is performed as follows :— Having made an incision in the conjunctiva along the external border of the cornea, and having detached it freely from the sclerotic, a thread is passed through the anterior extremity of the external rectus muscle, which is cut as in the operation for strabismus. This being done the eyeball is turned as far as possible to the opposite side, and the optic nerve is cut as far behind the eyeball as possible. It becomes then easier to turn the eyeball round so that its posterior pole becomes visible, and we can, without difficulty, cut at first the part of the optic nerve left on the eyeball, and all the ciliary nerves at a centimetre's distance round the optic nerve. Lastly, the eyeball is replaced in its normal position, the external muscle is attached to its scleral insertion, and the wound of the conjunctiva closed by sutures. After this we perform the tenotomy of the internal rectus muscle in order to cut the ciliary nerve, which passes under it. We thus establish complete anæsthesia of the cornea. After the operation a pressure bandage is applied.

PLATE II.

Figs. 1 and 2 illustrate the appearances presented by extensive *sclerotico-choroiditis* posterior. Towards the outer side of the disc there is a large whitish patch, over which the vessels appear to run a straight course. The vessels are somewhat more numerous and distinct than usual. In fig. 1, the white patch is in the form of a crescent, but in fig. 2 it surrounds the disc in an irregular form. The black spots observable on the white patch are the remains of the choroidal pigment left by the atrophic process in the choroid. In fig. 2 we find an isolated white spot also due to the choroidal atrophy, and we have an extravasation of blood in the macula.

The optic disc is oval, and its shorter diameter (in this case the horizontal) shows the direction in which the bulging is situated. In fig. 2 the surface of the disc has a deep partial excavation. The reddish part of the disc, on the right hand side, is the only portion on the normal level. The white and bluish portion is excavated and not distinctly delimited from the sclerotic, so that the ectasia of that membrane seems to involve the disc up to the emergence of the central artery.

Fig. 3 represents a case of recent *detachment of the retina* with spontaneous perforation. The upper part of the membrane bulges forward towards the vitreous humour. As the subjacent fluid is transparent, we see the reddish reflection of the fundus oculi albeit somewhat veiled. At the inferior limit of the detachment, near the three folds of retinal tissue and on the edge of the perforation, a greyish tint may be noticed.



FROM LIEBREICH'S ATLAS OF OPTHAMOLOGY

J. W. WATSON, LITH.

vitreous body, either as very fine dust or as flakes, or even as floating membranes, which may be present from the first, or supervene at a later period.

From the first attack the patients complain of mist, of fixed or movable opacities; and on functional examination we find a greater or less diminution in the visual acuteness, with contraction or deficiency in the visual field.

These different phenomena partially depend on opacities of the vitreous humour, and on functional alterations of the retina, which are due either to disturbance of the circulation, or direct pressure on the retina. The nearer the exudations are to the posterior pole the more do they injure central vision.

Moreover, we find sometimes sensibility of the eye to touch, and even spontaneous pain behind the eyeball during the acute stage.

Progress and Termination.—Choroiditis with exudation is a chronic affection. If the disease is of short duration and the patches not very extensive, they may pass off without leaving any trace. If absorption only takes place after some time has elapsed, the choroid remains, at the affected places, deprived of its pigment, which is accumulated round the patch. This change may give the fundus of the eye a speckled appearance.

At other times, the choroidal tissue atrophies at the points of exudation, whilst fresh exudations are formed; and we may see in the same eye exudation patches, spots deprived of their pigment, and atrophic patches. In addition to the irregular masses of pigment which surround these patches, brownish or reddish spots are also seen, probably indicating hæmorrhage from the chorio-capillaris.

Besides the alterations in the retina and vitreous body already mentioned, the disease is sometimes complicated with iritis. This indeed may be the primary disease which extends to the choroid, in which case the evil will begin in the peripheral portions of that membrane. In those cases of irido-choroiditis, where there is sometimes very little exudation, but prolonged hyperæmia, inflammations of the sclerotic are sometimes developed, which are very liable to recur. We then find prominent points on the sclerotic, which are of a violet colour, and are painful to touch.

Prognosis.—In all recent cases the prognosis is good; we may hope for perfect recovery. Any alterations of the tissue which may take place do not sensibly interfere with vision. The chances of complete recovery diminish with the duration of the disease, and our prognosis should be reserved when the exudation is near the posterior pole of the eyeball. We must also take into account the state of the visual field, and warn the patient of the likelihood of frequent relapses.

Ætiology.—The causes of this affection are often obscure; it is frequently met co-existing with affections of the general health, in women in conjunction with painful menstruation, after puerperal fever, during pregnancy, and at the change of life. It has also been attributed to the syphilitic diathesis, which, however, generally gives rise to another form of choroiditis with exudation, which will be described in due course.

Treatment.—There must be in the first place a very careful inquiry into the casual indications, so that we may suit our remedies to the general condition. Having satisfied ourselves as to these, we must order absolute rest for the eyes. If the beginning of the disease has been acute, and especially if from the very commencement there be a central scotoma, mercury is urgently demanded (calomel and friction with mercurial ointment); diaphoresis in order to bring about the absorption of the exudation. The defect in vision often rapidly disappears. The local hyperæmia is best checked by blood-letting, by means of Heurteloup's artificial leech.

If the disease be of old standing, we must ascertain if there are any recent exudations, and if such are found to exsist, we must follow the same treatment as in acute cases. If the exudation has been absorbed, or if there only remain atrophic patches, mercurial preparations are of no benefit. We then try the effect of the application of Heurteloup's apparatus, succeeded by four-and-twenty to thirty-six hours rest, and where the vision is improved we repeat the application every six or eight days.

Our general treatment should be suited to the indications of the patient's state of health (iodide of potassium or of iron, sublimate).

Iritic and sclerotic complications should be treated according to the rules laid down when speaking of these diseases.

2. Disseminated Choroiditis.

By means of the ophthalmoscope we find whitish spots, about the size of a pinhead, situated near the posterior pole of the eye, or in the periphery; sometimes they are isolated, sometimes very closely united into groups, but separated from each other by deeply coloured margins. They are situated immediately behind the retina, and are formed by exudations which displace the pigment. Beside these small whitish spots we sometimes find more deeply coloured or reddish spots.

Disseminated choroiditis very readily spreads to the retina (chorio-retinitis) which loses its transparency; the vessels becoming hyperæmic and tortuous. A still more frequent and almost pathagnomonic com-

plication of this disease, is the formation of opacities in the vitreous body, in the form of fine granules, threads, or membranes. They appear suddenly and hide the fundus of the eye. In a short time they pass off, reappearing in the course of the disease.

The disturbance of vision is very considerable; sometimes the patients complain of a general mist, sometimes of a floating cloud which momentarily hides objects from them, sometimes of luminous apparitions (photopsia and chromopsia).

At other times, examination reveals the existence of peripheral contraction or central deficiency (scotoma) in the field of vision. When there is a large central scotoma the power of perceiving colours is diminished, and green is the first colour to be mistaken. When the exudations correspond with, or are in the neighbourhood of, the macula, the central visual acuteness is very greatly impaired, and objects seem to the patient to be deformed (metamorphopsia) or diminished in size (micropsia).

Progress and Termination.—This disease runs a chronic course with acute exacerbations. If properly treated from the first, it may pass off without leaving any trace; but it may steadily progress till there is atrophy of the choroid, which may also be brought about by frequent relapses. If the retina has been involved in the disease, we may have atrophy of that membrane also, and even of the optic nerve. Opacities of the vitreous body may remain after the primary disease has been cured.

Prognosis.—This depends on the stage of the disease, and the alterations which have been already produced. It is absolutely bad where there is atrophy of the choroid and retina, and very unfavourable if the macula has been the seat of exudation for any length of time. In recent cases, on the other hand, the prognosis is extremely good, for although the exudation may occupy the entire fundus, proper treatment will ensure its complete absorption, and the restoration of vision to its normal state. Relapses are frequent.

Ætiology.—In most cases, this disease is of syphilitic origin. It often supervenes at a longer or shorter interval after a syphilitic iritis and we have observed it also in children with hereditary syphilis, suffering at the same time from, or having been previously attacked by, parenchymatous corneitis.

Treatment.—When we have to deal with a diathesis, we must begin our treatment with anti-syphilitic remedies (inunctions or subcutaneous injections), using for two or three months small doses of the sublimate ($\frac{1}{12}$ grain daily), iodide of potassium (15 to 30 grains daily). The hyperæmia may be controlled with Heurteloup's apparatus, dry cupping, sinapisms, &c.

The liability to relapse renders it necessary that for a lengthened period we should carefully watch the condition of the eyes. According to the general condition of the patient, we should either follow a course of tonic treatment, or administer laxatives and diaphoretics.

Regular diaphoresis, induced by the subcutaneous administration of pilocarpine, and darkening the room which the patient inhabits, are often of the greatest service.

Absolute rest to the eyes, the use of smoked glasses, and careful management of the visual power, even for some time after complete restoration, are necessary if we would avoid dangerous hyperæmia and relapses.

If after recovery we find that vision is decreased, and if the defect seems to be stationary, we sometimes improve matters by a series (10 to 12) of strychnine injections in the temple.

3. Areolar Choroiditis (Förster).

This special form of choroiditis with exudation has for its anatomical characteristic the formation of prominent round specks in the choroid, above which the retina becomes atrophied. These specks are composed of a transparent, areolar and colourless tissue. To the ophthalmoscope their appearance varies with the stage of the disease. At first, they appear as black pigment spots, yellow at the centre, and surrounded with a red hyperæmic ring.

At a later stage, these spots become yellowish, are surrounded with pigment, and at the same time we have some very large atrophic patches, traversed by choroidal vessels, with here and there masses of pigment. The disease is always localised round the optic nerve, and in the neighbourhood of the macula.

This disease is only a special form of exudative choroiditis, and there is no other peculiarity either as regards its symptoms or treatment.

ART. II.—Choroiditis with Suppuration.

Suppurative choroiditis is anatomically characterised by the products of inflammation, which are deposited between the choroid and retina, or in the vitreous body.

Thus we see even with the naked eye a yellowish reflection behind the pupil, which comes from the altered vitreous body or separated retina.

Simultaneously the eye becomes hard, the pupil dilated and immobile. The lens and iris are pushed forward towards the cornea. Generally the morbid process is rapidly communicated to the anterior parts of the eye, where we find symptoms of purulent iritis with hypopyon, and even purulent infiltration of the cornea, which infiltration may more or less rapidly cause the destruction of that membrane. In the worst forms of the disease, we find from the very beginning a well-developed chemosis of the ocular conjunctiva, which surrounds and hides the cornea with its livid swelling, and may even project beyond the palpebral fissure.

The eyelids are red and swollen, especially the upper eyelid, which falls down over the inferior lid. The cellular tissue of the orbit becomes the seat of inflammatory infiltration, which determines the protrusion of the eyeball and renders it immobile.

Besides a burning pain in the lids and in the entire ocular region, increased by the slightest movement or touch, the patients complain of a deep-seated pain in the eye itself, with a feeling of distension and pulsation, and in the orbit they experience a pain which extends towards the occiput and throughout one side of the face and head.

Inflammatory fever, often intense, then accompanies the disease.

Vision is entirely destroyed.

It should however be observed, that the inflammatory symptoms are far from being of the same intensity in every case. General disturbance is sometimes very feeble and may be entirely absent, the lids and the conjunctiva being scarcely at all injected; the eyeball, only slightly tender and prominent, preserving its mobility; and the pain, which is not severe, being only felt periodically Notwithstanding the insignificance of the inflammatory symptoms, the formation of pus on the choroidal surface, in the vitreous body and in the anterior chamber, is in these cases very rapid and abundant.

Progress and Termination.—As a rule, very acute suppurative choroiditis rapidly attains its maximum; rarely it takes several weeks, involving one after the other all the structures of the eyeball (*phlegmon of the eye*). Sometimes the inflammation then subsides, and the ball imperceptibly atrophies. More commonly the suppuration is prolonged till it produces rupture of the eye, either through the cornea or distended sclerotic. The purulent matters, and frequently part of the contents of the eye, escape, and from that moment the severe pain and inflammatory symptoms decrease and in time disappear. Suppuration also after a short time ceases, and the eyeball atrophies.

Sometimes the perforation becomes reclosed, the purulent products re-accumulate in the interior of the eye, the increased tension of the ball and the pain reappear, and only cease when a fresh perforation

allows the pus to escape freely from the eye. In any case the ultimate termination is an atrophic stump.

The atrophic stump, irregular in form, is about the size of a hazel-nut. It is sunk deeply in the orbit, which, in young persons, may become contracted after the atrophy of the eyeball. The lids, having lost their normal support, become closed and retracted into the orbit.

The interior of the stump contains remains of the choroid and disorganised retina, fibrous tissue mixed with amorphous organic matter, calcareous deposits, and occasionally true osseous formations. The stump is, as a rule, painless, and supports, without the least inconvenience, the wearing of an artificial eye.

In some cases, it becomes periodically the seat of inflammation, of intraocular hæmorrhage, and even of fresh purulent effusion.

Prognosis.—The loss of the functions of the eye, and even of its form, being the natural sequence of this disease, the prognosis is absolutely bad.

Ætiology.—The most frequent causes of choroiditis with suppuration are injuries, such as contusions of the eyeball, wounds, burns, the penetration of foreign bodies, operations for cataract, staphyloma &c. Displacement of the lens, which when displaced acts as a foreign body, or suppuration of the cornea producing destruction of that membrane, may also be the cause of this disease. Suppurative choroiditis has also been observed as a consequence of serious diseases affecting the system, such as meningitis, typhoid fever, malignant pustule, puerperal fever, pyæmia.

Treatment.—If the disease be the result of some irritation, such as is caused by the presence of a foreign body in the eye, dislocated lens, &c., this source of irritation must be removed as soon as possible. If we think it possible to arrest the progress of the affection, we may try an energetic course of mercury, which, however, is of no further use if suppuration once begins.

We must check the inflammatory symptoms, in the early stages, by blood-letting and cold compresses; and relieve the tension of the eye by repeated paracentesis of the anterior chamber.

As soon as suppuration sets in, we must try to lessen the patient's suffering, and cut short, as far as possible, the duration of the disease. Narcotics and hot compresses, but, first of all, a free incision to give issue to the purulent matters, fulfil these indications. Enucleation of the eye should not be attempted whilst the cellular tissue of the orbit is inflamed, for it has been followed by suppurative meningitis, terminating fatally. This operation or the evisceration of the eyeball is indicated only when the eyeball becomes the seat of a prolonged suppuration which threatens the life of the patient, or when we cannot

otherwise remove a foreign body which has penetrated the eye and becomes the cause of a sympathetic affection in the other.

Whilst the disease lasts, we must remove from the patient everything which could injure his eye or general health.

We should make him lie down in a dark room, which can be easily aired, and we should order a regimen suited to his state of health.

ART. III.—Atrophic Choroiditis.

The process which is the cause of this disease produces on one hand atrophy of the choroid, and on the other a softening or thinning of the sclerotic. Hence arises a disturbance of the equilibrium between the intraocular pressure and the resistance of the fibrous envelope, which yields and becomes ectasic, forming one or several staphylomata varying in position.

1. Sclerotico-choroiditis Anterior.

(Anterior Staphyloma.)

The intensity of the symptoms varies with the degree of acuteness with which the disease sets in. We find a general pericorneal injection, which surrounds the cornea with a rose-coloured zone. This injection is, as a rule, more marked in a limited portion of the circumference, where it extends more towards the equator of the ball; this portion is raised slightly above the level of the surrounding tissue. At the same time, the iris changes its colour and dilates slowly and irregularly, so that the pupil is slightly dilated, more markedly so near the most intensely injected portion of the corneal margin. In the position of this irregularity of the pupil, we see hyperæmia of the vessels of the iris and sometimes adhesions of the pupillary margin to the capsule of the lens; the aqueous humour becomes muddy, the anterior chamber is deeper, and the tension of the eye seems to be increased. Not unfrequently we find opacity of the cornea in the inflamed region.

After some time the curvature of the sclerotic round the cornea becomes modified, and the anterior part of the eyeball seems to be elongated, or part of the sclerotic begins to extend.

The swelling or swellings, for there are often several at the same time, are most frequently situated at some distance from the margin

of the cornea, at the spot where the anterior ciliary arteries perforate the sclerotic. This is the thinnest portion, and its resistance is diminished by the great number of canals which give passage to the vessels, and which, during the inflammatory period, are still further dilated. At a more advanced stage of the disease, the swelling takes the appearance of a slaty-bluish projection, due to the choroidal pigment showing through thin and softened sclerotic. The inflammatory symptoms then disappear, the white of the eye is traversed in all directions with varicose veins, and we have now to deal with an anterior sclerotico-choroidal staphyloma.

The pain, scarcely felt when the disease runs a slow course, may be very intense when it is rapidly developed. In addition to these ciliary pains, the diseased portion is painful to the touch.

Any disturbance in the visual function is due to alteration in the aqueous and vitreous humours, a common occurrence in this disease, to symptoms of progressive myopia (caused by elongation of the antero-posterior axis of the eye), or to the apparition of flashes of light or sparks (due to the compression of the optic nerve).

As the staphylomata increase in size and number, vision decreases, and is ultimately destroyed.

Anterior staphylomata present, according to their form and position, numerous varieties. Thus, they are found at the equator of the eyeball, or near the margin of the cornea, in the free space between the insertions of the recti muscles, or again at the circumference of the insertion of the iris. In this position there may be several of these ectasias, which become united into a single projection encircling the circumference of the cornea. This form of annular staphyloma may also be produced when the sclerotic has been thinned all round by the intraocular pressure, and distends circularly. In consequence of the general distension, the suspensory ligament of the lens (the zonule of Zinn) may be ruptured, and the lens itself dislocated; or again, the iris, being attached to the lens in some cases by adhesions, may be torn from its ciliary insertion. As to the staphyloma itself, its wall is formed by the modified sclerotic, which is very thin, and so distended that its fibres are separated from each other by small spaces. In these spaces we find deposits of choroidal pigment. The choroid is completely atrophied, so that there remains only a very thin pellucid membrane, which is closely adherent to the sclerotic. As to the retina, it may be in one of several conditions: sometimes it is atrophied and adherent to the base of the staphyloma, sometimes it forms a bridge at its base, or floats in its cavity. This cavity is filled with a fluid which resembles fluid aqueous humour. Again, the entire vitreous humour is often temporarily muddy or fluid in its anterior part.

In the neighbourhood of the staphyloma, the sclerotic shows signs of serous infiltration, the choroid signs of atrophy (irregularities of the pigment).

The vessels and nerves participate in the alterations of the diseased parts, and in the position of the ectasia are completely atrophied. This is the reason why, in the parts corresponding to the staphyloma, the cornea loses its sensibility and the iris its mobility.

Progress and Termination.—Sclerotico-choroiditis anterior is seldom acute; more frequently it is so insidious that the attention is

only aroused by the formation of an ectasia. Whenever this is formed the inflammatory symptoms disappear almost entirely, and the disease seems to be at an end.

It may indeed stop at this point, but more frequently there is before long a fresh inflammatory attack with the formation of a second staphyloma, or the enlargement of the first.

After a certain number of exacerbations, the disease may end in complete atrophy of the choroid, the eyeball preserving its distended form or becoming atrophied. We have also seen rupture of an isolated staphyloma (from injury, or spontaneously from excess of intraocular pressure), accompanied with the escape of the contents of the ball, and deep hæmorrhage followed by suppuration and atrophy.

Prognosis.—The prognosis is serious, for the disease is never cured entirely; we can only hope to arrest its progress if we meet it at its outset.

Not seldom it produces partial loss of vision and deformity of the eyeball.

Ætiology.—Although there seems to be no doubt that anterior ectasia of the sclerotic is, in almost every case, due to sclerotico-choroiditis—*i.e.*, to an inflammatory and an atrophic affection of the choroid, accompanied with softening of the sclerotic, there is great uncertainty as to the causes of this inflammation.

In young persons, in whom it most frequently occurs, it has been attributed to a lymphatic or scrofulous diathesis; in older people the sclerotic offers a greater resistance to the intraocular pressure.

Treatment.—In the early stages of sclerotico-choroiditis anterior, our treatment should be actively antiphlogistic; we should use the artificial leech, and, if the disease is very acute, we should give small doses of calomel, and mercurial frictions. In cases in which we have performed peritomy, we have seen this operation exercise a favourable influence on the course of the disease. At a later period peritomy is still beneficial in removing opacities of the cornea. If the affection has become chronic, we may give small doses of the sublimate, and administer remedies which increase more especially the functions of the skin, intestines or kidneys, according to the special indications of each case. If there be symptoms of serous iritis, or if the tension of the eye be increased, we must instil pilocarpine, or, in cases where there is posterior synechia, atropine; repeatedly performing paracentesis of the anterior chamber, and even iridectomy, by which we sometimes prevent or delay the formation of staphyloma.

Our general treatment must be suited to the state of the patient's health.

If staphyloma has once developed, it can only be removed by an

operation. Small ectasias of recent origin sometimes yield to iridectomy, or to the prolonged use of a compress and bandage combined with repeated paracentesis of the anterior chamber. Well-developed staphylomata have been operated on by simple incision with consecutive pressure, or by partial excision, or again by total removal. But these operations are not without danger, because they are often followed by severe hæmorrhage and suppuration. An attempt has been made to obviate such accidents by the preliminary application of ligatures; but there is always great risk of intraocular hæmorrhage, whenever the eyeball presents any considerable degree of hardness.

With the view of ridding the patient of the deformity, and of enabling him to wear an artificial eye, shrinking of the distended and blind eye has been induced, either by repeated paracentesis of the sclerotic, or by piercing the eye with a silken thread (*von Graefe*).

Again, when circumstances in the general condition of the patient or in the eye make it desirable to put a speedy termination to the disease, it is better at once to enucleate the eye by *Bonnet's* method.

2. Sclerotico-choroiditis Posterior.

(Posterior Staphyloma).

This disease, which is very common in myopic eyes, is easily diagnosed from its very beginning by the ophthalmoscope.

We find choroidal atrophy, which is recognised by the existence of a whitish patch of crescentic form, with its concavity resting on the margin of the optic nerve (Fig. 80).

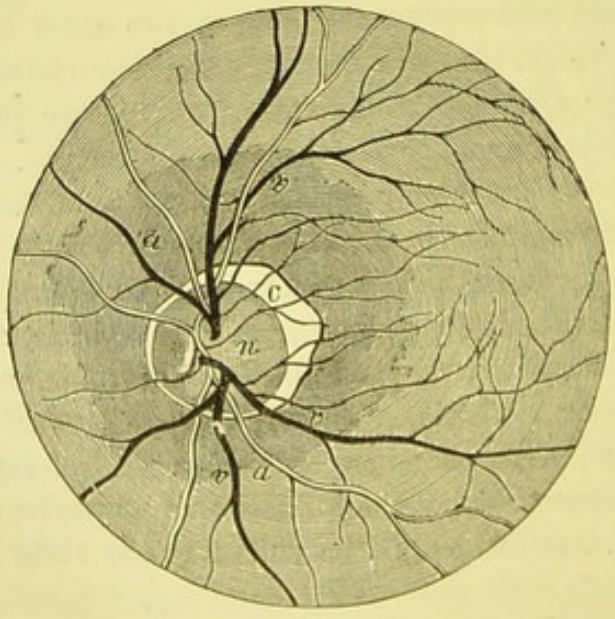


Fig. 80.

If we see the disease at its very beginning, we find, on ophthalmoscopic examination, that the choroidal pigment in the neighbourhood of the optic nerve has begun to disappear; in this situation the fundus of the eye is brighter, and the choroidal vessels are easily seen. These are larger than those of the retina, and are surrounded by greyish patches. The patches grow whiter and whiter, the vessels disappear, and the white crescent, characteristic of choroidal atrophy, is formed; the whiteness is due to the direct reflection of light by the denuded sclerotic.

The retinal vessels pass freely above these spots.

When the atrophic process has stopped, the external margin of the white patch is bounded by a very regular curve which separates it from the normal tissue (circumscribed atrophy). On the other hand, when the disease is progressing and involving the surrounding structures, we find an irregularity of the pigmentation preceding the atrophy, and by slow degrees the patch extends. Its contour is irregular, and often in a large patch we find several concentric circles, bounded by streaks of pigment, each of which marks what has at some past period been the external limit of the atrophy.

The atrophic crescent is most frequently situated to the outer side of the optic nerve, sometimes below it and more rarely above it, but it has been known to extend in all three directions, in trefoil form, and cases have been seen in which it surrounded the optic papilla like a ring.

When the staphyloma has attained a certain degree of development, the optic papilla is no longer fairly opposite the observer. It seems to be oval and narrower when the atrophy extends laterally, broader when it extends above or below. At the point where it touches the ectasia, the papilla is sometimes cupped, especially if there previously existed a more or less deep physiological depression. Apart from these changes, the nerve is often hyperæmic, above all while the disease is progressive.

Atrophy of the choroid and ectasia is not always confined to the immediate neighbourhood of the optic nerve; we also see it, with the characteristics already described, in other parts of the fundus—*e.g.*, in the neighbourhood of the macula, where it extends towards the papilla. Very rarely, we see, in the neighbourhood of the staphyloma or of the macula, reddish spots in the choroid, which indicate hæmorrhagic effusions in that membrane.

Besides the symptoms furnished by the ophthalmoscope, which indeed are the most characteristic, the presence of a staphyloma is also indicated by the following signs :—

1. The eye becomes myopic, or if myopic, the myopia increases

during the progressive period of the disease. This change is due to the elongation of the antero-posterior axis of the eye by the formation of the sclerotic ectasia (consult the chapter on Myopia).

2. The eyeball becomes ovoid in shape, as may often be seen on simple inspection; it protrudes, and on making the patient turn his eye inwards, we see that the sclerotic has lost its normal curvature towards the equator, and that the conjunctival fold has become effaced; in well-marked cases we can distinguish, near the posterior pole, the bluish prominence of that part of the sclerotic which forms the staphyloma.

3. The eyeball loses its mobility, in consequence of the posterior ectasia coming in contact with the walls of the orbit in lateral movements of the eye.

Again, since myopic persons can only see distinctly near at hand, they must make strong efforts of convergence, and the internal recti muscles are therefore kept in an almost constant state of contraction. These muscles thus lose their extensibility, and therefore prevent the eye from turning outwards to a normal extent.

In other cases, when the disease makes rapid progress, and consequently there is a great increase in the amount of myopia, the converging power of the internal recti does not increase correspondingly in the same length of time; there is thus an insufficiency of these muscles, which become incapable of maintaining the requisite convergence of the eyes, and a divergent strabismus may be the result (see chapter on Divergent Strabismus).

As to the anatomical characteristics of posterior staphyloma, they are perfectly similar to those described under anterior staphyloma.

Subjective Symptoms.—In the first place, the patients are annoyed by the progressive development of the myopia; this feature is specially noticed if their refraction was previously normal, or, as more rarely happens, hypermetropic. Later, they complain of fatigue following any prolonged use of the eyes, of dazzling, and of *muscæ volitantes*. More rarely they complain of true photopsia, which is due to the dragging of the retina. Again, as the eyeball elongates, the retina is put on the stretch, and its functions are altered, so there is a diminution of the visual acuteness. This is more markedly the case if the alterations are in the neighbourhood of the macula, for we then have a central scotoma, and the patients see better to the side than in front.

Any other disturbance of vision depends on the opacities of the vitreous body which frequently occur in this disease. Indeed, it is rare that we do not find with the ophthalmoscope secondary alterations of the vitreous body, in the course of a sclerotico-choroiditis, either in

the form of isolated opacities, more or less mobile according to the degree of fluidity of the humour, or, less frequently, as a diffuse haze, in which we can however distinguish membraneous shreds. The shadows of these opacities projected on the retina, often appear to the patient like cobwebs, flies, or dark spots of various forms.

Even where there is no loss of transparency, the vitreous almost always loses its consistence. This liquefaction in many cases is confined to the posterior portion, but it may become general.

In a more advanced stage of the disease the lens presents opaque, isolated striæ, or circumscribed opacities at its posterior pole, which opacities may remain stationary, or may involve the whole lens.

Exception made of the macula and its neighbourhood, the appearance of the retina is not changed either at the seat of staphyloma or in any other part; but, notwithstanding this apparent integrity, we find the functional disturbances which have been already mentioned.

The defects in the visual field, which careful examination discovers, depend on enlargement of the blind spot,* on the alterations of the macula, which produce central scotoma, or on some other complication of the disease, such as separation of the retina or glaucoma.

Glaucoma in such cases is due to the greater resistance of the sclerotic, which becomes more rigid with advancing years. If then the intraocular pressure increases, the optic nerve affords the least resistance, and the pressure acting on it causes glaucomatous excavation (consult the chapter on Glaucoma). Amongst the other symptoms we find retraction more or less rapid of the field of vision.

The separation of the retina, to which the progressive distension of the ball (yielded to less by the retina than by the other membranes) has rendered the patient liable, is due to an effusion of serum or of blood on the internal surface of the choroid. This complication of sclerotico-choroiditis posterior is one of the most disastrous, for it in great part destroys the visual functions of the eye, and it may supervene on both sides, if the other eye is similarly affected with progressive sclerotico-choroiditis.

Patients rarely complain of violent pain in the course of this disease. They suffer rather from a feeling of tension, from orbital neuralgic pains, especially after prolonged visual efforts, and in such cases we often have symptoms of irritation and hyperæmia—*e.g.*, slight pericorneal injection and redness of the optic papilla.

* In each eye attentive exploration of the field of vision may find at a certain distance from the fixed point, and on its external side, a small defect known since Mariotti's celebrated experiment under the name of the *blind spot* (*punctum cæcum*). This defect corresponds to the entrance of the optic nerve into the eyeball, the optic papilla being insensible to light.

Progress and Termination.—Sclerotico-choroiditis posterior, without showing any well-marked inflammatory symptoms, often follows a progressive course. The patient recognises this by the increase of the myopia, and the surgeon by the ophthalmoscopic symptoms already indicated. It may, however, come to a standstill, after a period of development, and remain stationary. In other cases, after a longer or shorter period of quiescence the process may begin again, and may be renewed from time to time. With each fresh attack, the ectasia of the sclerotic, the myopia, and the functional disturbance increase. In fine, by the complications which we have described, vision may be entirely destroyed, the retina and optic nerve being atrophied. The same result may ensue from absolute glaucoma, or from separation of the retina, causing the formation of a calcareous cataract, and gradual softening of the eyeball.

To repeat, we must distinguish three forms of this disease—(1) stationary, (2) periodically progressive, (3) continuously progressive.

Prognosis.—The prognosis is favourable when the disease is limited to the region of the optic nerve, and when it is of small extent and stationary. It is not bad if the progress of the disease be slow, and if the patient be in circumstances to follow the directions as to treatment indispensable if the disease is to be checked. The progress of the disease may be stopped at any stage by appropriate treatment. It is true that a high degree of myopia is always an aggravating circumstance which demands special attention. Moreover, central scotomas generally remain. The prognosis becomes very serious when a large part of the fundus is involved in the disease, when the disease makes rapid progress, and especially when there already exist any of the more serious complications—*e.g.*, separation of the retina.

Ætiology.—The causes of this disease have not been completely elucidated. It is, however, beyond doubt that in the great majority of cases the predisposition is to be found in the special formation of the eye, which formation seems to be hereditary, and is also the primary cause of the myopia.

This congenital predisposition consists in an arrest in the development of the sclerotic in the region of the optic nerve, where in the first period of fœtal life this membrane presents a solution of continuity (sclerotic hiatus of *Ammon*). We must also remember that in this same region the sclerotic is pierced by a number of canals which give passage to the ciliary vessels, and that it is not strengthened, as other portions of the membrane are, by the tendinous expansions of the muscles.

Again, to some extent the disease may be due to the antagonistic action

of the oblique muscles on one hand, and of the internal recti muscles on the other (*Giraud-Teulon*). This antagonism seems to promote the separation from each other of the two envelopes of the optic nerve, which by their union form the sclerotic.

Given these circumstances as considerably diminishing the resisting power of the sclerotic to internal pressure, and as therefore explaining the formation of a sclerotic ectasia in this situation, we must nevertheless have special causes for the development of the disease which we are discussing, for it is far from being developed in every case where this predisposition exists.

These causes must be sought in everything which promotes active or passive congestion of the eyes, for such congestions determine a hypersecretion of the internal fluids. In other words, an intraocular hypersecretion is the characteristic of sclerotico-choroiditis posterior, and on this account it may be classed with the hydrophthalmiæ. Although the anatomical changes observed in this disease are simply atrophic, their origin is a serous inflammation with functional disturbance of the choroid.

Amongst the causes of ocular congestion, we may mention prolonged efforts of accommodation, which in myopic persons are associated with a bent position of the head, and efforts of convergence, which are all the more hurtful inasmuch as the internal recti muscles do not always possess sufficient power to maintain the convergence.

In addition to these causes we have also general conditions of the circulation.

This disease is most frequently met with in myopic persons and those whose occupations demand close attention on near objects, but we observe also isolated cases with country people where none of these causes exist. We can easily understand that the risk of development of the affection under consideration is much greater if the myopia is complicated with weak vision (from corneal or lenticular opacities), or if the person wears too strong concave glasses, and requires to counteract their effect by efforts of accommodation.

Treatment.—In the progressive period of the disease, characterised by increase of the myopia, irregularity in the choroidal pigment, neuralgic pains and sub-conjunctival injection, we must employ antiphlogistic remedies. Repeated application of Heurteloup's leech in the evening, with rest in a dark room for at least twenty-four hours, is often followed by an immediate improvement of the visual acuteness.

Along with this we order diuretics, mild cathartics or sudorifics, according as one or other of the functions on which these remedies acts requires stimulation. We also give cold irrigations or douches to the eyes, and apply sinapisms to the limbs.

During the whole course of treatment the eyes must be kept at perfect rest; and, in order that there may be no effort of accommodation, it is well to use atropine for some weeks or months (*Schiess*).

If the alterations in the choroid are very extensive, we may advantageously administer small doses of the sublimate.

When the disease has become stationary, we must warn the patient to be careful in the use of his eyes, limiting the time given to reading and writing, advising him to rest his eyes every now and then, if only for a few moments. We must tell him to avoid every stooping posture of the head and body during work, to avoid insufficient light, as well as everything which may favour congestion of the head and eyes—*e.g.*, cold extremities, constipation, clothing tight at the neck, excesses of the table, &c.

The use of concave glasses should be in accordance with the directions which will be given in speaking of myopia, and dazzling sensations must be checked by blue or smoked glasses. The serious complications of the vitreous require the same treatment as the disease itself in its progressive form. Increase in the tension of the eye, especially if accompanied with glaucomatous excavation, should be stopped by iridectomy.

If there be senile cataract in an eye affected with sclerotico-choroiditis posterior, we must make a careful examination to ascertain the presence of central scotoma, or of a detachment of the retina behind the cataract.

This last complication is all the more likely to exist if the cataract has been rapidly formed, if there are calcareous deposits, and if the patient has not attained the age at which senile cataracts generally form. If we are satisfied that there is no complication of this nature, we may extract the cataract.

Again, our attention should be directed to the condition of the internal recti, for muscular insufficiency may contribute to the development of the disease, as it forces the patient to make special efforts.

In our chapter on muscular asthenopia we shall have to speak as to the methods of detecting and correcting muscular insufficiency.

ART. IV.—Choroidal Apoplexy.

To the ophthalmoscope this disease is characterised by irregular red spots, varying in size, form and colour with the quantity of blood effused.

They may be very easily distinguished from retinal hæmorrhages,

which, when they are small, assume a striated form, and are almost always found in the course, or in the neighbourhood, of a retinal vessel. These vessels, on the other hand, pass clearly above hæmorrhagic spots of the choroid.

The difficulty in vision varies with the seat of the apoplexy; it is insignificant if the apoplexy is near the equator of the eye, more pronounced if it is in the neighbourhood of the posterior pole, especially if the blood penetrates to the external layers of the retina. Moreover, in such cases vision is much more frequently influenced by effusion into the vitreous body or into the retina.

The effused blood on the internal surface of the choroid may cause separation of the retina, or it may pierce through the retina into the vitreous body, or, after a considerable time, it may be absorbed.

During absorption the apoplectic spot changes its colour, becoming yellowish, and leaving a permanent white atrophic spot with a border of black pigment.

These hæmorrhages are often of traumatic origin, being due to contusion of the eye or of its neighbourhood.

Sometimes they accompany acute choroiditis or sclerotico-choroiditis posterior, or are due to general affections of the circulation (diseases of the heart, arterio-sclerosis, dysmenorrhœa, &c.)

The **treatment** of this disease depends on the precise cause of the hæmorrhage, which by itself does not afford any indication for special treatment.

ART. V.—Rupture of the Choroid.

At the moment when rupture of the choroid takes place, it is generally accompanied with more or less abundant hæmorrhage, which prevents the direct diagnosis of the lesion.

As the blood is absorbed, we can, on ophthalmoscopic examination, recognise rupture of the choroid by the presence of a band which is at first yellowish, but afterwards becomes white, and is limited by a pigmented border. In most cases we find these ruptures not far from the optic nerve, surrounding part of the papilla; but it is probable that they also exist in the anterior periphery of the choroid, causing hæmorrhage into the vitreous body.

The retinal vessels pass over the band if the retina itself be uninjured.

The disturbance of vision depends on the intensity of the lesion,

which may simultaneously produce hæmorrhage in the anterior chamber and vitreous body.

In other cases, we may have, as a consequence of the rupture, inflammation of the choroid and retina. Nevertheless, vision, which is at first much affected, may be gradually re-established and regain its normal condition. Even in such cases we must give a guarded prognosis, for the contraction of the cicatricial tissue has been known to produce separation of the retina at a later stage (*Saemish*).

The **treatment** should be antiphlogistic in the early stages—leeches, compress and bandage. We must carefully watch the injured eye for some time, on account of the choroiditis which may be developed.

For the same reason, the eye must be kept at rest for a long period. Injections of strychnia may be of use when, after the wound has healed, the visual acuteness remains impaired.

ART. VI.—Detachment of the Choroid.

This disease has till now been rarely observed with the ophthalmoscope.* By its means a more or less developed spherical prominence is seen in the fundus of the eye projecting into the vitreous body.

Its smooth surface is free from folds, and on the top of it are seen the retinal arteries and veins. Beneath the retina we see the choroid, with its vessels and intervascular spaces.

The colour of the prominence is yellowish, but it is sometimes modified by hæmorrhage or deposits of pigment. Detachment of the choroid is distinguished from detachment of the retina by the immobility of the detached structures during movements of the eye.

The disturbance of vision is, as a rule, very great, and vision is ultimately entirely destroyed by separation of the retina. The disease ends in irido-choroiditis, softening and atrophy of the ball.

Choroidal separation is due to an effusion of serum or blood between the sclerotic and choroid, or to the development of a tumour which has its origin beneath the choroid. In this last case, the affection is almost always accompanied, at one period or other of its course, with symptoms of glaucoma, which are entirely absent if the separation be due to exudation or liquid effusion.

It may be admitted in general that this disease cannot be made the object of any special treatment, and that the indications are those of the primitive affection which causes it.

* V. Graefe's *Archiv f. Ophthalm.*, iv., 2, p. 226. *Liebreich*, Atlas of Ophthalmoscopy, Tab. vii., fig. 4. Iwanoff, in Graefe's *Archiv*, xi., 1, p. 191; and xv., 2, pp. 15, 46. V. Ammon, Stellwag, Virchow, Knapp.

ART. VII.—Tubercles of the Choroid.

Tuberculosis of the choroid was first observed in isolated cases by *Autenrieth* (1808), *Ed. Jaeger, Manz, Busch;* then in great number by *Buchut. Cohnheim* has proved by numerous anatomical sections that it is almost constant in miliary tuberculosis. *Von Graefe* and *Leber* have given a detailed ophthalmoscopic description.

Tubercles of the choroid vary in number from one to fifty; sometimes they are found in one eye only, sometimes in both. They appear as little round spots, slightly prominent, of a rose or greyish colour, and varying in size from $\frac{1}{3}$ of a millimetre to $1\frac{1}{2}$ millimetre. They are distinguished from similar affections of the choroid by their regular round form, and by the absence of a pigmented border. They are, as a rule, situated near the optic nerve and macula, and do not extend to the periphery unless they are present in great numbers.

Whilst it may be said that the eyeball is one of the last organs to be affected in cases of general tuberculosis, a few cases have been published of tuberculosis of the choroid existing before the appearance of the general disease.

ART. VIII.—Tumours of the Choroid.

Almost all the tumours of this membrane are sarcomata, sometimes mixed with carcinomatous elements; exceptionally we meet also true carcinomata. These neoplasms almost always contain abundant pigment (melanotic).

The ophthalmoscopic appearances vary, according as the tumour begins in the posterior part of the eye or near the ciliary body. In the latter case, we see brownish-coloured prominences, which advance into the vitreous body behind the lens, or displace it and make their appearance at the periphery of the anterior chamber.

When the tumour originates in the choroid, the serous effusion on its surface very soon produces separation of the retina. This separation masks the tumour; but, as the tumour grows, it reaches before long the separated membrane, and, if that has retained its transparency, we may distinguish behind it the smooth or nodulated tumour of the choroid, of a brownish or blackish colour according to the amount of pigmentation. When the sarcoma is poor in pigment, and the layer of fluid separating it from the separated retina very thin, we may, with an intense ophthalmoscopic light, distinguish the vessels of the tumour (*Becker*).

In other cases, the retina becomes thickened, undergoes fatty degeneration, and then furnishes a yellowish reflection.

But this reflection has not the opalescence of gliomatous tumours of the retina, nor does it show the rose-coloured tint which gliomata do when they are highly vascular.

A very important symptom in the diagnosis of choroidal tumours is the increase of intraocular pressure which accompanies their early stages, or at least the reaching of the separated retina by the neoplasm. We then observe all the symptoms of chronic glaucoma—viz., hardness of the ball, dilatation and immobility of the pupil, insensibility of the cornea, shallowness of the anterior chamber, dilatation of the subconjunctival veins, and, if it be still visible to the ophthalmoscope, excavation of the optic papilla and the formation of posterior sclerotic ectasia.

Simultaneously, the patients complain of sharp, shooting pains in the forehead and head on the same side as the diseased eye, and these pains periodically undergo great exacerbations. Sometimes true acute glaucoma supervenes. This has been several times observed after instillation of atropine. As a rule, the lens becomes opaque.

This condition may last till the tumour pierces the sclerotic. At other times a second focus is developed simultaneously in the fundus of the orbit, causing exophthalmos and a certain amount of immobility of the eye. Again, the disease may end in the ulceration and perforation of the cornea, either from the insensibility of that membrane, or from the excess of intraocular pressure.

The destruction of the cornea gives rise to a purulent panophthalmitis, and the eye atrophies as far as the presence of the tumour permits it. An eye thus atrophied is distinguished from an ordinary stump by the following particulars:—It is the seat of spontaneous, violent and periodic pains, whilst it is almost insensible to palpation. Moreover, the stump is of a special form, flat from before backwards; it preserves its equatorial diameter, and thus shows in a characteristic way on its anterior surface the depression produced by the insertion of the four recti muscles.

Again, as the atrophied eye prevents the neoplasm from growing forwards, it takes a retro-bulbar direction, pushing the eye in front of it so that the eye cannot shrink into the orbit as such eyes generally do.

These tumours spread to the parts beyond the eyeball; either by perforation of the sclerotic, generally anteriorly; or by the formation of neoplasms in the posterior portions of the periphery of the eyeball without perforation of the sclerotic, which remains intact; or the sarcomatous degeneration begins on the surface of the internal sheath of the optic nerve and in the neurilemma of the secondary fibres.

All tumours of the choroid must be looked upon as malignant, likely

to form secondary foci of disease, liable to recur if removed, and most probably ending in death.

They are rarely met with before the age of thirty, and never before the age of ten. They have never been observed to occur in both eyes.

The rate at which they grow is very variable; some have been watched for ten years, which, at the end of that time, did not fill the eyeball. In other cases, after the lapse of only a few years, they are found in other parts of the body.

The only treatment for these tumours is to remove them as soon as possible. This rule is of greater value when the tumour is still confined to the eye, and there are no symptoms of a general diathesis. If, however, there are such symptoms, any operation will soon be followed by a recurrence of the disease in other portions of the body; surgical interference in such circumstances seems even to accelerate the general progress of the disease.

When the eye only is affected, we enucleate the eyeball by *Bonnet's* method. With the view of dividing the nerve as far back as possible, a matter of no little difficulty after the enucleation, because of the retraction of the tissues, *von Graefe* has proposed to begin the operation with section of the optic nerve; and by adopting the following method we may easily succeed in cutting the nerve near the optic foramen.

Taking hold of the eyeball with fixation forceps, and drawing it well forwards and outwards in the direction of the axis of the optic nerve, we introduce a neurotome, of proper shape, along the external orbital wall, till it reaches the bottom of the orbit. The optic nerve is then cut at a few lines from the optic foramen; the nerve, being very tense, is easily divided by the blade.

When the neoplasm has extended beyond the eyeball to the orbital tissue, it is absolutely necessary to remove all the tissue affected. We begin the operation by extending the external palpebral angle by an incision made with a bistoury. Then, having fixed the eye with fixation forceps, we dissect the lids, separating them from the internal surface of the eyeball, and turning them upwards and downwards. We next remove the entire eyeball, and then by degrees all the orbital tissue affected by the disease. We must carefully examine the orbital cavity, and wherever we find diseased tissue, it must be thoroughly removed down to the bone. If necessary, we scrape the periosteum, and may perhaps be compelled to remove a portion of the bone forming the orbital wall.

The hæmorrhage, which is sometimes considerable, may be checked by iced-water injections and by plugging. The external commissure must then be united by simple sutures.

ART. IX.—Ossification of the Choroid.

Osseous tissue has often been observed in atrophied eyes. It arises from the deposition of calcareous salts in the cellular tissue of the choroid. Sometimes only a few bone corpuscles are found on the internal surface of the choroid; sometimes there exists a true osseous shell, extending from the optic nerve to the anterior portions of the eyeball, and even to the ciliary body.

This osseous change of the choroid in atrophic eyes may become a source of acute pain, spontaneously or on the eyeball being touched; the risk of a sympathetic inflammation in the other eye then demands the immediate enucleation of the atrophied one.

ART. X.—Congenital Anomalies of the Choroid.

1. The deficiency in the choroid, known as **choroidal coloboma**, is generally attended with a similar anomaly of the iris in the inferior portion of the eye. Coloboma generally begins in the immediate neighbourhood of the optic nerve, and ends at some distance from the ciliary body. Sometimes there is also a deficiency of the ciliary body, and there may even be a furrow on the lens. Sometimes the whole eye is affected with microphthalmia. We observe, also, more or less extended colobomata, oval and exactly limited to the macular region; they are considered as remains of the chloroidal fissure.

To the ophthalmoscope, the part where the choroid is deficient gives the white reflexion characteristic of the sclerotic. On this white patch we find traces of pigment and of the choroidal vessels: its border is highly pigmented.

The sclerotic at the coloboma presents an irregular ectasia. As to the retina, sometimes it also is absent, and, in place of these two membranes, viz., the choroid and retina, we find the sclerotic covered with a thin structureless layer. At other times, the retina, although thin, is normal, and covers the entire extent of the ectasia, or passes over it in the form of folds.

According to one or other of these conditions, the vessels of the retina are seen with the ophthalmoscope to follow a different course; sometimes they stop when they reach the coloboma, and then proceed along its margin; sometimes they are seen to cross over the coloboma,

forming at the margin of the ectasia a bend, which varies in depth with the depth of the ectasia. Having entered it, they are seen at the various levels of the ectasia. But again, the vessels may be in close connection with the ectasia of the retina, showing as many interruptions as that membrane has folds.

When the extremity of the coloboma does not extend to the optic nerve, the papilla appears in its usual form, or with a small cone, or even a small coloboma of its sheath. The papilla, oval in the horizontal diameter, can be distinguished from the coloboma only by its rose-coloured tint. In a few cases, coloboma of the choroid has been found in both eyes.

This anomaly is accompanied with a defect in the field of vision and a certain degree of amblyopia and myopia.

2. **Albinism**, or the congenital absence of pigment in the choroid, is met with in very varying degrees. The scarcer the pigment, the more distinctly do we see with the ophthalmoscope the choroidal vessels with their finer branches and the vasa vorticosa. Persons affected with albinism suffer greatly from a bright light, and therefore seek a dim one, in which they can see objects distinctly only on bringing them very near. Thus, in such cases, we have a development of myopia with a certain amount of amblyopia. The higher degrees of albinism, in which the epithelial cells and parenchyma of the choroid are almost devoid of pigment, are always accompanied with nystagmus.

This anomaly has been often observed in several members of the same family and seems to be hereditary.

We can do nothing more than relieve persons affected with albinism by prescribing blue or smoked glasses, which diminish the intensity of the light.

CHAPTER V.

GLAUCOMA.

GLAUCOMATOUS affections are characterised by increase of the intraocular tension, which excess of pressure gives rise to the following phenomena:—

1. The eyeball becomes harder and firmer; the existence of this hardness may be proved by the sense of touch or by various instruments, such as the tonometers of *Donders*, *Dor*, *Weber*, *Priestley Smith*, *Maklakoff*, but these instruments are not in very general use, because they are somewhat difficult to apply.

Bowman has proposed to represent the word tension by the letter T, and normal tension by Tn. If the tension is increased, he represents the various degrees by T + 1, T + 2, T + 3. But if, on the other hand, it is diminished, he represents it by T − 1, T − 2, T − 3.

When there is any doubt as to tension, it may be represented by T (?).

2. The anterior chamber becomes shallower, because the iris and lens are pushed forward. The lens may become less convex by the tension of its ligament, and this condition explains the fact that the eye becomes slightly hypermetropic. Less frequently it becomes myopic by the advancement of the lens.

3. The ciliary nerves lose their conductility from the excessive pressure, and thus ensue dilatation and immobility of the pupil, diminution in the power of accommodation (presbyopia and any latent hypermetropia becoming manifest), and anæsthesia of the cornea. This membrane shows more or less insensibility on being touched with a feather or small roll of paper, which is the article generally used to make this investigation.

The strain on the ciliary nerves also explains the violent neuralgic pains which accompany any sudden increase of intraocular pressure. The proof that we have here the true explanation of this phenomenon is to be found in the fact that the pains disappear immediately on our performing paracentesis of the anterior chamber (*von Graefe*).

4. The posterior circulation of the eye becomes disturbed, especially in the vasa vorticosa, which are compressed as they pierce the sclerotic. In consequence of this mechanical obstruction the venous blood from the eye is carried to the anterior ciliary veins, and thus we find the subconjunctival veins choked with blood, tortuous and forming many anastomoses.

5. The arteries of the optic papilla are seen to pulsate, either spontaneously or on the slightest pressure on the eyeball. The reason of these pulsations, which may also be produced on firmly compressing a normal eye, must be sought in the resistance which the tension of the eye gives to the circulation of the blood.

The flow of blood into the eye can only take place when the propelling power is greater than the intraocular pressure. In the normal condition, the arterial pulsations characteristic of glaucoma do not exist, because the tension of the arterial system is greater than the intraocular pressure, consequently the blood enters the eye in a continuous stream.

6. The optic papilla is pushed back through the opening in the choroid and sclerotic ring, sometimes even behind the level of the sclerotic (Fig. 81). The intraocular pressure acts, it is true, with equal power on any point of the membrane which encloses the vitreous body; but the optic papilla, less resisting, yields more readily, and the lamina cribrosa, with the vessel and nerve fibres, is pushed backwards (excavation of the papilla).

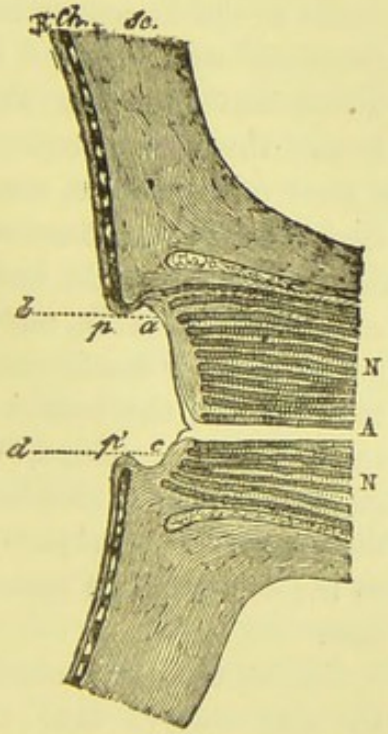


Fig. 81.—Excavation of the Optic Nerve.

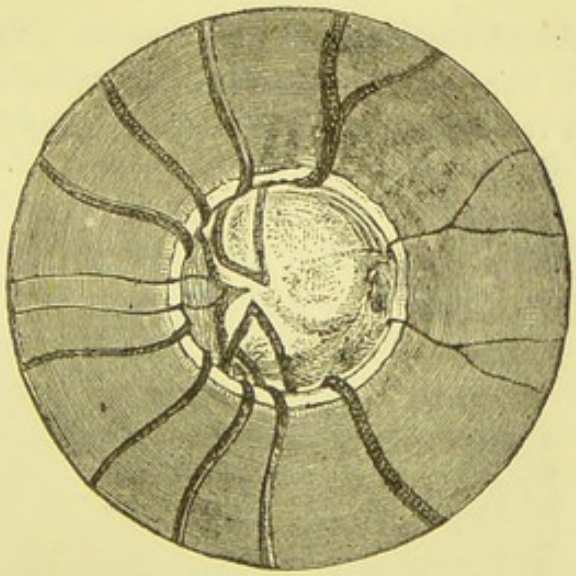


Fig. 82.—Glaucomatous Excavation.

At the papilla we therefore find a cavity with an overhanging superior margin, the bottom of which is formed by the lamina cribrosa and the optic nerve fibres and vessels. To the ophthalmoscope the appearance of glaucomatous excavation is very characteristic (Fig. 82); the margin of the excavation, with perpendicular edges, is clearly seen, and hides from us the peripheral portion of the bottom, which it over-

laps. Thus, on following the course of the vessels from the point where they emerge from the optic nerve, we see them at first running along the cavity and suddenly interrupted when they reach the periphery. The retinal vessels, when they reach the margin of the papilla, stop as if cut short, or go over it like a hook. There is thus an apparent solution of continuity between the vessels of the papilla and those of the retina, since we cannot see that part of the vessel which is on the side of the excavation and hidden by its border.

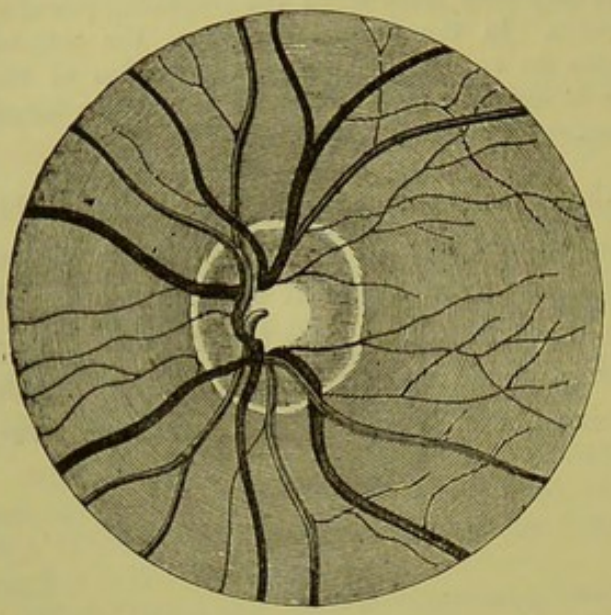


Fig. 83.—Physiological Excavation.

To make sure of the difference of level between the retina and the bottom of the excavation, we must give slight lateral movements to the bi-convex lens generally used in the indirect method. We then notice that the margin of the excavation, which corresponds with the level of the retina, comes in front of the margin of the papilla. On examining in the same way a vessel in the fundus of the eye, we find that the portion of the vessel situated on the retina undergoes a greater displacement than that on the bottom of the excavation. This difference (parallactic displacement) is greater in proportion to the depth of the excavation.

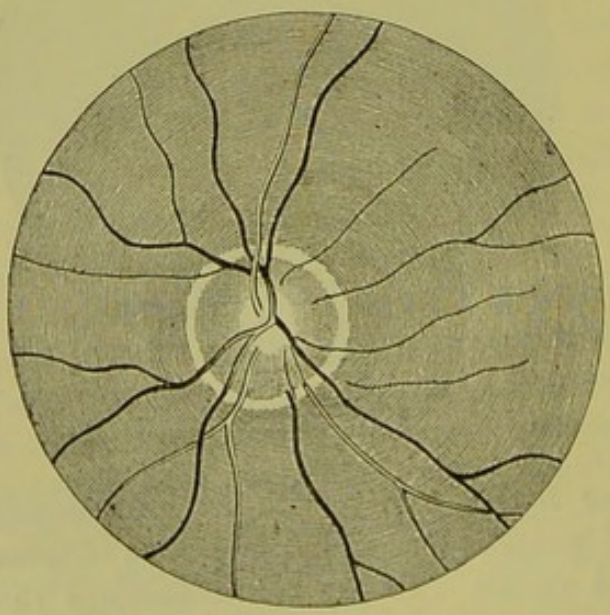


Fig. 84.—Atrophic Excavation.

Besides these phenomena, we also observe that the point of emergence of the vessels of the optic nerve is nearer the margin of the papilla, whilst in the normal state it is placed almost at the centre. The veins are engorged and flat, but the arteries are diminished in calibre by the resistance which they meet as

they emerge. Again, we should mention the peculiar appearance of the papilla, on which we can easily distinguish the meshes of the lamina cribrosa, and the white ring which surrounds the margin of the excavation. This ring is due to the atrophy of the choroid in the neighbourhood of the optic nerve (*Schweigger*).

It is important to distinguish glaucomatous excavation from physiological and atrophic excavations. *Physiological* excavation (Fig. 83), as a rule, only affects the centre of the papilla, round the point of emergence of the vessels, and never invades the entire nerve as does the glaucomatous excavation. On one side or another it is always separated from the margin of the papilla by a portion of nervous tissue, which is at the same level as the retina. *Atrophic* excavation (Fig. 84) extends to the very margin of the papilla, but gradually rises to the level of the retina. Its margin is not undermined, and consequently the continuity of the vessels is not interrupted—at most they are slightly bent. It is not extremely rare to observe eyes with characteristic glaucomatous excavation and no other symptom of glaucoma. I have myself seen a very striking example of it with full vision which never ended in glaucoma. Probably the defect is congenital.

7. As to the functional condition of the eye, in addition to the presbyopia and alterations of refraction which have already been mentioned, the ischæmia of the retina and the compression of the optic nerve give rise to diminution of the central vision, and to an irregular contraction of the field of vision, beginning almost always with the nasal side. Perception of colours, as a rule, remains normal, but the sense of light seems to become weaker. Patients affected with glaucoma often complain of coloured circles round the flame of a candle, the most external being red, and the most internal bluish-green.

This phenomenon has been attributed to irregular refraction of the lens, rendered more sensible by the dilatation of the pupil (*Donders*). It may also depend on imperfect transparency of the cornea, the aqueous or the vitreous. Moreover, this phenomenon also occurs in some affections of the cornea where there is no glaucomatous complication.

The different manifestations of increased intraocular pressure which we have just described fall into one of two groups, according as th pressure increases suddenly, or by slow degrees. By this we may distinguish acute from chronic glaucoma.

A. Acute Glaucoma.

In the majority of cases (70 to 75 per cent.), acute glaucoma is preceded by certain very characteristic prodromata. These symptoms

consist in the first place of a sudden diminution in the power of accommodation (presbyopia increasing, or a latent hypermetropia becoming manifest), in the appearance of coloured circles round flames, in temporary difficulties of vision, which may last from a few minutes to several hours and during which the patient sees objects as if through a fog.

The phenomena chiefly occur when the head is congested, as after taking food, after a sleepless night, emotions, &c. The patients also sometimes complain of acute pain in the bones forming the orbit. If, at the moment when these phenomena occur, the eye is examined, we find a slight haziness of the cornea and aqueous humour, changing the colour of the iris and the black reflection of the pupil, which is somewhat dilated and sluggish. These symptoms soon disappear, and everything again assumes the normal condition. Then, after a few weeks or months, they reappear, and so return after intervals of complete remission. This return of the eye to its normal state is characteristic of the incipient period of glaucoma, which may last one, two, or even more, years.

Yet a glaucomatous attack may supervene suddenly, without any of the forewarnings which we have just described. It sets in during the night, and is characterised by acute pain in the eye, radiating to the head, with well-marked subconjunctival injection, lachrymation and chemosis.

The aqueous humour is muddy, and sometimes forms deposits on the posterior surface of the cornea; the iris is discoloured, the pupil irregularly and widely dilated, giving a greyish-yellowish reflection. The eyeball becomes exceedingly hard, and the cornea insensible to touch.

Vision is more or less affected; it may be almost entirely destroyed, so that the patient cannot see the brightness of a lamp placed before the eye; or it may be partially preserved, the patient being able to distinguished night from day. Photopsia is almost always present.

During the glaucomatous attack we are unable to make an ophthalmoscopic examination, because of the haziness of the cornea, aqueous and vitreous.

The beginning of the disease is marked by a general febrile condition, sometimes with obstinate vomiting, which may cause us to think that we have to deal with a gastric affection or severe migraine.

Rarely does a first attack of glaucoma completely and permanently destroy vision. As a rule, after being present for a time varying from a few hours to a few days, the symptoms which we have enumerated diminish in intensity, by slow degrees vision returns, and after some time there remains no trace of the attack except a slight increase of

tension, a slight diminution in the acuteness of central vision, and a slight contraction of the field of vision.

This state of matters may last for weeks or months, but suddenly another glaucomatous attack supervenes, similar to the one which we have just described, and again followed by a remission of all the symptoms. Then the attacks become more and more frequent, and the intervals between them shorter.

After each attack the loss of vision increases, and portions of the visual field left intact by the previous exacerbation become more and more involved. The tension of the eyeball gradually increases, the cornea by degrees loses its transparancy and sensibility, the anterior chamber becomes shallower, the iris is discoloured, both iris and lens are pushed forward towards the cornea. The pupil becomes very large and fixed, and presents a greyish or greenish reflection.

If, during one of the periods of remission, after a few such attacks, we make an ophthalmoscopic examination, we find a diffuse haze of the cornea and vitreous humour, the characteristic alterations of the optic papilla (see p. 229), arterial pulsation and, exceptionally, ecchymoses of the retina and choroid.

Even after vision is completely destroyed (absolute glaucoma), the glaucomatous process may make progress, leading to the disorganisation of all the structures of the eyeball. The cornea still further loses its transparency and becomes the seat of ulceration; the tissue of the iris continues to atrophy till it is reduced to a narrow and discoloured ring. The lens becomes opaque, softens and swells, and there supervenes hæmorrhage into the anterior chamber, the vitreous body, and the parenchyma of the deep structures of the eye; this hæmorrhage still further increases the excessive tension of the eyeball. The dirty-coloured, greyish sclerotic at last yields to the pressure, forming ectasiæ in the equatorial region and in the anterior portions of the eyeball.

The eye may remain for some length of time in this condition, hard as a piece of marble, and the conjunctiva furrowed with the large ciliary veins which anastomose around the cornea. In other cases, there are signs of a slow atrophy, which may also take place as a consequence of purulent choroiditis or after separation of the retina (*Arlt, Schweigger*).

Still we must not think that all eyes affected with glaucoma follow precisely the course that has just been described. Acute glaucoma, losing its intermittent character and even the most of its inflammatory symptoms, may become transformed into chronic glaucoma.

B. Chronic Glaucoma.

We may distinguish two forms of chronic glaucoma—

1. Chronic glaucoma with inflammatory symptoms.
2. Simple chronic glaucoma.

1. **Chronic inflammatory glaucoma** is distinguished from the acute variety by the *uninterrupted presence* of the characteristic symptoms, which are periodically increased by slight inflammatory exacerbations. It begins with the prodromata common to it and to acute glaucoma, and these first symptoms become more and more pronounced, and finally become permanently and progressively established.

The cornea loses its brilliance and its sensibility, the anterior chamber becomes shallower, the aqueous becomes slightly turbid, the iris and lens advance towards the cornea, the sclerotic assumes a greyish tint, and the subconjunctival veins increase in number and volume. The eye becomes more and more hard till it feels like a piece of stone. On ophthalmoscopic examination, we find progressive excavation of the papilla with arterial pulsations. The vision continues to decrease, the visual field becomes contracted, generally from within outwards, and ultimately the patient becomes quite blind.

In the course of this gradual and slow progress, which may occupy a very variable space of time, acute exacerbations supervene, during which the inflammatory symptoms become more marked. The patient then complains of very acute ciliary pain, the hardness of the ball suddenly increases, the cornea becomes perfectly insensible, the dilatation of the pupil is greater, as is also the turbidity of the cornea and aqueous humour, and the patient sees everything as through a thick fog.

These exacerbations sometimes supervene without any obvious cause, more frequently when the head is congested by some passing condition. They may disappear in a few hours or last for several days, and the eye regain its previous condition, except that there is a greater diminution of the visual acuteness than the chronic disease would give rise to in the same length of time if uncomplicated with an exacerbation.

It may also happen that the course of chronic glaucoma is suddenly interrupted by a true subacute attack, and that afterwards it maintains the character of acute glaucoma. It may thus pass through all the stages which we have already described, and end in the same way as acute glaucoma.

Cases have also been observed in which the chronic glaucoma has lost all its inflammatory symptoms, and assumed the aspect of simple chronic glaucoma.

2. **Simple Glaucoma.**—In this variety of glaucoma the inflammatory symptoms are entirely absent, and the appearance of the eyeball does not materially differ from that in the normal eye. At most, we may find, after some exciting cause, a slight pericorneal injection, and a slight turbidity of the aqueous humour soon disappearing. In short, the patient does not complain of any pain, and the exterior of the eye preserves its natural appearance.

It is often difficult in the early stages, and even throughout the disease, to decide by the sense of touch whether the eye be harder than usual. This is all the more difficult that the physiological tension is subject to considerable variation.

To the ophthalmoscope the media of the eye seem to be completely transparent; but we find the characteristic excavation of the papilla, and the arterial pulsations, which are either spontaneous, or easily produced by slight pressure of the fingers on the eye.

Some time must elapse before the excavation is produced. The nerve fibres accommodate themselves for a certain length of time to the pressure (excavation of the papilla without disturbance of vision), and do not really suffer till the pressure has exceeded a certain amount. They then begin to atrophy, and the papilla takes the white colour of atrophic degeneration.

As to the vision, the visual field begins to contract generally on the internal side, and this contraction gradually extends towards the centre and round the periphery. The central visual acuteness may remain for a long time relatively good, until the defect in the visual field extends beyond the point of fixation. Thus, simple glaucoma may end in complete blindness without the patient experiencing any pain, only the eyeball being a little harder than normally and the optic papilla excavated.

The progress of the disease is slow, and generally lasts for several years; it usually affects both eyes successively.

It may also happen that simple glaucoma suddenly changes its character and becomes more like inflammatory chronic, or even acute, glaucoma.

Prognosis.—This disease was considered from the earliest times an incurable one, which sooner or later must produce absolute blindness.

The prognosis of glaucoma has considerably changed since the fortunate discovery by *von Graefe*, that iridectomy is a sovereign remedy. The earlier in the course of the disease this operation is performed, the more likely it is to prove efficacious.

If performed during the period of prodromata, it cuts short the disease and preserves, or even improves, the vision.

In acute glaucoma, complete restoration is obtained if the operation

be performed at once; at a later period, if excavation of the papilla and marked contraction of the visual field have already taken place, we can only hope to preserve the vision in the same condition that exists at the time of operation. During the first few weeks after the operation, the vision may somewhat gain in acuteness and the visual field extend. When the eye has been blind for a length of time, operation can only be of service in relieving the patient of severe ciliary pain.

In chronic glaucoma, the operation arrests the progress of the disease, and the functional condition of the eye remains as it was at the time of the surgical interference. But, if the iridectomy is performed immediately after an acute exacerbation occurring in the course of the chronic variety of glaucoma, the vision returns to the condition in which it was before the last attack.

In simple glaucoma, the effect of operation (iridectomy or sclerotomy) is much less sure. It sometimes preserves the vision in *statu quo;* more rarely it improves it. On the other hand, however, cases of simple glaucoma have been observed in which the operation did not arrest the progress of the disease; sometimes it has only arrested it for a time, and has had to be repeated; lastly, operation has also been followed by an immediate aggravation of the disease. Without considering the diminution of vision due to the astigmatism, which can be corrected by cylindrical lenses, following the operation, it happens, in cases where the contraction of the field of vision has attained nearly the point of fixation, that the central vision is entirely lost after and notwithstanding the operation. It may be that in the last phases of the disease the operation does not prevent the amount of vision from diminishing, because the atrophy of the nerve fibres, produced by the compression to which they have been subjected, proceeds even after its exciting cause has been removed. Apart from such facts, there are other cases in which the operation, performed when there only remains a small portion of the visual field to the upper and outer aspects, has preserved this remaining portion for many years.

Ætiology.—Although at the present day it seems beyond all doubt that glaucoma consists of an increase of the intraocular tension, opinion is divided as to the cause of this increase. According to *von Graefe*, it must be sought for in an inflammatory alteration of the choroid and iris (serous irido-choroiditis), with hypersecretion of serous fluid, which increases the volume of the vitreous body.

According to *Donders*, this hypersecretion is due to an alteration in the nerves which regulate the secretion, so that the cause of the disease is external to the eye. *Cusco* and *Coccius* hold that the starting

point of glaucoma is an inflammation of the sclerotic; the thickening and secondary contraction of the sclerotic tissue furnishing in such cases the mechanical cause of the intraocular compression. Again, *Weber* and *Knies* say that there are anatomical changes in the tissues surrounding the canal of *Schlemm* and *Fantana's* space, which, by compression and obturation of the so-called angle of filtration, diminish or prevent the exit of the intraocular fluids; and *de Wecker* has stated his opinion that the efficacy of the operation in glaucoma is due to the formation of a cicatrix which promotes the filtration of these fluids.

Brailey, having examined a large number of glaucomatous eyes, has not always found the anatomical changes stated above, and has even found them, as have *Pagenstecher* and *Schnabel*, in cases when the tension of the eyeball was diminished; he regards as a chief factor in the pathology of glaucoma the distension of the blood-vessels, especially of the ciliary region, and the thinning of their walls; these conditions producing the increase of the quantity of blood in the eyeball, and the hypersecretion of the intraocular fluids. *Priestley Smith* believes that progressive increase in the size of the lens, which he has ascertained to occur as life advances, diminishes or obliterates the interval between the margin of the crystalline lens and the ciliary processes, blocking the passage of the intraocular fluids, and giving the starting point for glaucoma. *Ulrich* considers this passage impeded by alteration of the iris, and *Stilling* by alteration of the optic nerve.

Whatever be the different theories as to the ætiology of glaucoma—and in our opinion this disease may be due to each of these causes in isolated or combined action, in so far as they produce hypersecretion or abnormal retention of the intraocular fluids, or both of them—age, and the rigidity of the sclerotic increasing with it, certainly occupy an important part. This disease is rarely found before the age of thirty, except in children with keratoglobus, and it most frequently occurs in persons of from fifty to sixty years of age. Gout and arterio-sclerosis seem to predispose; violent emotion, sorrow and depressing influences in general have been noticed to precede the onset of acute glaucoma. Instillation of atropine in a predisposed eye is liable to bring on an acute attack. We have observed several cases of the same effect produced by general contusion of the eyeball with mydriasis.

Glaucoma seems sometimes to be hereditary, especially in its inflammatory varieties (*von Graefe*).

Lastly, not unseldom do we find glaucoma occurring in eyes suffering from other diseases; and this variety, the symptoms of which are exactly the same as those of glaucoma in general, has received the name of *secondary glaucoma*.

C. Secondary Glaucoma.

In this complication we must distinguish those cases in which the primary disease predisposes to a glaucomatous attack, from those in which the glaucoma supervenes in a diseased eye which would ultimately have become glaucomatous even if otherwise healthy.

In the first group we must include all staphylomatous affections, in which a part of the envelope of the eye has yielded to the intraocular pressure—for example, staphyloma of the cornea, or, less frequently, of the sclerotic. In these diseases it may happen that the resistance of the surrounding membranes is increased with age, whilst the internal pressure remains the same. The pressure then acts on the weakest part, which corresponds to the optic papilla. Other affections of the cornea which become but seldom complicated with glaucoma are—diffuse keratitis, riband-like transverse infiltration, certain varieties of wide ulceration, and herpes corneæ.

We should also here mention cases in which the iris or choroid is subjected to prolonged irritation, as when there is a cicatrix with adhesion of the iris, or when, after an injury of the lens capsule, the lens is increased in size by the swelling of its cortical substance, and thus presses on the iris. Again, after dislocation the lens may act as a foreign body and irritate the structures with which it is in contact; for the same reasons tumours of the choroid are sometimes accompanied with glaucoma.

We would also mention serous iritis and posterior synechiæ; in complete annular synechia the communication between the anterior chamber of the eye and the vitreous body is interrupted, so that the fluids accumulate behind the iris and cause an abnormal tension.

In all these cases glaucoma is more easily established the greater the resistance of the sclerotic, and the less it yields to the intraocular pressure from loss of elasticity, as in old and rheumatic people.

Hæmorrhagic Glaucoma.—Retinal hæmorrhages are sometimes followed by acute or subacute glaucoma, although no other relation can be traced between these two diseases than those anatomical changes in the blood-vessels (arterio-sclerosis) which are the chief factors of both. Iridectomy in general seems of no avail in this form of the disease.

Treatment.—Our treatment is almost exclusively limited to the operation of iridectomy, which, according to *von Graefe's* great discovery, permanently diminishes the increased intraocular pressure. Puncture of the sclerotic with exit of some vitreous (*Mackenzie*, 1830), paracentesis of the anterior chamber (*Desmarres*, 1841), diminish the

pressure only temporarily, but do not prevent the progress of the glaucoma. Blood-letting and medication are of absolutely no use; and subcutaneous injections of morphia are only beneficial in so far as they soothe the pain for the time being till we are ready to operate.

Instillations of eserine (*Weber, Laqueur*) and pilocarpine exercise an important influence on the diminution of intraocular tension. These alkaloids should be employed when we have reason to fear the onset of a glaucomatous attack (period of prodromata); when, in a glaucomatous attack, we are obliged to delay operation for some good reason; when the operation has given an insufficient result; or in cases of hæmorrhagic glaucoma, in which iridectomy is generally of no service. In cases of this kind, in which one eye is already lost by glaucoma, we have seen the other, also affected by hæmorrhagic glaucoma, freed of its glaucomatous symptoms by regular instillation of pilocarpine; the visual acuteness, as also the field of vision, being greatly improved, and this improvement being maintained.

As to the method of performing the iridectomy, we would refer the reader to the article on Iridectomy. Eserine or pilocarpine have to be used previously in order to contract the pupil. The iridectomy must be made in the periphery, and a wide portion of iris must be removed.

According to the rules already laid down in the chapter on Iridectomy, the best position for this excision is directly upwards or directly downwards. It is of importance during the operation to make the escape of the aqueous humour as slow as possible, for, if the diminution of tension be too sudden, we may have retinal hæmorrhage, as has been observed after iridectomy for glaucoma.

After the operation, we must pay special attention to the consistence of the eyeball, the formation of the anterior chamber, and the process of cicatrisation.

Not unfrequently we find, on the day after the operation, a certain degree of tension, which gradually disappears in the course of a few days. This takes place when the formation of the anterior chamber is slow, allowing the iris to be brought into close contact with the cornea.

The use of eserine and perfect rest are then absolutely necessary, till the internal pressure is lowered to what it generally is after an iridectomy, and till the anterior chamber is re-established. When the eyeball preserves a marked hardness, even immediately after the operation, it is better not to use a pressure bandage, but merely to close the lids with strips of adhesive plaster (*von Graefe*). When there is pain, even although not severe, morphia must be administered by subcutaneous injections in the temple, or we may give chloral hydrate internally.

Von Graefe was the first to describe a peculiar form of cicatrisation which is occasionally seen after iridectomy for glaucoma. In this form

we find the cicatrix rising above the level of the conjunctiva, and assuming the appearance of a vesicle, elongated in the direction of the incision, and filled with a whitish liquid (cystoid cicatrix). In such cases we may suppose that the conjunctival wound has closed before the one in the sclerotic, so that the aqueous humour still escapes, and collects beneath the conjunctiva, which becomes raised like a blister.

As a rule, this form of cicatrix does not present any inconvenience; but, in presence of exceptional cases, in which, after remaining innocuous for years, it has been the starting point of an inflammation which has endangered the eye, our attention should be directed to the means of avoiding this irregular cicatrisation, or of arresting its progress. As to arresting its progress, our only advice is to prolong the application of the compress and bandage, or to attempt, after the lapse of a sufficient length of time, to make sure of perfect cicatrisation of the sclerotic wound by destruction of the vesicle.

As to the means of preventing the formation of the cystoid cicatrix, we only know one—namely, the methodical execution of the iridectomy. It is very reasonable to suppose that if the extremities of the iris flap are enclosed in the sclerotic wound, they will prevent the wound from uniting rapidly and regularly. The aqueous, especially when there is a certain degree of increased tension, will thus continue to escape, and will be collected beneath the conjunctiva, for the small wound made in the conjunctiva closes in a very short time. Hence we have a universal indication to excise the iris as carefully as possible to the very angles of the sclerotic incision, and to manipulate as already described in order to bring the margins of the artificial pupil within the anterior chamber. Still, we are forced to admit that, in spite of all precautions, a cystoid cicatrix will sometimes be formed even when the execution of the operation has left nothing to be desired.

We must also mention the fact that not unfrequently we find a glaucomatous attack occurring in the healthy eye a few days after the operation on the other. Although the possibility of this accident should not prevent our operating when necessary, still it imposes on us the duty of fore-warning the patient or his friends. This attack disappears rapidly and without return under the use of eserine, and does not require immediate operation.

When the operation has had no effect, we may be led to perform it a second time. In such cases, we select the opposite margin of the corneal periphery for the second operation. Thus, we perform it at the inferior margin if the first has been at the superior, and *vice versâ*. In the same circumstance, the re-incision of the sclerotic, in order to open again the cicatrix of the first operation (cicatrisotomy of *Wecker*, or oulotomy of *Panas*), has been also employed.

Attempts have been made to replace iridectomy, in the treatment of glaucoma, by section of the ciliary muscle. *Hancock's* method of operation is as follows:—A cataract knife is introduced at the inferior and external aspect of the corneal margin, at its junction with the sclerotic; the point of the knife is made to enter obliquely from before backwards and from above downwards, till the sclerotic fibres are obliquely divided for the eighth of an inch; any effused blood is allowed to escape along the knife. This operation is seldom followed by any disagreeable symptoms. In only one of *Hancock's* cases was there a little inflammation, which speedily disappeared.

Stellwag's and *de Wecker's* opinion, that the efficacy of iridectomy is not due to the excision of the iris, but to the incision of the sclerotic, has been put in practice by *Cuaglino* (1871), who has replaced iridectomy by sclerotomy. In order to avoid prolapse of the iris, eserine has to be used before and after this operation, which should not be performed if the pupil cannot be previously contracted to nearly pinhole size. The point of von Graefe's cataract knife is entered into the anterior chamber as for the puncture in cataract extraction, but at the distance of 1 millimetre from the corneal margin. The counter-puncture is made at the corresponding point at the other side of the anterior chamber, and the section is enlarged by a sawing motion of the knife, until only a bridge of tissue about 2 millimetres broad remains undivided (*de Wecker*). If, notwithstanding the use of eserine, the pupil be of irregular shape, the hard rubber or silver spatula should be introduced into the interior chamber to restore the pupil to its normal shape by gentle pushing of the iris. But, should this not prove satisfactory, or should there be an actual prolapse of the iris, it would be best to turn the sclerotomy into an iridectomy. Sclerotomy has been praised in case of hæmorrhagic glaucoma, as a supplemental operation when iridectomy has been of no use, and in chronic simple glaucoma. For this last disease, we have had to record its failure many times, and the vision repeatedly lost in eyes operated on by sclerotomy while vision was still very satisfactory. Drainage of the eye by means of a gold thread, also proposed by *de Wecker* for glaucoma, has not met with a favourable reception, and seems to have been given up even by its author.

After the iridectomy has been performed, we often find that the visual acuteness improves considerably under suitable treatment. This treatment consists in the administration of such mineral waters as act on the skin and kidneys, and in the frequent application of dry cups and artificial leeches. Persistent neuralgia may be checked by 10–15 centigrammes (2–3 grains) of quinine three or four times daily. *Badal* and *Abadie* have obtained in these cases immediate and lasting relief by the elongation of the external nasal nerve, and *Brailey*, by the same

operation performed on the supraorbital nerve. If there be symptoms of active congestion, we prescribe derivation on the bowels (Carlsbad or Marienbad), leeches in case of cessation of menses or hæmorrhoids, and if the head be also congested we can use wet cupping in the neck or Heurteloup's apparatus at the temples.

We should also advise our patients to observe great regularity in their mode of life, warning them of the dangers to which any great emotion exposes them, and interdicting any excessive use of the eyes.

In cases of glaucomatous degeneration, which is observed in the last phases of inflammatory glaucoma, and even after vision has been lost for a considerable time, it is better to free the patient of any source of pain by puncture of the sclerotic with escape of vitreous, by enucleating the ball, or by the neurectomia optociliaris.

CHAPTER VI.

THE OPTIC NERVE AND RETINA.

Anatomy.—The optic nerve arises from the brain at the posterior and inferior aspect of the optic thalamus; on account of its form it has been called the "**optic tract.**" After having passed round the cerebral peduncle, the optic tract intercrosses, at least partially, in the median line, with its fellow of the opposite side to form the **optic chiasma.**

From this junction arise the two optic nerves, which run outwards to the optic foramina, through which they pass into the orbit. Here the course of the nerve has almost the form of the letter S, and has a length of 28 to 29 millimetres to its ocular insertion, which is situated about 4 millimetres to the inner side of, and somewhat below the centre of, the posterior sclerotic hemisphere.

The principal connections of the optic nerve with different parts of the central organs have been indicated by *Stilling*, who has traced nerve bundles from the thalamus directly up to the corp. quadrigemina, and from the tract up to the cerebral peduncle. Other bundles coming from the tract follow the internal side of the corp. geniculatum to the inferior olive, to the origin of the oculomotorius, and to the crus cerebelli. *Gratiolet* and *Meynert* have noticed numerous bundles traced from the thalamus up to the white substance of the occipital lobe. Thus we obtain the anatomical explanations of **hemianopsia** (*vide infra*) in affections and wounds of certain parts of the occipital lobe (*Munk*), and of affections of the optic nerve in spinal diseases. Semi-decussation in the chiasma takes place in such a way that the lateral bundles of the tract pass directly into the nerve of the same side; but the bundles of the middle intercross with those of the other tract, and pass into the nerve of the opposite side. The intercrossing bundles are the more numerous, and supply with their nervous fibres the nasal parts (including the point of fixation) of both retinæ, while the lateral bundles supply the temporal parts.

Till they reach the point of junction, the optic tracts are composed of medullated fibres without neurilemma. At the chiasma, the pia mater furnishes an envelope which accompanies the optic nerves to the eyeball, and which sends cellular partitions into the thickness of the nerve, thus dividing the nerve into several secondary bundles. At the optic foramen the nerve receives a new fibrous envelope, which is a

prolongation of the cranial dura mater. This covering is composed of two concentric layers—viz., the **external sheath**, which is the thicker, and the **internal sheath**. Between these two layers there is a space which communicates at the optic foramen with the cerebral arachnoid space (*Schwalbe*).

The two sheaths unite to form the sclerotic, the fibres of the external sheath bending at an obtuse angle and becoming lost in the external and middle layers of the sclerotic, whilst the internal sheath, representing the neurilemma, comes to the intraocular surface of the sclerotic and becomes lost in its internal layer. We have thus a *fibrous ring*, which is slightly prominent, and which also gives a point of attachment for the choroid. The optic nerve pierces this ring with a diminution of its diameter from 3 to 1·5 millimetres, to enter the eyeball, where it helps to form the retina (Fig. 85).

The **central artery** of the optic nerve arises either directly from the ophthalmic artery, or from a ciliary or muscular branch of that artery. It pierces the envelopes of the nerve at a short distance behind the sclerotic, and enters the central canal, in which it runs forward till it reaches the intraocular extremity of the optic nerve (*optic papilla*). At the papilla the artery terminates in two branches which extend, the one upwards, the other downwards; and these branches again divide dichotomously on the optic papilla or near its margin, so that there are four arterial branches diverging over the retina.

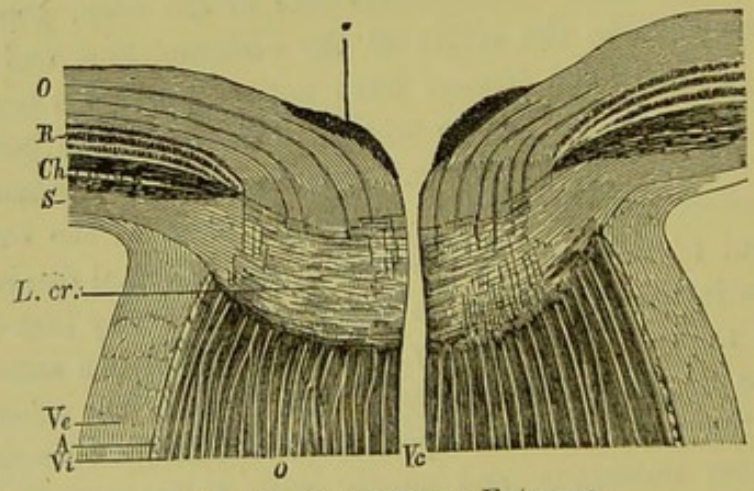


Fig. 85.—Optic Nerve Entrance.

The **veins** of the retina, as a rule, unite into four large veins, two superior and two inferior, which converge towards the optic papilla. These four veins, by their union at the margin of the papilla, form two branches, which generally become united into one near the point of emergence of the central artery, but which may remain separate to the lamina cribrosa, in the neighbourhood of the papilla. In addition to the central vessels, we also find a certain number of small arterial and

venous vessels which anastomose with each other. A few of these vessels, which supply nourishment to the optic nerve, arise from the central vessels, but the majority of them come from the ciliary and muscular arteries; it is by them that the vessels of the papilla and retina communicate with the ciliary vessels of the posterior part of the sclerotic.

The **retina** extends between the vitreous body and the choroid, from the optic nerve to the zonule of Zinn. Becoming thinner, it is united to the zonule; and, if its periphery be separated, it is found to be finely dentated. Hence, this region has been called the *ora serrata*. This termination, however, is only an artificial one, for traces of the retina may be found on the hyaloid membrane, to which the periphery of the retina is firmly fixed.

The thickness of the retina at its centre is about ·04 millimetre, but this gradually diminishes, so that in its equatorial regions it is reduced to one half, and, at the ora serrata to a quarter of its thickness at the centre.

The histological structure of the retina is very complicated. It consists of nerve and cellular elements, intimately combined, and sometimes difficult to distinguish in the exceedingly small and delicate details of this membrane.

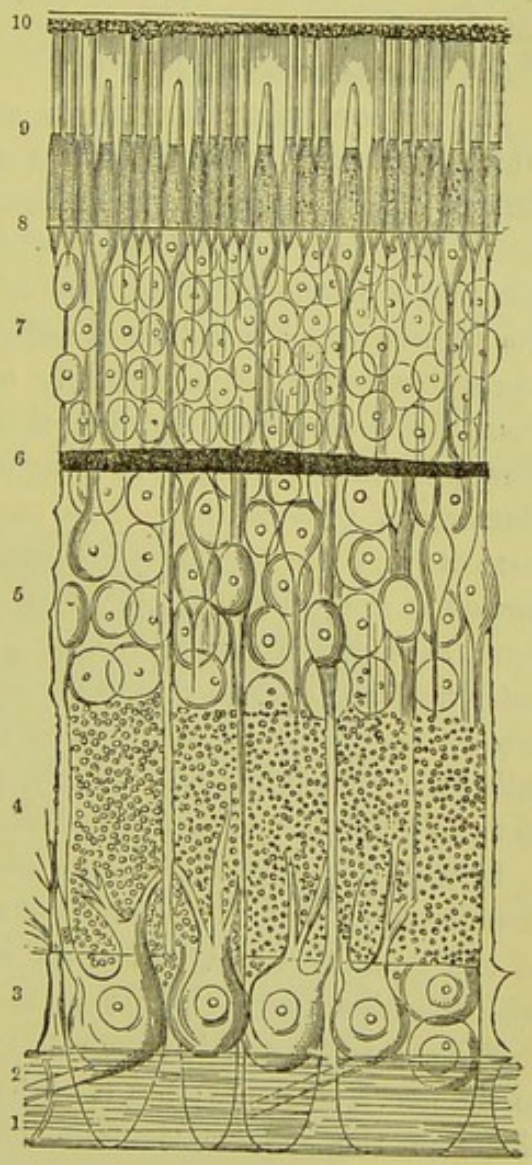


Fig. 86.—Diagram of the Retinal Structure.

I. **Nerve Tissue of the Retina.**—We can distinguish various layers of nerve tissue which, beginning with the one next to the choroid, are arranged in the following order:—

(*a.*) *Layer of rods and cones* (Fig. 86, 9).—Each of these elements is provided with a fibrous or elongated filamentous appendage (7), which communicates with the elements of the following layer.

(*b.*) The *external granular layer* is divided into three—viz., the

granular layer (7), the intergranular layer (6), and the cellular layer (5). These layers are separated perpendicularly by the fibres which support the rods and cones, and which are intimately connected with the elements of the granular layer.

These fibres also enter :—

(*c.*) The *molecular layer* (4), which is composed of a network of very fine and slender nerve filaments. This layer gives origin to the external prolongations of the ganglion cells, and these cells form, again,

(*d.*) The *ganglion layer* (3); and the internal offsets of the ganglia enter, finally,

(*e.*) The *nerve fibrous layer* (2).

II. The **cellular tissue** is composed of fibres and membranes which give support to the nerve elements of the retina. We have, first of all, the membrana limitans (1), the innermost layer of the retina, the internal surface of which is in contact with the hyaloid membrane of the vitreous humour. From its external surface arise the numerous and broad-based radial fibres of *Müller*, which almost all pierce the retina perpendicularly to the direction of the nerve fibres from the optic nerve, dividing them into bundles. The radial fibres then pass into the layer of ganglion cells, which they surround with filamentous prolongations. In the molecular layer the radial fibres form a very small meshed network. In the granular layer, they surround the cells with large meshes. Again, in the intergranular layer, they divide into a very fine network, and, passing through the outer nuclear layer as simple fibres, unite at the external limit of that membrane. This termination of the retinal cellular tissue has been called the "*membrana limitans externa*" (*Max Schultze*). It is fenestrated, so as to give passage to the prolongations of the rods and cones.

In these radial fibres, whose course through the retina has just been described, we find nuclei situated almost exclusively amongst the cells of the granular layer. They are ovoid, and their long axes coincide with the direction of the fibres; they also contain nucleoli.

We can easily see that the cellular tissue sustains and gives support to the nerve elements; but it is the nerve elements that determine the shape of the cellular tissue. Thus, when the nerve elements are globular, as in the case of the ganglion cells, the cellular tissue forms cavities; but, when the nerve tissue is fibrous, the cellular tissue forms a network.

The structure of the retina is subject to a few modifications in the arrangement of the various elements near the periphery of the membrane, at the optic nerve papilla, and at the yellow spot and fovea centralis.

The gradual thinning of the retina from the centre towards the

periphery affects, at first, almost all the layers of the membrane to an equal extent. Beginning at the equator, the granular layer and the layer of ganglion cells are the first to disappear; the layer of rods also disappears at the ora serrata, so that at that point the retina only contains cellular tissue.

At the entrance of the optic nerve, the retina contains only nerve fibres, which, having passed through the opening in the sclerotic and choroid, become deflected at a right angle to form the innermost layer of the retina. The external layers also take origin in this situation; sometimes their margin is very thin, and they gradually increase in thickness; while, on the other hand, their margin is occasionally thick and well defined.

At its entrance, the optic nerve measures on an average 1·5 millimetre diameter; it is round or slightly oval. At the centre of the papilla, the divergence of the nerve fibres causes a small hollow physiological excavation (Fig. 83), which is generally the point of emergence of the central vessels of the retina. Sometimes this excavation is placed eccentrically.

The nerve fibres of the retina, which are, in reality, only a fan-like expansion of the optic nerve, are in the optic nerve itself separated

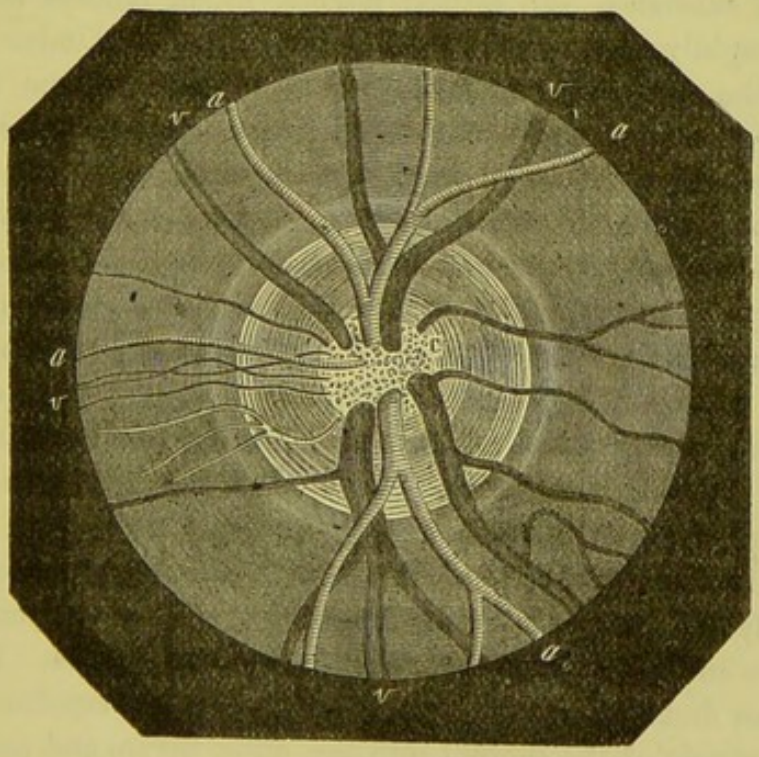


Fig. 87.

into bundles by cellular portions which arise from the envelope of the optic nerve. These cellular partitions stop at the sclerotic opening, where they form the fenestrated membrane (Fig. 85, L. cr. Lamina

cribrosa), which is partly connected with the choroid, and partly with the sclerotic, from the former of which it sometimes receives a few pigment cells, visible to the ophthalmoscope. Thus, beginning at the fenestrated membrane, the nerve fibres become perfectly transparent, having there lost the medullary envelope which makes their outline opaque.

At the centre of the retina we find the **yellow spot** (macula lutea), and at the centre of the yellow spot we find the **fovea centralis.** The yellow spot is about two millimetres in diameter, and is slightly oval in the horizontal diameter; in this region, especially at the level of the fovea centralis, the cellular tissue is much diminished. All the nerve fibres coming to this spot terminate in a very thin and almost imperceptible layer; the ganglion cells are here very numerous; the thickness of the nuclear layer is diminished, and replaced by the very much elongated filaments of the cones. The rods gradually disappear as we approach the macula, so that here we only find cones. It should also be mentioned that the radial fibres, which traverse the retina perpendicularly to its surface, in the macula change their direction, and converge towards the fovea centralis.

The external layers of the retina include, as has been proved by *Boll*, a coloured substance, the **retinal purple**, which renders it pink, and vanishes rapidly through the influence of light. Under the same influence the internal extremities of the cones become shorter, as *Engelmann* assures us, again becoming larger in the darkness. These changes are produced in both eyes, even when one of them only is exposed to light, while the other is kept in darkness; and they are also to be observed when both eyes are kept in darkness, the light acting only on part of the skin, for instance, on the back. After destruction of the brain, the effect of the light is produced only on the eye which is directly exposed, and not on the other kept in darkness.

As to the **vessels of the retina,** they come from the central arteries and veins of the optic nerve, which divide primarily on the optic papilla and then on the retina, forming with the retinal capillaries an almost independent system, connected with the choroidal vascular system only by the arterial circle of the sclerotic, which surrounds the optic nerve and sends vessels into the choroid and retina. In addition to these, we find numerous small arteries, veins and capillaries, passing from the margin of the choroid into the optic nerve, and anastomosing with the capillary network that surrounds the bundles of nerve fibres. The arteries and veins of the retina are generally found behind the layer of nerve fibres; in the region of the optic papilla they pass behind the membrana limitans; the capillaries extend to all the other layers.

The vessels surrounding the macula, as in a circle, provide it with delicate ramifications ending in capillaries in the immediate neighbourhood of the fovea centralis, which is, however, itself entirely devoid of blood-vessels.

The ophthalmoscopic image of the normal optic papilla (Fig. 87) has been described at p. 19.

DISEASES OF THE RETINA.

ART. I.—Hyperæmia and Anæmia of the Retina.

Hyperæmia cannot be considered as a distinct disease, but rather as a symptom of very various affections. It is so much the more difficult to define, that the degree of distension of the vessels which is its leading feature, is subject to very considerable physiological variation, so that a reliable diagnosis can only be obtained by comparing the two eyes.

Arterial, or active, hyperæmia is characterised by an abnormal redness of the optic papilla, which is due to the dilatation of the small vessels embedded in its substance. **Venous,** or passive, hyperæmia, again, is distinguished by the tortuosity of the veins, and by their being increased to double or triple their ordinary size. They are distended with blood, and are of a dark red colour. In very pronounced cases, this hyperæmia is accompanied by slight serous exudation, which is recognised as a greyish streak along the venous trunks.

The functional disturbances are:—Great sensibility of the eye to light, a sensation of fatigue whilst working, and the apparition of luminous points of dazzling; passive hyperæmia is most generally accompanied by an actual diminution of the acuteness of vision, which is due to the before-mentioned serous exudation.

These forms of hyperæmia are, as a rule, merely passing, and vanish with the trivial cause which has excited them.

When they form one of the prodromata or a concomitant of some ocular affection, their **progress** is naturally connected with that of the disease itself.

The circumstances which determine the hyperæmia, also decide the **prognosis.**

Ætiology.—*Active* hyperæmia is observed contemporaneously with a pericorneal injection, whenever the conjunctiva is much irritated; when the iris or choroid is congested; or, again, when the eye has been exposed to great dazzling, or has been overworked under hurtful conditions.

Venous hyperæmia is found in diseases of the retina, or owes its existence to affections of the general circulation (diseases of the heart, liver, dysmenorrhœa), or mechanical obstacles in the course of the central or ophthalmic vein or venous sinuses (orbital tumours, tumours of the brain, &c.) Finally, retinal hyperæmia has been noticed at the same time as severe headache in the first stage of constitutional syphilis.

Treatment.—Apart from any indication furnished by the exciting cause, an eye affected with hyperæmia requires rest, and to be protected from a bright light by darkening the room, or by the use of very dark coloured preserves. Cold compresses may also be employed, and, if necessary, light purgation, or even the artificial leech, observing the precautions already laid down.

Anæmia of the retina, characterised by discoloration of the optic papilla and an abnormal contraction of the retinal vessels, cannot be considered as invariably a symptom of a chlorotic anæmia. It is rather the consequence of some disturbance of the circulation, such as compression of the vessels in the optic nerve or orbit. When this compression is not merely passing, it rapidly produces other alterations, such as œdema, hæmorrhagic spots, &c. The so-called **progressive** or **pernicious anæmia,** the most serious of all forms of anæmia, is accompanied by slight œdema of the retina, seen by the ophthalmoscope as a thin white veil, covering the fundus, and with numerous small hæmorrhages in the course of the attenuated retinal vessels (see article on Apoplexy of the Retina). These hæmorrhagic spots, as a rule, have a white centre, and in a short time disappear, to reappear in other parts of the retina. The indications for treatment are those furnished by the general state of health.

ART. II.—Retinitis.

1. Serous Retinitis—Œdema of the Retina.

This disease can only be diagnosed by the ophthalmoscope, for the external appearance of the eye is not in the least changed, and the complaints of the patient are in no wise characteristic.

To the ophthalmoscope, there are two chief symptoms, but present in very variable degree. They are loss of transparency of the retina, and hyperæmia of its vessels. The first of these symptoms, due to a serous exudation (**serous retinitis**), is especially well seen at the point

where the membrane is thickest—*i.e.*, near the intraocular termination of the optic nerve. Thus, we find that the contour of the nerve loses its distinctness, or is completely masked by the retinal opacity.

When this opacity is situated in the deep layers of the membrane, we may find round the papilla exceedingly fine striæ, which radiate in the direction of the nerve fibres (Fig. 88).

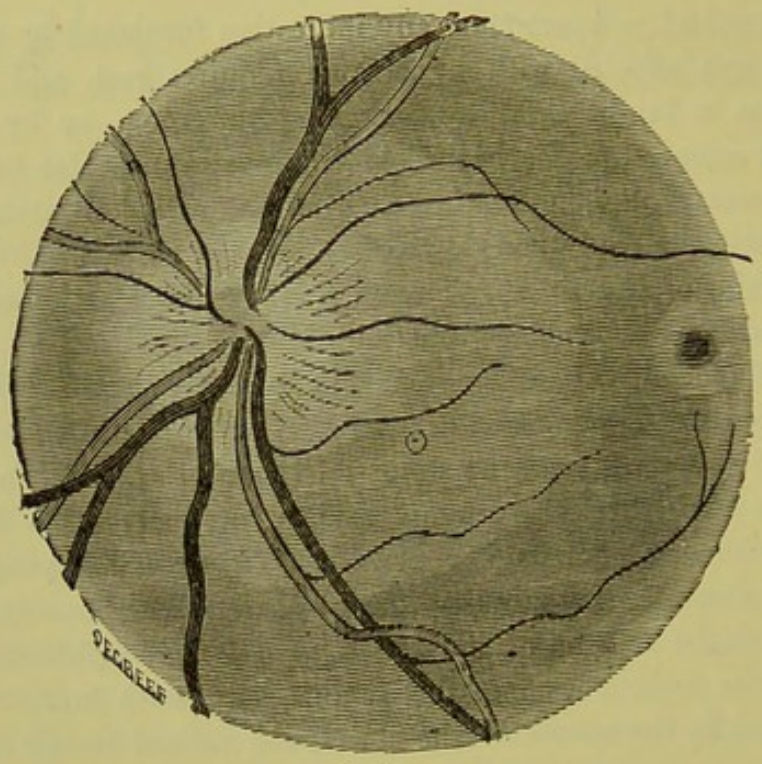


Fig. 88.—Serous Retinitis.

The serous exudation in the retina gives, moreover, a distinctly greyish tint to that membrane, especially round the nerve and along the course of the large vessels (**Peripapillary retinitis**), which tint gradually disappears as we approach the equator of the eye. At the yellow spot, the retina is much thinner than in the neighbouring parts; thus the brownish-red colour of the choroid shining through the retina, and in the midst of the surrounding grey, may simulate a hæmorrhagic spot.

As to the hyperæmia, it begins in the optic nerve, which becomes of an intense red, in consequence of the increase in number of its intimate vessels. The aspect of the veins is still more characteristic; they not only increase in calibre, but also elongate, and, with the ophthalmoscope, are seen to be of a very deep colour, and somewhat thick and tortuous. The flexuosities dip into the thickness of the retina, which, if it be opaque, hides the deep portions of the vessels, whilst the superficial portions are clearly seen and are of a bright red. Thus the veins seem to have some solution of continuity.

The arteries generally preserve their volume and direction. Yet, when the transudation and consequent imbibition of the tissue extend to the lamina cribrosa, the increase in the volume of the optic nerve experiences a certain resistance at the sclerotic ring. Hence, there is some compression of the central arteries, and, simultaneously with the hyperæmia of the veins, anæmia of the arteries which appear to be diminished in calibre. The other parts of the eye do not at all participate in the disease; the external aspect of the eye is normal, and all symptoms of irritation, such as lachrymation and pericorneal injection, are completely absent.

The disturbance of vision accompanying the retinitis varies very much, and must be attributed as much to the serous exudation as to the compression of the nervous elements by the swelling of the cellular tissue.

In the early stages, the patients have the sensation as if there were, between their eyes and objects at which they are looking, a fog, which, gradually becoming denser, diminishes more and more the acuteness of their central vision, till by-and-by they can only distinguish large objects. Contemporaneously the periphery of the field of vision is contracted, vision is gradually diminished from the periphery towards the centre, and in the more serious cases the patients can only distinguish night from day.

In other cases of retinitis, which show the same appearances to the ophthalmoscope, the visual disturbance is of quite another kind. The central visual acuteness is not diminished to any great extent, and the visual field remains almost entire. There appears, however, a slight cloud, as it were a veil before distant objects, and the patients suffer from a sensation of trembling in the air before the eyes. They also are greatly dazzled by ordinary daylight, and see much better in the evening (**Nyctalopic retinitis**, *Arlt*).

The perception of colours is, as a rule, normal, at least in slight cases of this affection. When the acuteness of central vision is much diminished, we also find a greater difficulty in recognising tints; but this quantitative dyschromatopsia is not characteristic, and is not of importance in the diagnosis of retinitis.

Progress.—Serous retinitis may remain in the state which we have just described for a long time, and end in resolution, although leaving for a very prolonged period some perturbation of vision.

More frequently it is followed by important alterations of the retinal tissue, and assumes the character of parenchymatous retinitis.

Our **prognosis** should always be very reserved, for we are never sure whether the disease which we see is not merely the first phase of a much more serious affection. It is more favourable if, after a somewhat

long duration, the ophthalmoscopic symptoms do not change, and if the visual field at the same time preserves its normal limits.

Ætiology.—As the first phase of other retinal affections, serous retinitis may be due to various circumstances which we shall enumerate later.

Serous retinitis, properly so called, frequently results from a chill, or may be the effect of too strong a light, or of excessive use of the eyes under bad conditions. In many cases the cause is very obscure.

Treatment.—It chiefly consists in giving the eyes rest, which may be accomplished by slightly darkening the room and wearing bluish glasses when out of doors.

We may also use the artificial leech of Heurteloup with due precautions; derivation through the skin; if necessary also mild laxatives. In general terms it may be said, that this disease requires a careful study of the general state of health, so that we may clearly realise the indications and contra-indications of treatment.

Retinitis from Contusion.—After contusion of the eyeball, œdema of the retina has been observed in the form of large greyish stains in the neighbourhood of the papilla, upon which the vessels look prominent and darker. Strength of vision is weakened to one-fourth or one-third of the normal, and the sense of light suffers in the same way. There may be also spasms of accommodation, with myosis or mydriasis, and slight muddiness of the cornea and the aqueous humour. Sight is generally restored in about a week. Rest of the eyes and atropine act favourably.

Macular Retinitis by Direct Sunlight has been noticed only on the occasions of solar eclipses, when it has been caused by observation with unprotected eyes. The patients complain of central scotoma and scintillation, and if this positive scotoma is not absolute, we may notice quantitative diminution of the colour sense. The ophthalmoscope shows alteration of the macula as by hæmorrhage, sometimes with a bright white spot in the middle. Experiments on rabbits prove a real burning of the retinal layers (*Cerny*). Improvement in vision takes place, but a slight central alteration in the field of vision persists for years. Darkness, cupping on the temple, and hypodermic injections of strychnia have been used in this affection.

2 Parenchymatous Retinitis.

This form of retinal inflammation, apart from the symptoms of hyperæmia and exudation already spoken of in connection with simple retinitis, presents also those of alteration of the tissue of the retina itself (hyperplasia and sclerosis).

These alterations, which extend throughout the entire retina (**Diffuse retinitis**), generally begin in the cellular elements and in the radiating fibres. From the compression of the nervous elements by the altered cells, the nervous tissue becomes more or less atrophied. This process may be localised, sometimes to the external retinal layers (affecting also the choroid), sometimes to the internal. In this last case the membrana

limitans is disorganised, and condylomatous growths are produced (*Iwanoff*) which project into the vitreous and there become vascular.

This morbid condition is accompanied with change in the structure of the retinal vessels, their walls being thickened by the hypertrophy of their adventitious membrane. Much more rarely, the retinitis seems to begin in the walls of the vessels and in their immediate neighbourhood (**retinitis Perivascularis**); it is localised to these structures, whilst the remainder of the cellular tissue is little altered, and the nervous elements are entirely preserved. In these exceptional cases, anatomical investigation has shown a considerable proliferation of cells in the adventitious membrane of the arteries, of the veins and of the capillaries, but in very various degrees (*Iwanoff*).

Diagnosis.—With the ophthalmoscope, we find in diffuse retinitis the signs of venous hyperæmia and retinal œdema (loss of transparency), which have already been mentioned in connection with simple retinitis. In addition, we also find whitish or yellowish, sometimes even greenish opacities on the retina, which may be in the form of isolated points, or of large irregular patches, in striæ or narrow bands.

The vessels are partially covered with these yellowish exudations; they seem to dip into them on one side and to come out on the other. The large vessels are bounded on both sides by a whitish line which extend along their walls.

Round the macula, the retinal opacities are grouped in a peculiar manner, in very fine lines, and more rarely small striæ, which radiate out from the fovea centralis; this star shaped figure may also be composed of very fine points. There are also sometimes more or less numerous ecchymoses, disseminated through the retina as small red spots, or as fine striæ, or even as irregular red patches in the immediate neighbourhood of the vessels of the retina. These will be fully described in the chapter on Retinal Hæmorrhages.

In **Perivascular retinitis**, the arteries and their branches seem to be transformed into whitish threads, in the centre of which a red line is visible; the larger veins are diminished and irregular in calibre; at the periphery only, a few branches have the same appearance as the arteries. The retina at various points seems opaque, and in these situations it is covered with punctated ecchymoses.

On the optic nerve, the point of emergence of the vessels is covered with a brilliantly white prominent mass, with red spots and striæ which come from the new vessels; these may be made momentarily to disappear by compressing the eyeball (*Nagel*).

The external appearance of the eye is perfectly normal; occasionally the tissue round the cornea is injected, sometimes the iris is slightly

sluggish in its movements, and after a certain time the pupil becomes slightly dilated.

In the early stages, the patient feels as if there were a cloud before the eye, or a fog round the objects at which he is looking, which cloud grows thicker when an effort is made to distinguish these objects clearly; the eyes are easily dazzled, and the patient complains of flashes of light. The central visual acuteness is considerably diminished; the visual field is contracted, or may present small absolute deficiencies (scotomata), which vary in form and situation. This weakening of the visual acuteness is especially remarkable in a dim light. As to colour-perception, we need only repeat the statements already made when speaking of serous retinitis.

Sometimes objects seem smaller than they really are (*micropsia*), sometimes larger (*megalopsia*), or contorted (*metamorphopsia*). The presence of the phenomena may be easily ascertained by placing a prism before the eye with the base turned upwards or downwards. The patient can then compare the images coming from the two eyes.

In very pronounced cases vision is completely destroyed, the patients are scarcely able to distinguish night and day, and the eye is not dazzled even by a very bright light. The condition of the eye, as seen by the ophthalmoscope, does not correspond with the functional symptoms.

As a rule, patients do not experience pain, or at most they suffer from a feeling of pressure in the bottom of the orbit.

The **progress** of parenchymatous retinitis is usually very slow. Even when the characteristic symptoms of the disease are rapidly established, it becomes after a short time almost stationary, with alternating remissions and exacerbations.

If the morbid process is not intense, if the exudations are insignificant, and if the disease is of short duration, we may perhaps expect complete recovery; but, even in such cases, relapses are frequent. If the disease is of long duration, with a considerable amount of exudation, and if there are already secondary changes in the nerve elements, recovery is always imperfect. Vision remains more or less altered, according as the process is localised to the centre or periphery of the retina. Again, the disease often terminates in atrophy of the retinal tissue and definite abolition of vision.

The **prognosis** is therefore always very serious, and should be guided by such special circumstances as the duration of the disease, the intensity and extension of the process, and its localisation. The prognosis becomes more grave with advancing years, with defects in the field of vision, with any tendency to vascular changes, and with the probability of an analogous cerebral affection. The more numerous the relapses, the greater is the danger of final atrophy.

Ætiology.—The cause of this affection, excepting where there is a syphilitic taint, is often unknown. It has been attributed to heredity, dysmenorrhœa, the sudden effect of a dazzling light, and contusions of the eyeball. The disease may also extend to the retina from the choroid; again, it may be in connection with some atheromatous alterations of the brain.

Treatment.—Complete rest to the eyes, keeping the patient for a long time in a room always at the same degree of darkness, and diet regulated to suit the general constitution are essentials; any considerable hyperæmia of the retina and congestion to the head demand repeated local depletion of blood, effected by applying a wet cupping-glass to the temple, cold compresses and mild purgatives. For the exudations we may give internally calomel, sublimate of mercury, and iodine preparations; externally inunction with mercurial and iodine ointment.

After there is an improvement in the condition, the patient should begin to use his sight only very gradually; he should avoid too bright a light, and for a length of time should use every precaution to prevent a relapse.

Retinitis punctata albescens and Retinitis striata.—Some observations have been published of a peculiar retinal affection in which the ophthalmoscope shows great numbers of small white round dots, chiefly between the papilla and macula. They are supposed to be the result of hæmorrhages, but they may be also of inflammatory origin. The defect of vision consists in the diminishing of central vision, the eccentric visual field remaining intact.

Much more frequently, extensive white striæ are seen in the retina, covering part of the vessels and even passing through the papilla. They result probably from development of connective tissue after hæmorrhagic or inflammatory processes. Vision is often but slightly affected. In both of these diseases treatment consisted in the application of Heurteloup's leech, iodide of potassium, small doses of sublimate, and care of the general health.

3. Syphilitic Retinitis.

Constitutional syphilis becomes localised in the retina as in other portions of the eye, such as the iris and choroid. In the nervous membrane, it is characterised by a general opacity which gives the fundus of the eye on ophthalmoscopic examination a greyish or bluish reflection, in which the outline of the optic nerve is no longer visible. This opacity disappears near the periphery of the membrane. It is very visible along the large retinal vessels. The veins seem swollen

and tortuous, but in a very variable degree; hæmorrhage has occasionally been observed. The detection of these symptoms becomes very difficult when we have also opacities of the vitreous, which in the early stages are very thin, but become more apparent as the disease progresses.

When, in any case, ophthalmoscopic examination leaves us in doubt whether we have to do with an opacity of the retina, or of the vitreous in the fundus of the eye, we must direct our attention to the periphery. In this situation, opacity of the retina becomes less and less and disappears, whilst opacities of the vitreous body are here much more pronounced than at the centre.

Another common complication is an alteration in the choroid. This, indeed, may be the starting point of the disease which has secondarily spread to the external layers of the retina (**chorio-retinitis**).

The changes in the choroid, concealed at first by the loss of transparency in the subjacent membrane, are often invisible till the retinal affection has passed off.

In a rarer form of syphilitic retinitis, the opacity is very well marked at the fovea centralis, and gradually decreases round the macula. The optic papilla and its neighbourhood preserve their transparency (recurring central retinitis of *von Graefe*). This condition supervenes suddenly and is accompanied with great diminution in the acuteness of central vision, which may even amount to blindness if both eyes are affected. In a short time the disease disappears, but returns after a few weeks or months.

The relapses may be very frequent, leaving after the first attacks a normal condition of the fundus and of vision. But later the vision is permanently injured, and the retinal affection remains constant.

In the ordinary variety of syphilitic retinitis, the functional disturbance consists in a diminution, at first of little moment, although sometimes very rapid, of the central visual acuteness, whilst the periphery of the field of vision in the majority of cases remains normal. The results of the examination vary considerably with the illumination (torpor retinæ). Frequently, patients complain of the presence of immobile black spots (positive scotomata), of floating bodies (opacities of the vitreous humour), of luminous and coloured apparitions (photopsia and chromopsia).

When the disease is in the form of chorio-retinitis, we sometimes find, with the perimeter, defects in the visual field, which correspond in form and situation to the disseminated foci on the fundus of the eye; thus, if the morbid process occupies the periphery, the visual field is perceptibly contracted. Yet there is not always a direct relation between the alterations visible to the ophthalmoscope and the amount

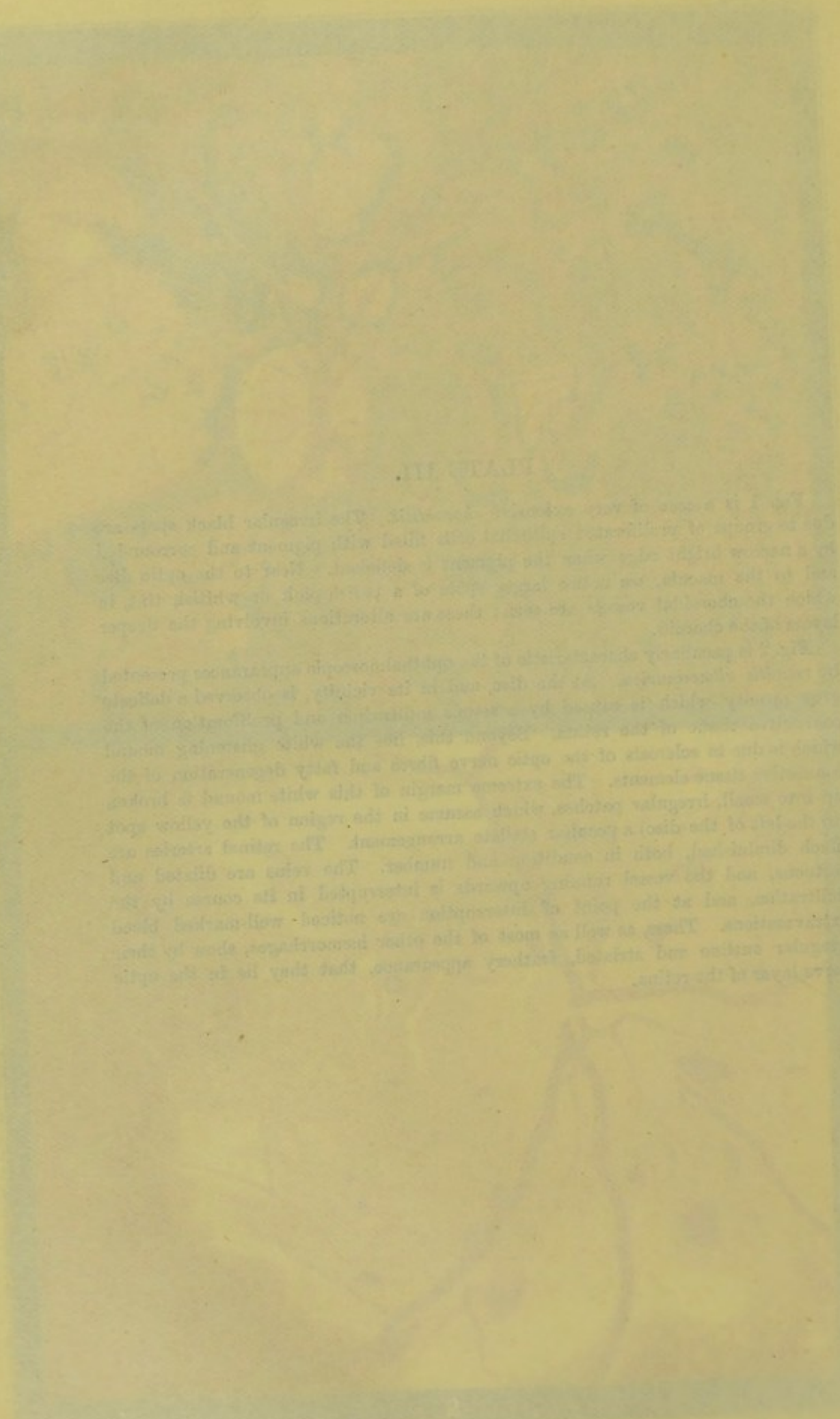
FROM LIEBREICH'S ATLAS OF OPTHAMOLOGY

J. W. WATSON, LITH

PLATE III.

Fig. 1 is a case of very extensive *choroiditis*. The irregular black spots are due to groups of proliferated epithelial cells filled with pigment and surrounded by a narrow bright edge when the pigment is deficient. Near to the optic disc and to the macula, we notice larger spots of a palish-pink or whitish tint, in which the choroidal vessels are seen; these are alterations involving the deeper layers of the choroid.

Fig. 2 is peculiarly characteristic of the ophthalmoscopic appearances presented by *retinitis albuminurica*. At the disc, and in its vicinity, is observed a delicate grey opacity which is caused by a serous infiltration and proliferation of the connective tissue of the retina. Beyond this, lies the white glistening mound which is due to sclerosis of the optic nerve fibres and fatty degeneration of the connective tissue elements. The extreme margin of this white mound is broken up into small, irregular patches, which assume in the region of the yellow spot (to the left of the disc) a peculiar stellate arrangement. The retinal arteries are much diminished, both in condition and number. The veins are dilated and tortuous, and the vessel running upwards is interrupted in its course by the infiltration, and at the point of interruption are noticed well-marked blood extravasations. These, as well as most of the other hæmorrhages, show by their irregular outline and striated, feathery appearance, that they lie in the optic nerve layer of the retina.



of functional disturbance. If the macula is affected, we find a central scotoma with dyschromatopsia throughout the entire scotoma; sometimes also patients see objects smaller than they are in reality (micropsia) and difformed (metamorphopsia).

The **progress** of the disease, besides being very slow, is very variable. It is often cured by active treatment in six or eight weeks, at other times it is very stubborn, and it is always apt to recur. When the relapses are very frequent, the arteries become thinner, with slow atrophy of the retina and optic nerve. In the last place, the pigmentary epithelium becomes diffusely discoloured, and black spots make their appearance in the fundus of the eye. From their star-like appearance and connection with the retinal vessels, the ophthalmoscopic appearance of this last stage of chorio-retinitis resembles very closely that of pigmentary retinitis, and we may fall into an error of diagnosis if we do not take into careful consideration the antecedents.

The **prognosis** is, as a rule, favourable in the early stages of the disease, and becomes more serious the longer it lasts, and the greater the number of relapses. The possibility of complete recovery depends on the density of the opacities, and on the alterations of the retinal tissue.

Ætiology.—Statistics as to the antecedents of patients affected with this disease show that the constitutional syphilis manifests itself in a large number of cases by retinal inflammation, with the *ensemble* of symptoms which we have described. If there is nothing in these symptoms absolutely pathognomonic, still they derive some value from the fact that they are much more frequently seen in syphilitic persons than in others affected with retinitis.

Treatment.—The treatment consists almost entirely of anti-syphilitic medication, regular mercurial inunction, with confinement to bed in a dark room, the internal administration of mercurials and iodide of potassium. We may add to this treatment with advantage sudorifics, which should be given according to the general strength of the patient.

When there are acute symptoms, we may derive benefit by applying the artificial leech to the temple. The treatment should be continued for some time after the disease has disappeared, and should only be gradually and cautiously stopped, as relapses are apt to occur.

The torpor of the retina, which sometimes remains for a considerable period, is best treated by subcutaneous injections of strychnia in the temple.

4. Retinitis Albuminurica.

In addition to venous hyperæmia, we find a greyish opacity of the retina, surrounding the optic papilla, obscuring its outline, and partially

veiling the vessels. This opacity is condensed, and in it we find small hæmorrhages of a round or striated form. At some distance from the papilla, there are developed a certain number of milk-white points or small patches, which increase in size, become united to each other, and so form a large greyish-white glittering ring around the nerve, sending offshoots towards the periphery of the eye, where we find a few isolated white patches. The vessels are to a large extent buried in the tumefied retinal tissue, on which we also find numerous apoplectic foci (Fig. 89).

Round the yellow spot, we observe a mass of small white spots, arranged in lines, radiating from the fovea centralis, which is of a deep red colour. The peripheral parts of the eye do not undergo any alteration.

This appearance of the retina is due to a serous transudation in the neighbourhood of the optic disc, with hypertrophy of the cellular tissue of the retina. We then have fatty degeneration of these structures, and, later, sclerosis of the nerve fibres and ganglion cells. As the radiating fibres in the region of the macula radiate from the central spot, their special arrangement explains the peculiar appearance in this

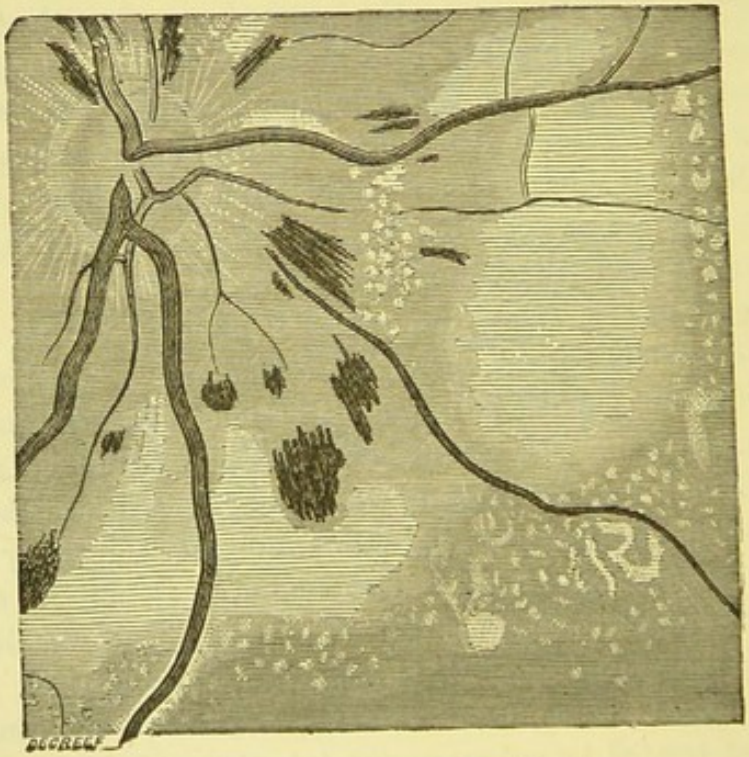


Fig. 89.—Retinitis Albuminurica.

region—that is to say, the star-shaped arrangement of the white points and spots which indicate the fatty degeneration of the radiating fibres.

The walls of the vessels also are affected with analogous changes.

In a few cases the inflammatory process is concentrated on the optic

nerve, and it becomes the seat of a considerable swelling, the ophthalmoscopic image of which exactly resembles strangulated papilla. (See Diseases of the Optic Nerve.)

In this disease, the functional disturbance is very variable, and does not bear any relation to the ophthalmoscopic alterations. Central vision always suffers more or less, but is rarely completely destroyed. In most cases the visual field remains entirely free, unless at a later stage the disease is complicated with separation of the retina. Perception of colours is normal. The disease generally affects both eyes, but in different degrees.

The **progress** of the disease is, as a rule, slow, being interrupted by stationary periods; at times there seems to be some improvement, and then again a sudden exacerbation.

Still, cases of complete recovery have been seen (in albuminuria, after scarlet fever, or in pregnancy), in which the retina and vision have returned to their normal state. In other cases traces of the retinal opacities remain, with the consequent disturbance of vision; or, again, the disease terminates in atrophic changes, or in separation of the retina. Often the progress of the general disease and the death of the patient put an end to the study of the development of the ocular affection.

Hæmorrhages beneath the conjunctiva and into the vitreous body are common complications. They are important as indications of a general hæmorrhagic condition, which may also manifest itself in epistaxis, pupura hæmorrhagica, cerebral apoplexy.

The **prognosis,** although bad in itself, becomes more serious, in consequence of the danger to which the general disease exposes the life of the patient. If the general health be re-established, the ocular affection may also pass off, and the vision improve, or even be restored to its normal state.

Ætiology.—This form of retinitis is closely connected with the appearance of albumen in the urine, especially if the albuminuria is chronic, consequently we have it in diseases of the kidneys (Bright's disease), in bad cases of intermittent fever, in chronic alcoholism, in the acute exanthemata, especially after scarlet fever, and during pregnancy. According to some authorities, the retinitis is due to a deficiency of the nutrition of the retinal tissue owing to the altered condition of the blood; according to others, it is due to the vascular tension of the arterial system, which increases with the disturbance of the general circulation (left ventricular hypertrophy) secondary to the disease of the kidneys. However, retinitis albuminurica is only observed in 8 or 10 per cent. of cases of Bright's disease, and if once established it may pursue a course perfectly independent of the general state.

Treatment.—The general state of health seldom admits of blood-letting, which, however, when performed in suitable cases on the temple, seems to be beneficial in checking inflammatory symptoms; it may be replaced by dry cupping, administration of derivatives, &c. As far as the condition of the eyes is concerned, good results have been obtained by general treatment with iodide of potassium, iron preparations, tannin, digitalis, and the moderate use of diuretics and diaphoretics; a milk diet is generally of great benefit.

The majority of these patients cannot stand any reducing treatment, their general condition requires rather a strengthening and tonic course.

[We must take care not to confound the disease which we have just described with **uræmic amaurosis**, which is also met with in Bright's disease, and which is not due to any alteration of the retina. It is characterised by sudden dimness of vision, which may amount to total blindness, coming on rapidly, and passing off after the attack (see further on Amblyopia from Intoxication)].

5. Leukæmic Retinitis.

Leukæmia must also be reckoned among the general affections which may give rise to retinitis.

On ophthalmoscopic examination we find the normal red colour of the fundus changed into a pale lemon, which is due to an alteration in the colour of the blood from the excess of leucocytes which it contains. This change of colour is not, however, constant.

The neighbourhood of the papilla is the seat of small, whitish, round opacities, which are often surrounded with hæmorrhages, and the largest of which do not exceed the diameter of the papilla; they then seem to project beyond the level of the retina. These opacities are found as far as the equatorial region of the eye, and sometimes accompany the retinal vessels as white bands.

The anatomical cause of these opacities has been found in the collection of leucocytes (lymphatic corpuscles, *Leber*), which are analogous to the leukæmic foci of other organs (*Virchow*), and of the choroid (*Engel*, *Reimers*). In other cases, the opacities are due to sclerosis of the nerve fibres of the retina (*Recklinghausen*).

The functional disturbance is, as a rule, inconsiderable, at least when the disease is not complicated with hæmorrhage in the neighbourhood of the macula, or in the vitreous body. Apoplectic foci have also been seen in the choroid (*Saemisch*). This affection does not require any special treatment beyond that of the general disease.

ART. III.—Retinitis Pigmentosa.

The first symptom of this disease, which is often present long before the characteristic alteration of the retina makes its appearance, is a marked diminution of the visual acuteness whenever the illumination is defective (**hemeralopia**). Hence, it happens that in the evening patients are not able to find their way, which symptom can be reproduced also in day-time by examining them in a dimly-lighted room. It thus appears that this phenomenon is due to torpor of the retina, which demands bright illumination to call forth its normal function.

For some time this hemeralopia is the only thing which annoys the patient; but in time there supervenes a contraction of the visual field, at first only noticed when the light is insufficient, but after a time in any light.

This contraction follows an irregular concentric course, and slowly but continuously advances towards the point of fixation. Central vision may for a long time remain unaltered. Even when the field of vision is reduced to a few inches, patients may be able to read the smallest type, and yet be quite unable to move about alone (exactly as when a normal eye looks through a narrow tube). Again, in trying to

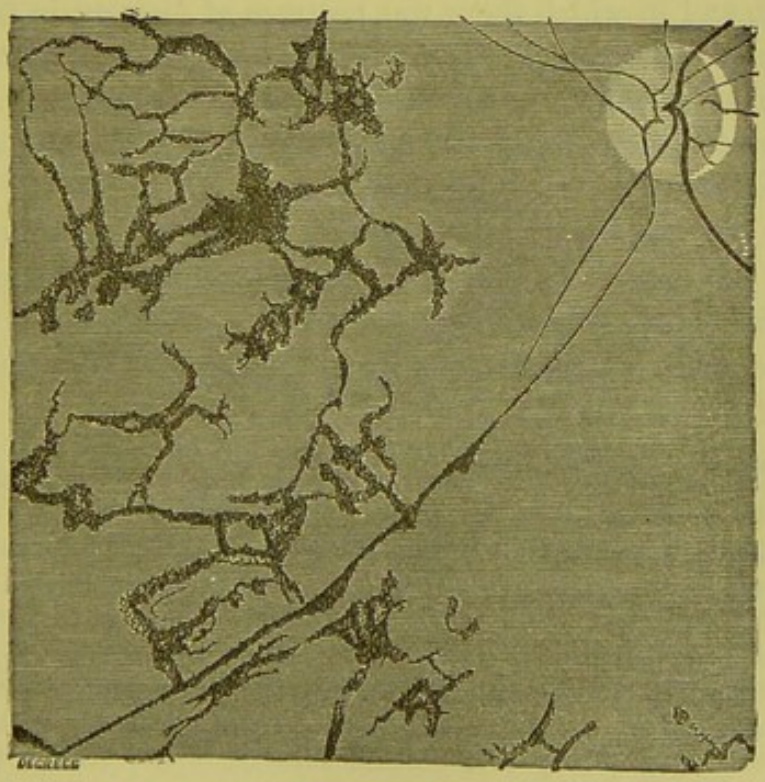


Fig. 90.—Retinitis Pigmentosa.

see successively the objects which a normal eye includes in one picture, the eyes move about rapidly. This unsteady uncertain and restless

look may assume the character of nystagmus. Colour-perception is normal; the sense of light considerably weakened.

Gradually the insensibility also invades the central portion of the retina, and the disease ends in complete blindness.

To the ophthalmoscope, this disease is characterised by the appearance of pigmentary masses in the retina, in the neighbourhood of the vessels and by a greyish or whitish discoloration of the optic papilla, which, however, never assumes a chalky whiteness, or resembles a tendinous reflection. There is also a more or less well-marked diminution of the calibre of the vessels in the fundus of the eye (Fig. 90).

The intensely black pigment, collected into denticulated and star-shaped masses, as a rule, appears first of all near the periphery, and is inconsiderable; after a time it increases in amount, and gradually encroaches on the posterior pole of the eye, often following the course of the vessels. The image of the fundus seems obscured by a slight veil.

The quantity of retinal pigment varies very much in this disease; sometimes the entire fundus is covered with it, so that the contracted vessels can scarcely be traced among the masses of pigment; sometimes we find only a few isolated patches of pigment in the equatorial region of the fundus of the eye; finally, cases have been recorded which presented all the functional symptoms so characteristic of retinitis pigmentosa, and in which there was no trace of pigment in the retina.

Along with the pathological alterations which we have just described, we sometimes also find modifications in the choroid, which consist of an irregular discoloration of that membrane, due to the loss of pigment in its epithelial layer.

In cases of advanced retinitis pigmentosa, we also meet with partial opacity of the lens at its posterior pole, which only occasionally is the starting point of a complete cataract. The vitreous body is sometimes the seat of flaky or filamentous opacities (*Mooren, Schweigger, Archiv für Ophthal*, vol. i., p. 103).

Histological research tends to show that the choroidal pigment of the epithelial layer may be infiltrated into the retina. This process was first observed in chorio-retinitis with exudation between the two membranes. In such cases the external layers of the retina are slowly destroyed, and the epithelial cells of the choroid with the pigment which they contain come forward to the internal layers of the retina; or again, these cells are disorganised, and their pigment alone penetrates the retina. In typical cases of retinitis pigmentosa, where there is no choroidal complication, we find a well-marked hyperplasia of the cellular tissue of the retina, more particularly in the neighbourhood of the vessels, the walls of which have undergone a thickening, which causes contraction of the large vessels, and complete obliteration of the smaller. At the same time, the pigmented epithelium is altered. On the one hand, we find cells which have become atrophied; on the other, cells highly pigmented, which are infiltrated into the

retina in the neighbourhood of the vessels. Finally, the nerve elements are also atrophied (*Leber*). The retinal pigment sometimes seems to come from the pigmented epithelium of the ciliary body (*Schweigger*).

The **progress** of this disease is exceedingly slow; it generally begins with hemeralopia in early youth, rarely at an advanced period of life; it attacks both eyes, and, at the age of forty or fifty, ends in complete blindness. Sometimes it may remain stationary for a long time.

The ultimate **prognosis** is thus absolutely bad.

The **ætiology** of this disease is not known; it often appears in several members of the same family, as if it were hereditary, and sometimes is coincident with idiocy or deaf-mutism. A certain number of children affected with the disease are the offspring of consanguineous marriages; others seem to be the subjects of hereditary syphilis. Pigmentation of the retina is also seen, as we have already said, in the last stage of chorio-retinitis. It is likewise observed in some cases of atrophy of the optic nerve and retina.

Hitherto all **treatment** has been ineffectual. Local blood-letting, with Heurteloup's apparatus, atropine and eserine lotions, the internal use of iodides, of iron and mercurial preparations, cod-liver oil, hydropathy—all have been tried, but with a negative result.

If the eye suffer from the light, we may give more or less deeply-coloured blue glasses. Subcutaneous injections of strychnia and the constant current have been employed to diminish the torpor of the retina.

ART. IV.—Hæmorrhagic Retinitis—Retinal Apoplexy.

In our description of the various forms of retinitis, we have noticed apopletic spots as being found along with the other changes which characterise the disease. In the present article, we shall speak of idiopathic apoplexy, which is found in what is to all appearance a healthy retina.

With the ophthalmoscope, we see the apoplectic foci as red spots, which vary in colour and form. Sometimes they are numerous, large, and closely packed; sometimes we only find a few isolated patches in the course of the retinal vessels, near the periphery, or just at the macula.

In the neighbourhood of the optic nerve, these apoplectic spots are

most frequently elongated, with striated contours (in the direction of the nervous fibres). Their colour primarily depends on the thickness of the hæmorrhagic spot, but to some extent on the general colour of the eye, inasmuch as they are bright red when the choroid is deficient in pigment, and deeper red when the eye is darker. Sometimes the spots are diffuse, and produce all around them serous infiltration of the retina.

The hæmorrhage may extend throughout the entire thickness of the retina, and may externally even penetrate to the surface of the choroid; more rarely the blood penetrates through the membrana limitans and hyaloid to the vitreous body; in a few rare cases it has been observed to spread between the retina and vitreous body.

The functional disturbance depends on the extent and situation of the hæmorrhage. When the extravasations are isolated and situated towards the periphery, central vision may be perfect, and the peripheral interruptions of the visual field can be detected only by very careful examination. Vision is seriously interfered with when the apoplectic spot occupies the macula, and each hæmorrhagic focus causes a corresponding deficiency in the visual field. This is partly due to the fact that the blood intercepts the luminous rays before they reach the layer of the retina suited to their reception, and partly to the destruction of the delicate tissue of which the membrane is composed, by the effused blood.

Progress and Termination.—The absorption of retinal hæmorrhage is always very slow; it may occupy several weeks or a few months.

During this time, the spots grow gradually paler, they split up into smaller fragments, and finally disappear without leaving any trace. Sometimes we find them replaced by choroidal alterations; or, again, their seat is often marked by the presence of blackish pigment. Sometimes the primary situation of the hæmorrhage may be recognised, even after all the extravasated blood has been absorbed, by a greyish or whitish coloration (due to the degeneration of the injured retinal tissue). If the hæmorrhage has been very extensive, or if it has recurred, the destruction of the tissue and the compression of the nervous elements may excite atrophy of the retina.

The disturbance of vision may in great part disappear with the absorption of the hæmorrhage, if it has not been very extensive. But, as a rule, the defects in the visual field remain, and where there is secondary atrophy vision is completely destroyed.

Very extensive retinal hæmorrhages seem to predispose to glaucomatous complications, against which iridectomy does not seem to be of any avail.

The **prognosis** in retinal apoplexy is serious; it is more so if the hæmorrhagic foci are numerous, very extensive, or situated in the region of the macula. It is rendered more serious by the liability to relapse.

Ætiology.—Hæmorrhage of the retina is met with, as we have seen, in various forms of retinitis. It may be due to injury, or to a sudden diminution of intraocular tension (as after iridectomy for glaucoma). Most frequently, hæmorrhage of the retina coincides with organic disease of the heart (hypertrophy of the left ventricle), or of the vascular system (rigidity of the arteries, atheromatous degeneration). In such cases, it comes on in advanced life, and there are other symptoms of cerebral congestion.

Hæmorrhage may also occur after the cessation of any habitual hæmorrhoidal flow, along with menstrual disturbance, or general diseases—such as diabetes, oxaluria, pernicious anæmia, purpura hæmorrhagica, jaundice, and scurvy.

The **treatment** must vary with the patient's general condition, and with the precise cause of the hæmorrhage. When antiphlogistic treatment is indicated or allowable, we use cold compresses and local blood-letting. In other cases, we give a derivative course, which tends to promote absorption, or strengthening and tonic medicines, milk diet, diuretics and purgative mineral waters, digitalis or Haller's acid elixir.

Along with this we give the eyes absolute rest, and make the patient avoid everything which would cause congestion of the head. The temporary use of a pressure bandage may also be of great service in hastening the absorption of the hæmorrhage.

ART. V.—Embolism of the Central Artery of the Retina.

The penetration of a blood-clot into the central artery, as a determining cause of sudden blindness, was first observed by *von Graefe* (*Archives d' Ophthalmologie*, 1859., vol. i., p. 136).*

With the ophthalmoscope, we find, shortly after the impaction of the embolon, a decided paleness of the papilla, which, however, is still

* The patient having died two years later from heart-disease, the dissection of the eye was entrusted to *Schweigger*, who has preserved the anatomical preparation, showing the embolon in the central artery, at 1 millimetre below the fenestrated membrane (Fig. 91).

transparent; the arteries seem to be empty of blood, and are seen on the retina and papilla as narrow white threads. The veins, generally contracted, are of a somewhat greater calibre in the equatorial region of the eye.

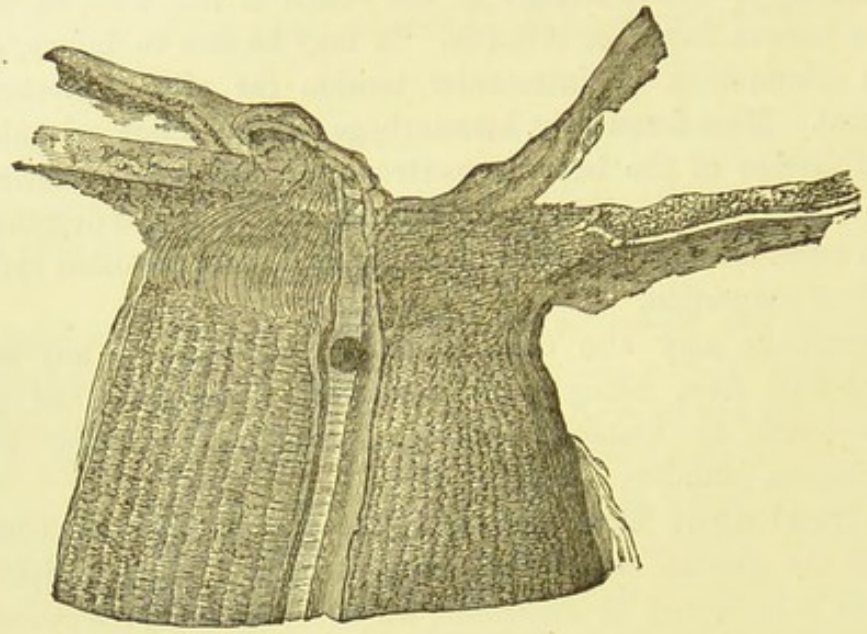


Fig. 91.—Embolism of the Central Artery of the Retina.

Soon the retina begins to grow dim, and is gradually rendered absolutely opaque by a greyish-white infiltration, in the midst of which the macula is seen as a deep red spot. During this period, we can observe in the veins a phenomenon which seems to be connected with the development of the collateral circulation. The blood which they contain flows from the periphery towards the optic nerve in a jerking manner, sometimes stopping short suddenly, and irregularly filling the various portions of the vessel.

The disturbance of vision begins with the sudden sensation as of a fog before the eye, but vision is totally extinguished in a few minutes.

Progress and Termination.—The retinal infiltration rapidly decreases, and the special colour of the macula also fades; gradual atrophy of the nerve and retina supervene. Vision is sometimes re-established to a slight extent, but very incompletely, and generally towards the periphery of the field; but it ultimately becomes extinct, and in general does not return.

The **prognosis** is therefore absolutely bad.

Ætiology.—Almost all the cases observed have been connected with organic disease of the heart, or an atheromatous degeneration of the vascular system; in one case, there was an aneurism of the primary carotid (*Knapp*). Cases have also been recorded in which embolism of

the central artery of the retina supervened during pregnancy and Bright's disease.

Treatment.—To promote the re-establishment of circulation, some have performed massage, frequent paracentesis of the anterior chamber, sclerotomy, and iridectomy, with the view of decreasing the pressure which the internal fluids exercise on the walls of the vessels.

Such remedial measures have, however, been without any result, except in cases in which the circulation was not completely impeded by the embolon.

Cases have also been seen in which the embolon was situated in one of the *branches* of the *central artery*, with infiltration of the corresponding portion of the retina, the macula still remaining normal.

The functional disturbance is then limited to a portion of the visual field, and may completely disappear.

Virchow has attributed the suppurative choroiditis which occurs in puerperal fever, phlebitis, pyæmia (see page 210) to embolism of the vessels of the eye, and has published several cases submitted to anatomical examination (*Gesammelte Abhandlungen*, 1856, pp. 539 and 711; *Archiv für Pathologische Anatomie*, 1856, vol. ix. fasc. 2, p. 307; and vol. x. fasc. 2, p. 179).

ART. VI.—Detachment of the Retina.

When the media of the eye are transparent, and when the detachment is considerable, the diagnosis does not present any difficulty.

With the mirror of an ophthalmoscope, we see, in a portion of the fundus of the eye, an unwonted greyish or greenish-blue reflection. This portion of the fundus presents folds and undulations when the patient changes the direction in which he is looking. We are not slow in recognising the retinal vessels in this floating membrane. They are somewhat irregular in their outline, being partially hidden from view by the folds of the separated surface. The vessels are generally of a deep brown colour.

On carefully examining the boundary of the detached portion of the retina, we find that the vessels are bent as they descend to its normal level. This shows that there is a serious infiltration at this point; sometimes there are small apoplectic spots.

In the majority of cases the detachment is found in the inferior half of the fundus of the eye; for, even when the retina has been primarily detached above, the sub-retinal fluid spreads between the

retina and choroid, and reaches the inferior portions. The superior part of the retina, primarily separated, may then become re-attached to the choroid and recover the integrity of its functions.

The **diagnosis** presents greater difficulty when only a small portion of the retina is detached, without formation of folds, and with transparency of the exudation which has produced the separation.

We must, in such cases, ascertain correctly the differences of level, which may be done either directly by means of a binocular ophthalmoscope, or indirectly by following the course of a vessel and observing, by slight lateral movements of the biconvex lens, that the portion of the vessel which crosses the detached retina is farther forward than that which lies on the normal fundus. Generally the vessels on the separated retina are dark coloured, stretched, and hidden here and there. Frequently perforation has been noticed in the detached portion. It can be recognised by its incurved margins and by the apparition of the red choroid. The exuded fluid that produces the detachment is, in most cases, serous, seldom bloody or purulent.

The disturbance in vision, produced by separation of the retina, is very characteristic; the patient complains of a greyish cloud which floats before the eye, and sometimes of mobile black patches which cross the field of vision in all directions.

Careful examination shows a defect in the visual field which corresponds exactly with the position and extent of the separated portion. Thus, when the separation is at the inferior part of the eye, the patient can no longer see, or can only imperfectly distinguish objects in the superior part of the field of vision. The degree to which the visual acuteness in this portion of the field is diminished, depends chiefly on the secondary changes which take place in the separated retina, so that while the affection is recent, the patient may still be able to count fingers; but vision is entirely destroyed when the separated retina is infiltrated, or when its tissue has undergone degeneration.

Between the defective portion of the visual field and the portion which is still preserved, there generally exists a zone in which the vision is very imperfect; this corresponds with the place at which the retina, without being already detached, begins to rise above the normal level, and at which we see the bend in the retinal vessels.

Central vision is generally diminished from the very outset of the disease, and more so if the separation takes place near the macula. The patients complain that objects seem to be deformed, and that straight lines are curved or interrupted (metamorphopsia). Difficulty in the perception of colour is also very well marked. When the separation involves the macula itself, and when all perception has ceased

in this region, the patient still uses the portion of the retina which is in connection with the choroid, and thus there is eccentric fixation.

The black spots which float before the eye are caused by opacities of the vitreous, which appear before, or often accompany, the retinal separation.

In addition, the patient sometimes complains of sparks of fire, of bright stars, or of luminosities which rapidly pass before the eyes. These photopsias are due to an irritation or dragging of the retina, which arises from a sudden displacement of liquid during ocular movements.

In the large majority of cases, separation of the retina is accompanied by a diminution in tension of the eyeball, the eye becoming more and more soft. It is only when the separation of the retina is due to a choroidal tumour, or in the still rarer cases where there is a complication of the iris, that separation is followed by an increase of intraocular pressure, the eyeball becoming harder.

The **course** of this disease is generally progressive. The separation may involve the entire retina, which then assumes an infundibular form, the greater opening being directed forwards. It is almost always followed by the formation of soft cortical cataract with capsular opacities, or by chronic iritis with occlusion of the pupil and symptoms of atrophy of the ball.

Yet, frequently we find that a detachment of the retina, having attained a certain stage, remains stationary; but it is only very exceptionally that we see cases where spontaneous cure has taken place from absorption of the fluid or from rupture of the retinal sac.

In the last case, the effused fluid escapes into the vitreous; the membrane is re-applied to the choroid and resumes its functions.

The **prognosis** is consequently very grave; complete cure, even temporary cure, is very rare. In cases which remain stationary, and even when there is some improvement of function (which is not often of long duration), the vision, as a rule, remains defective and subject to variations which annoy the patient. In the early stages of the disease, the patient, as a rule, sees a little better in the morning, for, after the prolonged dorsal decubitus, the retina becomes re-applied to the choroid; but any such improvement rapidly disappears. In making our prognosis we must also keep in mind that, when separation is due to something in one eye which also exists in the other (progressive myopia), we often have, at a later stage, the other eye also affected with separation of the retina.

Ætiology.—One of the most frequent causes of retinal detachment is the presence of progressive myopia. Either there is a special tendency in this disease to serous effusion on the anterior surface of the

choroid, or the retinal separation is the mechanical result of the elongation of the antero-posterior diameter of the ball (see Posterior Staphyloma).

The separation may again be caused by injury of the eye with serous or hæmorrhagic effusion between the choroid and retina. In other cases, the effusions are due to retinitis or choroiditis. In certain forms of irido-choroiditis with secondary changes of the vitreous body, membraneous opacities are formed in the vitreous, which are attached to the retina at one point, and on contracting, drag the retina away from the choroid. *Leber* has found that a perforation in the detached portion can be frequently noticed from the beginning of the affection; he thinks that it precedes the occurrence of the detachment, and is caused by the traction of the diseased shrinking vitreous, which, then pressing through the opening, separates the retina from the choroid. Separation of the retina has also been seen to occur as a consequence of sudden compression of the orbital vessels by intra-orbital tumours or abscesses, which retard the venous circulation. Choroidal and retinal tumours, and sub-retinal cysticercus are amongst the causes of retinal separation. Again, it has been seen to follow wounds of the sclerotic, when the cicatricial contraction diminishes the extent of the surface to which the retina is indirectly attached.

Treatment.—We must begin with derivatives and antiphlogistic remedies; rest in bed with a pressure bandage, mild laxatives, hypodermic use of pilocarpine and mercurial inunctions, the regular employment of Heurteloup's apparatus, are the usual remedies with which we hope to stay the progress of the disease, or perhaps even obtain the absorption of the sub-retinal fluid.

Puncture of the Sclerotic.—When this treatment proves unsuccessful, we have to perform puncture of the sclerotic. Graefe's cataract knife is entered through the sclerotic and choroid at a point corresponding to the detachment, taking care not to reach the retina, lest thereby it be further separated. The instrument is then given a slight rotation to make the wound gape and the fluid flow off. Sutures are applied to the wound of the conjunctiva and a firm bandage, and the patient is kept in bed. The amelioration or cure that has been obtained is not often lasting, but the operation can be repeated without danger to the eye. It was first proposed by *Sichel*, and is preferable to *von Graefe's* puncture of the retina from the inside, by entering a double-eyed needle 10 mm. behind the temporal margin of the cornea into the vitreous humour, and dividing the detached retina so as to make the fluid flow into the vitreous humour. *Bowman* performed the same operation with two needles. *De Wecker* had proposed drainage by introducing a golden thread through sclerotic and choroid, in order

to have a lasting filtration of the fluid, and he has also performed the perforation of the sclerotic and choroid with galvano-cautery; but these methods have not been of real use, and he proposes now to replace them by applying the actual cautery on the conjunctiva round the cornea.

In cases of separation of the retina with complete loss of vision, the eyeball is sometimes the seat of very painful dazzling or very intense phosphenes. The optic nerve must then be divided, and should this fail, we must have recourse to enucleation.

ART. VII.—Tumours of the Retina.

Histological research tends to prove that the tumours of the retina, described under the names of **fungus hæmatodes, medullary** or **encephaloid cancer,** are identical with the neoplasm to which *Virchow* has given the name of **glioma.** Besides this neoplasm, already described by *Robin* (*Sichel's Iconographie*, plate 61, fig. 14) and by *Schweigger* (*Archiv für Ophthalmologie*, vi., 2, p. 324), we find cases of *gliosarcoma*, which are much less common.

Glioma of the retina may be compared with similar tumours of the brain; for, as these latter originate in the cellular elements (neuroglia) of the brain substance, so the glioma of the retina begins in the external granular layers (*Robin, Schweigger*), or in the cellular tissue of the nerve fibres (*Iwanoff*). The tumour is composed of large granulation masses and nuclei, traversed by a fine meshed fibrous network, and of a small number of fibres and cells provided with filiform prolongations.

The neoplastic tissue is also supplied with vessels of tolerably large calibre, and the tumour becomes more vascular when, having perforated the eye, it develops externally.

Diagnosis.—Rarely do we see glioma at its very beginning because it usually attacks children who are too young to express any difficulty of vision, and the parents do not perceive the signs of the disease till it has reached a somewhat advanced stage. In the early stages the external appearance of the eye does not present any change; there is no pain nor any symptom of inflammation. If at this period we make an ophthalmoscopic examination, we find numerous white patches of variable size on the retina, some of which are still situated behind the retinal vessels, whilst others involve the whole thickness of the membrane and distinctly protrude beyond its level. Soon separation of the retina takes place, the membrane being pushed forwards by a fluid effusion, and the neoplasm now becomes more visible. It is seen to consist of crimpled prominences, white, like mother-of-pearl,

presenting in places a fine and close vascular network. This special reflection coming from an eye deprived of its visual power, caused it to be called formerly amaurotic cat's-eye (*Beer*). Although this reflection may also be produced whenever white masses (purulent matter, separated retina which has undergone secondary changes) are found immediately behind the lens, it is never so well marked as in glioma, because in this disease there is a complete absence of pigment, and the vitreous body remains perfectly transparent.

From the very beginning of the disease vision is seriously impaired, and it is soon entirely destroyed.

Progress and Termination.—This tumour always continues to develope (*von Graefe*). As it advances in the interior of the eye, the intraocular pressure increases, and the eye then assumes the characteristics of a glaucomatous eye; insensibility and diffuse haziness of the cornea, dilatation and immobility of the pupil, hyperæmia of the conjunctival and subconjunctival veins. The lens becomes opaque. Sometimes, during the development of the tumour, suppurative inflammation of the eyeball takes place, and ends in atrophy of the ball; which, however, does not stop the growth of the tumour. Glioma usually extends beyond the eyeball along the optic nerve, which may be attacked by the neoplasm shortly after it has begun in the retina, and long before it has filled the entire eyeball.

Again, when the tumour has completely filled the eyeball, it comes to the surface by perforating, either at the margin of the cornea or through the membrane itself, more rarely through the sclerotic. When in contact with the air, it assumes a deep red colour, bleeds easily, secretes abundantly and increases rapidly.

The symptoms which mark the extension of the neoplasm to the optic nerve are slight exophthalmos, a certain stiffness in all the movements of the ball, a feeling of resistance on making pressure towards the fundus of the orbit. The cavity which normally exists between the orbit and eyeball is effaced. All these symptoms are much more distinct if the neoplasm has invaded the orbital tissue, where it may arise from numerous foci, which rapidly unite to form tumours of considerable dimensions. The osseous walls preserve their integrity for a long time; but the degeneration extends along the optic nerve to the brain either in its continuity, or only affecting certain parts. Gliomatous tumours have also been observed in the diploe of the cranial bones, in the liver and in the ovaries. (*Knapp, Die intraoc. Geschwülste*, 1868, p. 5; *Schiess-Gemusius*, in *Virchow's Archiv*, Bd. xlvi., 3; *Heymann und Fiedler*, in *Archiv für Ophthalmologie*, xv., 2, p. 173.) The patient then succumbs with the special symptoms of one or other of these complications.

Ætiology.—Retinal glioma affects almost exclusively young children. In some cases it seems to be congenital. The influence of heredity cannot be denied, as the disease is often found in several members of the same family.

Prognosis.—If the eyeball is enucleated at the very beginning of the affection, when it is still confined to the interior of the ball, we may entertain hopes that a return of the disease will be avoided. On the other hand, if the optic nerve is invaded by the degeneration, and especially if there are traces of it in the periorbital tissue, it is certain to return after a very brief interval. Glioma is undoubtedly a malignant tumour, and the prognosis is consequently very serious. Often both eyes are successively affected.

Treatment.—When once the glioma has been recognised, the eye must be enucleated as soon as possible; and, as we cannot always forsee whether the optic nerve is already affected, it is of importance to cut it as high up as possible. *Von Graefe* for this purpose began the operation by first of all dividing the optic nerve. If we suspect the presence of morbid foci in the orbital tissue, all the suspected tissue must be removed after the enucleation of the eyeball.

Cysts of the retina have been observed on examination of enucleated eyes (*Iwanoff, Klinische Monatsblätter*, 1864, p. 417; *Vernon, London Ophthal. Hospital Reports*, vi., 3). Sometimes only one is found, sometimes several, varying from the size of a pea to that of a nut, and generally situated on the external surface of the retina. They appear as transparent vesicles, and are probably due to a development of colloid matter which forms the cyst contents, and to a hypertrophy of the radiating fibres. These hypertrophied fibres form the lateral and external walls of the cyst, whilst the internal or inferior wall is represented by the other layers of the retina (*Iwanoff*).

The symptoms arising from **sub-retinal cysticercus** will be described in speaking of cysticercus of the vitreous body.

ART. VIII.—Congenital Anomalies of the Retina.

In speaking of the histology of the retina, we have already said that the nerve fibres of the optic nerve lose their sheath near the fenestrated membrane, beyond which the fibres are transparent and of single contour.

It sometimes happens that several of the nerve fibres retain their

sheath till they reach the retina and remain opaque. This congenital anomaly is seen by the ophthalmoscope as a whitish patch just in the neighbourhood of the papilla, with striated dentilations at its periphery.

The retinal vessels which pass over the spot are sometimes slightly masked; sometimes completely hidden. As a rule, there are several of those white patches surrounding the optic nerve; they are of pyramidal form, and the apex extends into the retinal substance to a variable degree, but their diameter rarely exceeds that of the optic nerve. More rarely these whitish spots are found at a considerable distance from the papilla. In such cases the nerve fibres have as usual lost their sheath at the membrana cribrosa, but have resumed it farther on in their course (*Virchow*).

Whatever may be the situation of these white spots, they are surrounded by absolutely normal retinal tissue, and the vessels do not present any alteration. Again, the fibres which have the double contour have not lost their conductivity; the visual functions, apart from a slight enlargement of the blind spot, are perfectly intact.

This congenital anomaly, which is most frequently discovered accidentally whilst making an ophthalmoscopic examination, for it does not give rise to any symptom, is sometimes found in both eyes; sometimes only in one.

DISEASES OF THE OPTIC NERVE.

ART. I.—Inflammation of the Optic Nerve.

Optic Neuritis or Papillitis—Neuro-retinitis or Papillo-retinitis.

Inflammation of the optic nerve is characterised by ophthalmoscopic symptoms, which are limited to the papilla and to the retina in its immediate neighbourhood.

At first, we find a certain degree of hyperæmia and œdema, which may at first affect only a portion of the papilla. Soon, however, the whole structure becomes involved, as is shown by the red, greyish, or violet colour, which spreads to all the altered structures. These lose their usual transparency, and thus hide either wholly or in part the fenestrated membrane, the margins of the papilla, and the vessels in that situation.

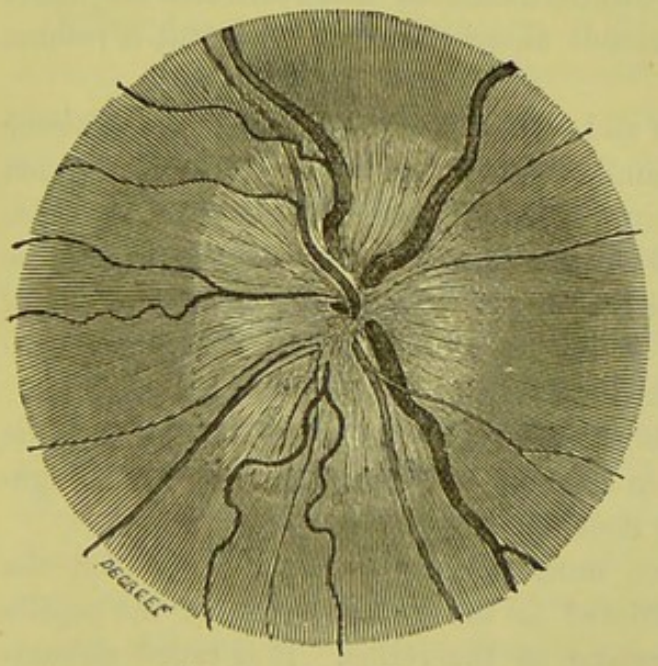


Fig. 92.—Optic Neuritis.

The optic nerve and the neighbouring portion of the retina are considerably swollen, but in different degrees. Rarely does the swelling of the retina exceed that of the optic nerve; generally the sharp edges of the papilla protrude considerably beyond the level of the membrane which surrounds it.

On the surface of these parts we find striated opacities, which radiate out to the limit of the tissues involved. Sometimes we find yellowish spots on the papilla, which extend beyond the borders of the optic nerve on to the retina. Not unfrequently do we meet with small hæmorrhages, which vary in size and shape.

The vessels of the retina are very much altered, the arteries are

diminished in calibre and sometimes scarcely visible, the veins are distended, enlarged, and tortuous; and at certain points these vessels disappear behind the aforementioned opacities.

Von Graefe distinguishes two principal varieties of optic neuritis:—

1. **Optic Neuritis** (choked disc)—*Stauungspapille.*—The characteristic alterations revealed by the ophthalmoscope are great prominence of the papilla, the margins of which are, however, well defined, red coloration of the optic nerve, tortuous and dark-coloured veins, and frequently ecchymotic spots. The infiltration of the tissues is limited to the immediate neighbourhood of the optic papilla, and the entire change seems to be concentrated in the intraocular termination of the optic nerve; it does not pass beyond the fenestrated membrane.

This variety seems to result from some disturbance of the circulation, followed by serous infiltration of the tissue of the optic papilla, commencing at the point where the sclerotic ring offers a resistance to any swelling of the optic nerve, which is thus, so to speak, strangulated.

2. The **neuritis, or neuro-retinitis descendens** originates in the nerve centre, and extends along the optic nerve till it reaches the eye.

The papilla is less swollen and not so red, the opacity of the tissue is much more pronounced, and of a greyish colour. The infiltration extends farther into the retina, especially along the vessels. We also find small whitish spots, due to sclerosis or fatty degeneration of the nerve fibres, and sometimes even the changes in the neighbourhood of the macula, which usually occur in retinitis albuminurica (a star-shaped figure composed of small points or white radiating lines).

In some cases, the ophthalmoscopic signs of the two forms of optic neuritis are so intermingled as to make the distinction between strangulated papilla and descending neuritis very difficult.

3. There is a third form, much more rarely seen, in which the inflammatory swelling is restricted to the circumference of the papilla and to the neighbouring portion of the retina. It is called **circumpapillary retinitis** (*Iwanoff*) or *peripapillitis.* With the ophthalmoscope the centre of the papilla is seen at its normal level, but seems to be more deeply coloured than usual; all around it the tissue is raised into a greyish ring, similar to that which is found in albuminuric retinitis. This form of peripapillitis has been observed in connection with meningitis.

The **functional disturbance** is generally considerable, the visual acuteness is much impaired, and the field of vision is irregularly defective. However, there is no ratio, even approximate, between the ophthalmoscopic condition and the state of vision. The perception of colours is quite normal in the beginning, but becomes affected

with the first symptoms of atrophy. The sense of light is always normal, or nearly so, even when the vision is already considerably impaired.

Sometimes the most marked alterations are seen in the fundus, with a nearly normal state of vision. The only thing which annoys the patient is complete but momentary loss of vision, which passes off as suddenly as it supervened. In other cases, vision is considerably impaired in the course of the disease, although the ophthalmoscopic signs do not vary.

The **external aspect** of the eye is not changed. The patient does not complain of pain in the diseased eye itself, but sometimes of neuralgia in its neighbourhood. In some cases a persistent watery discharge from the nose has been observed (*Nettleship, Priestley-Smith, Leber*) with more or less severe central symptoms. Chemical analysis has shown this fluid to be identical with the cerebro-spinal fluid, and *Leber* believes it to come from the third ventricle through an opening in the ethmoid bone.

Progress and Termination.—This disease may develop in very various ways. Sometimes the functional disturbance and anatomical changes gradually increase during several months; sometimes the disease attains its acme in a few days; occasionally vision is destroyed in a few hours (*von Graefe, Hutchinson*).

In most cases, the aggravation is rapid during the first days and weeks; later it becomes less and less perceptible.

In the form of neuritis which accompanies cerebral tumours, and which generally affects both optic nerves, the development is, as a rule, slower and more regularly graduated; the disease generally leads to almost complete loss of vision, followed by atrophy of the optic papilla. With the ophthalmoscope the papilla is seen to collapse, the vessels diminish in calibre, the ecchymotic and whitish spots disappear, and signs of atrophy of the optic nerve supervene.

But this atrophy following neuritis has certain peculiarities by which it may easily be recognised: the large venous trunks remain for a long time tortuous, their contour and that of the optic nerve continue veiled by the greyish haze of the retina, and the papilla neither presents that tendinous appearance which it has in ordinary atrophy, nor is there any cupping of its surface. Still, these differences may in a few years cease to exist.

In the forms of neuritis which are characteristic of encephalitis or meningitis, their development presents the greatest variations. The affection may stop short at any stage or may end in nerve atrophy.

Again, in a certain number of cases of neuro-retinitis, where the disease is due to disturbance of the menstruation or to affections of the

orbit, it is, as a rule, rapidly developed, and quickly acquires its greatest intensity; in such cases it is capable of complete cure.

Prognosis.—The prognosis of neuro-retinitis and of optic neuritis is, as a rule, very unfavourable; firstly because the remote causes (intracranial) often leave small hope of cure; then it may happen that the neuritis ends in complete blindness with atrophy of the papilla, although the primary cause may be of short duration (meningitis, &c.) We must, therefore, beware of giving a prognosis before we have, by prolonged observation, made ourselves thoroughly acquainted with the case in all its bearings.

As a rule, the disease may be expected to take a more favourable turn when it rapidly attains its greatest intensity, than when it increases slowly but steadily (*von Graefe*). For this reason, the prognosis in cases of cerebral tumour, with few exceptions, is absolutely bad; whilst, if the neuritis is secondary to disturbance of the menstruation, complete or partial cure may be expected.

Ætiology.—Optic neuritis is sometimes, although rarely, met with as an *idiopathic condition;* at least, it is impossible to find any cause. Sometimes we may be able to attribute it to a concussion, either of the orbital walls or of the eyeball; more frequently it seems to be due to some disturbance of the circulation in distant organs, *e.g.*, to dysmenorrhœa, or to constitutional causes, such as syphilis. Again, optic neuritis has been seen as a consequence of chills, of chronic alcoholism, of severe typhoid fever.

In the majority of cases, the affection is due to some cause (either organic or merely circulatory) which acts directly or indirectly on the optic nerve, either on the intracranial or intraorbital portion.

1. Sometimes the inflammation begins at the apparent origin of the optic nerve (encephalitis), in a morbid focus situated near its intracranial portion, or in the membranes of the brain at the base of the cranium (encephalo-meningitis). The inflammation seems to descend and extend along the optic nerve till it reaches the papilla and neighbouring portion of the retina (*neuro-retinitis*).

2. The disease, limited to the optic papilla (*choked disc, Stauungspapille*), appears to result from a mechanical hyperæmia, secondary to compression of the optic nerve or to venous stasis. Most frequently it is found in conjunction with cerebral tumours, hydrocephalus, numerous exudations or neoplasms at the base of the cranium, &c.

In like manner it has also been observed in connection with orbital tumours, with phlegmon of the fatty tissue of the orbit, inflammation of Tenon's capsule, &c.

Such conditions as we have just described increase the intraorbital or intracranial pressure; which, acting on the cavernous sinus,

impedes the venous circulation (*von Graefe*). Hence, we have dilatation of the vessels and infiltration of the optic nerve fibres. These latter have to pass through the scleral ring, which is very rigid. In doing so they undergo a literal strangulation, which increases the mechanical hyperæmia. These details explain the infiltration and prominence, which are sometimes great, of the nerve, as also the condition of the vessels which we have described.

This explanation, which we owe to *von Graefe*, has often been contradicted by cases of tumour or rapid exudation in the cranial cavity, without any corresponding optic neuritis; and, on the other hand, by cases which have been observed in which there has been this affection without any increase of the intracranial pressure. Again, *von Graefe's* hypothesis does not agree with the anatomical researches of *Seseman*. According to this observer, the central vein of the optic nerve communicates extensively by an abundant anastomosis with the ophthalmic vein, or may sometimes even join it directly, so that the compression of the cavernous sinus cannot produce that amount of disturbance of the optic nerve which has been attributed to it. The discovery of the space between the two sheaths of the optic nerve (intravaginal space), which communicates with the cerebral arachnoid space (*Schwalbe*), furnishes a simple anatomical explanation of the production of optic neuritis. The arachnoid liquid is pushed forward by any increase of intracranial pressure into this intravaginal space, till it reaches the fenestrated membrane, where it compresses and chokes the optic nerve in this situation (*Schmidt*, *Rimpler*). The fact that this phenomenon does not occur in every case where there is increased intracranial pressure may perhaps be explained by some interruption of the communication between the arachnoid and intravaginal space, which interruption the excess of cerebral pressure would itself cause at the optic foramen.

Panas thinks that when the arachnoidal space is filled with fluid, which flows off into the sheath of the optic nerve, papillitis is produced; but when a neoplasm or a fluid between the dura and the bone exercise pressure on the cavernous sinus, they only give rise to venous hyperæmia in the retinal vessels.

Parinaud considers optic neuritis as the consequence of a lymphatic œdema, propagated through the optic nerve to the papilla, whenever there is interstitial œdema of the brain. But in many cases there is no interstitial œdema of the brain, and in most cases the anatomical alterations are found in the papilla, the central parts of the optic nerve being quite normal.

Benedict tries to explain optic neuritis in diseases of the brain as a vasomotor neurosis due to the irritation of certain portions of the brain. This theory explains nothing at all.

Treatment.—If possible, our treatment should be directed towards the cause of the neuritis. Thus, we may have to treat irregularities of the circulation (dysmenorrhœa, &c.) by suitable remedies, or we may

have to open orbital abscesses, or remove neoplasms which compromise the intraorbital portion of the nerve.

Intracranial affections most frequently require derivative treatment—blood-letting at the temple, permanent vesicants or setons at the nape of the neck, internal administration of bichloride of mercury or iodide of potassium, regular mercurial inunctions, sudorifics, cathartics, &c.

If the patient is anæmic, we must abstain from all debilitating treatment, substituting dry cupping and mustard foot-baths, and giving internally preparations of iron and quinine.

The constant current has also been employed in this disease to check the neuralgia and sudden loss of vision, and seems to be beneficial. The positive pole should be applied to the nape of the neck, and the negative to the eyelids (*Benedict, Driver*).

In cases of imminent blindness and severe pain, *de Wecker* has performed incision of the sheath of the optic nerve, in order to carry off the fluid it contains. This operation seems to be effectual as far as the pain is concerned.

ART. II.—Acute and Chronic Retro-bulbar Neuritis.

The name of *acute retro-bulbar neuritis* has been given by *von Graefe* to cases where an obscuration of the vision occurs (with or without chromopsia and photopsia), ending in complete blindness, in the course of a few hours or days; sometimes following some form of systemic disease, as measles, scarlatina, gastritis, angina; but sometimes without any perceptible alteration of the general health. This affection usually attacks both eyes.

The pupil is much dilated, and does not respond to light. To the ophthalmoscope, the optic papilla presents a very slight diffused opacity, which extends to the neighbouring portion of the retina. The papilla is not raised above its ordinary level. The arteries are diminished in calibre, but the circulation in them is not interrupted; the veins are dilated and tortuous, but are everywhere distinctly seen, for the opacity of the tissues is not dense.

These ophthalmoscopic changes do not account for the complete absence of vision.

The course of this disease is somewhat analogous to that of true optic neuritis, when it assumes a most acute form.

The quantitative perception of light may be restored, even after prolonged blindness; sometimes there is complete recovery; at other times the nerve undergoes partial atrophy restricted to the temporal half; again, it may happen that the vision is permanently lost, in which case there is rapid atrophic degeneration.

Chronic retro-bulbar neuritis may in the beginning affect only one eye, and even without any alteration visible with the ophthalmoscope; or both eyes may be affected, and hyperæmia of the papilla observed. The functional disturbances are such as to cause complaints of a glimmering mist which covers all objects, and general dimness of vision. Examination discovers central scotoma; in the beginning a colour-scotoma only, but gradually all power of perception within its area may be lost. The anatomical reason is an interstitial neuritis at the axis of the optic nerve (Neuritis axialis—*Förster*, *Samelsohn*), and the best type of this affection is the central scotoma of toxic amblyopia, the course and treatment of which we shall have to describe afterwards.

The **prognosis** of the acute forms seems to be much more favourable in the case of children and young people than at a more advanced period of life.

Treatment.—In acute cases active administration of mercury, iodide of potassium, blood-letting, derivatives, have all been tried with varying results. On the supposition that the primary cause was an arrest of the circulation (thrombosis, ischæmia), some have proposed paracentesis corneæ and iridectomy. We must add that in a number of cases vision returns without any special treatment of the local disease.

ART. III.—Atrophy of the Optic Nerve.

Progressive White Atrophy—Atrophic Degeneration.

The **diagnosis** of this disease rests on the disturbance of vision, and on the alterations of the optic papilla as seen with the ophthalmoscope.

The first characteristic sign observed with the ophthalmoscope is a discoloration of the optic papilla. It becomes pale, loses its reddish tint, and resembles more and more a white piece of tendon, as the atrophic process of the nerve elements makes progress. Sometimes the reflexion of the optic nerve is bluish; more rarely greenish.

In the early stages of the disease, the opacity of the nerve tissue slightly veils the point of emergence of the vessels, so that the light from the mirror cannot penetrate to the fenestrated membrane. When the atrophy is more complete, this membrane, scarcely covered with a thin layer of nerve elements changed into cellular tissue, becomes on the other hand very distinct; it presents a surface absolutely resembling a piece of tendon, on which bluish points mark the passage of the bundles composing the optic nerve. Various observers have noted the presence of pigmentary deposits on the surface of the nerve.

The discoloration of the nerve most frequently begins in its temporal half, and on this side also the fenestrated membrane first begins to become distinct.

But again, the surface of the nerve is at a lower level than the neighbouring retina, and thus we find that there is a slight cupping, involving the entire papilla (atrophic cupping, see p. 231). This excavation is sometimes very deep, if the disease has attacked the intraocular extremity of a nerve in which there previously existed a physiological cup (*H. Müller*).

As to the vessels of the optic papilla, the numerous capillaries disappear, and to their obliteration we must in great part attribute the discoloration of the nerve (*von Graefe*).

The central vessels sometimes preserve their normal volume for a very long time, or it may even be slightly increased. This is almost always observed in atrophy of the papilla of cerebral or spinal origin.

When the atrophy is due to embolism of the central artery, or when that artery has suffered compression before reaching the surface of the nerve, the arteries of the papilla are thin and scarcely visible. The central vessels are also diminished in calibre, and sometimes entirely disappear when the atrophy of the papilla is secondary to retinitis or chorio-retinitis.

In all such cases of atrophy, the margins of the papilla are very well defined, and the contours very clearly demarcated; sometimes the diameter of the papilla seems to be diminished. After long continued atrophy, there is sometimes seen a curvilineal shrinking, which has been supposed to be due to a retraction of the external sheath of the nerve.

In speaking of optic neuritis, we have seen that it is very easy, at least for some time, to distinguish the atrophy of the papilla in which that disease terminates by the want of definition of the contour of the nerve, by its irregularity, and by the layer of exudation which masks portions of it.

The disturbance of vision, to which we shall have occasion to refer in greater detail in our chapter on Amblyopia and Amaurosis, may be

said to correspond generally with the atrophic alteration of the nerve tissue of the papilla. We must distinguish between the affections of the central vision (direct) and the modifications of the eccentric (alterations of the visual field).

We may find the central vision more or less changed, according to the nature and extent of the disease; the change varying from a central defect which can scarcely be detected, to absolute blindness. We see also strongly discoloured and even perfectly white papillæ with normal acuteness of vision.

The visual field may suffer in very different ways. It may for a very long time remain intact, both as to its limits and continuity. In other cases, it is generally or partially contracted. The general contraction may be perfectly concentric or irregular. The partial contraction sometimes involves only a very small portion of the visual field (scarcely a quarter), sometimes it involves an entire half (hemiopia).

Again, we find more or less complete interruption in the continuity of the visual field, to which the name of *scotoma* has been applied. Scotomata may occur at the centre or towards the periphery of the visual field.

All the defective portions of the field of vision may be distinctly limited, the adjacent parts of the retina being normal; sometimes, however, there is an intermediate zone in which vision is imperfect.

In almost all cases of optic nerve atrophy, the patients lose the power of readily distinguishing colours. This insensibility is first observed for the green, then for the red, next for the yellow, and finally for the blue. There is no exact relation between the progressive loss of the power of distinguishing colours and the diminution of the visual acuteness (consult the article on Amblyopia *infra*).

Lastly, it should be mentioned that the condition of the pupil was one of the symptoms to which great importance was formerly attached. It is true, that in a certain number of cases the response of the iris to light gradually decreases as the retinal sensibility diminishes, so that the weakness of vision is accompanied with dilatation of the pupil.

Still, this phenomenon is not constant; if atrophy only exists on one side, the pupil may contract when the retina of the healthy eye receives a luminous impression. Even when there is absolute blindness, the reflex action of the iris is not always entirely destroyed.

Again, when the atrophy is connected with an affection of the spinal cord (locomotor ataxy), the disturbance of vision is frequently accompanied with marked contraction of the pupils, which may not be larger than the size of an ordinary pin's-head. In such cases of myosis, the diameter of the pupil does not vary with the illumination, but is still capable of change in convergence and accommodation (*Robertson*).

The *general symptoms* which accompany atrophy of the optic nerves depend essentially on the cause of the disease. Sometimes they are entirely absent, and the patient complains only of the ocular affection; sometimes this absence of other morbid symptoms is only temporary. As a rule, these symptoms are those of cerebral disease; vomiting, headaches, sensibility of the head to palpation, dizziness, syncopy, disturbance of the intellect, paraplegia, hemiplegia, paralysis of the oculo-motor, trigeminous, or other nerves, buzzing in the ears, deafness, absence of smell, &c. Again, when atrophy of the optic nerves accompanies spinal disease, we find the usual ataxic symptoms.

Progress and Termination.—Sometimes the atrophy only affects one side; as a rule, it is found in both eyes, which may be affected simultaneously or successively, and to a different extent. The progress of the atrophy is generally slow; it rarely can be said to have definitely stopped, although it sometimes seems to have been arrested for a very long time. It usually terminates in complete atrophy and blindness of one eye, or of both. The duration of the disease, till it reaches this unfortunate climax, varies from a few months to a few years; the second eye may be affected immediately after the first, or after an interval of several years.

The **prognosis** is always very serious, when we cannot hope to deal with the primary cause of the disease effectively. Even when we can, the atrophy often follows a course independent of the exciting cause. If the atrophy is confined to one side, and is due to some intraorbital cause, whilst the nerve of the other eye remains healthy, there need be no anxiety for that eye.

Ætiology.—In a certain number of cases, there is no appreciable cause for the atrophy of the optic nerves; in other cases it is the termination of various diseases of the nerve, or of the retina (tumours of the nerve, optic neuritis or neuro-retinitis, embolism of the central artery, retro-bulbar neuritis, retinitis pigmentosa, chorio-retinitis).

Sometimes it is due to intraorbital disease, which either extends to or compresses the optic nerve. Amongst such diseases we may cite—inflammation of the cellular and fatty tissue of the orbit, and orbital tumours (cancers, cysts, fatty tumours, gummata, periostitis and exostosis), hæmorrhages, fractures or fissures of the bone in the region of the orbit or the optic foramen (*Berlin, von Hölder*). Other causes of optic nerve atrophy (progressive amaurosis) are to be found in very various forms of intracranial alterations or in spinal diseases. Again, clinically, we may distinguish a cerebral from a spinal amaurosis. The first in many cases arises from a descending atrophy, secondary to some interruption of the nerve conductivity near the base of the brain, as happens when there is tumour (exostosis, tuberculosis or gumma near the

chiasma), internal hydrocephalus, exudation or cellular proliferation (as in chronic basilar meningitis). Some cases of cerebral amaurosis are due rather to a retro-bulbar neuritis, for example, after typhoid fever, small-pox, dysmenorrhœa, abdominal stasis, suppression of the usual discharges.

Spinal amaurosis most frequently occurs in fatty degeneration of the posterior columns (tabes dorsalis); more rarely in myelitis of the lateral columns, and after traumatic lesions of the spinal marrow. The ocular disease often precedes the other symptoms by several years.

Essential atrophy of the optic nerves may often be ascribed to a combination of circumstances, such as chronic alcoholism, excessive use of tobacco, all sorts of excesses, great physical exhaustion, debilitating moral excitation, intellectual fatigue. The great preponderance of men (from thirty to fifty years of age) amongst those who are affected with essential optic nerve atrophy is sufficiently explained by special causes, which exert a special influence on the male sex.

Treatment.—The treatment of optic nerve atrophy demands a very careful study of its ætiology, and of the special character of the disease. When there is an abscess or intraorbital tumour, the surgical indication should be complied with as soon as possible. Syphilitic disease necessitates the use of specific treatment (mercurials, iodide of potassium). Cerebral affections must be treated according to the therapeutic rules which hold good for such cases. Remedies acting on the skin (actual cautery) and intestines have now taken the place of antiphlogistic treatment.

Violent and debilitating treatment only hastens the unfortunate termination of the disease. Again, it is better to preserve the patient's strength by a nutritious diet and tonics, than to resort to active, but fatiguing and painful, treatment. If the general state allows or requires local blood-letting, the effect of this treatment must be closely watched, and it should be repeated only with very great caution.

In essential atrophy, good has resulted from long continued transpiration, obtained by pilocarpine injections, and from the temporary use of a high temperature (Turkish baths). In spinal atrophy, some have recommended nitrate of silver, zinc, phosphorus, as also the prolonged application of ice bags or hot water to the vertebral column (*Chapman*). Elongation of the optic nerve has been also tried (*de Wecker*), but the verified results are absolutely bad.

Again, where there has been excess in the use of alcohol or tobacco, we must absolutely interdict them to the patient, prescribe bromide of potassium, preparations of iron, and a regimen calculated to promote the general nutrition.

Subcutaneous injections of strychnine, and the continuous current, have been extolled in all cases of atrophy of the optic nerve.

Numerous are the cases of improvement and of recovery attributed to this treatment in ophthalmological literature; yet not infrequently we find these remedies of no service.

We cannot too strongly insist on the necessity of making sure about the general indications of each case, by carefully inquiring as to the antecedents and concomitant symptoms, before beginning any course of treatment. We must regulate the patient's hygienic conditions as well as his diet, and see that the eyes have absolute rest.

ART. IV.—Tumours, Apoplexy and Hydropsia of the Optic Nerve.

Tumours of the optic nerve, although somewhat infrequent, are chiefly of three kinds—viz., myxoma, glioma and gliosarcoma or myxo-sarcoma. Carcinoma has only been observed as an extension from a neighbouring structure.

Von Graefe,* who has observed and published several cases of tumours, attaches great importance to the following symptoms from the diagnostic point of view:—

(*a*) The progressive propulsion of the eyeball parallel to the orbital axis, and a little outwards.

(*b*) Preservation of the mobility of the eye.

(*c*) Preservation of a cellular layer between the eye and the tumour, and integrity of the centre of rotation.

(*d*) Flabby consistence of the tumour.

(*e*) Absence of pain.

(*f*) Absence of subjective luminous sensations.

(*g*) Rapid abolition of the sight, more rapid than in other benign tumours.

These tumours are of slow growth, and require surgical interference. After the enucleation of the eyeball, the tumour is removed if it be circumscribed, or all the affected portions of the eyeball are extirpated. When the tumour is confined to the optic nerve alone, it may be excised and the eyeball preserved (*Knapp*).

Apoplexy of the optic nerve is rare, and is almost exclusively observed in connection with disturbance of the circulation in the

* See *Archiv f. Ophthal.*, x. 1, p. 193.

venous trunks or cavernous sinus. More frequently apoplectic foci are found between the nerve and its fibrous sheath after traumatic lesions, cerebral hæmorrhage (*Michel*), and hæmorrhagic meningitis (*Manz*). It is probable that to these hæmorrhages are due the dark pigment spots which are seen with the ophthalmoscope near the periphery, and surrounding the atrophied optic papilla. Yet, some observers have also shown that there may be pigment spots on the optic papilla without previous hæmorrhage.

Hydropsia of the optic nerve consists in a serous effusion into its sheath. According to the researches of *Schwalbe,* it is probable that in many cases the fluid comes from the cerebral arachnoid space which communicates directly with the space enclosed by the two sheaths of the optic nerve.

CHAPTER VII.

AMBLYOPIA AND AMAUROSIS.

The terms "**amblyopia**" and "**amaurosis,**" in their original acceptation, designate only a symptom—viz., a diminution or loss of the visual function. They are now, however, employed with a more restricted meaning, and are used to describe cases of visual weakness, in which, after thorough examination by all the methods at command, we can neither find any lesion whatsoever, nor any atrophy of the optic nerves.

The diminution may then be considered as due to an interruption of power of transmission in the nerve (*von Graefe*).

It is, therefore, of importance, in diagnosing amblyopic affections, to exclude with certainty any disturbance of the transparency of the media, diseases of the membranes which form the eyeball, and all anomalies of refraction and accommodation.

This being done, it remains for us to examine, according to the method already indicated (see p. 20), the visual acuteness at the centre (V) and at the periphery (Ve). This examination should also be conducted in a darkened room, with a lamp, the intensity of which can be approximately regulated, so that we may judge of the effect of various degrees of illumination on the visual field.

Moreover, a thorough examination of the visual field can only be made with a perimeter (p. 23) and by taking into account the perception of *colours*. *Von Graefe* classifies the various conditions of vision, revealed by functional examination, under three leading categories:—

1. Central vision is to a certain extent impaired, whilst the peripheral vision is **absolutely normal**. This condition, especially when the disease has already lasted for some time, almost certainly excludes the idea of progressive amaurosis.

2. The central vision being impaired, the peripheral is also diminished to a like extent; as a rule, there is a concentric contraction proportional to the decrease of central acuteness (the visual field is **relatively normal**). There, the functional disturbance does not suffice of itself to indicate the gravity of the disease. The condition of the optic papilla, and the duration and mode of development of the

disease, must also be taken into account. This form specially lends itself to rational treatment suited to the condition of the individual.

3. The diminution of the peripheral vision is irregular and defective (scotoma), and does not correspond to the central vision (the visual field is **abnormal**). In this variety, the prognosis is less favourable. Yet, although recovery is scarcely ever possible in such cases, the condition may sometimes remain stationary, as for example in hemianopsia. (See article on Hemianopsia.)

As a rule, when the amaurosis is dangerous, the vision of one eye is very seriously compromised before the visual acuteness of the other begins to diminish. We must then study the development in the second eye, so as to ascertain if the disease follows the same course in it as in the first. In this way we often obtain information as to the future of the disease.

The anomaly of the visual field most frequently begins to appear on its external side; but it is by no means rare to find it first on the inner side.

Apart from these functional symptoms, a certain importance is also to be attached to other phenomena, such as photopsia, chromopsia, muscæ volitantes, &c. Yet these phenomena belong rather to diseases of the *internal* membranes of the eye, and are not peculiar to amaurotic affections (consult the articles on Hyperæsthesia and Anæsthesia).

As to the difficulty in distinguishing colours (pathological **dyschromatopsia**) we have already said that this defect begins with the green, and extends to the red, to the yellow, and finally to the blue; we have also proved that the progressive loss of the power of distinguishing colours is not in accordance with the diminution of the visual acuteness. Yet, there is often a certain relation between these two functions, in so far as a diminution in the intensity and extent of colour-perception precedes, both at the centre and periphery of the visual field, any diminution of the visual acuteness at the same place. This symptom thus acquires a certain importance in the prognosis. When we find central amblyopia with absolutely normal peripheral vision, and, at the same time, a diminution in the colour-perception, the prognosis is less favourable than when the chromatic sense remains intact. We must not, however, at once conclude that we are dealing with progressive amaurosis, even when there is a slight discoloration of the optic papilla, for observation has shown that the disease may be permanently arrested. When the defects of the visual field (**scotomata**) are surrounded by a zone which preserves its colour-perception, we may admit that the scotoma will not extend for the present, but we must be guarded in giving our prognosis, for it may ultimately make progress. If there is already chromatic insensibility in the neighbourhood of the

scotoma, we may be sure that the amblyopia will also extend to these parts.

The examination of the **phosphenes** gives less certain results than the objective examination of the visual functions. It is only of value in a very limited number of cases, in which the phosphenes still remain in portions of the retina insensible to light.

Next in order to the functional examination, the **condition of the optic papilla** decides the nature and importance of the disease. We have already described the symptoms which belong to *atrophy* of the optic nerve. The absence of these symptoms, that is to say, perfect integrity of the papilla, when the visual acuteness has been diminished for some length of time, is not frequently seen; but in such cases we may expect recovery. Often, the signs of atrophy do not supervene till after the lapse of some time, and therefore we should be very cautious in our prognosis.

The mode in which amblyopic affections develop is very variable. It may happen, although rarely, that the disease supervenes suddenly, or is developed very rapidly. A few moments, hours, or days, suffice to establish a contraction of the visual field, central scotoma, or even complete blindness. These affections sometimes end favourably, sometimes the disease persists, and atrophy of the optic nerve ensues.

The prognosis therefore, as a rule, can only be determined in the course of the disease, and by a careful study of its progress. If there be no atrophy of the papilla, the prognosis is favourable, especially if the functional condition is stationary and improves, and if the phosphenes remain.

Much more frequently the visual disturbance develops slowly. In such cases, the disease takes several months before it becomes stationary, and, if the morbid cause remain, it may develop into progressive amaurosis. Generally speaking, it may be said that, in the forms which are primarily favourable, the visual functions become weakened simultaneously in both eyes and to an equal extent. When the disease has been for a long time stationary, and when there is no atrophy of the optic nerve, we may even hope for complete recovery.

Amongst these forms, we may mention cases of amblyopia due to excess in alcoholic liquors and tobacco, habitual constipation, affections of menstruation, suppression of hæmorrhoids, or of pathological and physiological secretions, venereal excesses, irregularity of sleep, or fatigue of the eyes from want of sleep. These causes act sometimes alone, but more frequently in combination. The more we succeed in accurately diagnosing the causes of the disease, and in removing or counteracting them, the more our prognosis will gain in precision.

The prognosis is more serious when there is room to suspect the

presence of a chronic meningitis; for, although active treatment often acts most beneficially, not infrequently do we see this amblyopia change into degenerative amaurosis.

Disturbance of vision occurring in conjunction with acute and violent cerebral symptoms (encephalo-meningitis) must be estimated according as the exciting cause of the affection is still in operation at the time of our examination, or has already passed off. In the latter case, if the disease has once become stationary, it may remain so, whatever be the form of the amblyopia or condition of the optic nerve.

On the other hand, if the exciting cause is still in operation, our prognosis must be very reserved.

It is true that cases of complete blindness, secondary to cerebral disease, have been recorded, in which a part of the visual power returned after several weeks. But, as a rule, if blindness after an acute affection is prolonged, and if degeneration of the papilla is also present, no hope can reasonably be entertained. The most unfavourable prognosis belongs to those forms of amaurosis in which the vision of one eye is gradually lost and there is at the same time an irregular contraction of the field of vision and atrophic degeneration of the papilla, whilst there is an analogous diminution in the other eye, generally setting in before the first is lost. Having thus spoken of amaurosis and amblyopia in a general way, it remains for us to describe the special forms which these diseases assume.

1. Congenital Amblyopia. Dyschromatopsia. Achromatopsia.

Congenital amblyopia is found in persons whose eyes are absolutely normal in conformation, and in whom the ophthalmoscope does not reveal any anomaly. The diminution of the visual power may be more or less considerable, but it is absolutely stationary. The visual field is normal, as is also the colour perception.

The amblyopia often affects one eye only, and is so great that the patients cannot count fingers beyond the distance of a few paces. We also find in the eye affected an eccentric fixation. Again, many of these cases of monocular amblyopia are accompanied with strabismus.

In other cases the amblyopia is present to a greater or less extent in both eyes; yet, in these cases the diminution of the visual acuteness never attains the same degree as in cases of monocular amblyopia.

A congenital deficiency in the perception of colours **(Daltonism)** may be *partial* or *total*. In *total* achromatopsia every colour appears

white or grey. In *partial* achromatopsia the eye fails to distinguish some particular colour or its complementary colour; or it always confounds them with grey (*complete partial achromatopsia*); or it may be able to distinguish pure colours, but gets confused among shades of the same (*partial incomplete achromatopsia, quantitative achromatopsia, torpor of the chromatic sense*).

Partial Achromatopsia.—The most frequent form of partial achromatopsia is for red; next in order comes achromatopsia for green, and the least frequent is for blue.

Red Blindness (Anérythropsia—Daltonism).—In this form red appears as dark-grey, its complementary tint as light-grey. Cinnabar red is confounded with brown or green, purple with violet or dark-brown. The red extremity of the spectrum is curtailed, and the entire spectrum seems to be composed of two colours only—*viz.*, yellow and blue.

Green Blindness (Achloropsia).—Green is seen as blue or grey, as is also its complementary colour, purple. We find that there is confusion between green and purple, and between yellowish-green and red, &c. The length of the spectrum is not diminished, but the green portion appears as grey, or is somewhat indefinite; on its left the red or yellow is seen, on its right the blue.

Blue Blindness (Akyanopsia) is very rare. It is characterised by an inability to distinguish blue and its shades; there is also a confusion between blue and yellow shades. The blue extremity of the spectrum is diminished.

Great difficulty occurs in many cases in which we have to distinguish between red and green blindness and between blue and yellow blindness, symptoms of both of these deficiencies existing in the same individual. Thus we are disposed to admit simultaneous blindness for the complementary colours, and to call those cases red-green blindness or blue-yellow blindness.

Total Achromatopsia.—In total achromatopsia the eye cannot distinguish any colour or shade; it only distinguishes variations in light and shade. The spectrum is curtailed on both sides.

Congenital dyschromatopsia is much more common in men (3–5 per cent.) than in women (less than 1 per cent. in the latter). It is hereditary, and is transmitted on the mother's side, although she herself is not affected with it. In all cases of congenital dyschromatopsia, the other functions of the eye are normal.

The various attempts which have been made to remedy defects in the chromatic sense have had for their object to facilitate and increase by systematically exercising the power of colour perception (*Favre*). It has also been proposed to use tinted glasses, chosen to increase the

sensibility of the eye for certain colours, and to diminish it for others (*Delbœuf, Spring*). Either of these means is of great benefit where there is torpor of the chromatic sense; they are, however, of no avail in achromatopsia, whether partial or total.

2. Amblyopia from Want of Use.

Amblyopia ex Anopsia.

It is generally admitted that when in early life, for some reason, an eye otherwise healthy does not participate in vision, the retinal sensibility becomes dull, and there is consequently a more or less pronounced amblyopia.

This decrease of retinal sensibility seems to be in proportion to the duration of the period during which the eye has been inactive. In the first stage, central vision is more or less impaired, whilst peripheral remains normal.

Later, the special sensibility of the *fovea centralis* is extinguished; the eye no longer fixes objects exactly, but moves about in an uncertain manner, seeking to use the portion of the retina most favourable for vision. In the end, the fixation is definitely eccentric, or perhaps the visual acuteness is reduced to the perception of light.

In many cases this form of amblyopia is followed by strabismus or nystagmus; but in other cases the *deviation of the eye* (monocular strabismus) is the origin of the impairment of the visual acuteness.

Other causes which may prevent an eye from participating in binocular vision, and so bring about an *amblyopia ex anopsia*, are opacities of the cornea and cataract in early life.

For these reasons it is not advisable to delay in making an artificial pupil in cases of congenital cataract, or in putting to rights any deviation of the eye. (See Chapter on Strabismus.)

In cases where this form of amblyopia is slight, considerable improvement is always obtained by regular exercises. This improvement is almost certain in the first period of the disease, and at the beginning of the second. At a later stage, the result is negative.

The exercise suited to the condition consists in making the amblyopic eye read, for a few minutes several times a day, large type, with the aid of magnifying-glasses. As the vision improves, smaller letters and weaker convex-glasses are used, whilst the duration of the exercise is increased.

These exercises may also be extended to the peripheral vision in the following manner:—After having closed the healthy eye, we set up an object of medium size, a card for example, and move round this

card various objects which the patient must try to see and recognise. The objects chosen at first are of considerable size, and are held very near the fixed card, so that the diseased eye can easily recognise them. By degrees they are brought nearer the limits of the visual field, and are diminished in size.

Subcutaneous injections of strychnine have also given good results (*Nagel*). They may be used in conjunction with regular exercise of the eye, or alone when the full benefit of such exercise has been obtained.

3. Hemeralopia.

The characteristic symptom of this disease is inability to see except in a strong light. It is, therefore, apparent in the twilight, or after sun-set, or when, in broad daylight, the patient is placed in darkness. The sense of light is considerably lowered, and the adaptation of the eye to reduced light very small (torpor of the retina).

In good light the patients see perfectly; their visual field is normal, as is also their colour perception.

As the intensity of the illumination is decreased, the central acuteness and extent of the visual field are also diminished. Sometimes eccentric vision is better than the direct. During the period in which the amblyopia is manifest, the colour perception is also impaired. Simultaneously, dilatation of the pupils, loss of accommodation and weakness of the oculo-motor muscles in general have been observed (*A. von Graefe*).

All these phenomena are absolutely independent of the sun and moon; they can be produced at will, by putting the patient in a dark place.

The affection always attacks both eyes, but often in different degrees.

Dryness of the conjunctiva (*Habbenet*) and white pearly patches near the margin of the cornea (*Bittot*) have been said to be characteristic of this disease. In cases of hemeralopia of sudden origin the ophthalmoscope reveals nothing abnormal, or at most a slight hyperæmia of the papilla. The result of the ophthalmoscopic examination is very different when the disease is a symptom of an affection of the deep membranes of the eye (consult article on Retinitis Pigmentosa).

In the few cases where an autopsy has been made of persons affected with hemeralopia, considerable roughness of the ciliary ganglion has been found, with congestion of the vessels of the optic nerve.

Progress and Termination.—The course of acute hemeralopia is very characteristic. It comes on suddenly, and attacks at the same time a certain number of persons exposed to the same injurious

influences (endemic or epidemic hemeralopia); it increases during the first days, and often disappears when the injurious surroundings are removed; if not, the disease may last for weeks or even for a few months. Prolonged duration of the disease is most common in persons suffering from a relapse. It is very apt to recur.

In all such cases, however, the disease ends favourably.

Prognosis.—The prognosis of acute hemeralopia is absolutely good; on the other hand, it is very serious when accompanied with permanent disturbance of the vision or with gradual contraction of the visual field, as in retinitis pigmentosa.

Ætiology.—Hemeralopia is especially common in spring, and amongst classes of the community exposed to the heat of the sun and night chills. Hence it is common among soldiers, sailors, &c. Those who are weak and badly nourished are most liable to be attacked by it. Among sailors hemeralopia is often found along with scurvy; the officers enjoy almost absolute immunity from it.

Again, epidemics of hemeralopia, due to a bad regimen and dazzling light, are seen in prisons and in educational establishments, as also in the southern provinces of Russia at the time of the prolonged fasts.

All these facts tend to prove that hemeralopia is due to the prolonged action of bright light on a retina weakened by some general debilitating cause.

Treatment.—Besides the remedies which are suited to the general condition (clearing the gastro-intestinal canal, administration of quinine, iron, cod-liver oil), it is of great importance to remove the patient from every injurious influence.

The most rapid results are obtained by keeping persons affected with hemeralopia in a dark apartment (*Förster*, Dark Rooms of *Netter*). For some time after, in order to prevent relapses, we must protect them from too strong a light by making them wear blue or smoked glasses. Epidemics of hemeralopia have been cut short by a continuance of rainy or cloudy weather. Favourable results have been ascribed to instillations of pilocarpine or eserine (*Galezowski*).

4. Anæsthesia and Hyperæsthesia of the Retina. Optic Hyperæsthesia. Asthenopia.

Retinal anæsthesia is characterised by a diminution of the central visual acuteness, generally inconsiderable, rarely well-marked; in some cases there is almost complete blindness. The visual field is always abnormal and very much contracted concentrically or irregularly. True hemianopsia is very rare. Chromatic anomalies are, so to speak, never

absent; sometimes the patient ceases to recognise some one or more colours; sometimes the colour blindness is absolute. The phosphenes are preserved.

Functional examination rapidly fatigues the retina (*Schweigger*). Spasm of the accommodation is often present. Some patients are relieved by the use of yellow glasses.

There is also a certain *hyperæsthesia* of the retina, which, in hysterical subjects, often attains considerable intensity, or may be manifested only by slight photophobia. In such cases the patients see best through dark-coloured glasses, or in feeble light, and the visual field is then enlarged.

The optic papilla preserves its normal aspect, even although the disease is of long duration.

The disease is almost always found in both eyes, but in different degrees.

Progress and Termination.—This affection is suddenly developed, or attains its maximum in the course of a few hours or days. Sometimes it remains stationary for a certain time; more frequently recovery is complete at the end of a few weeks. In a few isolated cases recovery is not perfect, especially when the general health is not restored to the normal conditions (in hysterical patients).

The **prognosis** is therefore, as a rule, favourable.

Ætiology.—Retinal anæsthesia almost exclusively affects women and children. It is observed in conjunction with cutaneous anæsthesia (hemianæsthesia) or with muscular spasms, in persons of a generally irritable disposition, and under the influence of psychical excitement. It is especially apt to attack people who are nervous, anæmic, or hysterical, or who are convalescent from some serious disease, such as scarlatina, measles, typhoid fever, &c.

Treatment.—Patients must be placed for a few days in an absolutely dark room, and, beginning with the sixth day, the light must be gradually increased. When the patients go out, different shades of blue glasses must be prescribed. Afterwards, when anæsthesia prevails, the use of yellow glasses is often successful. The internal administration of the preparations of zinc in increasing doses ($1\frac{1}{2}$ to $4\frac{1}{2}$ grains of zinc lactate daily) and bromide of potassium (15 to 45 grains daily) have been recommended. Absolute rest to the eyes, strengthening diet, aromatic and saline baths (hydrotherapeutics), complete the treatment.

Good results have also been obtained from the subcutaneous injection of strychnine, from inhalation of nitrite of amyl, which must be very carefully used, and from the constant current.

Retinal anæsthesia of hysterical origin may be effectively treated by

metallo-therapeutics (*Burq, Charcot*). When we have ascertained which metal, on being applied to the forehead, causes the amblyopia and dyschromatopsia momentarily to disappear, strips or plates of it should be kept on for a considerable time, and along with this we administer the preparations of the same metal internally.

Hyperæsthesia of the optic centres presents itself with the following characteristics:—In slight degrees, the patient is tormented with the persistence of retinal impressions (secondary images and complementary colours). The more serious cases are characterised by dazzling, muscæ volitantes, luminous impressions, more or less intense, chromopsia, and dreadful hallucinations. These phenomena co-exist either with a normal or an amaurotic state of the vision, and are sometimes accompanied by ciliary hyperæsthesia, lachrymation, and orbicular spasm.

This affection has been attributed to the irritating action of an intense light; for example, the light reflected from a large expanse of snow illuminated by strong sun-light; or to sudden variations of illumination. It may also come on when the eyes have been used for a long time on very bright objects. At other times, the hyperæsthesia seems to be due to a cerebral affection (prodromata of insanity) and to the prolonged use of certain narcotics. Sometimes it is one of the symptoms of hysteria or hypochondriasis.

Treatment.—The eyes must be kept absolutely at rest, by the patient either remaining in a dark room, or wearing dark-coloured glasses. Congestive states of the brain require saline purgatives, cooling drinks, and even local blood-letting. In a case of complete amaurosis accompanied by optic hyperæsthesia, which resisted all other means, *von Graefe* divided the optic nerve, which completely relieved the patient.

Retinal Asthenopia occurs chiefly as a defect of visual energy, the vision being otherwise healthy. In some persons we find that although we carefully correct any existing anomaly of refraction and accommodation, as also any insufficiency of the internal recti, they are still unable to use their eyes for their ordinary occupations, although their visual acuteness is normal. Severe pains in the eyes, with dimness of vision, always come on, and sometimes very quickly. Blue or smoked glasses are without effect, but in some cases yellow glasses afford immediate and lasting relief. Santonin, which has been recommended, is of no benefit, and the same remark holds true regarding the instillation of pilocarpine.

5. Toxic Amblyopia.

1. The most frequent form of toxic amblyopia is due to excesses in alcoholic drinks and the use of tobacco.

This form is characterised by a more or less considerable diminution of the central visual acuteness (*central scotoma*), whilst the visual field retains its integrity. The scotoma is usually oval in shape, its long axis being horizontal, and extends from the fixation point towards the blind spot. Patients often tell us that they see better by reduced than by strong light. The colour-perception is impaired in the neighbourhood of the scotoma.

In the early stages of such affections the ophthalmoscope does not reveal any alteration in the fundus of the eye; later, we find a well-marked hyperæmia of the nasal half of the optic papilla, and a paleness of the temporal half. Again, we may find signs of nerve atrophy.

The disease almost always affects both eyes to a nearly equal extent. It attains its acme very slowly, remains stationary, and passes off if the patient is protected from every injurious influence before the disease is very far advanced. In such circumstances, and under proper treatment, vision may be completely restored.

On the other hand, relapses are frequent if the patient is again exposed to the original injurious conditions. The relapse may assume a more serious form of amblyopia, and terminate in progressive atrophy. The disease is due to chronic retro-bulbar neuritis (see p. 282).

Prognosis.—So long, therefore, as there is no alteration in the optic papilla, and so long as we are able to remove the patient from every injurious surrounding or bad habit, the prognosis is exceedingly favourable. The chances of complete recovery diminish with the duration of the disease and with the appearance of atrophic symptoms in the optic papilla.

In our **treatment** we should take into account all the ætiological conditions. The disease sometimes yields if tobacco and alcohol be absolutely interdicted, and the patient's mode of living regulated both as regards food and sleep. In order to hasten recovery and make it more certain, we may beneficially use, according to the general constitution of the patient, either local blood-letting, or diaphoretic or aperient remedies. Yet, amblyopia from excesses in alcohol and tobacco most frequently occurs in persons who are weak and badly-nourished, and whose general condition prevents any enfeebling treatment, and requires rather such remedies as will stimulate their vital forces. Often it is beneficial, after a favourable change has set in, to

stop all remedies, and to resort to them again only if the favourable progress of the disease is interrupted. The internal administration of potassium bromide, and subcutaneous injections of strychnine, seem to be of use in chronic cases.

2. *Amblyopia from lead-poisoning.*—It also affects both eyes simultaneously, and is often so rapidly developed that in a few days the amaurosis is almost complete, the pupils being widely dilated. In other cases the disease developes slowly, and begins with central amblyopia without any contraction of the visual field. Sometimes with the ophthalmoscope we find no visible alteration of the fundus; more frequently we find changes which resemble those of albuminuric retinitis and optic neuritis (choked disc) ending in atrophy of the papilla. In our treatment of this form of amblyopia we must follow the general indications afforded by lead-poisoning (iodide of potassium, injections of morphine, milk diet).

3. *Uræmic amaurosis.*—Along with the other symptoms of uræmia, such as headache, fever, faintness, dyspnœa, vomiting, syncopy, convulsions, and coma, there is a sudden diminution of the visual acuteness, which in a few days may almost amount to complete blindness. In most cases, the vision speedily returns, but not always in a regular manner. With the ophthalmoscope nothing is seen, except perhaps slight œdema of the papilla and of the surrounding retina (*Schmidt-Rimpler*).

4. *Amblyopia* supervening after large doses of *quinine* is very rare, and is almost always transitory (like the buzzing in the ears and the deafness). Cases have been recorded in which the disturbance of vision persisted, and even a few cases in which there was complete blindness, with pallor of the optic papillæ, smallness and scarcity of the retinal vessels. *Salicylic acid* in large doses has also caused analogous impairment of vision (*Riess*).

We may here state that any circumstance which produces *general debility* may give rise to a diminution of the visual acuteness. Severe epistaxis, repeated menorrhagia, prolonged suppuration, profuse secretion, or prolonged lactation, may be counted amongst such causes. In these cases it often suffices to remove the cause, and strengthen the patient's system, to arrest the disease and procure a steady improvement. If, however, we find on ophthalmoscopic examination some disturbance of the nutrition of the nerve, we must be very guarded in our prognosis.

6. Amblyopia from Concussion of the Eyeball and from Reflex Action.

We place these two classes of amblyopia in the same group, for the impairment of vision which characterises them has not as yet been explained. Thus, we have seen that after some shock to the eyes, as by the passage of a projectile before them—a blow from a fist or the cork from a bottle—the visual acuteness is very much diminished, and there may even be complete blindness. At first, the ophthalmoscope may not show any change; later, we may find atrophic degeneration in the optic nerve. In these cases subcutaneous injections of strychnine have been very highly recommended.

The so-called **reflex amaurosis** has been observed in connection with lesions or prolonged irritation of the fifth pair (supra-orbital and dental nerves, &c.) Thus, in these cases we have seen the disease arrested, and even the vision improved, by the excision of frontal cicatrices which involved the supra-orbital nerve, as also after the extraction of decayed teeth.

7. Hemianopsia.

A symptom which frequently accompanies migraine and gastralgia consists in the sudden and transitory suppression of one half of the field of vision (*visus dimidiatus, amaurosis partialis fugax* of *Förster*). This phenomenon sometimes lasts some minutes, a quarter of an hour, or longer, and is generally accompanied with luminous apparitions (*scintillating scotomata*), which occupy the patient's attention to such a degree that he does not observe the hemianopsia. These attacks appear at irregular intervals, sometimes for the whole life, but with diminishing intensity and frequency in later years. During the intermissions between the attacks the vision is quite normal. The hemianopic and transitory character of the disease indicates that it is due to a limited central ischæmia. Some observations show complication with disturbance of speech, hemiplegic weakness, and other symptoms of a persistent central disease (*Charcot*). Usually we prescribe bromide of potassium and other remedies used in migraine, such as quinine (metallo-therapeutics). The attack is sometimes shortened by a dose of alcohol.

In true **hemianopsia** one half of the field of vision in each eye is blind. Most frequently the half of the visual field which is defective is situated in both eyes on the same right or left side (lateral homonymous hemianopsia, right or left); more rarely it is

crossed, so that the nasal or temporal half is wanting in each eye (internal nasal, or external temporal hemianopsia).

1. In **homonymous hemianopsia** (right or left) there is always a very distinct line of demarcation separating the corresponding blind halves of the two retinæ on which the disease depends, from the halves in which the vision is preserved. This line does not, in general, pass through the point of fixation, which, therefore, is included in the half preserving its vision. The visual acuteness of this point remains normal, and its chromatic sense is not disturbed.

The ophthalmoscopic appearance of the nerves does not show any alteration, even after the hemianopsia has lasted for a considerable time. *Von Graefe*, however, observed a case of atrophy of the papilla, limited to the corresponding half of the nerve with retinal anæsthesia.

Hemianopsia commonly comes on suddenly and remains stationary; in some cases, however, it is developed in the course of a few weeks, and the progressive blindness for colours in the affected part of the visual field precedes the hemianopsia. It may remain always at the same point, but also the condition may improve, and there may even be complete recovery. When the fixation point escapes the deficiency, vision is little interfered with. Reading and writing being executed from the left to right, the right hemianopsia is much more felt than the left; the patients counteract it by turning their heads sideways.

The explanation of this defect in the visual field is to be found in the semi-decussation of the optic nerves in the chiasma (Fig. 93). The right optic tract (r. t.) supplies fibres to the temporal side of the right eye and nasal side of the left. Any lesion of this tract will, therefore, produce left hemianopsia. Right hemianopsia is similarly explained by a lesion of the left optic tract (l. t.)

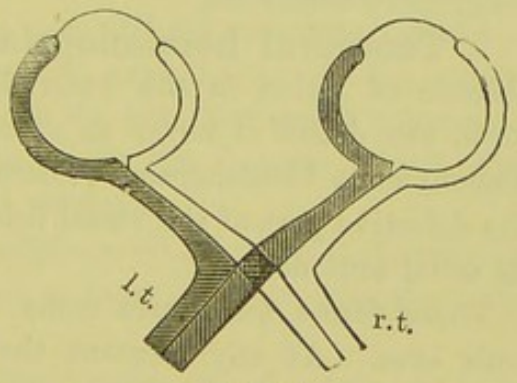


Fig. 93.

Crossed temporal hemianopsia can only depend on some cause which acts on the nerve fibres as they cross in the chiasma; nasal hemianopsia on multiple lesions acting on both tracts.

The **prognosis** can only exceptionally admit the restitution of the deficiency, but, so far as the danger of blindness is concerned, is absolutely good. Blindness can only supervene if there is some lesion of the other optic tract or some new intracranial affection. In cases where chiasma is implicated and the affection a progressive one, such as a tumour, complete blindness may result.

Ætiology.—The most frequent cause of these various forms of hemianopsia is cerebral hæmorrhage or some circumscribed focus of inflammation, periostitis, tumours, embolism, and injuries. It occurs equally in affections of the corpora geniculata or quadrigemina, the optic thalamus, the pulvinar, the fibres of Gratiolet, and the cortical substance of the occipital lobe. It is here that the optic tract of the same side takes its origin, and wounds of this optic centre produce hemianopsia, as we have learnt by the interesting experiments of *Munk*, which have been confirmed by some pathological (*Westphal*) and clinical (*Schmidt-Rimpler*, *Nieden*) observations. *Munk* believes that the cortical centre, receiving the symmetric retinal impressions of both eyes, includes also the visual centre, that is to say, the region where the visual perceptions are transformed into notions. Therefore loss of the visual centre involves also the loss of the notions accumulated in this region by time and experience, so that an object may be seen without awaking the notion of its signification or use. This has been called mental blindness (*Seelenblindheit*); we think that it would be better to call it loss of the visual memory, *visual amnesia*.

Hemianopsia may be accompanied with hemiplegia, hemianæsthesia of the same side, and aphasia if the deficiency is on the right-hand side.

In a few cases we find *hemianopic deficiencies of the superior or inferior portions of the visual field*, which are without anatomical explanation. When they are clearly defined, and when, at the same time, the acuteness of the central vision is nearly normal, they do not forebode progressive amaurosis.

2. **Temporal hemianopsia** (external) is characterised by the absence of vision in the external half of each eye. Still, in this form, the defect is never so exactly limited to the median line as in homonymous hemianopsia. There is always a transition zone between the defective part of the visual field and the part which still preserves its usual acuteness.

These forms sometimes come on suddenly and symmetrically in both eyes. At any moment the condition may become stationary, recede, and even completely disappear. But the defect may also gradually extend to the opposite half of the visual field and lead to complete blindness.

Therefore the **prognosis** in such cases of hemianopsia should be very reserved, as we are unable, especially in the early stages, to distinguish the progressive forms from those which are more favourable. The latter are characterised by rapid and symmetrical development in both eyes, by the relatively good central visual acuteness ($\frac{1}{4}$ or $\frac{1}{6}$), and by the perfect integrity of the optic papilla, even although the disease is of some duration.

Ætiology.—The most frequent cause is tumour, or some localised inflammatory affection, at the base of the brain. Anything in this region which is developed immediately in front of or behind the chiasma will, first of all and by preference, affect the crossed nerve fibres, which circumstance explains the anæsthesia of the internal portions of both retinæ.

3. **Nasal hemianopsia** (internal), that is to say, blindness in the nasal portion of the visual field of each eye, can be produced only by a disease on both sides of the chiasma or on the external side of both optic nerves. The condition is of doubtful existence.

There is nothing special as regards the eye in the **treatment** of hemianopsia. The central cause, to which the anomaly of the vision is due, can alone furnish us with indications.

8. Scotomata.

This name is applied to *interruptions of the continuity of the visual field.* These interuptions are situated at the centre of the field of vision (**central scotoma**) or towards its periphery (**eccentric scotoma**).

Again, the scotoma is either well defined, or there is a diminution of the visual acuteness in the surrounding parts.

In cases of **central scotoma,** the acuteness of vision may be so reduced that the patient, instead of using the centre of the retina, prefers to use an adjacent portion (eccentric fixation).

In such cases, ordinary examination suffices for purpose of diagnosis. In other cases, the central vision has not suffered so severely, and the diagnosis is then greatly assisted by the examination of the colour perception (*Leber*). Thus, the patients do not distinguish colours in the part of the visual field corresponding to the scotoma, which they perfectly distinguish in the unaffected portions.

Along with central scotoma, the periphery of the visual field may be absolutely normal, or there may be a more or less irregular contraction.

Again, central scotomata may either come on suddenly or take several weeks or months to develop; they affect both eyes simultaneously or successively. During the period of development, they may extend outwards, or there may be a general diminution of the visual acuteness which becomes, by degrees, limited to the central region, and assumes the form of a scotoma.

If the disease, toxic central scotoma excepted, has once been stationary for a few months, there is little chance of its extending at a later period; but we can no longer hope to restore vision in the anæsthetic portions of the visual field.

Eccentric scotomata are often situated symmetrically in both eyes. If the peripheral vision, in the parts near the scotoma, is perfectly normal, there is no fear of blindness. If otherwise, the disturbance of vision often indicates the beginning of an amaurotic affection. The examination of the colour sense in the neighbourhood of the scotoma is very important; for, as long as the perception of colours is normal, the extension of the scotoma is not imminent.

To the ophthalmoscope the optic papilla and retina sometimes seem to be absolutely normal; but more frequently there are symptoms of optic nerve atrophy.

Prognosis.—Except in the case of toxic central scotoma the vision rarely improves or regains its normal condition. If the scotoma has been present for some time, and if the periphery of the field of vision is normal, the prognosis is favourable, in so far as there is no danger of blindness. When the eccentric vision (apart from the scotoma and not in connection with it) is diminished, the disease has then the characteristics of progressive amaurosis.

Ætiology.—The cause of these scotomata is rather obscure. They are due to circumscribed alterations in the cerebral terminations of the optic nerves, or to a retro-bulbar neuritis. The disease sometimes seems to be hereditary.

Treatment.—Since there is this uncertainty, the treatment should be adapted to the constitution of the patient and to the conditions which seem to have determined, or which accompany, the disease. Local blood-letting, revulsives, diaphoretics, aperients, are sometimes useful. In other cases, benefit is obtained from tonics, iron, hot baths, residence in the country, &c. Iodide of potassium, lactate of zinc, nitrate of sliver, have also been recommended, as also injections of strychnia, and the constant current.

The *cerebral* and *spinal* forms of amaurosis have been discussed in our chapter on Degeneration of the Optic Nerve.

It remains for us to indicate the means which are employed for the detection of a simulated amaurosis.

Simulated Amaurosis.

Pretended blindness *in one eye* may easily be detected by a prism placed with its base upwards or downwards before the admittedly healthy eye, while the patient is made to look at a black point on a piece of paper. If he says that there are two points, it is evident that he sees with both eyes.

We may also place before the healthy eye a prism, so that its base crosses horizontally the middle of the pupil; in that way it produces

monocular diplopia, and convinces the malingerer that he has diplopia with his good eye alone. Then we open his other eye and push the prism upwards or downwards, so that it covers now the whole pupil. Diplopia would be produced now by the vision with both eyes, and, when two images are seen, simulation is sure.

Another method consists in placing a prism of 10 or 15 degrees with its base outwards before the eye said to be blind. If it sees, it will turn inwards for the sake of single vision, and we will also observe the movement of readjustment outwards when the prism is withdrawn (*de Weltz*). An eye really deprived of vision will not move, as binocular vision no longer exists. Ordinary stereoscopes, with prismatic lenses or with mirrors (*Flees's* apparatus), are very useful in discovering pretended monocular blindness.

Another good method of detecting simulation is the use of *Stilling's* black sheets, on which letters are printed in various colours. These letters become invisible when looked at through a glass of a determined colour, thus red letters are invisible if looked at through a green glass, &c. A great variety of these tests can be obtained in drawing upon ordinary white paper signs or words with red and blue pencils or inks, which become invisible to the eye provided with a red or blue glass (*Bravais*).

To avoid any error, the surgeon will do well, first of all, to ascertain what takes place for his own eye; then he should place the same glass before the good eye of the person whom he is examining, the other eye, which is supposed to be blind, being kept open. If the person reads all the letters the simulation is evident.

Simulated amaurosis of *both eyes* can only be detected by careful observation of the movements of the pupils, and by taking into consideration the mode of the pretended development, compared with the results of ophthalmoscopic examination.

CHAPTER VIII.

THE VITREOUS BODY.

Anatomy.—The **vitreous body** occupies the entire space of the cavity of the eyeball comprised between the posterior surface of the lens and the retina. It is exactly adapted to this cavity, being convex posteriorly and to the sides, whilst anteriorly there is a slight depression in which the lens is lodged.

The **vitreous humour** is a clear, perfectly transparent mucoid substance. It is enclosed in a very thin vitreous membrane, the **hyaloid membrane,** which is united to the neighbouring structures at two places only—*viz.*, at the ora serrata near the zonule of Zinn, and at the optic papilla.

The **histological structure** of the vitreous body is but imperfectly known; according to some authorities, its substance is perfectly homogeneous, and does not contain any formed material. Still, the fact that foreign bodies may be encysted in the vitreous body, and the transformations which it undergoes when laid bare, seem to point to the presence of a cellular stroma. *Brücke* thought that he recognised the presence of several concentric membranes, and *Hannover* believed that there are numerous membranes dividing the vitreous into segments like an orange. All such formations, as also the star-shaped cells of the vitreous body, observed by several anatomists, are thought by others to be artificial, depending on the method employed in the histological preparation of the tissue. According to *Ritter*, the surface of the hyaloid membrane, which is next to the vitreous, is covered with a very delicate epithelium. *Stilling*, again, finds a *central canal* having a diameter of 2 millimetres. This canal becomes wider as it approaches the optic nerve, where its opening exceeds by 2 millimetres the diameter of the papilla. *Stilling* has also been able to distinguish a *cortical substance*, which nearly occupies the peripheral third of the vitreous body (in concentric layers), and a star-shaped nucleus which has three rays, similar to the nucleus of the lens.

The vitreous body has neither vessels nor nerves. It derives the materials for its nutrition and reconstruction from the uveal tract.

DISEASES OF THE VITREOUS BODY.

ART. I.—Inflammation of the Vitreous. Hyalitis.

Idiopathic inflammation of the vitreous body was long contested; it has only been admitted since we have been able to observe with the ophthalmoscope the changes which take place when a foreign body is introduced into the vitreous humour. At first we notice a slight haze round the body, which grows thicker, and finally hides it from our view. At the same time other filamentous or flaky opacities are formed in other portions of the vitreous. If circumstances allow us to watch the ulterior evolution of the phenomena, we find that the greyish opacity surrounding the foreign body assumes a yellowish colour, which gradually extends to the surrounding tissue, and, if situated immediately behind the lens, may change the appearance of the pupil.

Again, we may be able to observe suppurative inflammation of the vitreous body after excision of corneal staphyloma or the extraction of cataract by flap operation. In such cases purulent infiltration of the vitreous takes place very rapidly.

The course of these alterations is very variable. Sometimes there is an abundant formation of cellular tissue which becomes vascular, and the vessels of which communicate with those of the deep structures of the eye. At a later stage, this tissue contracts, and may thus cause separation of the retina. In other cases, as, for example, when a foreign body is encysted, the formation of the cellular tissue is limited to a circumscribed area. But it is especially after affections of the choroid and ciliary body that we have an opportunity of observing the alteration of the vitreous body, and the symptomatology of the suppurative inflammation is precisely that of suppurative choroiditis and cyclitis (see p. 209). We would refer to the chapter on the treatment of these affections for the treatment of inflammation of the vitreous body.

ART. II.—Opacities of the Vitreous Body.

The form of these opacities is very variable :—

1. Sometimes, in the midst of the vitreous body, which is otherwise

perfectly transparent, we see well-defined opacities, with very fine prolongations, which remain almost immobile. Generally only a few are seen, almost always situated in the neighbourhood of the optic nerve. We find them secondarily to retinitis, or in cases of posterior staphyloma, or, in elderly persons, without any other alteration of the eye (*Schweigger*).

2. In other cases, the opacity of the vitreous is in the form of a very fine or dotted veil which is spread out in front of the fundus of the eye. It presents to the ophthalmoscope a somewhat diffuse appearance, which may be confounded with the haze of retinal œdema. This form of opacity occurs especially in syphilitic affections (retinitis and choroiditis).

3. The most frequent form is that of mobile, filamentous, or membranous opacities. They are easily recognised with the ophthalmoscope, when the patient moves his eye rapidly. The rapidity with which these opacities move, and the extent of their excursions, may give us some information as to the degree to which the vitreous humour has become liquid. Those opacities are chiefly seen after hæmorrhages or diseases of the deep membranes of the eye (cyclitis and choroiditis). Still, there is nothing to prevent such opacities forming after idiopathic alterations of the vitreous body.

The *disturbance of vision* depends on the shadows thrown by these objects on the retina.

If that membrane be very sensitive (hyperæsthesia of the retina), and especially if the look be directed on some well-illuminated surface, the eye, even in the normal state, easily perceives a great variety of small opaque bodies (globules isolated, or strung together, curled up filaments, &c.), which have been called **moving scotomata** or *muscæ volitantes* (myodesopsia). These phenomena are a great source of annoyance to many patients. Still the *muscæ volitantes* have no importance when the visual acuteness is normal, and when, on ophthalmoscopic examination, we do not find any real opacity of the vitreous body.

Real opacities of the vitreous influence the vision in very different ways. Diffuse opacities more or less veil the entire visual field; flaky or membranous opacities, when extensive, may so intercept the luminous rays as to destroy vision for small objects. The patient then gets into the habit of moving his eye abruptly so as momentarily to free the central part of the visual field; but soon the opacities regain their former position, and the visual field is once more obscured. These movements are often repeated by the patient (as when he wishes to read), and this symptom is, therefore, very characteristic of the disease which we are discussing.

We can easily obtain information from the patient as to the details of these opacities of the vitreous, by using the endoptic test. For this purpose, the patient must look on some bright surface through a very small opening pierced in a card. A strong convex lens placed before the eye will aid him in seeing the opacities.

The **cause** of these opacities must be especially sought for in those affections of the ciliary body or of the choroid which in various ways bring about this alteration of the vitreous body:—

a. By disturbance of its nutrition, or by inflammatory irritation.

b. By different kinds of effusion: serous, purulent, but especially hæmorrhagic.

Effusions of blood may also result from injury, from a blow on the eye, from extraordinary muscular effort, as in violent coughing or vomiting, or, again, from congestion of the eye due to a sudden cessation of hæmorroïdal or menstrual discharge, or in diseases of the heart and the blood-vessels. The effused blood may occupy the entire vitreous body, or only a portion of it; after a short time it sinks to the bottom of the vitreous and becomes absorbed. Long afterwards we can still see with the ophthalmoscope flaky opacities, the mobility of which corresponds with the fluidity of the vitreous.

The **prognosis** varies with the nature and origin of the opacities. When they are due to hæmorrhage, without any serious disease of the choroid, and the vitreous is otherwise healthy, they may be absorbed. But generally opacities of the vitreous remain, and do not completely pass off. Disturbances of the general circulation are likely to occasion relapses. We must also remember that in cases of myopia, opacities of the vitreous often precede separation of the retina, and that in other cases separation of the retina may follow the contraction of the newly formed cellular tissue in the vitreous body. Purulent effusions (abscess of the vitreous body) usually lead to the loss of sight.

Treatment.—Very often the treatment is that of the choroidal or retinal affection, of which the opacities are a consequence. In cases where the effusion arises from general disturbance of the circulation or local injury, it may be necessary to apply the artificial leech of Heurteloup to the temple, to keep cold compresses on the eye, to use foot-baths, and to enjoin absolute rest. We must also take into account any special indications, such as hæmorrhoïdal discharge, menstrual disturbances, &c.

To aid the absorption of the opacities, we may produce diaphoresis by means of injections of pilocarpine; we may also give laxatives, corrosive sublimate, iodide of potassium; hot compresses often seem to act favourably. We have obtained very good results from repeated paracentesis of the anterior chamber with slow escape of the aqueous

humour, especially in the common case of persistent opacities of the vitreous humour accompanying posterior staphyloma. The constant current has also been recommended for the rapid absorption of these opacities (*Giraud-Teulon, Lefort*).

In one case, *von Graefe* obtained a great improvement of the visual acuteness by lacerating and displacing membranous opacities of the vitreous with a needle.

ART. III.—Fluidity of the Vitreous Body, Synchysis.

The vitreous body may lose its normal gelatinous consistence, and become more or less fluid (**synchysis of the vitreous body**). Often, only a portion of the vitreous body (anterior or posterior) is thus affected. The synchysis can only be diagnosed with certainty when there are also present opacities of the vitreous, which, by the rapidity and extent of their movements, may indicate to us the degree of fluidity of the medium in which they float.

Softness of the eyeball has wrongly been cited as a symptom of this affection, for while it is true that there is almost always a fluid vitreous in such eyes, yet the disease is often observed in eyes which have rather an increased tension.

Tremulous iris, especially at the periphery, is also said to be a symptom of the disease which we are discussing, but is not immediately due to it, but to the fact that the iris has lost the point of support on which it should rest. This symptom, then, merely indicates that the same circumstance which has produced softening of the vitreous has also caused displacement of the lens (from rupture of its suspensory ligament).

Partial fluidity is chiefly met with in cases of sclerotic ectasia, and in that portion of the vitreous which is next to the ectasia. General liquefaction of the vitreous body is also observed in staphylomatous eyes, as also after effusions, after dislocation of the lens, after loss of a portion of the vitreous, and, again, where there is some affection of the deep structures (choroiditis).

A very remarkable phenomenon is produced by the presence of cholesterine crystals of tyrosine and of phosphates (*Poncet*) in the midst of the vitreous body. With the ophthalmoscope we then see numerous bright shining bodies, which become endowed with rapid movement

whenever the eye moves, and gradually sink to the bottom of the vitreous when the eye is fixed (scintillating synchysis).

These crystals may be found in a transparent vitreous, or they may be mixed with other filamentous opacities, to which they may be adherent. Their origin is not exactly known. They are also met with in the lens, in the retina, and between the retina and choroid, and in perfectly healthy eyes—notably in those of aged persons.

ART. IV.—Foreign Bodies in the Vitreous Humour.

When a foreign body, such as a fragment of lead, iron, stone or glass enters the vitreous humour, and the lesion of the parts which it pierces before being brought to rest is not such as to prevent an examination of the media of the eye, we can, at least for a short time after the accident, diagnose its presence either with the ophthalmoscope or the endoptic test, or, again, by the functional condition—especially by the examination of the field of vision. After some time, it is often lost to view in the inflammatory disturbance which its presence excites, or it becomes encysted by a membrane, through which it can for some time still be recognised by its characteristic reflection, or it sets up immediately a suppurative hyalitis.

If once encysted, the foreign body may sometimes remain for a long time—even to the end of life—without occasioning any disturbance. Yet this immunity of the wounded organ is never sure, for it is often lost by inflammation at a period long after the accident (probably from displacement of the encysted body).

Again, it must not be forgotten that the presence of a foreign body in one eye threatens the other eye with sympathetic inflammation.

For these reasons, it is always important, when a foreign body has entered the vitreous, to ascertain if it cannot be extracted. If we are fortunate enough to find it still in the lips of the wound, we may extract it, enlarging the wound if necessary, then applying a pressure bandage, and following such a course of treatment as the lesion seems to demand (cold compresses, atropine, &c.)

If the foreign body has already entered the eye, and if, on account of its nature and the danger its presence involves to both eyes, we decide to operate, we must make sure of its exact position with the ophthalmoscope, and by carefully examining the surface of the sclerotic with a probe.

If we find a spot which is specially painful, the foreign body is most likely in the corresponding part of the vitreous (*von Graefe*). Moreover, the situation of the external wound, the course of the foreign body, and careful probing of the wound should aid us in our diagnosis.

Method of Operation.—At the spot where it is believed the foreign body may be most easily reached, a meridional incision from 1 to 1·5 centimetre in length should be made through the sclerotic to the vitreous, and an attempt made to seize the object with a blunt hook or forceps.

In the case of a fragment of iron, the extraction should be performed with the electro-magnet (*Hirschberg's*), by means of which success is often attained even when the object is invisible, and its exact position unknown. It is sometimes necessary to reinsert the magnet several times, or to change the pole, as the fragment may itself have been magnetised in forging. After the operation, the sclerotic wound may be closed by a suture.

The cases in which vision has been partially or wholly preserved by the aid of this instrument are so numerous that its use is expressly indicated. If a traumatic cataract exists as the result of the injury, extraction may be made, and the magnet inserted into the corneal wound and through the pupil. Should the operation be unsuccessful, it will then become necessary, in order to prevent sympathetic affections in the other eye, to practice enucleation, or evisceration.

The operation which we have just described is also available in cases where the lens, being dislocated into the vitreous, becomes the starting point of an inflammatory affection of the eye, which, by its influence on the general health or on the other eye, may render surgical interference necessary. We may attempt its removal by a simple sclerotic incision according to the prescribed rules, or by a peripheral linear incision of the cornea with iridectomy, using a curette or a blunt hook (Fig. 94) to draw the lens out of the eye.

Fig. 94.—Graefe's Blunt Hook.

Cysticercus of the Vitreous Body.—When we have an opportunity of watching the development of the cysticercus before it enters the vitreous body, we find in the fundus a bluish-grey opacity situated between the retina and choroid. This opacity increases in extent and density, and the retinal vessels at this point gradually grow dimmer till they become imperceptible. Then the greyish opacity

extends forwards to the hyaloid membrane, and a small cysticercus vesicle is detached, which enters the vitreous body. At other times, the vesicle is placed below the retina, causing separation; it then perforates that membrane, and escapes into the vitreous humour.

To the ophthalmoscope, cysticercus of the vitreous body appears as a bluish-grey transparent vesicle, showing at its periphery a clear, slightly-reddish (hydatic) reflection; occasionally the head and neck of the cysticercus are to be seen, as they sometimes advance out of, and retract into, the vesicle.

At a later period, the diagnosis of cysticercus may be rendered difficult by opacities of the vitreous body. These opacities are characteristic: they appear as a system of curtains or multiple veils, their folds presenting themselves to the ophthalmoscope as furrows or deep striæ, the configuration of which varies with the movements of the eye.

The visual disturbance at first consists of a well-defined, fixed interruption of the visual field, in the form of a black globe, but at a later stage there is in addition a more extensive cloud.

If the disease is left to itself, it leads to chronic irido-cyclitis with periodical exacerbations, and ends in atrophy of the eyeball. Sometimes there may even supervene a purulent panophthalmitis with exophthalmos.

Two cysticerci have been observed to exist in the same eye, but the presence of a cysticercus in both eyes of the same individual has not been noted. The presence of cysticercus does not seem to render the other eye liable to a sympathetic disease. Cysticercus of the vitreous body is very common in the North of Germany, but rare in the South of Germany, in England, Switzerland and France.

The natural course of this disease having been always disastrous, the extraction of the cysticercus is undoubtedly indicated, and should be attempted as soon as possible, even though the object be imbedded under the retina.

The best results accompanied by preservation of the sight have been obtained by *Alfred Graefe*, who has also constructed an ophthalmoscope for the special purpose of determining the precise location of the cysticercus. This being done, he makes at that point a meridional incision in the sclerotic, as in the operation for detachment of the retina, if the cysticercus is implanted under the retina, or directly into the vitreous.

Sometimes the cysticercus appears at once; if not, it has to be drawn out with forceps. Should suppurative inflammation supervene, enucleation must be resorted to.

ART. V.—Persistence of the Hyaloid Artery.

During intra-uterine life, as is well known, the hyaloid artery crosses the vitreous body from the papilla of the optic nerve to the hyaloid fossa. This artery disappears at the end of fœtal life.

In very rare cases it persists throughout life. It is seen as an opaque cord, surrounded with a second, somewhat greyish, zone (*Saemish*); with focal illumination, some have even thought that they observed a red colour in the cord, along with undulatory movements (*Zehender*). The persistent artery has also been seen to be attached to a dislocated cataract (*Wecker*). Lately, we observed * such a case where the cord began on the papilla as an irregular greyish opacity occupying the upper half of the optic nerve and the surrounding retina; it crossed the vitreous body outwards and downwards, and was attached to the lower half of the capsule, which it enclosed in a concave opacity. The same eye had also remnants of the pupillary membrane in the form of filaments beginning on the anterior face of the iris and uniting into a central pigmentary spot upon the capsule. The patient could, with this eye, count fingers at 1 metre's distance.

ART. VI.—Separation of the Vitreous Body.

This separation has been observed and demonstrated anatomically by *Iwanoff* in eyes which had sustained injury and in myopic eyes.

In cases of posterior staphyloma, the injured vitreous retracts, and detaches itself from the hyaloid membrane, which remains adherent to the retina (*Duke Charles of Bavaria*). The ophthalmoscopic character of this disease remains as yet undecided. *Galezowski* claims to be able to recognise it, at least in the direct image, by the existence of a grey crescent surrounding the papilla at a little distance from it.

* Vide *Debierre*, French Ophthalm. Society, 1886, Paris.

CHAPTER IX.

CRYSTALLINE LENS.

Anatomy.—The **lens** is a completely transparent body, and in shape resembles an ordinary bi-convex optical lens. Its anterior surface is contiguous with the iris and aqueous humour; its posterior surface, much more convex than the anterior, is in contact with the vitreous body, and lies in the hyaloid fossa.

The crystalline lens is enclosed in a capsule composed of a very elastic, structureless, transparent membrane, which is divisible into an anterior and posterior portion; the internal surface of the anterior portion is lined with a layer of epithelium. By its capsule the lens is attached to the zonule of Zinn (suspensory ligament), which is merely a continuation of the hyaloid membrane. Near the ciliary processes this ligament divides into two layers, one of which becomes united with the anterior capsule, the other with the posterior. The space between these two layers and the equatorial portion of the capsule is called the **canal of Petit.** It contains small quantities of fluid.

The lens-substance is divisible into **nucleus** and **cortex,** the former being composed of the innermost layers of the lens. The cortical substance consists of superimposed layers; it is softer and more succulent than the nucleus. As age advances, the lens, which in youth is clear like water, becomes yellow and even brown. Simultaneously, its substance becomes more dense, partly because the nucleus increases in size, and partly because the cortical substance becomes less soft.

Histology.—The primary elements of the lens are the **crystalline fibres.** They form elongated hexagonal prisms, and enclose nuclei with nucleoli when they belong to the cortical layer, whilst the latter are wanting in the cells of the interior portion of the lens. The contour of the fibres is smooth in the cortical, irregularly dentilated in the central portion, because the latter, of earlier growth, are compressed by the fibres of more recent formation which proceed from the elongation of the epithelial cells of the capsule, more particularly by those situated near the equator of the lens. The fibres are united by a cementing substance, and form by their union **concentric lamellæ.** Each of these *lamellæ* presents the same arrangement of fibres, which are so grouped that the angle formed by the surfaces of two contiguous fibres is filled by the acute angle of another fibre. Their extremities are cut short, the one being oblique, the other round.

On carefully examining the lens, we may find a star-shaped figure with three rays on either side; the superior ray of the anterior surface occupies the vertical meridian, as does also the inferior ray of the posterior surface, so that the figure of the latter seems to be at right angles to the former. These star-shaped figures are formed by the termination of the crystalline fibres in the following manner:—

A fibre springs from the centre of the lens, and its extremity curves round the equator, ending near it on the posterior surface, a second lens fibre, close to the first, arises a little higher, and as they are of equal length, it terminates beside the other, and a very little farther from the equator; all the contiguous fibres one after the other are arranged in a similar manner, so that all their extremities are situated in a straight line which forms one of the rays of the figure. A molecular amorphous substance and a system of inter-fibrillar canals are found occupying the figure.

The nutrition of the lens is furnished by the zonule of Zinn and the canal of Petit formed by the two laminæ of this ligament. As age advances, the lens fibres become dense and hard, and acquire a yellowish tinge. The nucleus is then more easily distinguished from the cortex by its density and more decided yellowish hue. At the same time, the liquid surrounding the lens diminishes.

DISEASES OF THE LENS.

ART. I.—Cataract.

A. General Considerations.

By **cataract** is meant the more or less complete opacity of the lens. In the early stages it is not always easy to diagnose the presence and extent of a disturbance of the transparency without very minute examination. For this purpose the pupil should be dilated with atropine, and we should make use both of focal illumination and of the ophthalmoscopic (plane) mirror.

To *focal illumination*, the opacities of the lens seem to be of a greyish or whitish colour. In examining old persons, care must be taken not to confound the physiological aspect of the lens with a real opacity; for at an advanced period of life the lens always reflects a good deal of light, and the nucleus takes on a yellow tint; yet this error is easily

detected when the visual acuteness is normal for the patient's age, and when the lens appears transparent to the ophthalmoscope.

By using the *ophthalmoscopic* mirror alone with a feeble illumination, the slightest opacity can be detected as striæ or points which appear black on the red fundus of the eye. Translucent opacities produce the effect of a veil spread over the ophthalmoscopic image.

When the opacity involves a great portion of, or the entire lens, it is easily detected at first sight by the greyish or whitish tint of the pupil. Cataract can then be confounded only with plastic deposits in the pupillary field (**false cataract**); but in the latter, the iris is adherent and of an unhealthy appearance, and we look in vain for the dark shadow which the pupillary margin of the iris throws on the lens. The breadth of this shadow is in direct proportion to the distance between the cataract and the iris.

The **disturbance of vision** varies with the form and exact seat of the cataract. When the opacity begins in the centre, the patient sees better in dark places, and in any condition in which the pupil is dilated; the opposite is the case when the opacity is in the periphery of the lens. During the early stages the patients often complain of myopia and of polyopia; objects appear surrounded with a haze or cloud, and the difficulty of seeing increases imperceptibly and slowly for months or years, till they can no longer distinguish anything more than day and night.

The **progress** of cataracts is, as a rule, rather slow. Except in a few special forms (congenital, traumatic cataracts, &c.), the lens only becomes opaque at an advanced period of life, and the progress of the disease is more or less inactive; sometimes it seems to come to a standstill. Ultimately, the cataract generally occupies the entire lens or nearly so; the time which it takes to mature may vary from several months to several years. As a rule, the two eyes are successively attacked.

Ætiology.—The latest anatomical researches show that **senile cataract** is preceded by diminution in volume of the lens (*Priestley-Smith*) consequent upon progressive induration. The capsule, being retained by the suspensory ligament, is unable to follow the contraction of the lens substance, and separation of the peripheral layers occurs, associated with the formation of vacuoles in which the fluid of the lens collects, thus giving rise to opacities at first apparent, then real (**incipient cataract**). At the same time, the cellules of the capsule and the peripheral fibres of the lens, especially those containing vigorous nuclei, begin to multiply and extend into the empty spaces (*Becker*). Hence, there is a proliferation of epithelial cells in the vicinity of the anterior pole (capsular cataract), the formation of a layer of cells in the internal face of the posterior capsule, and finally the formation of large

vesicular cells in the equatorial zone of the lens, and solitary ones on the internal surface of the capsule.

Retrograde metamorphosis of the lens fibres ensues, during which they become atrophied, brittle and opaque, and eventually transformed into molecular detritus, fat, crystals of cholesterine and phosphates. The general and special causes of these changes in the lens are not exactly known. Sometimes they seem to be due to a disturbance of the general nutrition (diabetes, ergotism, senile marasmus, &c.), sometimes to inflammatory affections in the uveal tract, or in the deep membranes of the eye in general (choroiditis, irido-choroiditis, choroido-retinitis, &c.) *Michel* has attributed the origin of cataract to arterio-sclerosis; others to renal atrophy (**nephritic cataract**).

However this may be, cataract is especially a disease of advanced life, and is oftenest found in persons over forty-five years of age. Sooner it is secondary to internal diseases of the eye (iritis, choroiditis, separation of the retina), or to general diseases, such as diabetes, or again it may be due to injury of the eye (**traumatic cataract**). In a certain number of cases, the opacity of the lens appears after recovery from diseases of the skin which have involved a considerable portion of the cutaneous surface. Cataract is also found at birth (**congenital cataract**), or it may be formed during the first years of life as a consequence of perforation of the cornea.

Treatment.—The recorded cases of recovery from cataract by medication may be attributed to an error in diagnosis. Cases of spontaneous recovery of sight are probably cases of dislocation of an opaque lens, or of absorption, without lesion of the capsule or after rupture of the capsule by injury.

Recovery from cataract can only be obtained by surgical interference.

B. Varieties of Cataract.

Cataracts have always been grouped according as the opacity affects the capsule (*capsular cataract*), or the lens itself (*lenticular cataract*), or both structures at the same time (*capsulo-lenticular cataract*).

Lenticular cataract is either partial and stationary (*zonular or polar cataract*), or total and progressive (*senile cortical cataract*).

1. Soft or Liquid Cortical Cataract.

The opacity is greyish and like milk; generally the lens is swollen, and, as a consequence of this increase of volume, the iris is pushed forwards, the pupil is somewhat dilated and sluggish. At a later stage, the contents of the capsule may become completely liquid and

remain for a long time in this condition (*cystic or sedimentary cataract*), or they may undergo a retrograde metamorphosis.

This retrograde metamorphosis consists in the gradual absorption of the liquid portion, and a deposition of calcareous and fatty matter on the capsule. As a consequence of these changes, the volume of the cataract slowly diminishes, and may at length be reduced to the two layers formed by the capsule with the above-mentioned deposits (*cat. arido-silicosa*). The anterior chamber is deeper than in the normal condition, the iris is tremulous when the eye moves, or its pupillary margin is adherent to the capsule.

2. Nuclear Cataract.

We get from the pupillary field when dilated a greyish or yellowish reflection. With focal illumination we can easily detect the presence of an opacity in the centre of the lens, separated from the capsule by transparent layers (the shadow cast by the iris is very large). To the ophthalmoscope, the opacity sometimes seems to be inconsiderable, but well defined, and the periphery of the lens transparent.

The visual disturbance consists of a diminution of the visual acuteness caused by the lenticular opacity, and of myopia or rather myopic astigmatism. When the pupil is dilated with atropine the vision is improved.

This condition may last for a long time, but the longer it remains the more intense is the colour of the cataract; it becomes brownish-red or dark brown; and finally the cortical substance may also be affected, the cataract becoming complete.

3. Senile Cataract.

This variety, which is by far the most common, begins in the cortical layers nearest to the nucleus. The opacities assume the form of short striæ or irregular patches of a greyish coloration. Simultaneously the nucleus becomes yellowish or brownish.

As the cataract developes, the cortical opacities are sometimes in the form of large striæ which glisten like an aponeurosis; sometimes the striæ are narrow and very white; at other times no striæ can be discerned, the opacity being composed of irregularly disseminated greyish points or patches.

The extent and intensity of the deeper colour at the centre gives us some idea of the consistence and extent of the nucleus.

The cataract is ripe when all the lens substance has become opaque; when it has been for any length of time in this condition, its appearance

and consistence may be modified by the condensation of the cortical masses, which condensation sometimes begins before the entire cortex is opaque.

The period occupied by the development of the cataract is very variable, being in some cases a few months, in other cases several years.

Sometimes, in senile cataract, the nucleus is so dark that to simple inspection the pupil appears black. These *black cataracts*, which can be easily diagnosed with the ophthalmoscope or with focal illumination, are uniformly due to sclerosis of the nucleus. *Von Graefe* has expressed the opinion that the dark colour is due to hæmatine from old intraocular hæmorrhage being carried by the endosmotic current into the lens.

In other cases of senile cataract, the opaque nucleus is hard, and the cortical substance is perfectly liquid (cataract of Morgagni). This variety of cataract is easily diagnosed when the capsule is transparent; for the nucleus, instead of being found at the centre of the cataract, is seen to have sunk to the bottom of the liquid. It disappears when the patient throws his head backwards, and reappears when he bends forwards.

When the senile cataract is complicated with inflammatory conditions of the deep membranes, we often find calcareous masses on the internal surface of the capsule, while the remainder is shrunken. Thus we have the **calcareous cataract**, distinguished by its chalky appearance. With this there often exists a relaxation of the zonule of Zinn, so that any movement of the eye produces a trembling of the cataract (**tremulous cataract**).

In other cases we find fatty masses in the cataract, as also cholestrine grains characterised by their peculiar scintillating reflexion. Again some have even observed fibrinous and osseous alterations in the lens elements (*Stellwag*), the presence of which, however, has been doubted by other observers (*Virchow, H. Müller*).

C. Forms of Partial Cataract.

Not unfrequently do we find isolated opacities in the lens, as very narrow striæ, situated near the periphery of the cortical substance. Such opacities are, as a rule, covered by the iris, and so may exist without causing any disturbance of the vision; they may be present for a number of years without invading the rest of the lens.

More rarely we find opaque patches in the cortex at some distance from the anterior capsule; such opacities remain for a long time isolated and circumscribed.

Sometimes also we see in the lens a great number of points or opaque striæ in the midst of the transparent cortical substance. This condition, which sensibly disturbs vision, is often stationary for a length of time, or the opacity only makes very slow progress. Complications of the deep membranes of the eye can be diagnosed in some cases, but not in all.

1. Zonular Cataract.

Zonular cataract occupies only a few layers of the lens next to the nucleus, which retains its transparency, as do also the peripheral layers (fig. 95). On examining the pupil, we find in it a greyish or

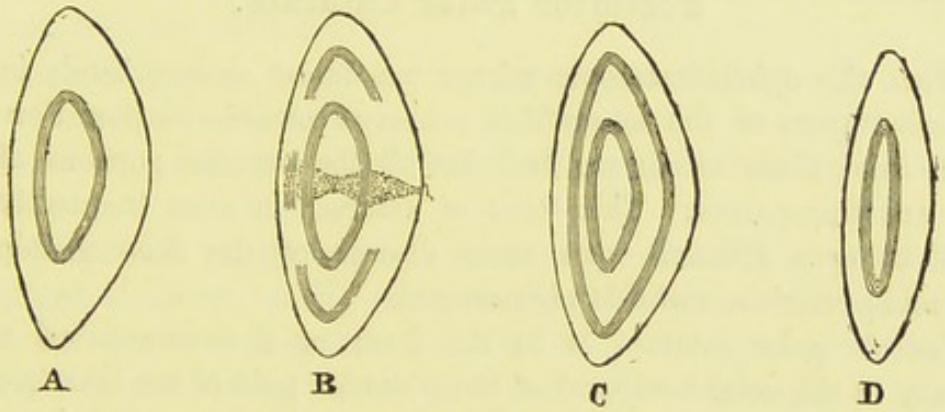


Fig. 95.—Zonular Cataract.

whitish opacity, which with focal illumination can easily be ascertained to be separated from the iris by a layer of transparent cortical substance.

This form of cataract, which is either congenital or developes during infancy, is most frequently stationary throughout life; progressive cases are characterised by the presence of a few striæ or opaque patches in the transparent region of the lens.

The disturbance of vision varies according as the pupil is contracted (as in broad daylight), or dilated (as in a weak light, or after using atropine). In the first case the patients see very little, and guide themselves with difficulty. In the second, they see tolerably well, sometimes sufficiently so to read. The necessity of obtaining large retinal images obliges them to bring objects very near their eyes, so that they appear very myopic; sometimes patients affected with this form of cataract become really myopic. Not unfrequently do we find that such persons are affected with nystagmus.

This variety of cataract is often found in several members of the same family. In most cases, zonular cataract affects both eyes, as in rachitic children, where there is also some irregularity in the formation

of the enamel (*Horner*). Its mode of development has been connected with cerebral affections accompanied with convulsions (*Arlt, Horner*).

When the cataract is stationary, and the vision of the patient sufficient for ordinary occupations, there is no need of operation. When, in the same conditions, the patient can only read easily with a dilated pupil, we may constantly use instillations of atropine, or perform an iridectomy so as to allow luminous rays to enter by the transparent peripheral portions of the lens. When the cataract is very extensive or shows signs of a progressive nature, we may practice discission or extraction.

2. Circumscribed Cataract of the Posterior Cortex—Posterior Polar Cataract.

With the ophthalmoscopic mirror we detect opaque bands in the posterior layers of the lens which converge towards its posterior pole. With focal illumination we find that all the anterior portions of the lens are transparent. This form of cataract is most frequently met with in eyes affected with some disease of the deep membranes (choroido-retinitis, retinitis pigmentosa).

Posterior polar cataract is in the form of a circumscribed round opacity in the neighbourhood of the posterior pole of the lens (perhaps in the vitreous body?) Its position is recognised on ophthalmoscopic examination by the fact that the opacity remains fixed at the centre of the eyeball, no matter how it moves; it is often found in conjunction with posterior staphyloma and atrophic choroiditis.

3. Capsular Cataract.

Capsular cataract arises, as we have already stated, from the proliferation of the epithelial cells of the capsule near the anterior pole. Prolongations sent out by some of these cells penetrate between the epithelial layer and the capsule proper. The epithelium thus detached from the capsule covers up the newly formed tissue either entirely or in part. Occasionally a thin subjacent layer of the capsule becomes detached and raised up with the epithelial layer, so that a capsular cataract produces a true splitting of the capsule (*Becker*). Under the epithelium are found deposits of finely granulated hyaline in many layers forming a fibrillary tissue. Besides these deposits, calcareous substances may be seen in the lacunæ which surround atrophied cells (*Becker*).

The following is an enumeration of the various forms of capsular cataract:—

(*a*) **Central Capsular Cataract.**—This appears in the middle of the pupillary field as a round, chalky-white patch surrounded with a greyish zone. The opacity, as a rule, projects beyond the level of the capsule, either slightly or in the form of a small pyramid, the summit of which is sometimes connected with the posterior surface of the cornea by a filamentous prolongation (**pyramidal cataract**).

This capsular opacity is also found on the internal surface of the capsule, that is to say, in the lens itself (*H. Müller*).

It is found in newly-born children; or it is formed in early life, generally as a consequence of perforations of the cornea. A similar opacity, projecting into the vitreous body, is sometimes found on the posterior capsule. It indicates the insertion of the hyaloid artery, traces of which are seen in certain cases as a thin filament connecting the lens with the optic nerve.

Central capsular cataract may remain throughout life without increasing; in such cases, no operation should be performed, as luminous rays pass easily between the opacity and the margin of the pupil.

(*b*) **Capsular cataract** as an **accompaniment** of **lenticular cataract** is always readily recognised by its chalky-white appearance, which is due to calcareous incrustations. It is most frequently observed in cataractous lenses that have passed maturity. At other times it is found in eyes that have suffered from choroidal or iritic inflammation; in the latter case we often find adhesions between the capsule and the pupil (**adherent cataract**).

(*c*) **Traumatic Cataract**—*Foreign bodies in the lens.*—Any lesion of the eye which produces an opening in the lens capsule exposes the cortical substance to the action of the aqueous humour. The cortical masses become swollen by imbibition, and, assuming a whitish colour, escape by the capsular wound and fall into the anterior chamber. The aqueous humour then attacks another portion of the cortical substance, and in this way the entire lens may be absorbed. This is observed in young persons when the capsule has been opened to any extent.

At other times, when the wound has been very small, it may happen that it cicatrises in a short time, so that we find a greyish opacity which may diminish in extent, or even disappear.

If the capsular opening has been very great, and the accident has happened at twenty-five or thirty years of age, there is cause to fear that sudden swelling of the lens which is apt to set up inflammation of the iris. At a more advanced age, the absorption will be more tedious, and inflammation of the iris or choroid is more to be dreaded. In our prognosis, moreover, we must take into account such complica-

tions as may arise from injury to other portions of the eye (penetrating wound of the cornea, prolapse or tearing of the iris, intraocular hæmorrhages, separation of the retina).

As a result of violent contusions of the globe of the eye without any lesion of the capsule, a slow and progressive opacity of the lens has been observed to follow in a short time, and may be attributed to defective nutrition (after rupture of the suspensory ligament), or to a severe shock to the lens fibres.

As to the treatment of ordinary traumatic cataract, it is important above everything to obtain and maintain complete dilatation of the pupil with atropine. If we do not succeed in this, or if the swelling of the lens menaces the eye, we must perform an iridectomy, or extract the traumatic cataract with or without iridectomy.

When a foreign body, such as a fragment of iron or stone, is lodged in the lens, it is possible to detect its presence in the early stages before the lens substance has become perfectly opaque. Later, metallic bodies may still be recognised by the brownish colour which their oxidation imparts to the surrounding tissue. If, in such circumstances, the cataract is absorbed, the foreign body may remain attached to the capsule, or it may fall into the anterior chamber or behind the iris. In the last case, its presence gives rise to all the dangers of foreign bodies in the eye (irido-choroiditis, sympathetic disturbance in the other eye). The same danger naturally exists if the foreign body has pierced the lens and is lodged in the fundus of the eye (sympathetic affections). Whenever a cataractous lens, enclosing a foreign body, requires to be removed by extraction, this should be done in such a way as to extract the foreign body at the same time, lest it should fall into the inaccessible parts of the eye. As a rule, a curette should be intoduced behind the foreign body, so as to make sure of it before everything else.

D. The Consistence of Cataracts (Diagnosis of).

Having dilated the pupil with atropine, so as to be able to examine the entire extent of the lens, we ascertain the exact coloration and appearance of its surface by focal illumination.

At first we detect the presence of the *nucleus* by the slightly darker amber or yellow coloration of the central portion of the lens. The intensity of this shade and its extent afford indications as to the hardness, size, and thickness of the nucleus.

The diagnosis of the consistency of the *cortical masses* is much more difficult. In the first place, some idea of their consistency may be got from the **volume** of the cataract, in so far as, other things being equal,

the cataract is soft when the cortical substance is very considerable and presses the iris forwards; the anterior chamber is then shallower, and there is an unwonted sluggishness in the movements of the pupil. Yet, these symptoms are only of value where a comparison with the other eye shows that they do not depend on some physiological condition, and where there is no other circumstance which might account for them, such as an increase of intraocular pressure.

The **conformation** of the cortical masses is of chief importance in the diagnosis of the consistence of a cataract. It is soft when there are large radiating striæ, of a bluish or rather greyish colour and bright metallic lustre; between the striæ we find less opaque portions of the lens filled with greyish points or patches of an irregular form. When the striæ of the cataract are of medium size, they are then, as a rule, very bright; the cortical mass, although soft, has still sufficient consistence to adhere to the nucleus during expulsion. Sometimes the striæ are narrow, or of medium size, and whitish, so that if we judged by colour alone we should be apt to think the cataractous matter soft. Yet, in such cases it is very cohesive, and the cataract is, as a rule, hard. We may be certain that it is hard when the striæ are narrow, linear and radiating, no matter what may be the colour. Let us also add that, in all such cases, other things being equal, the greater the size of the nucleus the more probably is the cataract hard (very coherent). When the cortical substance is striated, and so thin that we can see the dark nucleus more readily than in ordinary circumstances, it indicates that the cataract has undergone a retrograde metamorphosis, and that the cortical mass is adherent and of laminated structure. The space between the anterior capsule and the pupillary margin is in such cases unusually deep, and a greater quantity of light passes by the peripheral portions of the cortical substance, causing the patient to hope that the cataract will be cured spontaneously.

Any conclusion which we may draw as to the consistence of the cortex, depending on the form and colour of the striæ, cannot be of service in that numerous class of cases in which the striæ are not present. Here the diagnosis of the consistence of the cataract is a matter of the greatest difficulty. Still, some importance may be attached to the following characteristics:—If the cortex preserve some of its normal transparency—that is to say, if it be not completely opaque, but present only a diffused whitish or greyish appearance, it may be considered as of normal consistence; it has not yet become softened. On the other hand, when it has lost all transparency, and is to all appearance perfectly amorphous, without striæ or patches, and of a greyish or whitish colour, it is most probably liquid. In such cases, we can easily detect the presence of a nucleus, which is no longer at

the centre of the cataract, but at the bottom of the liquid cortical masses. The **position of the nucleus** is thus of importance in judging of the degree of softness of the surrounding cortex. If the cortical substance is greyish, and its surface uniformly dotted or speckled, we judge of its consistence chiefly by its transparency. If the opacity is almost complete, the substance is most likely soft, but at the same time grumous, so that it will readily adhere to the capsule. Often the extraction of the nucleus is attended with difficulty.

When we find between the opaque patches other portions which are still transparent, the consistence is nearly that of the normal lens—that is to say, it is gelatinous, and all the more so the more numerous the transparent portions. The presence of narrow striæ between the points indicates, on the other hand, that the cortical substance is harder.

In concluding these observations on the diagnosis of the consistence of cataracts, we can only repeat the advice which *von Graefe* so often gave:—When we are not perfectly certain as to the consistence of a cataract, it is better to consider it as tolerably coherent, for an incision somewhat too large, if not greatly in excess, endangers the success of the operation less than an extraction rendered difficult by the smallness of the incision.

E. Cataract Operations.

General Considerations.—Before operating for cataract, it is absolutely necessary to take into account the general condition of the eye which is to be subjected to operation, especially as regards its visual functions, so that after the operation we may not be disappointed by some **unforeseen amaurosis.** For this purpose, we must carefully examine the tension of the eyeball, the condition of the anterior portions, such as the iris and pupil. We should also inform ourselves as to the state of vision before the cataract supervened, and as to the rapidity with which it was formed; and, most important of all, we should examine the present condition of the visual functions of the cataractous eye.

The examination of the external portions of the eye often affords us very valuable indications. The presence of synechiæ, easily discovered, especially when atropine is used, the condition of the iris itself (decoloration, disorganisation, atrophy), the hardness or softness of the eyeball compared with its fellow, all give us information as to the nature of the complication. The peculiar appearance of the cataract, and the youth of the patient relatively to the age at which cataract usually supervenes, often induce us to examine most carefully

the visual functions, especially if the patient be very myopic, and if we find in the other eye the usual alterations which accompany progressive myopia of a high degree.

These various complications, according to their gravity and according to the influence which they exercise on the visual acuteness, demand from us a corresponding degree of caution in our prognosis; and in cases in which we foresee that there would be no improvement of vision, we must abstain from any operation.

When the only complication present is some affection of the conjunctiva, of the eyelids, or of the lachrymal passages, we should, by appropriate treatment, remove all such sources of irritation before operating.

Should we operate on one eye for cataract whilst the other is completely healthy?

Von Graefe answers this question in the affirmative in those cases in which it is nearly certain that the operation will be successful, as, for example, in cases which are suited for operation by discission or by simple linear extraction; in other cases it is better to abstain.

When, on the other hand, cataract has begun to be formed in the other eye, or has even become so considerable as to prevent the patient following his usual avocations, we need not hesitate to operate on the eye which was first affected, without waiting till the patient is completely blind.

Should we wait till the cataract is completely mature before operating?

Experience has shown, it is true, that the cataract comes out of the capsule more easily and more completely when the entire lens substance is involved, and therefore we prefer, as a rule, to wait till this takes place. But it often happens that a long time must elapse before the cataract attains this state of maturity, and we will thus be obliged to defer the operation till the long period of relative immaturity has passed, or, at least, till the patient can no longer use his eyes. In these cases we need not wait till the cataract is completely ripe, but may practise artificial ripening, and select a mode of operating which does not involve any particular element of danger. In cases of congenital cataract, or of cataract occurring at an early period of life, the rule is to operate early, for the defective condition of the vision may easily become at this period of life the source of strabismus or of nystagmus.

Should we operate on both eyes at the same time?

As a rule, we are opposed to this practice, for the reason that the behaviour of the patient during the first operation, the progress towards recovery, and the ultimate result, often give very valuable indications as to the manner in which our second operation should be

performed. It is only under special circumstances that we decide to operate on both eyes at the same time, such as when the patient cannot be sufficiently long with us to wait for a second operation, or cannot return to have it done, or expressly desires it.

Extraction of Cataract.

The honour of having originated the extraction of cataract belongs to *Jaques Daviel*, who, about 1747–1750, brought forward his method. This process, which required several instruments—*viz.*, a lance for puncturing, a two-edged knife for enlarging the puncture, and scissors for finishing the flap—consisted in making a section in the form of an arc in the corneal border, which detached about the lower two-thirds; then, after turning up the flap, the capsule was opened and the lens removed.

Modifications of this method, made by his successors, related at first to the instruments employed; the knife of *Richter* appearing in 1773, and that of *Beer* in 1813; and to the flap, the base of which was brought nearer to the horizontal diameter of the cornea (*Richter*, 1773), and cut in the superior border (*Wenzel, Santarelli*, 1795). At a much later period the corneal section was brought nearer the sclero-corneal juncture, and the depth of the flap also diminished more or less according to the consistency of the cataract (*Jacobson*, 1863). Moreover, the operation became gradually surrounded with various precautions. Instead of operating with the patient in a sitting posture, he was made to lie down, and was left in bed until the cicatrisation of the wound was completed. The compressive bandage was improved, so as to immobilise the eyes as much as possible, and the after-treatment, following the general progress of knowledge in medicine and surgery, was directed in a more rational manner. Again, **Iridotomy** (*Petit, Maunoir* and *Carron du Villars*, followed by *Hasner, Coursserant Sr.*, and *Chavernac*) and **Iridectomy** were resorted to as means of overcoming the obstacles arising at times from the rigidity of the pupil, and of preventing the dangers resulting from the prolapse of the iris. The latter procedure was at first only adopted in exceptional cases, afterwards in combination with the flap method, either as a preliminary measure (*Mooren*, 1862) or as a simultaneous operation (*Jacobson*, 1863). The form of the incision likewise underwent several modifications. A linear incision was substituted for the large flap in cases of cataracts without nuclei (*Gibson*, 1811, *von Graefe*, 1852) and, for the other forms with nuclei, an almost linear incision or small flap, cut with a straight knife, in the sclero-corneal border, combined with iridectomy (*von Graefe*, 1865).

It should be added that the application of antiseptic principles and

the use of cocaine (*Koller*, 1884) constituted a manifest advancement, both in facilitating the operation and in diminishing its dangers.

As for the results obtained by extraction methods, *Daviel* was successful in 182 out of 206 operations; *von Graefe* obtained 90 per cent. of good results in 1,600 cases operated by the flap method, and by his own method 95 per cent.; whilst *Horner*, by means of the latter procedure, combined with the use of antiseptics, obtained 98 per cent.

1. Extraction by Flap Operation.

Indications.—Flap extraction is only applicable for cataracts in which the nucleus is hard in proportion to the surrounding cortical substance. We can, therefore, employ it: 1st, in senile cataracts, when there is a hard nucleus of some size, although the cortex may be of normal consistence, softened, or even have passed into the stage of retrograde metamorphosis; 2nd, in young persons, where there is a very large nucleus, no matter what may be its consistence; 3rd, in cataracts which have fallen into the anterior chamber.

Preparations.—Aseptic precautions being preferable to antiseptic ones, the chief preparation will consist in strict cleanliness for the patient and his surroundings. On the evening preceding the operation, a mild purgative should be prescribed, so that he may be allowed to remain quiet a few days without going to the closet, also a general bath, and repeated bathing of the face with a solution of boracic acid, some of which should be inhaled into the nostrils.

Neither atropine nor eserine should be employed, because the former, by paralysing the sphincter, invites prolapse of the iris, and the latter induces constriction of the pupil, which makes the passage of the lens more difficult.

During the operation, the patient should recline on the bed which he will occupy during his recovery, so as to avoid unnecessary movement. It is important to be able to place at his disposal the services of a nurse who is thoroughly trained in her duties, for a person who has been operated on must abstain as much as possible from any sudden movement of the head and of the entire body. The patient's room should be easily darkened and aired.

The instruments necessary for this operation are—fixation forceps (Fig. 60), a cataract knife with a straight or curved edge (Figs. 96 and 97), and a cystitome (Fig. 98), or a little pointed hook, which we prefer. All the instruments should be carefully dipped in a solution of boracic acid just before using.

Description of the Operation.—The patient, whose healthy eye should be covered by a light bandage, must lie so that the light may fall in a suitable manner on the eye which is to be operated on.

The eye and the lids should be cleansed with a solution of sublimate 1 : 5000, care being taking that the hands of the operator and of his assistants are absolutely clean. The cornea and the conjunctiva

Fig. 96.

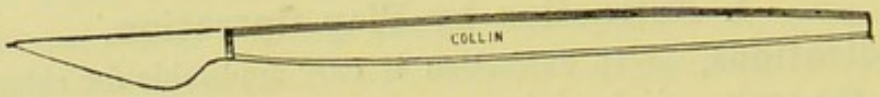


Fig. 97.

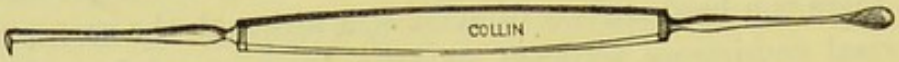


Fig. 98.

may then be anæsthetised by means of cocaine. The head should be firmly fixed, and the eyelids separated by an assistant placed behind the patient.

The first step in the operation is the formation of the flap, either in the superior or inferior aspect of the cornea (superior or inferior keratotomy).

The extraction by superior flap, although more difficult of execution, is to be preferred, as it is less likely to cause escape of vitreous, and allows the superior eyelid after the operation to play the part of a bandage, covering and slightly compressing the wound. We are forced to operate inferiorly—1st, when there is an adhesion between the superior pupillary margin and the capsule; 2nd, when the patient cannot voluntarily turn his eye downwards, which action is necessary for the introduction of the cystitome, and for the natural expulsion of the cataract in the third step of the operation.

(a.) Inferior Keratotomy.

1. **First Stage: Section of the Cornea.**—The operator takes the fixation forceps in his left hand, and the cataract knife in his right, holding the cutting edge downwards. With the first he seizes a fold of the conjunctiva very near the internal margin of the cornea, a little above its horizontal diameter. The surgeon has most command over his forceps when he holds them near the extremity of their branches; and he should take hold of the eyeball at that moment when, following his indications, the patient places his eye in the most suitable position for operation, which, if he adopts our method, is when the patient looks slightly upwards and outwards. As soon as the eye is fixed in this

position, the forceps are only required to prevent its displacement, and they should not exercise any dragging influence or pressure on the eyeball.

The cataract knife is held between the first three fingers (Fig. 99), so that the index and medius are opposite to the thumb, whilst the

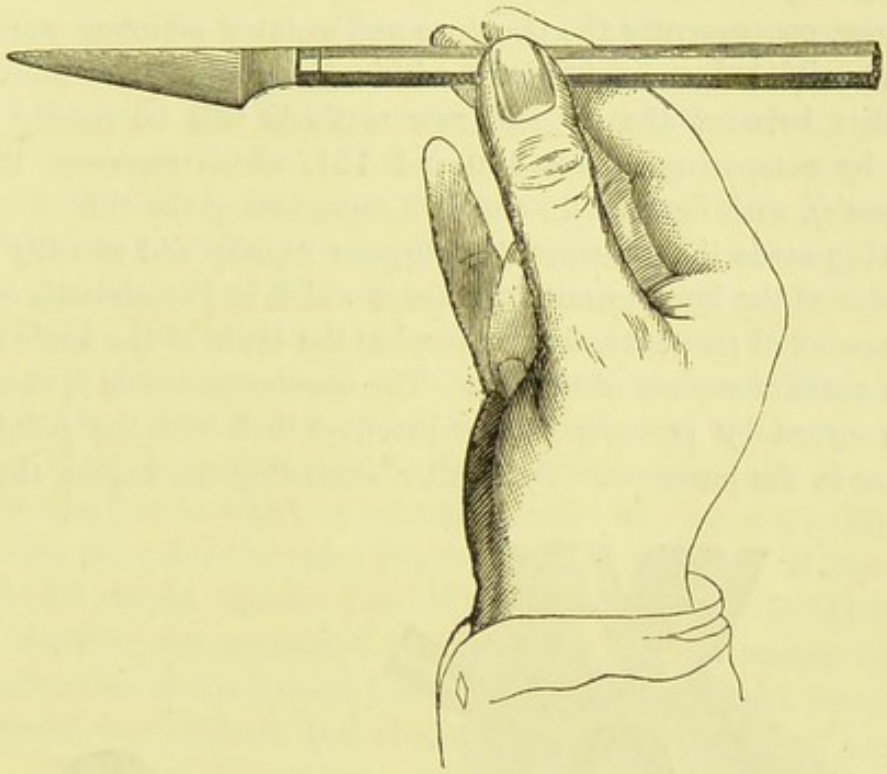
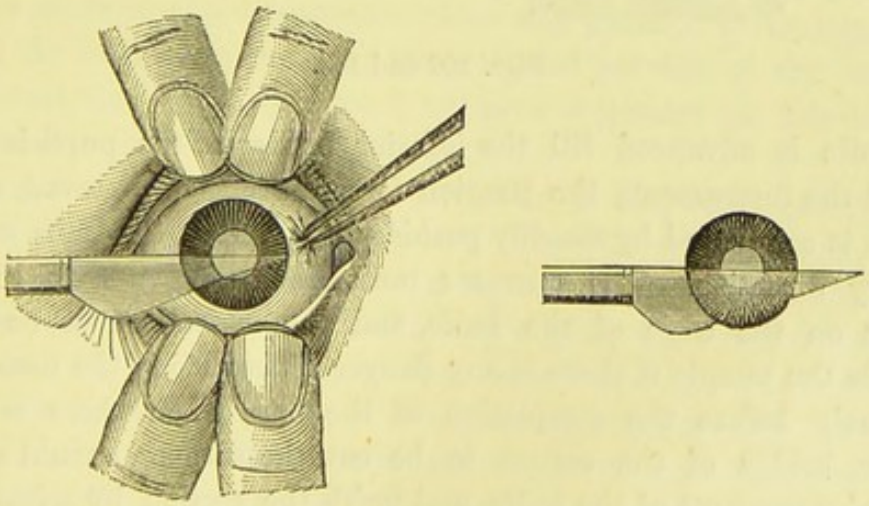


Fig. 99.

fourth is folded on the palm, and the fifth supports the hand on the bony prominence. The operator first holds the knife in front of the eye, in that position which it should occupy in the organ itself, that is



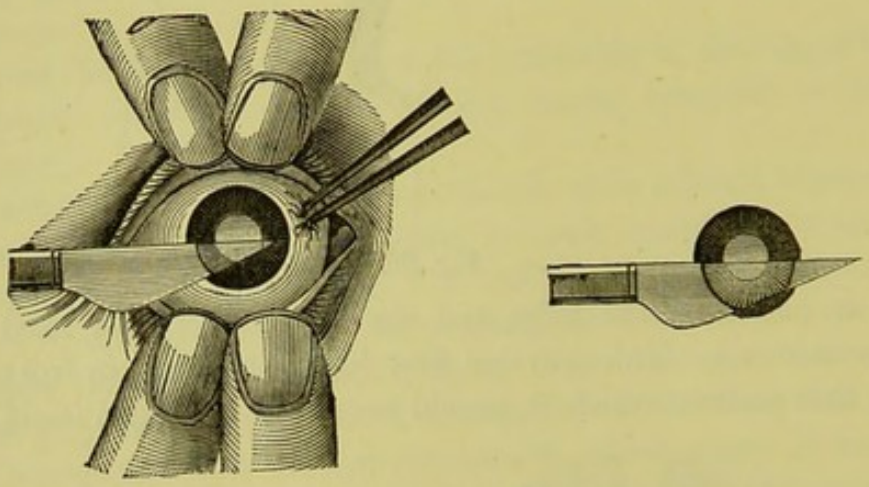
Figs. 100 and 101.

to say, he should hold the point horizontally with the edge turned downwards, parallel to the plane of the iris. When he has assured

himself that the diameter of the knife is suitable, and that the extension of his fingers will suffice for the formation of the flap, he pierces the external margin of the cornea with the point of the knife at its junction with the sclerotic, at a point one millimetre beneath the transverse diameter of the cornea.

According to the old method, the flap was made in the corneal substance, consequently the puncture and counter puncture were made at points situated one millimetre within the conjunctival limb. The difference between the old and new methods will be readily understood by comparing figures 100 and 101, which represent the new (*Jacobson's*), with figures 102 and 103 representing the old.

Having made the puncture, the surgeon rapidly and steadily pushes the point of the knife towards the point which is diametrically opposite to the point of puncture, always keeping the blade of the knife parallel to the anterior surface of the iris. The counter puncture is then made in the cornea by piercing the conjunctival limb with the point of the knife as in the puncture. By further extending the fingers, the flat of



Figs. 102 and 103.

the knife is advanced till the inferior border of the pupil is hidden behind the instrument; the fixation forceps are then removed, and the section is completed by steadily pushing the point of the knife on in its primary direction. The operator must be careful not to lean any weight on the edge of the knife, and the eyeball must be turned towards the temple if there is any danger of wounding the nose.

Shortly before the completion of the flap, when there is only a narrow bridge of the cornea to be cut, the surgeon should stop the forward movement of the knife, and finish the section by withdrawing the knife as gently as possible. By so doing, he will round off the flap, which, to be regular, should be made entirely in the conjunctival limb. As the section approaches completion, the assistant must let the

lids go gently, and the surgeon, on withdrawing the knife, should direct the patient to shut his eyes as if to sleep, that is to say, without spasm of the orbicularis.

Accidents which may happen during the first step of the operation.—If it happens that the point of puncture has been badly chosen—that is to say, above or below the point at which the operator proposed to make it, the operation should be continued, provided the difference is not too great; the point of counter puncture may be altered so that the flap will possess the necessary dimensions. But if the knife has entered the sclerotic or cornea at such a distance from the conjunctival limb, that a slight turning of the edge forwards or backwards does not bring the incision to the corneal periphery, it is better to withdraw the knife, and for the time being to abstain from any operation. In acting otherwise, we run the risk of making a very irregular flap, either too small or too large, which would be followed by very serious consequences during the second stage of the operation.

If the knife, in crossing the anterior chamber, leaves the plane parallel to the iris, in which it should advance, the point may come in contact with the cornea or, more frequently, with the iris. If the point of the knife should wound the iris immediately after it enters the anterior chamber, the surgeon, if dexterous, may, by a simple change in the inclination of the handle, free it, avoiding the slightest retraction, which would be followed immediately by the escape of the aqueous humour. But if the knife has already gone farther into the iris, and the aqueous escapes when it is disengaged, it is advisable to withdraw the knife altogether and delay the operation, being ready to begin again when the eye has once more regained a state of rest. When the iris has been punctured near the pupillary margin, it is better to continue the operation without any attempt to disengage the point of the knife. In this way the wounded portion of the iris will be removed, and we may expect to have a greater or less amount of irregularity in the form of the pupil.

The counter puncture may be irregular, it may have entered the cornea too soon, or the sclerotic too late. In the first case, if the position of the counter puncture be not too far from the conjunctival limb, we may, by turning the blade very slightly backwards, cause our incision to run in the limb; in the second case, we may attain our purpose by directing the edge of the knife slightly forwards. In cases where there is a premature escape of the aqueous humour, it sometimes happens that the iris comes in front of the cutting edge; if the counter puncture has already been made, we must stop for a moment and disengage the iris by pressing very gently on the cornea with the pulp of the index finger; then the corneal section must be finished rapidly.

More frequently we cannot avoid cutting a considerable piece of the iris. When on account of this excision there exists an opening in the iris, it should be made to communicate with the pupil, which can be done by dividing the bridge separating them before terminating the operation.

If we have to deal with a very nervous patient who contracts his eyelids firmly, or if we foresee from certain irregularities in the puncture or counter puncture that the flap would be too small, and

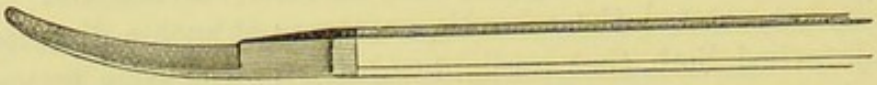


Fig. 104.

require ultimately to be enlarged, it is advisable to leave the flap attached, by preserving a narrow bridge at its summit (*Desmarres*). This bridge, as we shall again see, is cut after the second stage of the operation. By so doing, we are more likely to avoid prolapse of the iris and of the vitreous body; we may even, if the agitation of the patient demands it, continue the fixation of the eyeball till the incision is enlarged, and even till we have completed the second stage of the operation.

The irregularity of the incision may cause the flap to be too small; we may then enlarge the corneal incision either with a knife which has a slightly concave blade rounded at the point (Fig. 104), or with a pair of curved scissors (Fig. 105). As a rule, scissors are to be preferred, for with them the incision can be made more rapidly, and without that pressure on the eyeball, which is almost inevitable with the blunt-pointed knife.

2. **Second Stage: Opening of the Capsule.**—Having left the patient a few moments at rest, and having wiped the lids with a piece of clean linen, the surgeon directs his assistant to elevate the superior eyelid very carefully, whilst he himself draws down the inferior one, avoiding all pressure on the eyeball.

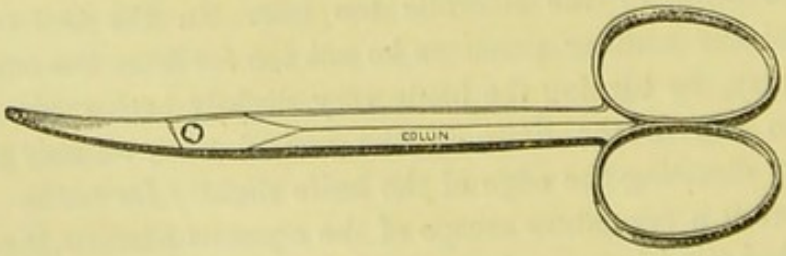


Fig. 105.

If the surgeon has not perfect confidence in his assistant, he should hold the superior lid himself. It should be held very lightly, and

let go at the first contraction of the orbicularis muscle which the patient makes. The operator introduces the cystitome under the flap, elevating it as little as possible, separating the lips of the wound by slight pressure with the neck of the cystitome. The instrument is introduced with its back forwards (see Fig. 106), and the small blade is kept flat against the cornea till the edge is fairly in the pupillary field. Taking great care not to touch the iris, the back of the instrument should be pushed till it comes into proximity with the superior margin of the pupil. On reaching this situation, the surgeon, by a slight rotatory movement of the instrument between his fingers, turns the edge towards the capsule, which he incises by drawing the instrument down till it nearly touches the inferior margin of the pupil.

The cystitome is held flat whilst being withdrawn, and the back of the instrument should be brought out of the wound first, without unnecessarily raising the flap.

As soon as the instrument is clear of the eye, the lids are allowed to close gently.

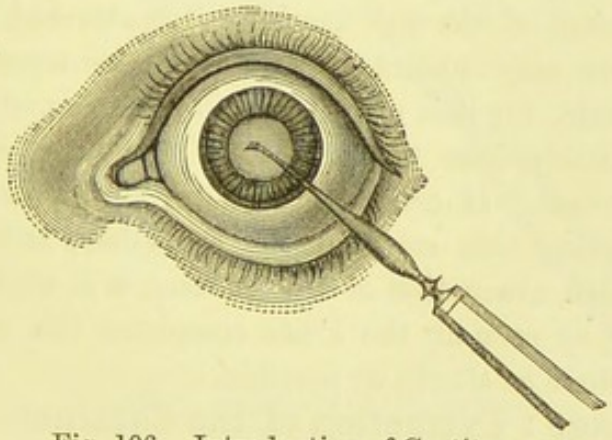


Fig. 106.—Introduction of Cystitome.

More than twenty years ago we saw *Iarjavay* practise the method of opening the capsule with the point of the cataract knife while crossing the anterior chamber in making the corneal flap. When the point arrived opposite the pupil he thrust it into the capsule, withdrew it, and continued the division of the cornea. We shall presently see how this idea has been revived in more recent times.

Accidents which may happen during the second stage.—It may happen that on lifting the eyelids to commence the second step in the operation we find a greater or less prolapse of the iris. Without giving heed to this for the moment, we follow exactly the prescribed rules for the introduction of the cystitome, and avoid hooking the iris. If it should get caught, we must try to disengage the instrument; but, if it has been at all dragged upon, we prefer to excise the wounded portion.

The incision of the capsule is sometimes a matter of difficulty, chiefly when the consistency of the membrane is increased, as is apt to happen, especially when the cataract has passed the period of maturity; it then becomes necessary to exercise slight pressure with the cutting edge of the cystitome on the capsule. This naturally requires great delicacy of manipulation, which practice alone can give, as there is a danger that the surgeon may rupture the hyaloid membrane and cause a prolapse of the vitreous. Moreover, this pressure must cease as soon as the small blade of the cystitome has entered the cataractous mass, and it is safer even to hold the instrument almost flat whilst continuing the incision of the capsule; if this precaution be neglected, we may have a dislocation of the lens. If we are not quite sure that the capsule is sufficiently divided, we must repeat the incision in the manner indicated, before withdrawing the cystitome from the eye. Complete opening of the capsule is generally indicated by a slight forward movement of the lens with a perceptible dilatation of the pupil and a slight rising of the flap, which may be taken advantage of in removing the instrument.

When the summit of the flap has been left attached by a bridge of corneal tissue, we may advantageously use Desmarres' cystitome in opening the capsule, for it is provided with a cutting edge, with which we may, immediately after the rupture of the capsule, complete the section of the cornea. If necessary, the fixation of the eye may then be continued during this stage of the operation; but if we wish to prevent the sudden evacuation of the cataract, it is well to remove the fixation forceps as soon as the knife completes the corneal section. This should be done as slowly as possible.

3. **Third Stage : Extraction of the Cataract.**—The surgeon, gently raising the superior lid with the thumb of his left hand, draws the inferior lid slightly downwards with the index and middle fingers of his right hand, and directs the patient to look up; these movements are often sufficient to cause the cataract to escape from the eye.

Fig. 107.—Cystitome of Desmarres.

Fig, 108.—Daviel's Curette.

When the spontaneous muscular contractions of the patient are not sufficient to start the lens, the surgeon can, with his fingers placed as

indicated, easily make slight pressure through the eyelids on the part corresponding to the superior margin of the lens, whilst he also makes slight counter pressure below on the sclerotic (Fig. 109). Such

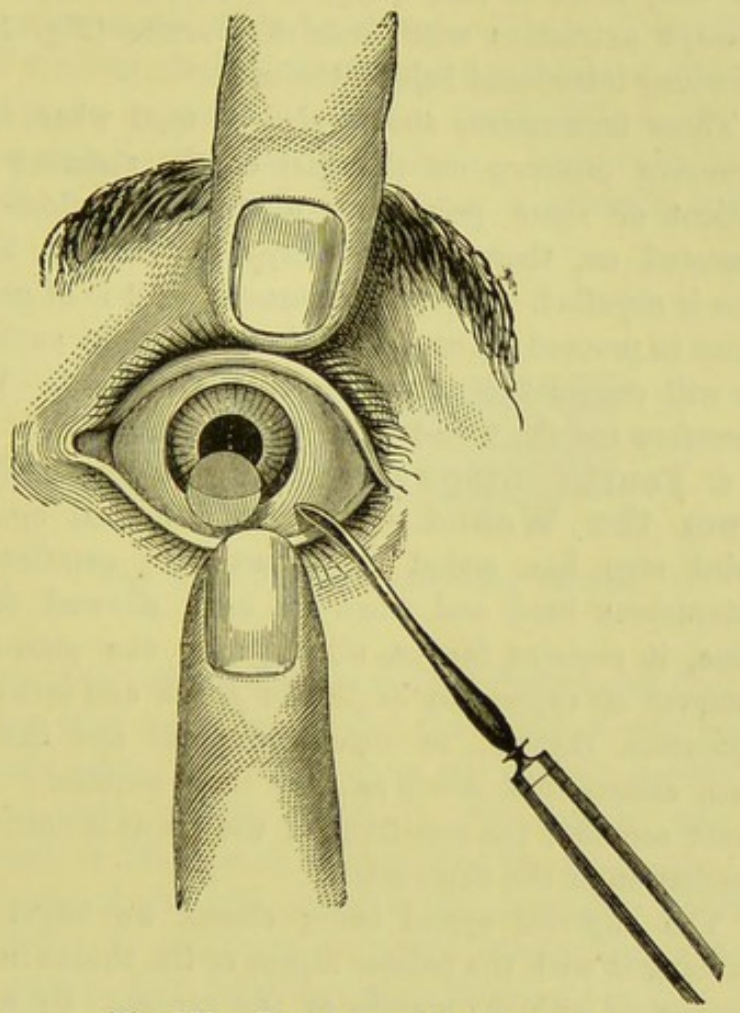


Fig. 109.—Expulsion of the Cataract.

pressure must be made very gently, and should continue, gradually increasing, till the greatest diameter of the lens crosses the pupil; it should then diminish, entirely ceasing when the inferior margin of the lens presents itself in the wound. If these manipulations are not successful in removing the cataract, we must seek for the source of failure, which may be an insufficient opening of the capsule, a contraction of the pupil, or some fault in the flap. In the first case, it is necessary to re-introduce the cystitome; in the second, whatever may be the origin of the pupillary contraction, we must abstain from any exaggerated pressure on the eyeball, as prolapse of the vitreous body is apt to occur. It is better at once to proceed to the excision of a portion of the iris, which, as a rule, makes the expulsion of the cataract very easy. Instead of iridectomy, *Coursserant Sr.*, more than twenty years ago, made an incision in the iris with scissors, from the ciliary border towards the pupil, as *Petit, Maunoir* and others had previously

advocated. *Chavernac* proposes a similar incision in the pupillary border, when the expulsion of the lens is impeded by the iris. If, notwithstanding the light pressure exercised on the eyeball through the lids, there is still delay, it then becomes necessary to attempt extraction with *Critchett's* curette (Fig. 110) or a wire-loop introduced behind the iris.

Fig. 110.

These instruments should also be used when, from some excessive pressure on the part of the assistant or of the patient or some peculiarity of the eye which is being operated on, there is an escape of vitreous before the lens is expelled. In such circumstances it is of great importance to proceed without loss of time, and in such a manner as will ensure the extraction of the cataract. We should therefore use the wire-loop or the curette.

4. **Fourth Stage: Clearing away of Debris from the Wound.**—When in a normal operation the third step has ended in a successful expulsion of the cataractous lens, and when we have allowed the lids to close, it remains for us, after giving the patient a short interval of repose, to begin the *fourth* and last step of the operation, that is, to clear the pupil and the wound of such cataractous *débris* as they may contain. Lastly, we must see that the condition of the pupil is normal, and the coaptation of the flap perfect.

The superior eyelid being closed, we begin by gently rubbing it with the palmar aspect of the thumb in a direction concentric with the margin of the cornea. By so doing, we collect the cortical masses retained behind the iris at the centre of the pupil. We then direct these masses towards the summit of the flap by lightly sliding the superior eyelid over the cornea from above downwards.

After the complete expulsion of the cortical masses, if we find that there are capsular opacities, we try to remove them by means of a small hook, or with curved forceps with fine teeth (Fig. 111), or with Graefe's capsular forceps (Fig. 112). The blades of the forceps are closed, and introduced along the posterior

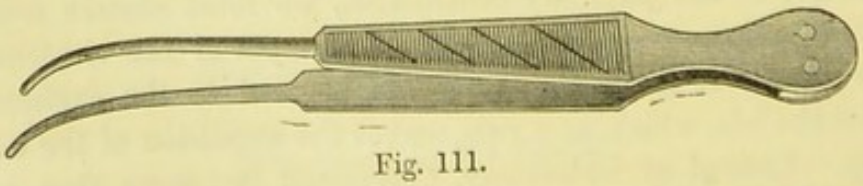


Fig. 111.

surface of the cornea so as not to wound the iris. The opaque portion is then taken hold of by the forceps without including the

hyaloid membrane. The extraction of the opaque capsule is often followed by a loss of vitreous.

The pupil, when it is properly cleared, is of a deep black.

Our attention should then be directed to the proper coaptation of the flap; if it be insufficient we must try to ascertain the cause, which may be either the presence of cortical matter between the lips of the wound, or a prolapse of the iris; or, again, a hernia of the vitreous.

To free the wound of cortical substance, it generally suffices to wait

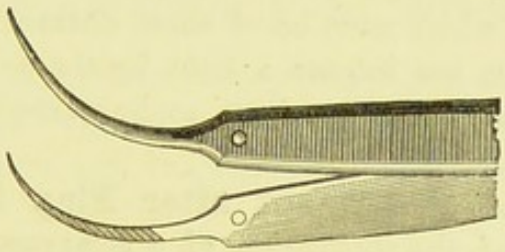


Fig. 112.—De Graefe's Capsular Forceps.

a little till the aqueous humour has again collected, and then to separate the lips of the wound slightly, so that the liquid current may wash out the cataractous *débris;* if not, we may use Daviel's curette (Fig. 108), or a tortoise-shell spatula, which is very gently slid along the sclerotic margin of the wound, beginning at the nasal side.

If a prolapse of the iris prevents the coaptation of the flap, we should endeavour to reduce it by gentle friction across the lid, or by means of a spatula, with which we push the iris back into the anterior chamber. When the pupil regains its usual form and position, a drop of eserine may be instilled. But, if the pupillary border be displaced in the direction of the wound, and especially if the prolapse be persistent, we must not hesitate to practise iridectomy.

The flap may again be raised by the vitreous body, which, enclosed in the hyaloid membrane, presents itself between the edges of the wound. It suffices, then, to open the membrane by a small cut with a pair of scissors; a few drops of vitreous escape, and the hernia of the hyaloid having disappeared, the coaptation of the lips of the wound becomes more perfect.

In cases where a badly-formed flap prevents the perfect coaptation of the margins of the wound, a pressure bandage may, as far as possible, serve to remedy the defect, and to diminish the chance of an unfavourable result from this state of matters.

Sometimes, after the extraction of the lens, the cornea seems to be sunk down, folded, or even deeply depressed. The reproduction of the aqueous may establish its normal curvature; but, in other cases,

this defect persists till a bandage is applied, which ought to be made more compressive than usual.

We merely mention—not having tried it ourselves or seen it put in practice by others—*Hasner's* proposal to puncture, in cases of corneal collapse, the vitreous body, the fluid from which then fills the anterior chamber, and may thus cause a more perfect coaptation of the flap.*

When the surgeon has found that the position of the flap is good, he may, to reassure the patient and raise his courage, make him count fingers or show him a few objects which are not too brilliant. During such examination, which must be of short duration, it is advisable to shield the eye from too intense a light by the hand used as a screen. At last the eye and the lids have to be washed carefully with the antiseptic solution.†

Dressing and Treatment after Flap Extraction.—The dressing consists of the application of a compressive bandage on the eye which has been operated on; the other is also closed, and the room somewhat darkened. Great care must be taken that the dressing fulfils the condition of steadying the globe as much as possible without annoying the patient. We may then leave it in position forty-eight hours undisturbed, which we consider a great advantage in the process of repair. The patient, attended to if possible by a thoroughly trained nurse, should be kept absolutely at rest for the first twenty-four hours, during which time he should get only such nourishment as does not require mastication. However, there are some patients who become restless in bed during the daytime, and who will sit quietly in an arm-chair. In such cases we do not hesitate to allow them to do so.

If there be any reason to fear sleeplessness, we administer a subcutaneous injection of morphia, or a dose of chloral hydrate.

The second day after the operation we change the bandage, and if we find everything going on well it may remain during the next forty-eight hours. On the fifth and sixth days we remove the bandage in the morning, at each dressing paying strict attention to cleanliness, and bathing the eye with a solution of sublimate if required. Even after

* *Henry Williams*, of Boston, has proposed the application of a suture on the summit of the flap through cornea and sclerotic, or, having formed a conjunctival flap, the attaching of it by a suture to the sclerotical conjunctiva. *London Ophthalm. Hosp. Reports*, 1867, vol. vi., pp. 28, 35; and Knapp's *Archiv*, 1869, I., i., p. 91.

Panas finishes the operation by injecting an antiseptic solution into the anterior chamber and the capsule. *Wicherkiewitch* and *M'Keown* recommend these injections also for the complete removal of cortical matter.

† *De Wecker* proposes to cover the wound with iodoform powder. *Galezowski* applies on the wound a gelatine disc, which contains sublimate and cocaine.

that interval, we still use the bandage at night, whilst a simple knitted bandage is used during the day. After eight days, if the progress of the recovery has been uninterrupted, the patient begins to wear a loose shade of black silk, then dark spectacles, with which he may be able to go out about the beginning of the third week, according to circumstances—especially according to the irritability of the eye to light.

(b.) Superior Keratotomy, or Superior Section.

In this method, the fixation forceps take hold of the conjunctiva at a point beneath the horizonal diameter of the cornea, the knife is held with its edge upwards, and the flap is made according to the principles already indicated.

The **second step** is much more difficult than with the inferior flap, because the natural disposition of the eye is to turn upwards. It is therefore better, especially if the operator is somewhat inexperienced, when this method is adopted, and when the patient is agitated, to pre-

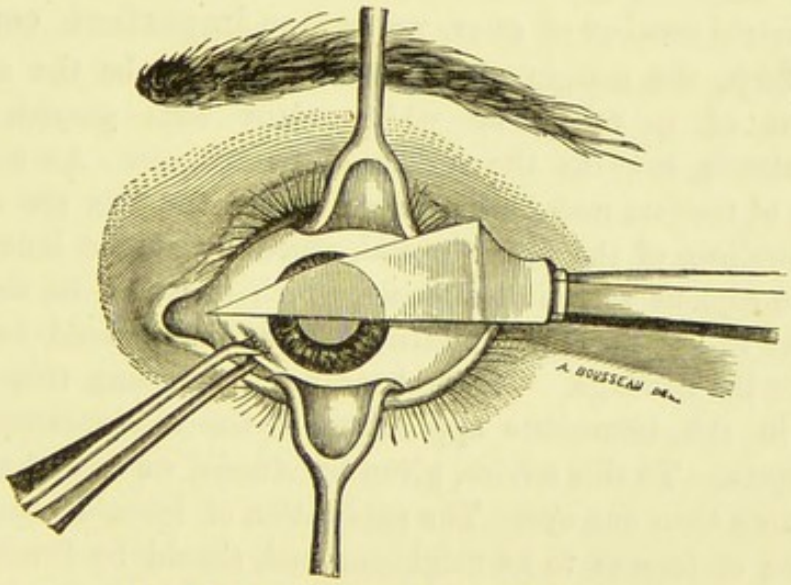


Fig. 113.—Superior Section, Left Eye.

serve a small bridge of corneal or conjunctival tissue at the summit of the flap (Fig. 113), so that the capsule may be divided whilst the eye is kept fixed.

In the **third step**, the hands are placed exactly in the same position as for extraction of the lens by inferior keratotomy; but the principal pressure should naturally be made on the inferior margin of the lens, with the index and middle fingers of the right hand.

All the other manipulations are the same as those which are made

in inferior keratotomy. It is easy to understand that the expulsion of the cortical masses becomes much more difficult, and iridectomy, in cases of prolapsed iris, almost impossible, if the patient cannot of his own accord turn his eye downwards.

Accidents which may happen after Extraction by Flap Operation.—The pain which the patient feels during the hours which immediately succeed the operation need cause us no alarm; in old persons this symptom seems to be even more favourable than complete insensibility of the organ which has undergone the operation. If the pain continues till the evening, and is likely to produce insomnia, we give a subcutaneous injection of morphia or a dose of chloral, as already indicated.

If the patient, the day after the operation, or at a later period, complain of pain in the eye, or in the forehead and head on the side of the eye, which has been operated on, it is necessary to seek for the cause of the pain by closely examining the organ. This examination is best made by the light of an ordinary candle, which may be very advantageously used for direct illumination, or the light may be concentrated with a convex glass on the separate points which we wish to inspect.

In a certain number of cases, we find an **imperfect coaptation of the flap**, the margin of which may already be the seat of an infiltration of a yellow or white colour with greyish striation, which extends towards the centre of the cornea. As a rule, this condition of matters may be diagnosed before the lids are opened by a slight swelling of the upper eyelid, especially at the inner canthus, by a more copious secretion of tears, which may also be detected by the greater or less degree of moistness of the linen placed next to the eye, under the bandage. The best means of arresting this exudation consists in the immediate application of the electro-cautery to the affected spots. To this advice, given by *Abadie*, we owe the preservation of more than one eye. The application of ice-cold compresses to the eye, or of leeches to its neighbourhood, should be firmly rejected, as being in reality dangerous. According to the effect produced we repeat the cauterisation, and apply the compressive bandage in the intervals. At each dressing, the conjunctival sac and the region of the wound are carefully cleansed with the sublimate solution. The pain is most effectively checked with subcutaneous injections of morphia.

In other cases, particularly when blennorrhœa of the lachrymal sac is present, and (more rarely observed) when the patient is in an advanced state of senile marasmus, we find, generally from twenty-four to forty-eight hours after the operation, that the superior eyelid is

swollen and shining; this is accompanied with a yellowish or dirty greyish nearly liquid discharge, traces of which are found on the linen of the bandage; the matter is also accumulated in the internal angle of the eye. On opening the lids, we notice that the same matter mixed with tears escapes; we find conjunctival chemosis and a general infiltration of the cornea, which is most pronounced in the flap, where by degrees it gives place to a profuse suppuration, which spreads over the entire cornea. We may be able to counteract this condition by cauterisations, and by active treatment with sublimate; but when this diffuse suppuration is thoroughly established, neither remedies nor bandages are of any further use. Hot fomentations and, at a later stage, cataplasms can alone help to ease the pain.

Apart from those misfortunes which may originate in the flap, there are other complications which begin in the **iris**. Ordinarily they do not appear till a few days after the operation, except in cases where they are due to cortical masses retained in the eye. The patients complain of severe periorbital pain in the early stages of the disease; there is lachrymation, with deep injection and sometimes slight serous chemosis. The aqueous humour is muddy and the pupil begins to contract. In such circumstances we attach the greatest importance to the instillation of duboisine; we use a very strong solution, instilling one drop every five minutes for half an hour; we repeat these instillations several times a day. Subcutaneous injections of morphia check the pain and procure the sleep which is so beneficial in such affections. At the same time, we order mercurial frictions, with fractional doses of calomel internally. The application of leeches before or behind the ear on the same side as the operated eye has also a good effect, when we are not dealing with a too enfeebled constitution.

When the iritis supervenes at the time of cicatrisation, and seems to be caused by a prolapse of the iris, we may act according to circumstances. If there is only a slight displacement of the pupillary border, indicating that the iris has been drawn into the corneal wound, we persist in the application of a compressive bandage, which is undoubtedly the best means of promoting the formation of the cicatrix. In case of an actual prolapse it becomes necessary to excise it, in order to clear the wound and avoid, at the same time, these changes in the curvature of the cornea which almost always result from the enclosure of a portion of the iris in the wound. Cauterisation of the iritic hernia is not advantageous under these conditions.

The general regimen, as also the general treatment of such accidents, must depend in all cases on the constitution of the patients, on their age, and on their temperament. To full-blooded persons we give mild

laxatives and non-stimulating drinks; for old and weak patients we order nourishing food, wine, quinine, &c.

2. Flap Extraction Combined with Iridectomy.

At first iridectomy was only performed on account of synechia, or when the iris was perceptibly contused or even pushed between the edges of the wound (*von Graefe*). Later, this combination of iridectomy with flap extraction came to be preferred in every case where there was occasion to use very special precautions (*Mooren*); for example, when a person had already lost one eye in consequence of iritis after a cataract operation, or when, after the instillation of atropine, the slow or imperfect dilatation of the pupil showed, previous to the operation, a marked predisposition of the iris to inflammation. Afterwards, it was proposed always to perform iridectomy in conjunction with flap extraction, it being thought that the greater number of good results should outweigh the inconvenience arising from the deformity in the pupil (*Jacobson*).

Iridectomy was combined with flap extraction in two different ways: sometimes the iridectomy was performed several weeks (fifteen days to six weeks) before the extraction of the cataract (*Mooren*); sometimes both operations were performed at the same time (*Jacobson*).

Jacobson, who practised as a general method flap extraction combined with iridectomy, made the flap entirely in the conjunctival limb at the inferior aspect of the cornea. To him belongs the merit of having, by his method, directed the attention of surgeons to the great advantages, as concerns the recovery of the eye, to be derived from a peripheral section, advantages which are probably due to several causes. These causes are—1st, the highly vascular nature of the conjunctival limb, which also explains the well-known fact that lesions and ulcerations of the cornea heal the more readily the nearer they are to the corneal margin; 2nd, the possibility of excising the iris to its ciliary insertion when the section is peripheral—by so doing, we prevent the cortical masses from lodging behind the iris and becoming a source of irritation; 3rd, having made the iridectomy, the possibility of opening the capsule with the cystitome in the neighbourhood of the lens margin—this condition especially affords an explanation of the complete expulsion of the cortical substance; 4th, the more easy expulsion of the cataract, the border of which is found in the immediate neighbourhood of the wound, and moves in its normal position, without any rotation round its axis.

On the other hand, the peripheral flap predisposes much more than does the classical flap to prolapse of the vitreous, and this circumstance

compelled *Jacobson* habitually to use complete general anæsthesia during the operation.

We must admit that the statistics published by the author of this method undoubtedly contained a greater number of favourable results than had hitherto been obtained by flap extraction; but it must also be added, that the notable enlargement of the pupil, caused by the inferior iridectomy, exercises a most prejudicial influence on the toleration of variations in the illumination. It produces also a most uncomfortable dazzling, and increases the patient's difficulty in guiding himself, rendering it more difficult to distinguish objects at different distances without change of glasses.*

As regards the execution of flap extraction combined with iridectomy, it only differs from the classical operation by the introduction, between the first and second steps, of the excision of a portion of the iris. If we prefer to maintain the fixation of the eye during the iridectomy, it is necessary to leave a bridge of corneal tissue at the summit of the flap.

The blood which sometimes escapes after the iridectomy, and which may conceal the pupil, is easily evacuated by pressing the superior eyelid very gently on the eye. If, notwithstanding these manipulations, some blood remain in the anterior chamber, we must open the capsule according to the ordinary method, and, as soon as the cortical mass enters the capsular opening, we will find the blood retract to the periphery of the anterior chamber. The dressing, as also the after treatment, does not differ from that prescribed after the classical extraction.

3. Cataract Extraction by Linear Incision.

General Considerations.—The dangers of flap extraction, which arise from an incision involving almost the half of the circumference of the cornea, and from defective coaptation of the flap, naturally led to the idea of restricting as much as possible the section destined to give passage to the cataract. On the other hand, it could not be overlooked that the expulsion of the lens through a wound too small to allow it to pass easily, must cause contusion of the margins of the wound and straining of its angles. Daily experience, indeed, warns us that we must carefully avoid a tedious extraction, if we do not wish to run serious risks.

Consequently, the extent of the incision should be in direct propor-

* For these reasons, the author of the method has abandoned it in favour of *von Graefe's* operation, declaring (*Arch. f. Ophth.*, 1868, xvi. 2, p. 269) that the latter includes all the progress attained at that epoch, and stating the causes to which it owes its superiority. These we will explain in treating of this operation.

tion to the consistence and size of the cataract. It is one of the greatest merits of *von Graefe* to have established linear extraction on its true basis, and to have restricted its use to certain well-defined groups of cataract cases.

(a.) Simple Linear Extraction.

Indications.—This method is suitable for entirely soft or liquid cataracts, which may have developed spontaneously, or may be the result of an injury of the lens in a young person.

This variety of cataract is almost exclusively observed in children and in young adults up to the age of twenty or twenty-five. At a more advanced age it is sometimes developed as a consequence of deep-seated disease of the eye, and requires a careful examination of the functional state before decision as to the operation. If such examination reveals the absence of the visual faculty, the operation for cataract can have no other end than to give the pupil its normal black reflexion.

The extraction of a capsular opacity through a linear incision in the cornea is only advisable in cases where there is no direct continuity between the capsular fragments and the margin of the pupil; even then the surgeon must use every precaution, and relinquish the attempt if slight traction does not draw out the opacity. Prolonged traction on the iris or on the ciliary processes frequently becomes the source of iritis or irido-cylitis, which may end in the loss of the eye. We shall indicate in a future chapter the method which is suitable for such cases. (See Chap. on Discission.)

Description of the Operation.—The instruments necessary for the operation are—1st, a spring speculum for the lids (Fig. 59); 2nd, fixation forceps (Fig. 60); 3rd, a triangular keratome (Fig. 61); 4th, von Graefe's cystitome (Fig. 98); 5th, a large curette (Fig. 114).

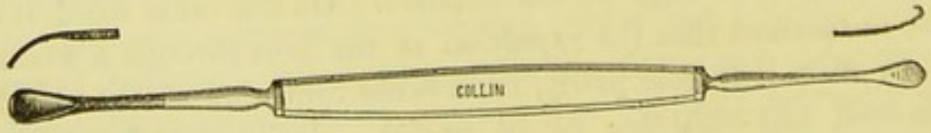


Fig. 114.

Fig. 115.—Probe Pointed Knife.

There may also be at hand a probe pointed knife (Fig. 115) to enlarge the wound if necessary, and iris forceps and curved scissors, in case it is required to excise a prolapsed iris.

First Step: Section of the Cornea.—The patient being placed on a couch in the ordinary manner, and the speculum introduced under the eyelids, without separating them to a needless extent, the surgeon takes hold of a fold of the conjunctiva, near the internal margin of the cornea, and at the nasal extremity of its horizontal diameter (Fig. 116); he then proceeds to make his incision in the following manner:—The triangular keratome being directed towards the fixation forceps, the surgeon rests the point of the instrument, held flatly, on the point of the cornea which is situated in the horizontal diameter at 2 millimetres from the scleral ring. Having made a slight depression at this point, he penetrates the anterior chamber, and pushes the point of the instrument, parallel with the plane of the iris, right on towards the fixation forceps (Fig. 116), till the wound is about 6 or 7 millimetres in length.

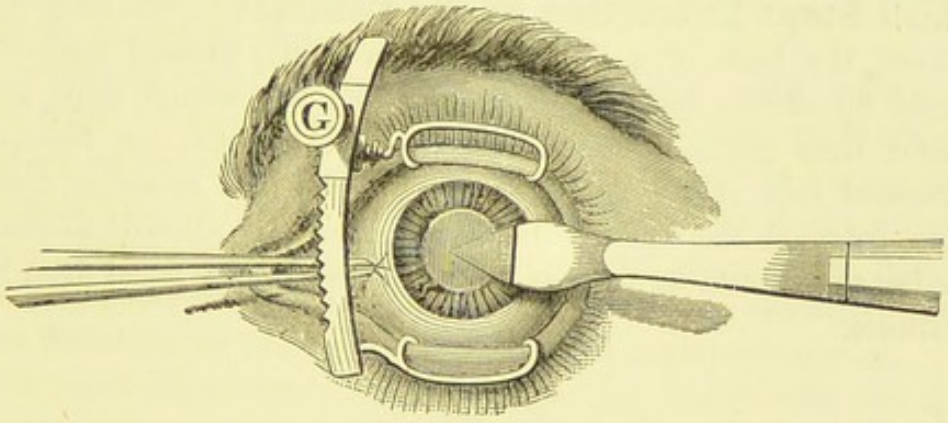


Fig. 116.—Linear Incision.

Then, lowering the handle of the instrument towards the patient's temple, so that the point is brought nearer to the posterior surface of the cornea whilst the aqueous humour is escaping, he withdraws the instrument gently, at the same time enlarging the internal wound. This enlargement of the internal wound, which is of importance for the regularity of the opening, is easily managed by holding the handle of the instrument towards the patient's cheek when we wish to enlarge the superior angle of the wound, or towards the forehead when we wish to enlarge the wound at its inferior angle.

Second Step: Rupture (Discission) of the Capsule.—Without removing the fixation forceps, the cystitome is now taken, and its small blade is held flat against the external lip of the wound, which is gently depressed, and the instrument is introduced, with the back of the blade forwards, into the anterior chamber along the posterior

surface of the cornea (Fig. 117). On reaching the internal pupillary margin, the edge of the cystitome is turned towards the capsule, which is ruptured by withdrawing the instrument till its point is only a short

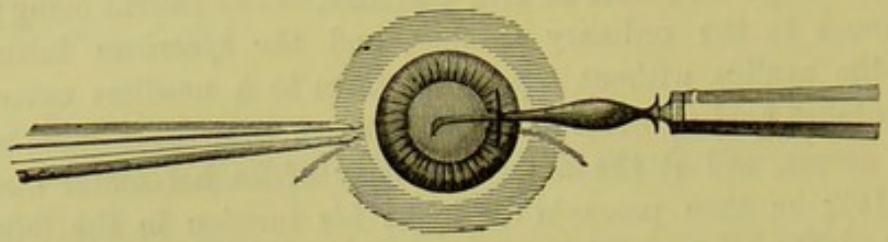


Fig. 117.

distance from the external margin of the pupil. If a sufficiently large opening in the capsule has thus been obtained, the blade of the instrument is again held horizontally, the back being now turned towards the wound, and, holding it against the posterior surface of the cornea, it is removed from the anterior chamber, so that the point of the cystitome leaves the wound last.

Third Step: Extraction of the Cataract.—Still keeping the eye fixed, the back of a large curette is gently pressed against the external lip of the incision, so as to make the wound gape, and at the same time gentle pressure is made with the fixation forceps on the internal side of the ball (Fig. 118). The lens emulsion speedily escapes between the lips of the wound, which is allowed to close by removing the curette as soon as the pupil regains its usual deep black appearance.

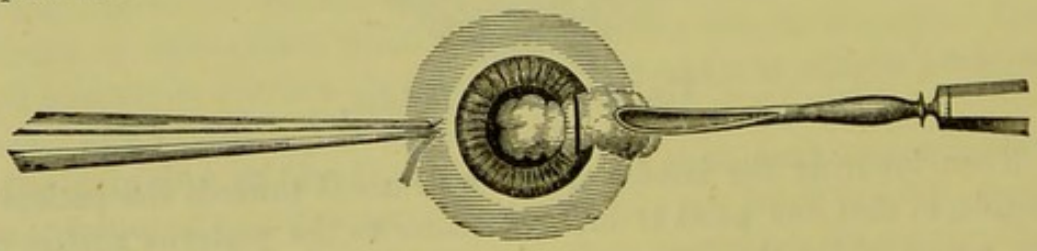


Fig. 118.

All that is then required is to remove the fixation forceps and the lid speculum. When all the cataract does not come completely out, we allow the lids to close, and, while lightly rubbing the superior lid over the periphery of the cornea, so as to bring the lens fragments into the pupil, we wait patiently till a portion of the aqueous is re-secreted. The *débris* is then generally washed out by the aqueous humour which escapes through the wound. These manipulations may be repeated several times at short intervals, and they are much to be preferred to the introduction of a curette into the anterior chamber. Moreover, the retention of a small portion of a soft cataract in the anterior

chamber does not materially influence the result of the operation, for such fragments are speedily absorbed in young persons. Nevertheless, for reasons indicated in speaking of flap extraction, we prefer to evacuate the lens masses as completely as possible by exercising a little patience; and, by repeating the prescribed manipulations several times, we almost always obtain the desired result.

Having thus finished the operation, we hold a moist sponge for a few seconds on the closed lids, and then apply a pressure bandage, as after flap extraction.

The **secondary treatment** is of the most simple description. During the first two days we leave the bandage in position, and then change it every morning, instilling a drop of atropine at each dressing. After the lapse of a few days, while continuing the instillation of atropine, we replace the compress and bandage by a black silk bandage worn loosely before the eye, and very gradually accustom the patient to day light. We may allow him to go out as soon as all traces of irritation have disappeared from the operated eye, generally in about a week from the operation, making him still wear, however, shell-shaped spectacles of smoked glass.

Accidents which may occur during and after the operation.—When there is a prolapse of the iris, we attempt its reduction by lightly rubbing the superior lid over the cornea, or by pushing it back by means of a spatula. Nevertheless, if the reduction is not easily made, or if it will not remain in place, rather than run the risk of occasioning a serious complication in an operation usually almost harmless, we unhesitatingly excise the prolapsed portion.

This small iridectomy does not considerably increase the size of the pupil, for it can only remove the pupillary margin of the iris to the level of the internal lip of the wound.

Prolapse of the vitreous is an accident of great rarity; it may be caused by the cystitome, when it penetrates directly through a thin cataract into the vitreous body, or by misdirected pressure on the eyeball. Should this accident occur before the expulsion of the cataract, we must at once extract the lens by introducing a curette into the eye. Apart from the prolapse causing the expulsion to be more difficult, and, as a rule, less complete, there is the danger of a portion of the vitreous being caught in the wound. In that case, we apply a tight-fitting compress and bandage for several days. Notwithstanding this precaution, we sometimes find an irritation of the lips of the wound, and the formation of a cicatrix much more apparent than the almost imperceptible whitish line which ordinarily indicates the situation of the linear incision in the cornea.

If the surgeon has made an error in his diagnosis as to the con-

sistency of the cataract, and if he recognises, after making his incision, the presence of a nucleus of some size, he must enlarge the wound with a blunt-pointed knife and extract the nucleus by means of a curette or Weber's hook.

When, after the expulsion of the cataract, there remain capsular opacities in the pupillary field, they may be easily removed by introducing through the corneal wound a pair of forceps or a small hook.

If we are dealing with a non-adherent shrunken capsular cataract, after the corneal incision we introduce into the anterior chamber a pair of capsular forceps or a sharp hook, with which we take hold of the cataract and draw it out. Even when this form of cataract is in part adherent (at most for a third of its pupillary margin), we can make the corneal section just above the adherent portion, take hold of the cataract with a sharp hook near the opposite pupillary margin, extract it and cut off the portion of iris drawn out quite close to the opening in the cornea.

We rarely have occasion to see after a normal operation any serious accident during the period of convalescence. When there is secondary iritis, we should follow the same course as when it occurs after the flap operation.

Extraction by Suction.—We should mention here the extraction of cataract by suction, the best instrument for which is Bowman's suction needle. In order to introduce this needle, a small linear incision in the cornea, and the opening of the capsule, are required. As this operation can only be applied to soft or nearly liquid cataracts, which may be easily extracted by the usual linear method, the use of the suction needle seems to be superfluous.

(b.) Linear Extraction Combined with Iridectomy.

General Considerations.—The easy and rapid recovery after linear sections of the cornea, compared with the dangers to which the eye was exposed from the flap opening, naturally led to a desire of being able to use the linear method in such varieties of cataract as were reserved for flap extraction. The first attempts made for the purpose of extending linear extraction to hard cataracts with a large consistent nucleus, very soon showed the dangers which were run in forcing the cataract out by a passage which is too narrow for it.

It was found that the violent contusion of the iris and of the margins of the wound, which results from the disproportion between the size and consistence of the cataract and the dimensions of the wound, seriously compromised the recovery; and the results of the

method were such that linear extraction was restricted by all judicious and conscientious observers to soft cataracts.

The attention of those who continued to study the question was naturally brought to bear on the possibility of enlarging the passage, and of helping the expulsion of a cataract with a nucleus, either by previous trituration (*Desmarres*), or by using traction instruments. With this object in view, the extent of the linear incision was first increased till it embraced a quarter of the corneal circumference; the principle of a linear wound being thus, to some extent, abandoned, whilst the incision retained the form of a slit, whose margins tended to close accurately as soon as the lens had passed. To this enlargement of the corneal wound situated near the sclerotic margin, there was added the excision of a portion of the iris (*von Graefe*), in order to protect that membrane from the dangers of contusion, and to increase the size of the pupillary opening, which by its contraction might readily prevent the application of a suitable curette (larger, flatter, and provided with a sharper edge than Daviel's curette) which is used to draw out the cataract. Yet *von Graefe*, who was the first to propose linear extraction combined with iridectomy and the use of the curette (see *Archiv für Ophthal.*, 1859, v. i., p. 158), only wished to use it in certain varieties of cataract, where the nucleus is of medium size and the cortical substance soft and abundant. He proposed to substitute this method for flap extraction, especially where the latter, from conditions of the general health, seemed dangerous, as when there was senile marasmus, chronic catarrh of the bronchi, asthma, or some other affection which would prevent the patient from being confined to bed for any length of time. He also recommended this method for soft adherent cataracts, and for such as contain a foreign body. *Waldau* attempted to generalise the method by comprising as suitable cases senile cataracts. He had a traction instrument made, which resembled a large curette with edges. This, being introduced behind the nucleus, in reality forced a passage for the hardest cataracts through a linear incision at the external margin of the cornea. Still, the results obtained by this proceeding as a general method were not sufficiently fortunate to allow him to abandon advantageously the classical method of flap extraction.

Linear extraction combined with iridectomy and extraction of the cataract with a curette, underwent important modifications in *Critchett's* hands. He increased the dimensions of the incision (to one-third of the corneal circumference), and made it at the superior aspect (see Fig. 119), so that the deformity of the pupil from the iridectomy might be hidden by the superior eyelid. This method, it is true, greatly reduced the inconvenience of the enlarged pupil. Moreover,

he replaced Waldau's curette by another, which was much thinner, was perfectly flat, and had a margin only at its extremity. But notwithstanding these important modifications which distinguish the English method (spoon extraction) from that of *Waldau*, it could not pretend to replace in a general manner flap extraction. It is true that in the English method the after-treatment is much shorter and more simple, and the number of completely successful operations was almost the same as with flap extraction; but the number of imperfect recoveries was much greater.

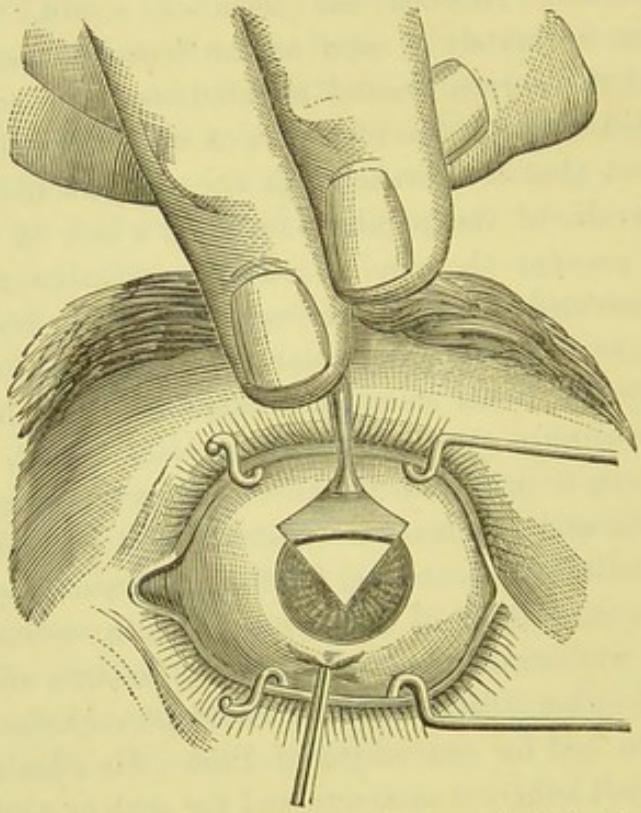


Fig. 119.—*Critchett's* Linear Incision at the Superior Margin of the Cornea.

Consequently, linear extraction combined with iridectomy at that period could be considered only as an exceptional method, applicable to certain forms of cataract. There was thus no reason for abandoning the classical method, in vogue for such a number of years and on such a large scale, for this new method, which, moreover, demanded that the surgeon should familiarise himself with manipulations to which he was not accustomed, and be provided against unforseen dangers.

Such was the state of the question when *von Graefe* was led, by continual study and close investigation, to propose a new method, which, realising more perfectly the advantages of the linear extraction, and the easy expulsion of the cataract, was immediately put into practice on a large scale by the author himself, as also by other surgeons, so that, in a relatively short time, this new method gained the favour of all those who were able to assure themselves of the

great advantages to be reaped by the fortunate combination suggested by the Berlin professor.

We may enumerate the advantages of this method under the following heads :—

1. The situation and form of the wound. The incision is as nearly linear as the necessary extent of the wound permits; it is made in the scleral limb, and is situated at the spot to which the lens will come as soon as the aqueous humour escapes. The cataract, after the excision of the iris, will come out directly, without the rotation forwards which is necessary when the wound is situated in the cornea itself. This peripheral situation, besides, gives to the operation a less dangerous character; for the observation of injuries and of operations had proved that wounds at the corneo-sclerotic margin are in a more favourable condition for cicatrisation, and present fewer dangers during the period of recovery, than those made in the cornea itself.

2. The excision of the iris, after the peripheral section of the cornea, allows the capsule to be opened at the equator of the cataract, thus affording an easier expulsion of the lens, and a more complete removal of the cortical substance, which separates from the nucleus as it passes through the corneal wound. In fact, this lenticular *débris* remaining in the eye is usually hidden behind the iris.

3. The cataract readily slips through this incision without the introduction of a traction instrument. This advantage removes the drawback which was justly attributed to curette extraction—viz., the necessity of introducing a curette into the eyeball and the risk occasioned thereby.

4. The wound may be covered with a conjunctival flap, which circumstance, in the opinion of *von Graefe* and of other observers (*e.g., Arlt*), promotes the rapidity of the cure, if it has not a considerable influence in the ultimate result of the operation.

Again, the form of the wound allows, without the slightest danger, all those manipulations which are of use in expelling as completely as possible the cortical substance.

These advantages, and what is of more value than all theoretical considerations, the statistics of the results, incontestibly showed the superiority of *von Graefe's* method over all others. We shall, therefore, give a description of his method in all its details.

(c.) Peripheral Linear Extraction (von Graefe's Method).

Indications.—Linear extraction combined with iridectomy was already used in cases of cataract where the nucleus was relatively

small and the thick cortical masses soft. *Von Graefe's* method, which gave an easy exit even to the largest and hardest cataracts without the introduction of a traction instrument, has extended the primitive use of the linear method to all senile cataracts. It may, therefore, be adopted instead of the classic flap extraction.

Description of von Graefe's Operation.—We will not repeat here the necessity of cleanliness and antiseptic precautions indicated in a preceding chapter. In *von Graefe's* operation, atropine is not instilled into the eye, for, as we have seen, the margins of the coloboma re-enter the anterior chamber much more easily after the iridectomy, when it is not used. We thus always avoid all difficulty with the iris.

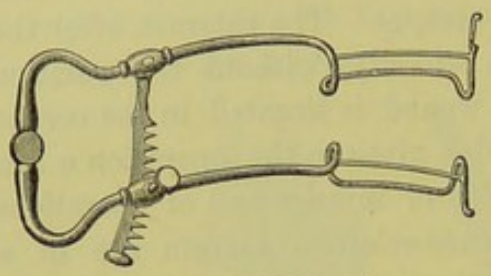


Fig. 120.—Lid Speculum.

The **instruments** necessary for the operation are:—A lid speculum without a spring, which opens and closes with a screw (Fig. 120); Waldau's fixation forceps, with a catch (Fig. 121); a von Graefe's

Fig. 121.

Fig. 122.

Fig. 123.

Fig. 124.

knife (Fig. 122); iris forceps, straight or curved (Figs. 123, 124)

a pair of bent scissors (Fig. 125), or Wecker's scissors forceps; a curved cystitome (Fig. 126); a caoutchouc curette (*von Graefe*) (Fig. 127), and a tortoise-shell spatula.

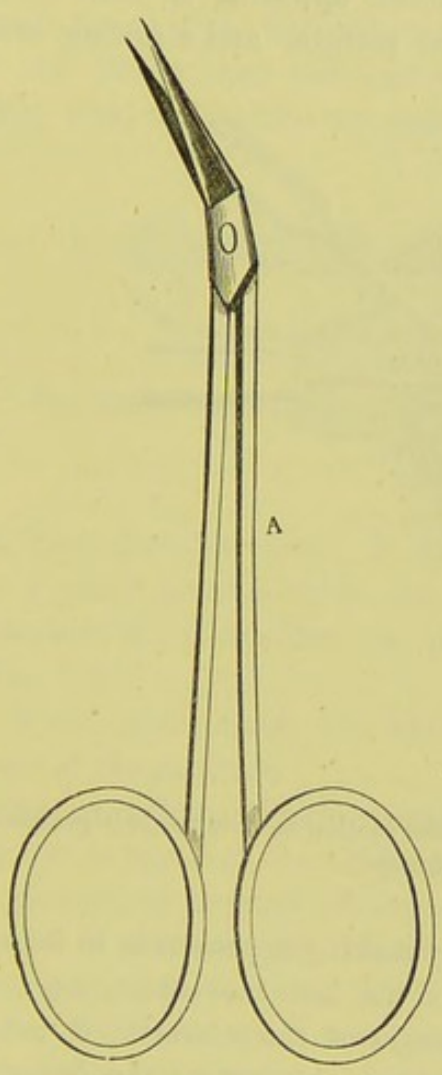


Fig. 125.

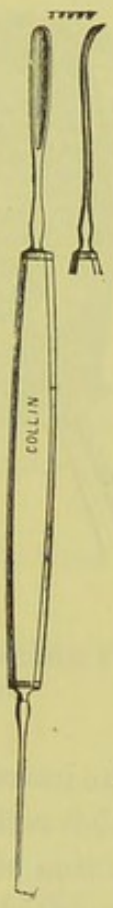


Fig. 126.

Fig. 127.

First Step: Peripheral Section.—Having inserted the speculum under the eyelids, the surgeon steadies the eyeball, and draws it gently downwards by taking hold with the fixation forceps of a fold of the conjunctiva immediately beneath the inferior border of the cornea. Holding the knife with the edge upwards, he punctures the sclerotic at a point situated about 1 millimetre from the corneal margin, and 2 millimetres below the tangent to its summit. The point of the knife, on entering the anterior chamber, is at first directed towards the centre of the cornea, till the instrument has advanced 7 or 8 millimetres; then, lowering the handle of the instrument, the point is raised so as to be brought under the sclerotic margin near the point of counter-puncture (Fig. 128).

This point should be symmetrical to the point of puncture, that is

to say, at the same distance from the margin and from the tangent the summit of the cornea: we know that the counter-puncture is made when the point of the knife no longer finds any resistance. The edge, which till now has been directed upwards, is then turned obliquely forwards towards the corneal margin, and a sawing move-

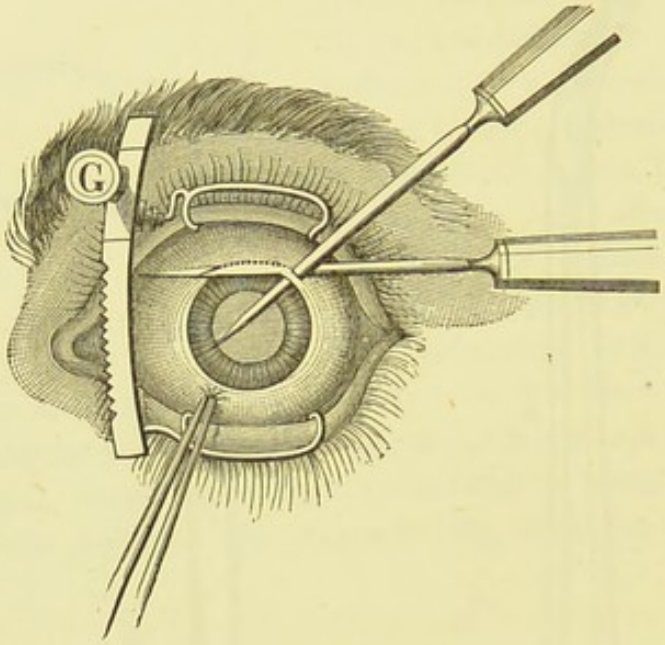


Fig. 128.—*Von Graefe's* linear section; the section as now made is generally 1 millimetre lower.

ment is imparted to the instrument by making it penetrate to its entire extent and then withdrawing it. This last movement, as a rule, suffices to effect the section of the margin of the sclerotic; if not, the sawing movement is repeated till the knife, having cut the last strand of sclerotic tissue, is free and mobile beneath the conjunctiva (dotted line, Fig. 128). To cut the conjunctival tissue, the edge of the knife is directed forwards, or even a little upwards if a conjunctival flap is wanted.

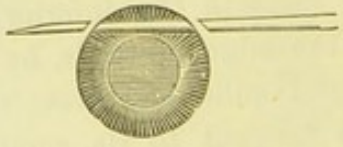


Fig. 129.—Puncture and counter-puncture.

Many surgeons, and we among their number, do not like the conjunctival flap, and never make the incision in the sclerotic. We are in the habit of making our incision in the corneal margin, at the junction of that membrane with the sclerotic, and the puncture and counter-

puncture are made 3 millimetres below the tangent to the summit of the cornea (Fig. 129). By so doing we best avoid hæmorrhage into the anterior chamber, and prolapse of the vitreous, two accidents which may be due respectively to a conjunctival flap and to a section made too much in the periphery.

Ad. Weber has constructed a special form of triangular knife (Fig. 130) with which we obtain a linear incision similar to that which

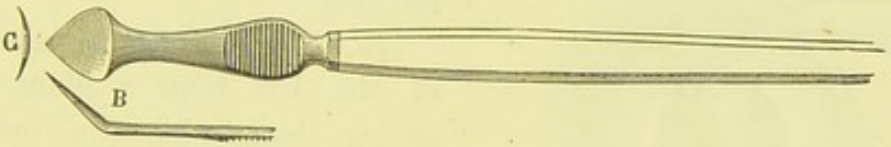


Fig. 130.—Weber's triangular knife—B, degree of curvature ; C, concavity of the blade.

we have just described. It is introduced at the base of the cornea, in a plane parallel with the base, and is advanced in the anterior chamber till it reaches the point opposite to the point of puncture (Fig. 131).

Weber recommends the knife in two sizes according to the dimensions of the cataract.

Second Step: Iridectomy.—Having intrusted the fixation forceps to an assistant, the conjunctival flap, if present, is everted on the cornea by means of the straight iris forceps; the prolapsed iris is thus left completely bare. With the same forceps the iris is taken hold of towards the external part of the wound and gently drawn out; it generally shows itself in the form of a triangle, which is incised at the very angle of the wound itself (Fig. 132). Then by a second snip of the scissors the iris is cut at the centre, and by a third at the internal angle of the wound. In doing this, care must be taken not to draw the iris into the angles of the wound, lest it should remain caught. To make the matter perfectly certain, we must watch, after the iridectomy, if the sphincter of the iris enters the anterior chamber, and promote its return by gentle pressure with the spatula on the angles of the wound. We have seen already that this

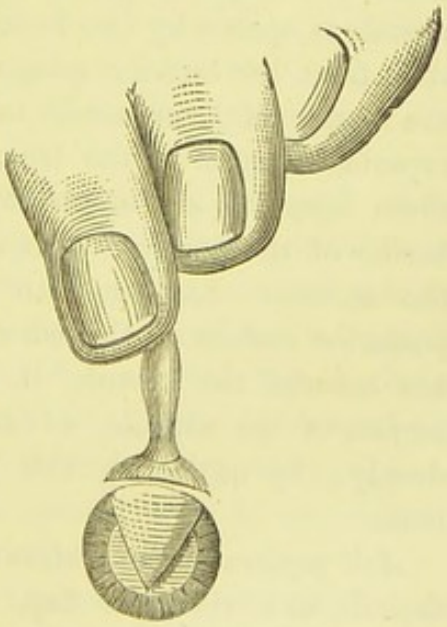


Fig. 131.

result is most easily obtained when atropine has not been instilled into the eye before the operation.

If we wish to make a small iridectomy, or a simple incision of the sphincter, we return the iris to the anterior chamber; because we can then seize as small a portion as we wish, and at the desired spot, which is impossible if the prolapse remains.

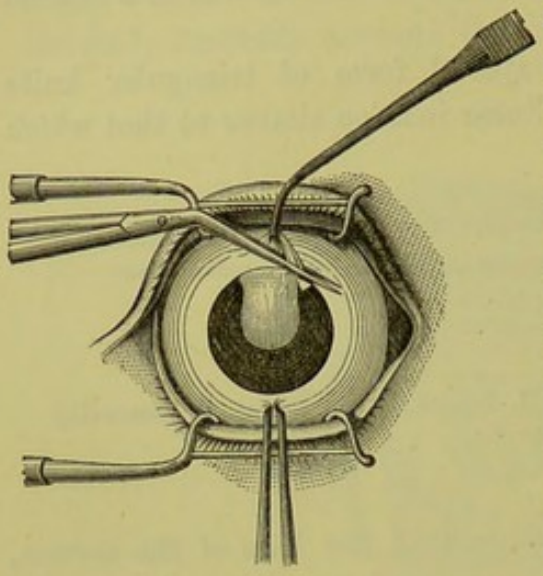


Fig. 132.

Ad. Weber prefers to take hold of the iris with a blunt hook rather than with the ordinary forceps, and we are of the same opinion.

Third Step: Opening of the Capsule.—After the iridectomy, and till the operation is finished, it is well to follow the advice of *Horner*, who causes the speculum to be gently removed by an assistant thoroughly accustomed to do so, and thus all pressure which that instrument may exercise on the eyeball is avoided. We prefer to have the lids separated by the fingers of an assistant, thus doing away with the speculum. The fixation forceps being taken from the hands of the assistant, the capsule is opened by two incisions of the bent cystitome, both of which start from the inferior margin of the pupil, and go, the one towards the nasal side, the other towards the temporal, till they reach the superior margin of the lens. Generally the superior extremities of these incisions are united by a third made parallel to the superior border of the cornea. It is important to introduce the cystitome into the anterior chamber with great care, guiding it flatly along the posterior surface of the cornea. When the point of the instrument has entered the capsule, it is well to hold it almost parallel to the surface of the capsule, so that it does not penetrate the cataract too deeply; by neglecting this precaution we may easily dislocate the lens.

Arlt prefers to the cystitome a sharp hook, with which he opens the capsule in a triangular flap, and *Becker* uses a cystitome curved back so as to form a sharp hook, which we believe is much superior to the ordinary cystitome.

To obtain a still more complete opening in the capsule, *Ad. Weber* uses a double hook, the fine teeth of which are placed one beneath the other (Fig. 133). He moves it in the capsule from one

side of the pupil to the other, and from the two angles of the capsular wound towards the incision in the cornea. He then cuts off a capsular flap which may remain attached to the hook. We have constructed a cystitome (Fig. 134) which is introduced in the ordinary

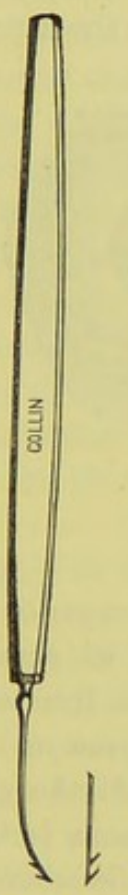


Fig. 133.
Weber's double hook.

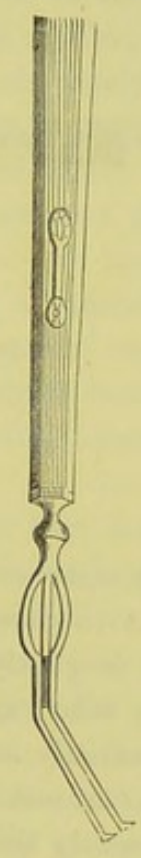


Fig. 134.
Meyer's double cystitome.

way into the anterior chamber; on arriving at the inferior margin of the pupil, by our pressing on a button the cystitome becomes double, and, on drawing it back towards the corneal margin, a large central opening is made in the capsule. Before withdrawing it from the wound we close it, and thus drag out the capsular flap. This flap is absent only when, from fear of penetrating the cataract, the instrument has been inclined too much. In this case it often happens that only one point enters the capsule, which is then opened as if by an ordinary cystitome.

De Wecker has constructed a similar cystitome in the form of forceps.

Gayet has proposed to open the capsule of the lens near its superior border. For this purpose he makes slight pressure on the eyeball, so as to bring the margin of the lens into the corneal wound, and opens the equator of the cataract with the linear knife. *Knapp* also adopts the same method.

Fourth Step: Extraction of the Cataract. —The removal of the lens is effected in the following manner:—

A large curette is taken, and the back of the instrument is lightly laid against the sclerotic, close to the centre of the wound, so as to make it gape. At the same time, with the fixation forceps, the ball is gently drawn downwards (Fig. 135). During this movement,

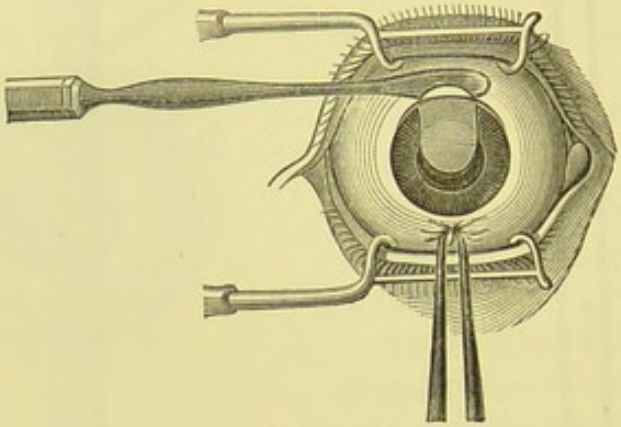


Fig. 135.

the cortical masses come forward, and the superior margin of the nucleus begins to present itself. To hasten its expulsion, the back of the curette is gently slid along the sclerotic from one angle of the wound to the other, and *vice versâ* (gliding movement). The pressure should be gradually and carefully increased till the greatest diameter of the nucleus crosses the wound. The pressure is then diminished, and simultaneously the curette is slid along the sclerotic to a greater distance from the wound; it is moved from below upwards, in a line corresponding to the middle of the incision. Just as the inferior margin of the nucleus leaves the wound, it is well, in order to

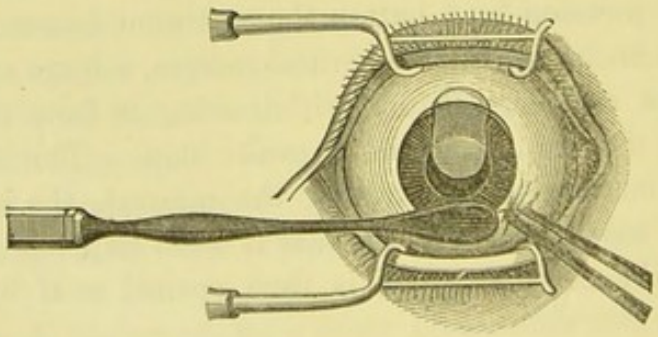


Fig. 136.

prevent a needless separation of the lips, to direct the eyeball slightly upwards, and when it is in this position the fixation forceps should be removed.

Another means, proposed by *von Graefe*, of bringing about the

expulsion of the cataract is the following:—The back of the curette is applied to the sclerotic near the inferior margin of the cornea (Fig. 136). Slight pressure on this region, made towards the centre of the eye, causes the superior border of the lens to appear in the wound. The curette, slightly inclined forwards, is then guided on to the corneal surface, from below upwards, so as, as it were, to push the cataract out of the wound. If this second method be adopted, the fixation forceps must, at the beginning of the operation, be placed a little more towards the nasal side of the corneal periphery, otherwise there will not be space for the proper application of the curette. In a few cases where the expulsion of the cataract is difficult, it is advisable to intrust the fixation forceps to an assistant, and to facilitate the removal of the lens by applying a second curette to the sclerotic border of the incision, which is thus opened more easily.

After the expulsion of the cataract, the surgeon takes the speculum from the hand of his assistant, who has held it till now, and carefully removes it.

Fifth Step.—It very frequently happens that the whole of the cortical substance does not come out with the nucleus. For reasons already explained, it is important to remove it as thoroughly as possible. With this end in view, the lids are allowed to close till the aqueous is at least partially reproduced, and the upper eyelid is gently rubbed, as has been previously explained, in order to collect the cortical fragments as much as possible into the pupillary field; then the patient is directed to look downwards. By pressing lightly with the elevated superior lid the wound is made to gape, and the inferior eyelid is used to push the lens substance towards the wound. To clear the capsule of *débris* we may make use of injections of warm water (*M'Keown*), or solution of sublimate (*Panas*), or boracic acid (*Wicherkiewitz*). When the pupil appears quite black, we must cleanse the wound and the eye, carefully removing with small forceps the blood clots that are generally formed. Lastly, the aqueous humour, often mixed with a little blood, is evacuated. The normal condition of the pupil should be noted. If there be a conjunctival flap, it is replaced, either by sliding the convex surface of the small curved forceps over the cornea on to the sclerotic, or with the back of the caoutchouc curette. This manipulation, at the same time, removes from between the lips of the wound the cortical substance and iris pigment which are hidden in that situation. In order to insure the thorough cleaning of the pupil, we may avail ourselves of focal illumination by a lamp or electric light if the daylight be insufficient.

Dressing and after Treatment.—The dressing is the same as that used after flap extraction.

Little need be said as to treatment after the operation. The pressure bandage, renewed for the first time forty-eight hours after the operation, should then be changed daily. As regards light, we must observe, for the first few days, those precautions which are usual after every cataract operation. We should keep the patient at rest, but in all respects less rigorously so than after flap extraction. As to diet, we may give anything which does not heat or require to be chewed. If a portion of the cortical substance remain in the eye, we early instil a few drops of atropine, and keep the pupil dilated if the conjunctiva can bear the use of atropine. As a rule, when the course of the recovery is normal, we abstain altogether from using atropine or eserine. After the first three or four days, the pressure bandage may be replaced by a small loose bandage, and at the end of the second week the patient may be allowed to go out if his eyes are protected by dark spectacles. When the operation has been perfectly normal, we rarely find any interruption in the natural progress of the recovery.

Of course, the same precautions as regards cleanliness and antiseptics are to be observed here as in the flap operation.

Accidents which may happen during and after the Operation.—If, notwithstanding the use of cocaine, the patient struggle considerably during the application of the speculum or fixation forceps, it is better to administer chloroform till complete anæsthesia is obtained; the inconveniences of so doing are, by reason of the form of the wound, much less to be feared than in flap extraction. It is then preferable to make the operation in the lower border of the cornea. We also use chloroform when palpation shows a marked increase of the internal tension of the eye, which is not diminished after the use of cocaine.

When the point of puncture has been badly chosen in relation to the margin of the cornea, if the knife has already entered the anterior chamber, it should be withdrawn, and the operation should be postponed. The extremely insignificant wound soon heals, and in a few days we may proceed with the operation. If the point of puncture is at the corneal margin, but too low or too high, this difference may be compensated by our choice of the point of counter-puncture without changing the size of the incision. The only inconvenience which then arises is a slight deviation of the coloboma, which, according to rule, should be placed directly upwards.

When the point of the knife has been carried towards a point of counter-puncture other than the one prescribed, and this is discovered before the sclerotic margin has been pierced, we may without fear draw the point of the instrument back into the anterior chamber and

then direct it to the proper point; the form of the knife prevents the escape of aqueous humour. It, however, escapes as soon as the point, in making the counter-puncture, pierces the sclerotic, and sometimes raises up a large extent of the conjunctiva. This, when seen for the first time, is apt to cause alarm, but need not in the least alter our mode of action: it generally disappears with the cutting of the conjunctival flap, during which we must be careful to turn the blade of the knife directly forwards.

The escape of blood into the anterior chamber, which often follows the excision of the iris, may hinder the precision of the movements of the cystitome; we may, in such cases, make an attempt to remove the blood by causing the wound to gape, but in the majority of cases we are forced to allow it to remain, and with a little practice the capsule can be opened notwithstanding the blood.

Prolapse of the vitreous occurs when the wound is made too much in the periphery, or it may be occasioned by the contractions of the voluntary muscles, or, again, when the pressure of the instruments on the eye is too great; in other cases, it is due to some diseased condition of the eye (partial atrophy of the zonule of Zinn). It naturally presents the greatest inconvenience when it takes place before the expulsion of the cataract. If by chance this accident takes place at the end of the first step, the fixation forceps and stop speculum should be removed at once, and the patient put fully under the influence of chloroform. A trustworthy assistant may then gently separate the lids with his fingers, whilst the surgeon very carefully accomplishes the various steps in the operation. It then becomes almost always necessary to use the curette or Weber's loop in extracting the lens, for any other manipulations may increase the prolapse of the vitreous, without insuring the expulsion of the cataract.

Where, on the other hand, the prolapse of the vitreous has taken place after the excision of the iris or after the rupture of the capsule, we advise the immediate extraction of the cataract by the curette or Weber's loop. It need not be said that, in all these cases, there is nothing more to be done than to close the lids, omitting the fifth step altogether, so that the bandage may be applied at once. Collapse of the cornea after the operation, even although considerable, does not prevent a normal recovery when the bandage is carefully applied.

Anomalies in the course of recovery require the same treatment as after flap extraction (see p. 344).

It is rare that the ordinary progress of the recovery is interrupted by any serious accident after the third or fourth day.

An effusion of blood into the anterior chamber has been observed at different times during the first day or two days after the operation, or

even at a later period. It sometimes persists for a few days, and may recur even after complete absorption. This hæmorrhage is never considerable, and disappears on the prolonged application of the bandage.

On the second, third, or even fourth day after the operation, we not unfrequently find a slight serous chemosis, without tumefaction of the lids, increase of the secretion, or infiltration of the wound—in a word, without any other sign of irritation or infiltration. This chemosis is probably due to the conjunctival flap. The patient complains of a slight feeling of pressure in the eye, which disappears when the chemosis is incised with curved scissors.

When the iris has not been carefully replaced, there may be, especially in eyes which are relatively hard, an imprisonment of that membrane in the cicatrix, and thus we may have the period of cicatrisation prolonged, as well as a persistent susceptibility of the eye. Besides, in these circumstances, the pupil dilates very imperfectly under atropine, small staphylomata are found at the angles of the wound, and, in consequence of the cicatricial contraction, which also affects the sphincter of the iris caught in the wound, the free margin of the pupil is drawn more and more upwards. In this way the pupil assumes a form very unfavourable for vision. It is very difficult to improve this state of matters at a later stage without surgical interference, and this inconvenience prompts us once more to insist on the necessity of carefully excising the prolapse of the iris, and of watching closely the position of the sphincter during and after the operation. When necessary, we never hesitate to complete the iridectomy by again excising the iris at the points indicated, and we never rest satisfied with the operation till the sphincter has completely entered the anterior chamber, and is situated at some distance from the corneal incision as indicated in Fig. 137.

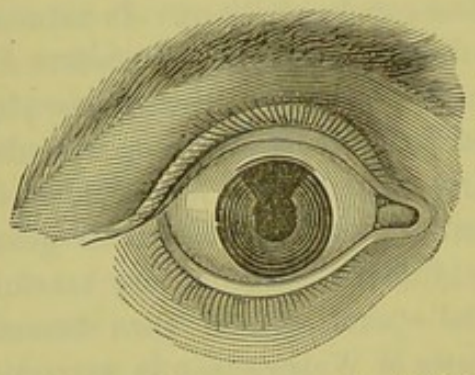


Fig. 137.—Sphincter as seen in Anterior Chamber after Iridectomy.

Methods of Küchler, Liebreich, Lebrun and Jaeger.

In cataract extraction, *Küchler* makes a linear incision in the transverse diameter of the cornea (Fig. 138); the puncture and counter-puncture are made in the corneo-sclerotic ring.

Liebreich extracts through a very small curved section, occupying the inferior portion of the cornea. The puncture and counter-puncture are made in the sclerotic (Fig. 139).

Lebrun extracts through a small medium flap. The puncture and counter-puncture are made at 1 or 2 millimetres below the extremities of the transverse diameter of the cornea. The flap formed in the superior half of the cornea is about 3 or 4 millimetres high (Fig. 140).

In none of these three methods is iridectomy performed.

Fig. 138.—Küchler's Method.

Fig. 139.—Liebreich's Method.

Edward Jaeger uses a special knife for cataract extraction (*Hohlmesser*), and makes the puncture and counter-puncture in the sclerotic at 2 millimetres from the margin of the cornea, and 3 below the tangent to its summit. This incision, placed at the superior margin of the cornea, should measure 12 millimetres. The iridectomy, cystotomy, and expulsion of the cataract are the same as in *von Graefe's* method.

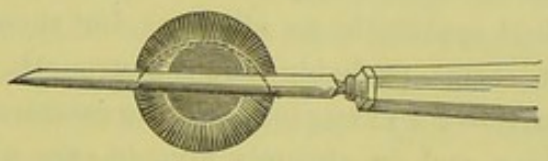


Fig. 140.—Lebrun's Method.

4. Extraction of the Cataract in its Capsule.

Since extraction has been adopted as the general method of operating in cataract, various attempts have been made to remove the entire crystalline system—*i.e.*, to extract the cataractous lens in its capsule. Such attempts, based on the fact that the capsule, if allowed to remain in the eye, often becomes a source of imperfect vision, have nevertheless been abandoned on account of the dangers to the eye which they involve. Indeed, this operation, in the majority of cases, gives rise to a more or less considerable loss of vitreous humour, which exposes the organ to serious dangers, and often causes the loss of the eye. It is, however, right to add that, when the operation succeeds, it gives the best results as to visual acuteness. This circumstance explains why certain of our Italian and Spanish *confrères* exclusively use the method of extraction in the capsule in their cataract operations.

The majority of surgeons who have adopted this method insist on the necessity of complete anæsthesia in extracting with the capsule, evidently with the view of diminishing the muscular contractions of the patient, which increase the danger of prolapse of the vitreous body.

In performing extraction of the lens in its capsule, a large incision is generally made at the inferior half of the cornea. *Pagenstecher* makes his incision in the sclerotic at a millimetre from the corneal margin, and leaves his flap attached by a small conjunctival bridge. He then performs iridectomy, completes his section, and removes the entire lens by introducing a large curette behind it. Other operators complete their flap at once.

Delgado, of Madrid, has attempted to extract the cataract in its capsule as follows :—He begins by introducing into the anterior chamber, as in discission *per corneam*, an instrument which combines the needle with a spatula; with this he detaches the lens, and makes it mobile by gentle pressure on the periphery of the cataract. Having done so, he withdraws the instrument, waits till the aqueous has again filled the anterior chamber, and then extracts the lens in its capsule, using *von Graefe's* peripheral incision and the superior iridectomy. Several operations performed in this way have given him very satisfactory results.

Extraction of the lens in its capsule does not appear to be admissible as a general method applicable to all cases, but should be restricted to those in which it seems probable that the strength of the suspensory ligament is defective—for example, when the cataract is over-ripe, when the iris is tremulous, and in strongly myopic eyes where a general distension of the globe exists.

WHAT METHOD OF CATARACT OPERATION SHOULD WE ADOPT?

It is evident that of all the various operations employed in senile cataract, flap extraction is the most perfect when it succeeds. It preserves a round, mobile pupil, which is a great advantage both as regards appearance and the function of the iris; but the writings of the ablest and most conscientious surgeons, able to testify concerning a sufficiently large number of extractions without iridectomy, leave no doubt as to the relatively large number of unsuccessful cases which followed the classical operation, as also the dangers which may arise even after a perfectly normal operation.

At present it is found by all surgeons who use *von Graefe's* method on a large scale that it gives a larger number of perfectly successful cases; that cases of complete failure are much less frequent; that, in a word, the result of an operation is more in proportion to the way in which it has been performed. The dangers which, for the first fifteen days or even for a longer period, attended the recovery of an eye which had undergone flap extraction, are not present for more than two or

three days in linear extraction, and the progress, as well as the duration, of the convalescence does not try in the same degree the patience of the surgeon or of the patient.

Since the advantages of *von Graefe's* method—regarded as to the rarity of unsuccessful cases and the rapidity of the recovery—have been generally recognised, flap extraction has been almost entirely abandoned. *De Wecker*, who, in 1875, attempted its revival with certain modifications (small peripheral flap and frequent instillation of eserine), returned, after a year or two, to the process with iridectomy, as being the method generally suited to cataract extraction.

Those who object to this method because it is combined with iridectomy, on the one hand lay stress on the extent of the lesion, and on the other on the necessary deformity of the pupil.

Whatever theoretical considerations may be raised in support of this objection, daily experience shows that the combination of extraction with iridectomy, far from increasing the dangers or retarding the recovery, seems rather to be beneficial, either by facilitating the complete expulsion of the cataract, or by modifying the conditions of the circulation and intraocular tension in some advantageous way.

As regards the deformity of the pupil which results from iridectomy, we cannot deny its optical inconveniences. These are a slight dazzling, and a more pronounced radiation than in eyes operated on without iridectomy. Yet even with an iridectomy, the visual acuteness may be sufficiently good.

Moreover, when we operate according to the directions laid down by the author of the method, performing the operation at the superior margin of the cornea, and taking care to avoid the enclosure of the iris in the wound, the artificial pupil is hidden by the superior lid, and the inconveniences which have just been cited no longer exist.

Again, what conscientious surgeon, or what intelligent patient, would hesitate to choose an operation shown to be superior by the number of satisfactory results, even at the price of some slight optical inconvenience or trifling defect?

When possible, it is of great advantage to perform the iridectomy some weeks before the extraction of the cataract, and this rule should always be followed when the eye to be subjected to the operation is the last hope of the patient, or when the special circumstances of the case demand great care. If this method could be adopted in all cases, the number of successes would perhaps attain a maximum, but, for many reasons, the idea of two separate operations at a few weeks interval is not often entertained by the patient.

Some oculists, especially in France, show a tendency to return to the principle of extraction without iridectomy, detaching the corneal border

in about one-third of its circumference. Graefe's knife is used in cutting this small flap. In order to avoid the use of more instruments than are absolutely required, the capsule is opened with the point of the knife, either in its passage across the anterior chamber or after the section is completed. Doubtless our progress in the knowledge of antiseptics, local anæsthesia and myotics warrants and explains these attempts; and their general adoption will depend upon the benefits arising from them, rather than upon the attacks now directed against extraction with iridectomy, which has been advocated for the past twenty years, and supported by numerous favourable statistics.

CATARACT DISCISSION.

Indications.—This method may be used for all cortical cataracts of children* and young adults up to the age of twenty or twenty-five. It is also used for zonular cataracts, when the extent of the opacity does not allow us to hope for a sufficient amount of vision from the formation of an artificial pupil. It is also employed to divide very thin secondary cataracts.

After the age of thirty or thirty-five, the consistence of the cataract is usually such, that absorption can only be effected very slowly and after repeated discission. Besides, the iris neither tolerates so well the contact of the lens fragments which escape through the capsular opening, nor the pressure of a cataract which has become soft and swollen from the penetration of the aqueous humour; so that discission of cataract at an advanced period of life exposes the eye to the serious risks of an iritic inflammation and its consequences.

By the method in question, we propose to incise the anterior capsule, and thus place the cataract in contact with the aqueous humour, which, entering into the lens substance, softens it and prepares it for absorption. The time necessary for absorption varies from a few weeks to several months, according to the age of the patient and the degree of consistency of the cataract. It takes place more quickly when a considerable quantity of the aqueous enters the lens substance, which happens when the capsule has been torn to a great extent. The free access of the aqueous humour to the cataract causes it to increase in volume proportionately to its consistence and to the extent of the capsular opening.

The dangers from the sudden pressure of a bulky cataract on the iris require that we should previously study the nature of the cataract

* *Alfred Graefe* has shown that discission is not well adapted for certain cases where unusual firmness exists. For these, the linear extraction is preferable.

and the irritability of the iris. The special signs by which we estimate the consistence of a cataract have already been given in detail. The irritability of the iris may be to a certain extent determined by the effect of atropine on the pupil. If the pupil dilates rapidly, and if the dilatation is maintained, we may conclude that the iris will the more easily bear the consequences of the operation.

From what has been said, it may be gathered that the capsule may be widely opened when the cataract is very soft and the iris not very irritable, a combination of circumstances most frequently met with in very young children. In cases of the contrary kind, the extent of the incision must be adapted to the special circumstances, and, as a general rule, *it is better to make the capsular opening too small than too large.* In the least favourable conditions the capsule should be simply punctured, and the operation repeated if the process of absorption is arrested.

In zonular cataracts it is always prudent to begin with a small incision of the capsule, on account of the presence of transparent cortical masses, which by their rapid imbibition considerably increase the size of the lens.

Preparation for the Operation.—Cataract discission requires complete dilatation of the pupil; consequently, it is necessary to instil previously a sufficient quantity of a strong solution of atropine. The patient, if a child, must be wrapped up in some covering, so as to keep the limbs still.

The instruments necessary for the operation are:—Fixation forceps (Fig. 60), and a discission needle. The latter should be so constructed

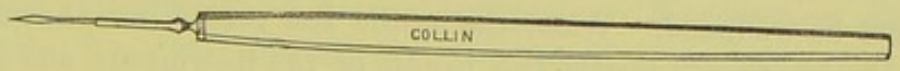


Fig. 141.—Discission Needle.

that its neck completely closes the small opening made by the point, for then no premature escape of aqueous can take place. We generally use Bowman's stop needle (Fig. 141), which cannot be introduced further than its stopping point. The head of the patient, who as usual is in the recumbent position, is held steady, in the way that has already been described, and an experienced assistant separates the lids. In the absence of an assistant, the lid speculum may be used. The surgeon stands before the patient when operating on the left eye, but behind his head when he wishes to operate on the right eye and prefers to use his right hand.

(a.) Description of the Discission Operation for Cataract.

The surgeon, taking the fixation forceps in his left hand, and the needle in his right, with the first takes hold of the conjunctiva near the internal and superior margin of the cornea. The needle is held with its edge towards the surface of the cornea, which it pierces

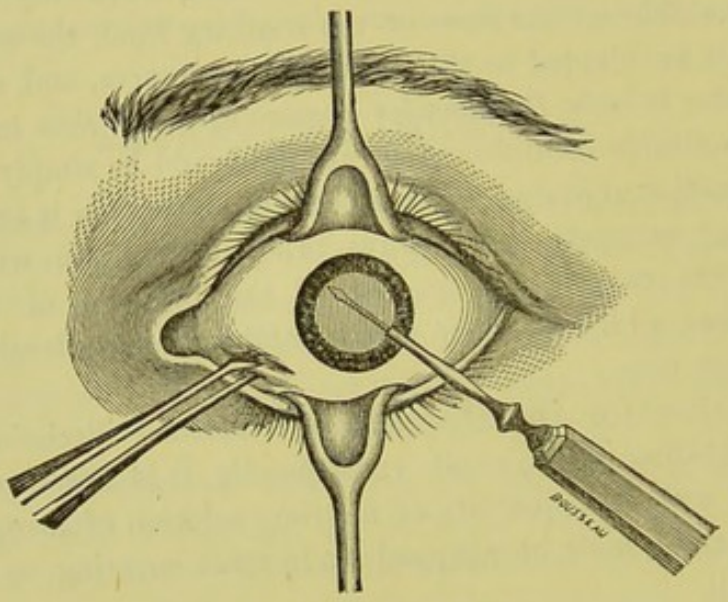


Fig. 142.—Discission.

perpendicularly at a point opposite the margin of the dilated pupil. The puncture should be made downwards and outwards, and the iris must not be wounded. When the needle has passed into the anterior chamber, the surgeon lowers the handle of the instrument, and pushes the needle towards the superior aspect of the lens to within a millimetre of the pupillary margin (Fig. 142). He then turns the edge of the needle down on the capsule and makes a longitudinal incision in it, at the same time withdrawing the instrument slightly so that it does not penetrate the lens substance too deeply. In cases where, according to the rules already laid down, the operation should end with a simple incision, there is nothing more to be done than to withdraw the needle, and take off the fixation forceps. The assistant allows the lids to close, and all is finished. When, on the other hand, circumstances allow a more extensive incision, the needle is semi-rotated so that the two blades face the angles of the eye. The point is then directed towards the internal margin of the pupil (Fig. 143), to within a millimetre from the margin of the iris, and a transverse incision is made, which should also terminate at a millimetre from the external margin of the pupil. Whilst making this

second incision, we must also, for the reason already stated, withdraw the instrument slightly from the wound.

The surgeon should carefully avoid making any great pressure with the collar of the needle on the corneal wound, and should hold his

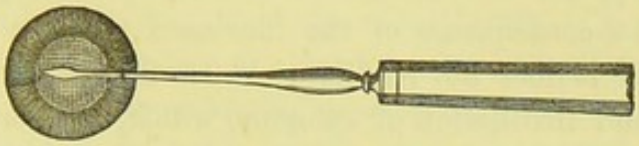


Fig. 143.

fingers, during the various steps of the operation, so that the corneal opening may be the centre of rotation of all movements of the needle.

On finishing the operation, a compressive bandage is applied. It is better to keep the patient in the recumbent position for the first twenty-four hours in a dark room. The bandage is changed as usual, a few drops of atropine being instilled each time. The use of atropine must be continued during the entire time taken by the absorption, that is to say, till all lenticular opacities have completely disappeared.

If the progress of the recovery be not interrupted, the compressive bandage is replaced after a few days by a small loose bandage, and at a later period by dark glasses.

If we find, some time after the operation, that the process of absorption has been arrested, the opening in the capsule having become closed (usually by the formation of a hyaline substance which unites the edges of the wound), the operation must be repeated and a fresh discission made, all the more courageously if the size of the cataract has been diminished by partial absorption. To ascertain that the absorption has been arrested, and that there are no longer portions of the lens substance swollen with the aqueous humour, it is almost indispensable to examine with focal illumination. Before deciding to repeat the application of the needle, it is well to wait till all irritation or redness of the eye (pericorneal injection) has passed away.

The time required for complete absorption of the cataract after discission varies with the age of the patient and the consistence of the cataract. In young children absorption often takes place in from six to ten weeks, and one discission only is sufficient. We know that at this age the iris is not very irritable, and we may, therefore, make a larger opening in the capsule. With older patients, the discission has to be performed with more caution and the operation must be repeated several times, so that the complete absorption of the cataract may require several months, and even more than a year.

Accidents which may Supervene after the Operation.—The most frequent accident which may occur after discission of a

cataract is inflammation of the iris. The patient then complains of pain in the eye, as also in the surrounding structures, and in the entire inferior half of the head on the side of the operated eye. Along with these symptoms there is pericorneal injection, and the aqueous humour becomes muddy, the iris changes in colour, and the pupil contracts. If the iritis is a consequence of the increased pressure of the swollen cataract, and if it does not readily yield to the continued application of ice (*Arlt*) and instillation of atropine, which, by dilating the pupil, withdraws the iris from all dangerous pressure, it is in vain to strive to subdue the inflammation by the ordinary remedies, that is to say, by blood-letting at the temple, instillation of atropine, and administration of mercurials. We should rather hasten to free the iris from the unwonted pressure which has given rise to, and which keeps up, the inflammation.

The only efficacious remedy in such circumstances is to extract the cataract by a linear incision combined with iridectomy; and we cannot put off doing so without exposing the eye to the most serious risks, and the patient to the severest pain.

The necessity of freeing the inflamed eye as quickly as possible of the cataract, which is the direct cause of the inflammation, is too evident to require to be enforced. It might seem, *a priori*, a dangerous proceeding to combine extraction with iridectomy, when the iris is the seat of an inflammation. Yet the iridectomy is necessary to facilitate the expulsion of the cataract, for the pupil is generally firmly contracted and often cannot dilate because of the presence of posterior synechiæ. It has also been shown, as we have already said in speaking of iridectomy, that this operation, far from increasing the iritic inflammation, may be the most powerful means of checking it.

A slighter form of iritis has also been observed when, in consequence of a very large incision in the capsule, a considerable quantity of the lens substance or the nucleus falls into the anterior chamber. To check this inflammation, we may try the effect of atropine by itself; but if the symptoms of iritis persist or increase, it becomes urgent to evacuate the masses contained in the anterior chamber, by a paracentesis performed at the inferior periphery of the cornea. After this has been done, the iritis generally disappears, or, at least, rapidly yields to the usual applications.

In cases where the soft and liquid consistence of the cataract enables us to foresee that a great quantity of the lens substance will fall at once into the anterior chamber, and when the youth of the patient forbids linear extraction, *von Graefe* has proposed to perform discission through the cornea with a larger needle than is generally used.

Holding this instrument on the cornea in such a manner that the

edges are directed towards the angles of the eye, the surgeon transfixes the membrane so as to enter the anterior chamber, and the discission is finished before the aqueous humour can escape. Whilst the needle is being withdrawn, slight pressure should be made on the inferior lip of the corneal wound, thus permitting the escape of the aqueous humour and a certain portion of the soft cataract.

If, after this, the portion of the lens remaining in the eye is too great, we wait till the aqueous humour has been re-accumulated, at least in part; then we again gently open the wound with an Anel's stylet, curved on its external lip.

For the rest, it suffices to have removed the more fluid portions of the cataract, and we may leave the few remaining gelatinous flakes to be absorbed, as they do not cause any considerable irritation. These cases could also be operated by suction.

Another mishap, which has been sometimes noticed, consists in an irritation, or even infiltration of the cornea at the point of puncture. This complication, although very unfrequent, may arise from infection, or from the cornea having been injudiciously dragged on by the needle. It generally yields to antiseptics (iodoform, sublimate, galvano-cautery), and the prolonged use of the tight bandage, together with the occasional application of hot fomentations.

(b.) Discission Combined with Iridectomy.

The ease with which cataract discission is performed, and the relatively slight danger to which it exposes the eye, have naturally raised a desire to extend the indications of the operation as widely as possible. Unfortunately, it cannot be applied to the ordinary cataract of mature life, for this does not readily undergo absorption, requiring a considerable length of time (from eighteen months to two years), during which the eye is exposed to serious complications—iritis, glaucoma. Such dangers are all the more to be feared, as the structures involved are more apt in advanced life to take on an inflammatory process than in youth.

Sometimes, even after the age which is fixed as the limit for discission (twenty to twenty-five), we find varieties of cataract, which, from their consistency, might admit of this method of operation, were we not afraid of exposing the entire organ, especially the iris, to the risk of the prolonged process of absorption. On the other hand, there are, even in youth, at which period the eye more easily bears the consequences of a discission, varieties of cataract, which, after discission, undergo an excessive and dangerous amount of swelling. In both cases, prudence obliges us to forego discission, notwithstanding the

desire to use a method which, if properly followed, may certainly be considered as giving the best results. *Von Graefe* has devised a plan, by which, even in such cases, we may use discission if it is combined with iridectomy.

The results of this combination are so satisfactory, that it seems to us of special importance to indicate very carefully the cases in which it deserves a trial.

Firstly, in cases of cataract in young persons, where atropine does not sufficiently dilate the pupil. The inefficiency of the atropine instillations sometimes arises from the presence of synechiæ, which have been formed by a previous iritis; in other cases it depends on some special condition of the iris tissue. We are also obliged to have recourse to preliminary iridectomy when we wish to perform discission in the case of a person who is more than fifteen years of age, especially in those forms of cataract whose very slow absorption is not without danger to the eye, as, for example, in zonular cataract. We do not, however, say that fifteen is the extreme limit between simple discission and discission combined with iridectomy; but, given this form of cataract in persons of different ages, we must judge as to the necessity of preliminary iridectomy chiefly by the greater or less irritability of the iris.

We know, for example, that zonular cataract, after discission, usually becomes greatly increased in volume, and if the circumstances of the case cause us to perform discission at a relatively advanced period of life, we should take the double precaution of performing a preliminary iridectomy, and of making our first discission very small, leaving ourselves free to repeat it when necessary. Yet, after an iridectomy we can rupture the capsule more extensively, and thus shorten the period of absorption; for the swollen cataract, and the lenticular flakes which are detached, are brought less in contact with the iris, because that membrane can yield more freely to the pressure, and, the sphincter being cut, offers less resistance. Again, if there should be inflammation, the iridectomy renders it less dangerous. It should also be added that, in recent times, for this class of cataracts, the method in question has often been replaced by *von Graefe's* linear extraction, which, in special cases, has this advantage, that the patient is freed from the cataract at a single sitting; whilst discission with iridectomy requires at least two operations, if not three or four, and a considerable time must elapse before the cataract is completely absorbed.

Von Graefe's extraction should therefore be preferred, when the cataract has a certain consistence, as is occasionally found in young persons; when the patient cannot remain so long under the observation

of the surgeon as may be necessary for discission; or when his eye presents symptoms of great irritability.

As to the way of performing discission with iridectomy, little remains to be said.

The iridectomy is best made at the superior aspect of the eye, so that the artificial coloboma of the iris may be as far as possible concealed by the superior lid. As to the details of this operation we refer the reader to the description which we have given under the heading of Iridectomy.

It is necessary to allow a sufficient time to elapse between the iridectomy and the discission; sometimes twelve or fifteen days may suffice; in other cases we must wait several weeks, till all trace of irritation has disappeared.

The after treatment, and the remedies to be employed in case of accident, are the same as after simple discission.

(c.) Discission for Artificial Ripening and Förster's Method.

Not unfrequently do we see cases of cataract, where the slowness with which the disease matures severely tries the patience of the sufferer who desires to have his vision restored. A time then comes when the patient can no longer use his eyes, whilst the surgeon, from the special appearance of the cataract, and from his observation of the previous course of the disease, is in a position to conclude that complete maturity cannot be attained for a long time. On the other hand, we always hesitate to extract a cataract which is not perfectly ripe, being deterred by the fear that a portion of the lens substance which is still transparent may be left in the eye, and that, by its secondary swelling, it may give rise to serious complications during the period of recovery.

As an escape from this disagreeable position, which gives us the alternative of either performing a dangerous operation, or allowing the patient to remain for a long time in such a condition that he cannot use his eyes, and that at a period towards the close of life, it has been proposed to hasten the formation of the opacity in those portions of the lens which remain transparent, by introducing a discission needle. This ingenious idea has, however, not met with general favour.

The process of *Förster* for artificially ripening the cataract consists in performing iridectomy, after which, the anterior chamber being drained of its contents, a sort of kneading of the lens is made, with the blunt end of a strabismus hook across the cornea and slight pressure applied upon the surface. The movements of the hook

should be made from the centre towards the periphery, and also in a concentric manner. After one or two days, as a result of this manipulation, opacification of the previously transparent parts of the lens takes place, and its extraction may be made some weeks later.

When the lens is removed before its maturity, portions of its cortical substance are likely to remain adherent to the capsule, the result of which may be an imperfect cure, inflammation, or secondary cataract. To combat this tendency, *Wicherkiewitz* advocates washing the capsular sac by means of injections of solution of boracic acid thrown directly into it, a method from which he has derived excellent results. *M'Keown* advocates the same procedure, using warm water and a special syringe (scoop syringe).

Preliminary discission has also been employed, chiefly by English oculists, as a preparatory step to suction, in those cases where the cataract is not completely soft or liquid: on this subject we have already expressed our opinion.

(d.) Couching of the Cataract.

Couching, the earliest operation for the relief of cataract, possesses for us only a historical interest. It will be well, however, to give a brief description of it, and to note the reasons which led to its abandonment. Examination of the statistics of couching operations show that, after a lapse of one or two years, little more than half the operated eyes permanently regained their vision. These, moreover, were constantly menaced with the serious complications liable to result from the presence of the lens in the vitreous, for it was only in a very small number of cases that the reabsorption of the lens was complete. Although these facts were perfectly well known for a long time, even the opponents of the operation were obliged to resort to it in exceptional cases, where flap extraction was impracticable. Thus it occupied a place in ocular surgery up to the time when *von Graefe's* operation became universal.

There were different methods of displacing the cataract, the most important of which was to reverse the lens (Fig. 144) as it was being pressed downwards, in such a manner that the anterior surface was directed upwards, the instrument used being a slightly curved cataract needle, with a lance-shaped head (Fig. 145). The pupil was dilated with atropine, and the puncture made in the sclerotic about 3 millimetres from the temporal border of the cornea (Fig. 146). By an upward and outward movement of the handle of the needle the lens was displaced down-

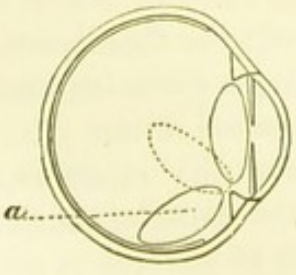


Fig. 144.

wards and backwards into the vitreous. Then, after pausing a moment

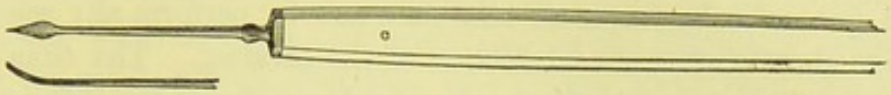


Fig 145.

to assure himself that the lens remained depressed, the operator withdrew the needle, taking care that its surfaces were in the same position

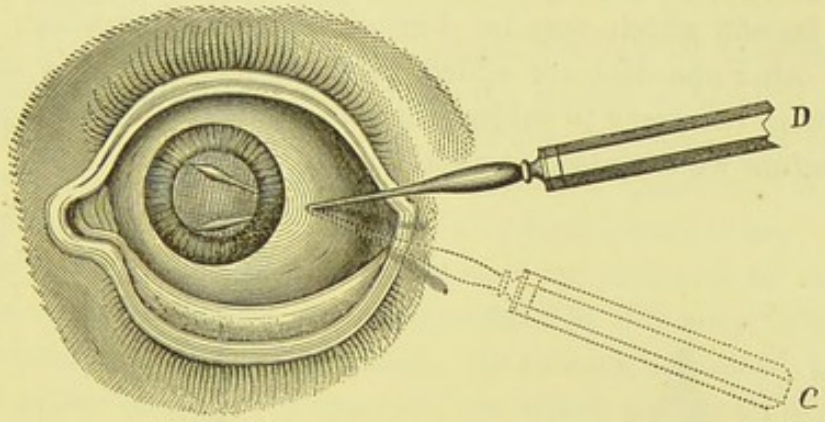


Fig. 146

as upon entering. This operation merits no place in surgery now, having been entirely superseded by the extractive methods.

OPERATION FOR SECONDARY CATARACT.

Under the name of *secondary cataract* are included opacities of various kinds, which are formed in the pupillary field after a cataract operation, and which prevent the complete re-establishment of vision.

If we carefully examine with focal illumination eyes which have been operated on for cataract, and in which, after the anomaly of refraction has been corrected according to the ordinary rules, the visual acuteness is less than it should be, taking into account the patient's age, we often find that the deficiency in vision is caused by the presence of an exceedingly slight opacity, stretched like a cob-web behind the pupil. This is then a first variety of secondary cataract, and it arises from the formation of a new tissue by the proliferation of the epithelial cells of the anterior capsule.

In other cases the capsule itself becomes thickened, so that a denser opacity is formed, which can be seen behind the pupil by simple inspection. Again, in a third series of cases, the iris takes a part in the inflammatory process, and an iritic exudation is then added to the capsular opacity. This deposit may vary from more or less numerous simple synechiæ to the formation of true plastic deposits.

The mode of operation must vary according to the nature of the secondary cataract.

As a general rule, we must take care not to perform any secondary operation shortly after the extraction of the cataract. The time which we must wait varies with the duration and severity of the inflammatory process which the eye has undergone. We should decide to perform a secondary operation only when all traces of irritation, such as swelling of the lids, photophobia, pericorneal injection, have disappeared. If we do otherwise, we are apt to revive the inflammation, and not only lose the benefit which may be derived from our operation, but also find that other opacities are added to those which already exist. It then becomes necessary to subject the patient to another long period of waiting before we can attempt another operation on that eye.

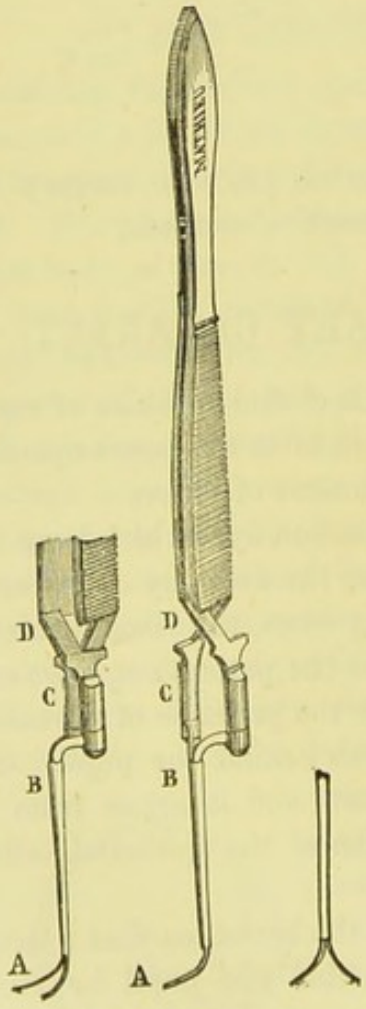
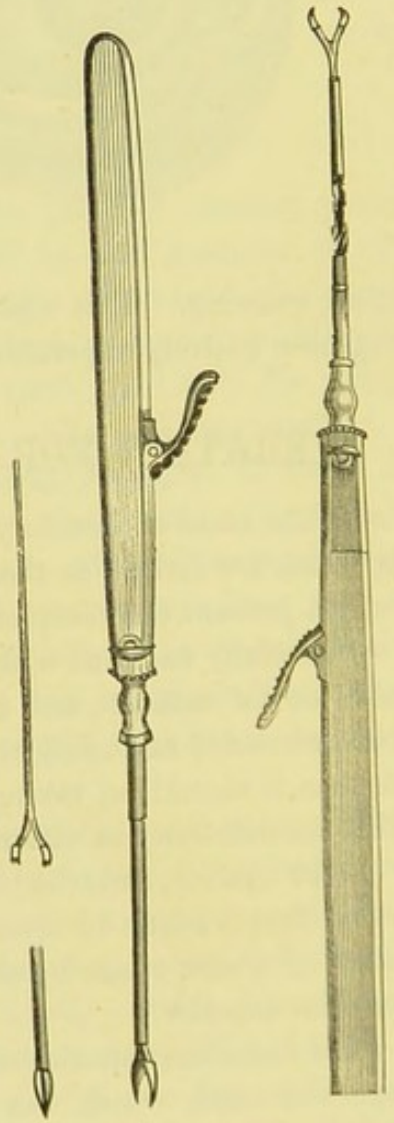


Fig. 147.



Figs. 148 and 149.

We must be very specially careful when we have to deal with the plastic membranes which are formed in iritis. These membranes,

always highly vascular, readily become the starting point of fresh inflammation when they are irritated by contact with instruments. In such cases, we must delay the operation for the secondary cataract for a year or more, till all irritation has passed away from the eye, the vascularity of the membranes has disappeared, and the eye is in a state of perfect rest. Still, this period of waiting is not always thus prolonged, and when the opacity is inconsiderable we are sometimes at liberty to perform the operation for secondary cataract a few months after the extraction of the lens.

In the first variety of secondary cataract which we have mentioned, simple discission always suffices to effect a central opening in the slight opacity found in the pupillary field. As these opacities are not always easily seen with ordinary light, the discission is sometimes more easily performed in a dark room with the aid of focal illumination.

In attempting to operate by discission on cataracts of the second class, we often encounter an insurmountable difficulty, the opacity yielding before the edge of the knife, which cannot succeed in cutting it. The extraction of such opacities, for which numerous instruments have been invented (capsular forceps, Fig. 78; Liebreich's forceps, modified by Mathieu, Fig. 147; Serretelles, Figs. 148 and 149), requires, as a first step, the formation of a corneal incision, and is often dangerous or even impracticable; for, not unfrequently, there are more or less numerous adhesions between the secondary cataract and the iris, which is, therefore, inevitably exposed to considerable traction.

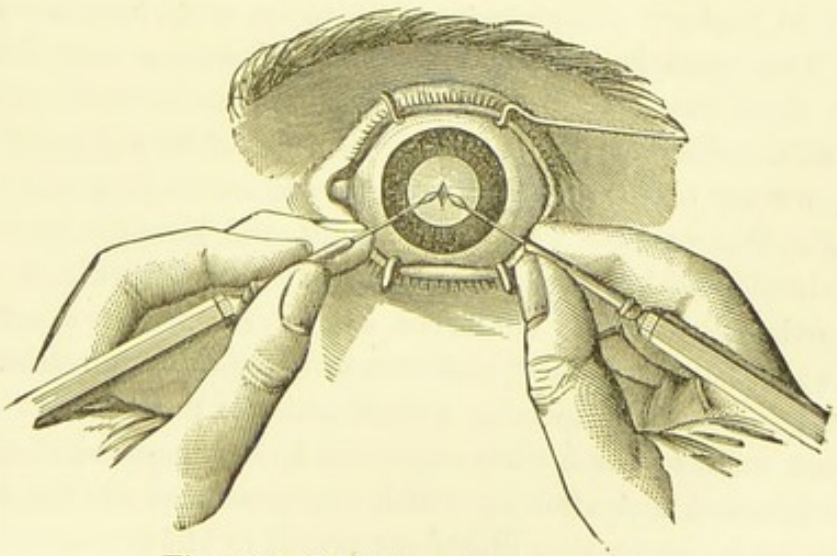


Fig. 150.—Discission with two needles.

If, however, we attempt to extract these opacities, we must previously divide the synechiæ, or perform an iridectomy where they are situated. When the adhesion is only partial, we can also make an incision in the cornea at the point of adhesion, take hold of the

secondary cataract at the part where it is free, extract it, and cut it off near the corneal surface (*Arlt*).

The wisest operation for this variety of cataract is that indicated by *Bowman*, and known as *discission by two needles* (Fig. 150). To perform this operation, the surgeon with his left hand introduces a discission needle through the internal portion of the cornea into the opacity itself. The eye being thus fixed, he introduces a second needle with his right hand, through the external part of the cornea, directing it towards the point in the opacity where the first needle is situated. He then attempts to tear the secondary cataract by separating the points of the needles. By this manipulation, which is somewhat difficult to perform, he succeeds in making an opening in the pupillary opacity sufficiently great to permit of vision.

Agnew, of New York, operates in these cases as follows:—With a von Graefe's cataract knife he transfixes the cornea in its horizontal diameter so as to obtain a wound nearly 2 millimetres from the nasal and temporal margins of the cornea. While withdrawing the knife, he pierces the capsular opacity with its point. He then introduces two hooks, which are almost blunt at the points, the one by the opening on the nasal side, the other by that on the temporal, and inserts them into the opening made in the cataract by the point of the knife. By traction on the two hooks he dilates the opening as much as may be required, without dragging either on the iris or ciliary body.

In the other varieties of secondary cataract, it is almost always necessary to perform iridectomy or iridotomy, or perhaps a *combination* of these two operations. An iridectomy, sometimes very difficult to make in these cases, may be advantageously made with von Graefe's linear knife. When we have succeeded in establishing an opening in the iris, we try to form a slit in the plastic membranes with a strong hook. For this purpose we use a resistant and strongly curved hook, which is implanted in the membranes, so that, if possible, it may tear away portions of them. Often, in serious cases, the opening thus effected again becomes closed, and even after repeated operation we are not always successful in forming a small artificial pupil.

For such cases *von Graefe* has suggested another method of operation, the principle and execution of which are contained in the following note, written for us by that illustrious savant in 1869:—

"When, in consequence of a cataract operation, the lens is absent, and when there is highly developed retro-iritic exudation, with disorganisation of the iris tissue, flattening of the cornea and the other sequelæ of a destructive irido-cyclitis, I substitute simple iridotomy for iridectomy, which is the operation hitherto performed, generally

without success. The operation consists in inserting a double-edged knife, resembling in shape a very sharp triangular knife, through the cornea and newly-formed tissues till it pierces the vitreous body, and immediately withdrawing it; and, while withdrawing it, enlarging the wound in the membranes without increasing the size of the corneal wound. Experience shows that such plastic membranes attached to the atrophied iris and to the capsule of the lens have a tendency to contract sufficient to maintain, to a certain extent, the opening which has been made.

"If, in the ordinary method of iridectomy, combined with laceration or extraction of the false membranes, we find that the artificial pupil usually becomes closed, we must attribute this to an excessive vulnerability, which immediately sets up proliferation in those tissues which have been touched, and which are endowed, in consequence of their structure, with an irritability altogether peculiar. We know that even the transitory reduction of the intraocular pressure, which follows the evacuation of the aqueous humour, is sufficient to give rise to hæmorrhage in the anterior chamber, which interferes with the perfect success of the intended operation; but most of our failures in the ordinary methods are due to the irritation caused by the forceps and the traction on the surrounding structures. Simple iridotomy is free from such inconveniences; it is, so to speak, a subcorneal act, and enjoys the immunity which belongs to subcutaneous operations.

"I have also reduced the corneal wound to a minimum, by using small falciform knives. These are passed through the false membranes, which are then cut from behind forwards."

De Wecker has invented scissors with which iridotomy may be very conveniently performed.

An incision 4 millimetres long is made in the cornea and iris with a triangular knife, in the corneal periphery where the radiating fibres of the iris converge at the superior margin. Through this opening, one branch of the scissors is introduced behind the iris and the other in front, and an incision, 5 or 6 millimetres in length, is made downwards and inwards. If the opening in the iris does not seem to be wide enough, a second incision is made downwards and outwards. In this way an iris flap is formed, which contracts.

To simplify the operation, as also to avoid the contusion inseparable from the introduction of the scissors and the escape of vitreous, *Sichel* follows *von Graefe's* original method, using a special instrument called an iridotome (Fig. 74), with which he penetrates the anterior chamber and makes one or two incisions in the pupillary membranes which converge towards the pupil. *Galezowsky* has also devised a small falciform knife for this operation. The double-edged needle which

von Graefe used in separation of the retina may also be very conveniently used.

In cases where the sphincter of the iris is caught in the cicatrix and sets up a prolonged irritation, *Green* has strongly recommended the following proceeding:—The cornea is incised with a straight triangular knife at about 2 millimetres from its external margin, and at the same time the iris is pierced; then de Wecker's scissors are introduced by the opening—one branch behind the iris, the other in the anterior chamber. The scissors are advanced to 3 millimetres beyond the opposite pupillary margin, and both margins, as well as the intervening membrane, are divided by a single snip.

When, from atrophy of its tissue, the iris has lost its power of retraction to such an extent that section of that membrane does not afford a sufficient pupillary opening, simple or double iridotomy does not suffice. Here we have to deal with considerable exudation behind the iris, with disorganisation of its tissue and flattening of the anterior chamber.

In such serious cases *Ad. Weber* and *von Graefe* advised that a double-edged, slightly-curved, lance-shaped knife should be used, which should be made to traverse the cornea near its external margin, and to pass behind the iris nearly to the opposite border of the cornea, at which point it should be brought out to its entire breadth from behind the iris. All the tissues should be cut at the angles of the wound with a pair of very fine scissors (see Fig. 79), one branch of which should be introduced behind the iris, while the other remains in the anterior chamber. The tissue thus circumscribed is removed with a strong pair of capsular forceps. Later, *von Graefe* made use of linear section for this kind of iridectomy (compare p. 382). *Bowman* also operates on thick secondary cataracts by two incisions made simultaneously with two triangular knives at the external and internal margins of the cornea, piercing the cornea, the iris and the cataract. The section of the tissues is finished with scissors, and the extraction is effected with a pair of forceps. *De Wecker* also uses a triangular knife, which he introduces in its entire breadth through the cornea at its superior border, at the same time incising the iris and secondary cataract; the knife should be directed as much as possible parallel to the iris. With two cuts of the scissors, which begin at the angles of the wound and converge towards the inferior margin of the cornea, he excises a triangular portion, which must be extracted with iris forceps. Another method, devised by *Bowman*, may be had recourse to in operating on adherent secondary cataracts. It consists in penetrating the anterior chamber with a large triangular knife at the superior margin of the cornea. When the point of the knife reaches the centre of the

normal pupil, it should be pushed behind the iris and false membranes so as to make an incision 4 millimetres long in the iris and capsule (Fig. 151). The portion thus circumscribed is excised by means of

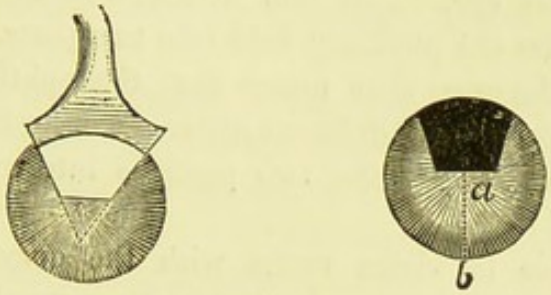


Fig. 151.

small scissors. The vertical section, *a b*, should only be made when we are unable to detach the iris from the opaque particles which obstruct the pupil.

Krüger has constructed an instrument in the form of a punch, with which he removes a morsel of the membranes which block up the pupil. The results obtained with this instrument in desperate cases—of which we have seen two remarkable instances—deserve the greatest attention.

ART. II.—Dislocation of the Lens.

The lens may be displaced in various ways. Sometimes it swings round its centre of rotation, which, however, maintains its normal situation (*incomplete dislocation*); sometimes the lens is altogether displaced (*ectopia*), either remaining between the iris and the vitreous body, being displaced upwards or downwards, to the nasal or to the temporal side, or being carried into the anterior chamber, or into the vitreous body. If there is rupture of the sclerotic, it may be found beneath the conjunctiva. It may even be completely expelled from the eye.

The symptoms of displacement of the lens are very characteristic.

1. **Incomplete Dislocation.**—When the lens is removed from its normal position, the iris, which was in apposition to its entire anterior surface, loses its support. There is then an undulatory movement at the part where the lens is absent; and at this point we can see a tremulous condition whenever the eye moves. The other parts of the iris are pushed forwards by the margin of the lens, which is nearer to the cornea. Consequently, on this side, the anterior chamber is perceptibly shallower, whilst it is deeper at that part where the iris has lost the support of the lens.

When the dislocation is well marked, it is not difficult to see, with an ophthalmoscopic mirror, the margin of the lens thrown backwards when the pupil is dilated. The margin appears as a black line on the red fundus of the eye. This line is, like the equator of the lens, convex, and divides the pupillary field into two parts. An experienced observer will at the same time notice that the ophthalmoscopic image of the fundus is formed at different distances, according as he observes it through one or other of the two portions into which the pupillary field is divided.

The disturbance in vision varies with the degree of dislocation. When the displacement is very slight, the normal visual acuity is scarcely interfered with, except in so far as there is a more or less complete absence of accommodation. If the movement of rotation has been sufficiently great to throw the margin of the lens into the pupillary field (the pupil being dilated), vision is very much disturbed, and the patient may suffer from monocular diplopia. If the luminous rays gain entrance by that part of the pupil in which the lens lies, we shall find a strong myopia with irregular astigmatism.

If the lens before displacement was affected with cataract, dislocation may restore vision to that eye, by removing from a portion of the pupil the obstacle which the cataract offered to the transmission of luminous rays.

Ætiology.—Any traumatic cause, such as a blow sustained on the eye, or on its surrounding parts, may determine incomplete dislocation of the lens. This is all the more easily produced if there already exist such predisposing causes as fluidity of the vitreous body, relaxation or rupture of the zonule of Zinn, as is found in cases where the anterior portion of the eyeball is dilated (sclerectasia anterior). In such cases the dislocation may occur spontaneously.

At other times, incomplete dislocation is caused indirectly by a portion of the iris being engaged in a peripheral staphyloma of the cornea; if this portion of the iris adheres to the capsule, the lens is also involved in the same process.

Again, **congenital** dislocation of the lens has been observed, sometimes even in both eyes, and in several members of the same family. It would, therefore, seem to be hereditary. As a rule, the displacement increases as age advances.

Treatment.—When the displacement of the lens is so slight that the vision does not suffer, there is no call for interference. If necessary, we order glasses suited to the state of the refraction and accommodation. In cases where the movement of rotation has brought the margin of the lens into the field of the dilated pupil, and the lens has become opaque, vision may be re-established by an artificial pupil similar to

that made in zonular cataract. As this operation is always performed so that the artificial pupil is clear of the lens, whether opaque or not, the eye will then be, as far as vision is concerned, in the same condition as after cataract extraction (consult Article on Aphakia at the end of this chapter).

2. **Complete Dislocation.**—The tremulous movement of the iris, and the changes in the depth of the anterior chamber, will be the more pronounced the greater the portion of iris deprived of its support by the dislocation of the lens. If the margin of the dislocated lens occupies the pupillary field, it forms a curved line, which is of a greyish colour to focal illumination, but appears black to the ophthalmoscope.

We may ascertain the portion of the pupillary field in which the lens is absent, by its deeper colour, and by the absence of such reflections as come from the capsule; which are, on the other hand, easily seen with focal illumination in the portion of the pupillary field still occupied by the lens.

Again, ophthalmoscopic examination not only reveals the edge of the lens in the pupil, but also the difference of refraction in the two portions of the pupillary field, and sometimes, when the lens acts as a prism, we see simultaneously two ophthalmoscopic images.

On examining the functional condition of the eye, we at once detect the deficiency in the accommodation which is always present. The state of the vision, moreover, depends on the size of that portion of the pupillary field which is deprived of the lens. When the margin of the lens occupies the pupil, even when it is retracted, there is generally, on account of the irregular refraction of light (astigmatism), considerable disturbance of the vision. In such cases, also, patients complain of monocular diplopia. When the lens no longer occupies the pupil to any great extent, it is possible, either by a stenopaic slit, or by myotics, to make the light enter only by the portion of the pupil deprived of the lens; and then vision may be considerably improved by very strong convex glasses.

If the lens is opaque, the diagnosis is much more easy; for we then see that a portion of the pupil has been rendered free of the pre-existing opacity, and the eye suddenly recovers to a certain extent the vision which had been destroyed by the presence of the cataractous lens.

Ætiology.—Dislocation of the lens is sometimes congenital, and frequently occurs in several members of the same family. In such cases the lens is, as a rule, transparent, but smaller than in the normal condition, or even in part wanting (*coloboma of the lens*). Sometimes it is so small that it slips through the pupil into the anterior chamber whenever the patient bends his head forwards. We find coinciding

with this condition a certain amount of amblyopia, and often some nystagmus.

When the displacement of a transparent lens takes place suddenly, it almost always is the result of an injury which has produced relaxation or rupture of the suspensory ligament. In every case the displacement may gradually increase.

The dislocated lens sometimes remains transparent for a length of time, but more frequently it becomes opaque, either immediately, or a few months after the accident.

(*a.*) **Dislocation of the lens into the anterior chamber** is easily diagnosed, whether the lens preserves its transparency or becomes cataractous; in the latter case it is generally shrivelled. A transparent lens enclosed in its capsule appears in the anterior chamber as a very large pearl, and may remain transparent for a very long time. Rarely is its presence tolerated without producing symptoms of irritation, which are specially to be feared when the lens partially rests in the pupil. Sometimes the dislocated lens contracts adhesions with the cornea or iris, and becomes the starting point of some serious inflammation, which may threaten the existence of the eye (iritis, irido-choroiditis, glaucoma).

When there is, along with the dislocation, rupture of the capsule, the lens substance becomes swollen from the contact of the aqueous humour, and, by pressing on the iris, sets up an irritation, the intensity of which is in proportion to the rapidity with which the lens substance has become swollen.

As to vision, if the dislocated lens is transparent, the patient may still be able to see very near objects, the increased curvature of the lens, and its distance from the retina, making him very highly myopic.

Treatment.—In dealing with a dislocation into the anterior chamber, we may first of all, provided there are no inflammatory symptoms, attempt to reduce the lens in the following manner:—Having widely dilated the pupil with atropine, the patient's head is laid backwards, and gently shaken from before backwards with the surgeon's two hands. If the lens return behind the iris, the patient must be kept on his back, and the pupil must be kept contracted for a considerable time with eserine.

If the lens has already set up an inflammation, or if there has been a rupture of the capsule, it would be imprudent to attempt its reduction. We may try to protect the iris from the mechanical action of the lens by keeping it dilated with atropine; but, should the irritation persist, we must extract the lens through a linear incision in the cornea, or, better still, by a flap incision.

(*b.*) **Dislocation of the lens into the vitreous body** pro-

duces a tremulous movement of the entire iris, and the absence of the capsular reflections. With focal illumination, and more clearly with the reflecting mirror of an ophthalmoscope, we can detect the lens in the vitreous body. It is recognised by its characteristic form, by the peculiar brightness of its margin, and by the movements which it executes round the portion of the suspensory ligament to which it is attached. These movements resemble those of a door on its hinges, and are easily seen when the eye is moved.

The vision of the eye, except when there is some other lesion accompanying the dislocation, is such as is found in an eye deprived of its lens (consult Article on Aphakia).

A lens thus displaced in its capsule may retain its transparency for a long time. Sometimes its presence in the vitreous body does not occasion any inflammatory symptom; sometimes it sets up serious inflammation, or a simple non-inflammatory glaucoma.

Our **treatment** must be regulated by the special circumstances of the case. If the lens does not cause any disturbance, it is needless to interfere: if it becomes a source of irritation, we must attempt to remove it by means of a hook or curette, after having made an iridectomy.

(*c.*) **Dislocation of the lens beneath the conjunctiva,** after rupture of the sclerotic, is always the result of violent injury. It is exclusively observed in persons whose age would indicate a diminution in the elasticity of the sclerotic. This rupture of the sclerotic generally takes place in front of the insertion of the recti muscles, at the superior and internal margin of the cornea.

Violent injury, which alone can produce dislocation of the lens, will also give rise to other inflammatory symptoms, such as swelling of the lids, subconjunctival and intraocular hæmorrhage. When it is possible to examine the eye, we are sure to find some lesion of the iris, a portion of which is caught in the sclerotic wound; we shall find that the remainder of the membrane is tremulous, the pupil irregular and without capsular reflections, if the lens has been dislocated in its capsule. When, however, it has been ruptured, the *débris* will be found in the pupillary field. Again, at the point indicated, a small tumour, having the characteristic form of the lens, is observed.

We may remove the lens through a small incision made in the conjunctiva over the tumour. A compress must be kept on for several days.

(*d.*) **Complete expulsion of the lens from the eye** has been observed after such severe contusion of the eyeball as has produced a large wound in the sclerotic and cornea—*e.g.*, after a blow from the horn of an ox. Strange to say, eyes damaged in this way

have been known to recover, notwithstanding the serious nature of the injury. The absence of the lens is then easily detected by the symptoms already indicated—viz., tremulous iris, absence of the capsular reflection, alteration in the refraction of the eye.

At the time of the accident, it suffices to clear the wound, to excise the herniæ of the iris, and to apply a compressive bandage.

In our **prognosis**, it is important to remember that, notwithstanding an apparent recovery, eyes which are so seriously injured often become atrophied. This is the result of chronic inflammation due to the enclosure of the iris or ciliary body in the wound, or may supervene after separation of the retina. We must also consider the risk of sympathetic ophthalmia.

ART. III.—Aphakia, Absence of the Lens.

The term **aphakia** is applied to that condition of an eye in which luminous rays in their course from the cornea to the retina do not encounter the crystalline lens, which has either been removed by operation, or has been dislodged from the pupillary field by dislocation.

The symptoms of this condition are:—Tremulous iris, its support being gone, absence of the capsular reflections, and, again, the peculiar state of the refraction of the eye.

The refractive power of the eye is considerably diminished by the absence of the lens, so that luminous rays are no longer brought to a point on the retina, but considerably behind that membrane. If the eyeball is of normal length we have thus a high degree of hypermetropia, sometimes complicated with astigmatism, which should be corrected by strong convex or cylindrical glasses, the choice of which will be explained in the next chapter.

The lens being also the organ of accommodation which allows the eye to see near at hand as well as at a distance, this power will be absent in aphakia. Eyes in which the lens is absent, when provided with glasses, can only see distinctly at one distance; they require a different glass for each separate distance at which the patient wishes to work. The method of choosing these glasses is explained in the following chapter.

CHAPTER X.

REFRACTION AND ACCOMMODATION.

Physiology.—When luminous rays enter the eye, they encounter a collection of refractive media denser than the air (cornea, aqueous humour, lens, vitreous body), which causes them to deviate in the same way as does a system of biconvex lenses.

Let us, therefore, in a few words recall the laws which regulate the formation of images by such lenses, and, in so doing, we shall explain the laws of refraction in the eye.

By **refraction** is meant the deviation which a luminous ray undergoes when it passes from one medium into another. Further, we know that if a luminous ray passes from one medium into a denser, it is refracted towards the normal at the point of incidence, whilst, if into a rarer, it is refracted away from it.

All luminous rays which are parallel to each other, after being refracted by a convex lens, converge to a point which is called the *principal focus* of the lens, which point coincides with its centre of curvature. For example, a lens made of a convex sphere, which has a radius of curvature of 25 centimetres, will have its focal distance at 25 centimetres (see Fig. 152). All rays which come from a great distance are practically considered as parallel.

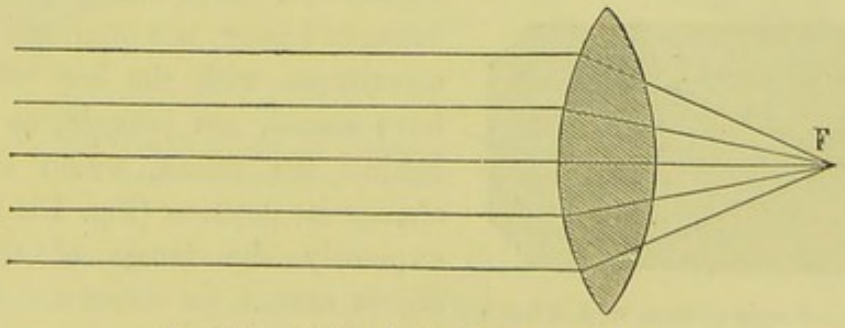


Fig. 152.—F is Principal Focus of Lens.

The more the luminous source approaches the lens, the farther does the focus recede from it. If the luminous point coincides with the centre of curvature, the luminous rays which come from it are parallel to each other on leaving the lens; they do not form a focus. If the luminous source is placed between the principal focus and the lens, the refracted

rays diverge, and do not come together, although it should be stated that their prolongations meet in front of the lens at the point known as the *virtual focus*.

Luminous points situated between infinity and the centre of curvature of the lens, and the points at which the rays emanating from these points are brought to a focus, are said to be *conjugate foci*, for their relation is such that the focus and luminous point are reciprocally the foci of each other. In Fig. 153, F and *f* are conjugate foci, for if the luminous source is at F, the focus will be at *f*, and *vice versâ*, C being the principal focus.

Refraction of Light in the Eye.—In the normal (emmetropic) eye, the refractive power of the dioptric apparatus is such that luminous rays coming from a very distant point are brought to a focus on the retina, or, to be more exact, on the layer of rods and cones (Fig. 154).

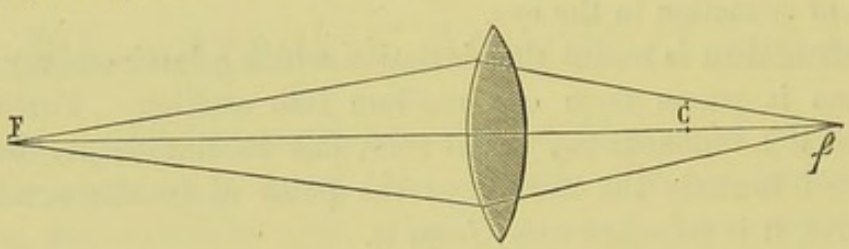


Fig. 153.—Conjugate Foci.

Again, in order that vision be clear and distinct, the focus of the luminous rays must *always* be formed on this layer of the retina. This condition is fulfilled, as we have shown, in the normal eye for distant objects, whose image is thus naturally formed on the retina by the simple refractive power of the media in relation with the length of the eye. But when the object is brought nearer, the luminous rays, in accordance with the law which we have stated, are brought to a focus behind the retina, which does not change its position (Fig. 155). Consequently the image of the near object cannot be distinct. Yet, we see objects distinctly near at hand as well as at a distance. There must, therefore, be some change in the eye, the intervention of some force modifying the relations of the refraction of the ocular apparatus and its length; this is the *power of accommodation*.

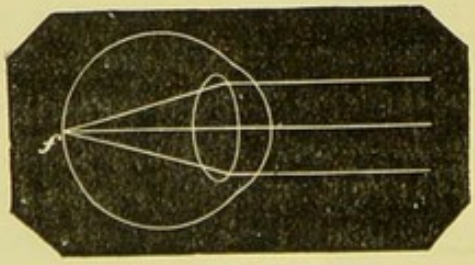


Fig. 154.—Focus of rays which have been parallel before entering the normal eye.

Accommodation of the Eye.—Modern researches have demonstrated that the eye, when it looks at a distance, is in a state of

absolute rest, and when it looks near at hand undergoes the following changes :—The anterior surface of the lens becomes more convex and approaches the cornea; the posterior surface scarcely becomes any

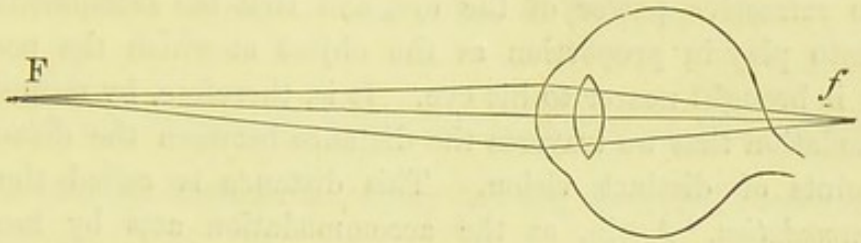


Fig. 155.—Course of luminous rays coming from the near point, F, entering an eye accommodated for a greater distance.

more convex, and does not perceptibly change its position (Fig. 156) (*Cramer, Helmholtz*).

Opinions are divided as to the exact mechanism of accommodation. According to one theory, the contractions of the ciliary muscle bring its two points of insertion—that is to say, the periphery of the iris and choroid—nearer each other. As the zonule of Zinn is intimately connected with the choroid, the forward movement of the latter must relax the zonule, and the lens, being allowed to respond to its own natural elasticity, becomes more convex. *H. Müller* is of

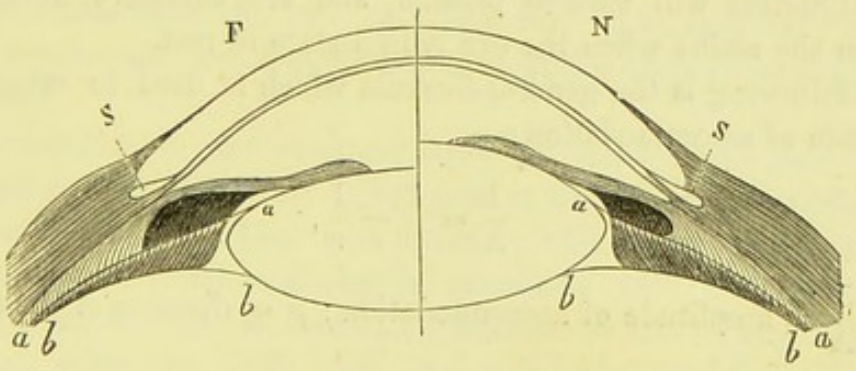


Fig. 156.—F, Adaptation of eye for distance; N, adaptation for near; S, canal of Schlemm; *a*, anterior capsule; *b*, posterior capsule.

opinion that the circular fibres may, by their ciliary processes, press on the equator of the lens, thereby making it more convex; drawing backwards at the same time the peripheral insertion of the iris. Simultaneously, the radiating fibres relax the suspensory ligament; besides they draw the choroid forward, and thus increase the pressure of the vitreous body on the lens, which is carried forward against the iris; but the iris, being contracted, offers resistance, and the lens becomes more convex, as it were yielding at that point where it is not supported by the iris.

This much is certain, that accommodation for near objects is effected by the lens and ciliary muscle.

Measurement of the Accommodation.—We have already seen that, in normal conditions, vision for very distant objects requires only the refractive power of the eye, and that the accommodation is called into play in proportion as the object at which the person is looking is brought nearer to his eye. It is, therefore, by means of the accommodation that we traverse the distance between the distant and near points of distinct vision. This distance is called the *range of accommodation*. Again, as the accommodation acts by increasing the convexity of the lens, we may, following the example of *Young* and *Donders*, compare the lens of an eye at rest and the lens of an eye accommodating for a given distance to two convex lenses of different strength.

The accommodative power of an eye must, therefore, be equal to the optical effect of a convex glass, which, when added to the lens in a state of accommodative rest (punctum remotum), will enable the eye to see the near point of distinct vision (punctum proximum).

The normal (emmetropic) eye has its distant point of distinct vision at infinity; if its punctum proximum is at 10 centimetres from the eye, the range of accommodation is equal to a convex glass which has a focus of 10 centimetres. All rays passing through that glass from 10 centimetres will emerge parallel, and are, therefore, brought to a focus on the retina when the eye is in a state of rest.

The following is the general formula which is used to calculate the amplitude of accommodation:—

$$\frac{1}{A} = \frac{1}{p} - \frac{1}{r},$$

where $\frac{1}{A}$ = amplitude of accommodation; p = distance of the punctum proximum from the eye; r = distance of the punctum remotum from the eye.

In the emmetropic eye, we know that $r = \infty$, therefore $\frac{1}{r} = 0$; therefore $\frac{1}{A} = \frac{1}{p}$. For example, when the punctum proximum is $0^{m}{\cdot}20$ from the eye, we have $\frac{1}{A} = \frac{1}{0{\cdot}20} = 5$ dioptries (5 D). *

* By dioptrie is meant the refractive power of a lens which has a focal length of 1 metre. A lens of two dioptries has twice the refractive power of a lens of one dioptrie; its focal length is therefore 50 centimetres.

In the myopic eye the punctum remotum is at a fixed distance; if the punctum remotum is at $0^{m}{\cdot}50$ from the eye (myopia $= \frac{1}{0{\cdot}50} = 2$ D), and the punctum proximum at $0^{m}{\cdot}20 = 5$ D, we have $\frac{1}{A} = 5$ D $- 2$ D $= 3$ D.

In the hypermetropic eye, which is adapted for rays which converge to a point situated behind the retina, $\frac{1}{r}$ is negative, and therefore must be added to $\frac{1}{p}$. If $p = 0^{m}{\cdot}20$ and $-r = 0^{m}{\cdot}10$, $\frac{1}{A}$ will be equal to $\frac{1}{0{\cdot}20} + \frac{1}{0{\cdot}10} = 5$ D $+ 10$ D $= 15$ D.

In practice, we obtain a sufficiently exact result by finding the farthest and nearest points of distinct vision for test-types of a certain size.

In this way the *absolute accommodation* of the eye is measured; we have still to examine *binocular accommodation*.

In the normal condition, the most distant point of distinct binocular vision is the same as that of monocular vision. But the near point is no longer the same, one eye alone being able to see distinctly at a shorter distance than the two eyes together. The amplitude of the absolute or monocular accommodation thus differs slightly from that of the binocular.

This diminution in the accommodation is easily understood when we remember that to see an object near at hand we must make the eyes converge on it. There is a limit to this convergence, and as the movement of accommodation is associated with the movement of convergence, the one is necessarily limited by the other. On the other hand, when we look with one eye only, the movement of accommodation, which is then not limited by convergence, may be greater.

But the power of convergence and the power of accommodation are, to some extent, independent of each other, as may be proved in the following manner:—If we look with both eyes at an object at some little distance (say 3 metres), and then place before one of the eyes a weak prism with its base turned outwards, which has the effect of diverting the retinal image towards the side of the base, the retinal image will be carried beyond the fovea centralis.* At first there is

* The fovea centralis is the most sensitive part of the retina. In order that an object be seen singly with both eyes, an image must be formed on the fovea of each retina, or at least on corresponding points of the retinæ.

diplopia: to correct this, the eye before which the prism is placed converges, so that the posterior pole of the eye, that is to say the fovea, is turned outwards. Notwithstanding this movement of convergence, the object is distinctly seen with both eyes, which could not be the case if the contraction of the internal rectus was accompanied with accommodation.

There is another method of proving the independence of the two movements. When we look at an object close at hand the two eyes converge upon it; if now a weak convex glass is placed before one eye, the accommodation of that eye is relaxed; yet the convergence does not diminish, as the object is still seen singly. By observing the relations between convergence and accommodation, we can measure the amplitude of accommodation for any given degree of convergence, and thus obtain the *relative amplitude* of accommodation.

But in practice it is specially important to note here that there are two distinct parts in the relative power of accommodation; the one is *negative*, the other *positive*. To understand what is meant by this division of relative accommodation, let us take the following comparison:—

Let us suppose that an arm can lift and hold suspended for a certain length of time a weight of 50 lbs. at the height of a metre; if, instead of 50 lbs., 20 lbs. be taken, the entire force is not used, and a force equal to 30 lbs. remains unused; therefore it can sustain a weight of 20 lbs. longer than one of 50 lbs. It could sustain it till the spare force of 30 lbs. were exhausted. As soon as this takes place, the weight will fall. The force which is brought into requisition is called *negative force*, that which still remains at our disposal, the *positive force*.

The same thing takes place in the eye for the *muscular force of accommodation*. Everybody knows that although we may be able to read certain characters at a very short distance from the eye, yet we cannot do it for any length of time without fatigue; whilst if we try to read the same characters at a greater distance from the eye, a distance varying with the individual, we can do so for a much longer time.

To measure the *negative accommodation* (that which the person uses in reading at a certain distance), the strongest convex glass which enables him to see as distinctly at the same distance is placed before his eye. This convex glass replaces the increased curvature which the effort of accommodation had caused the lens to assume, and which is now no longer required; the eye returns to a state of rest. The number of the glass indicates the degree of accommodation employed—the negative accommodation.

To measure the *positive* part (that which the person has still at his disposal), we adopt a plan similar to that which we mentioned as

being applicable for the arm. If the arm has the strength to support a weight of 50 lbs., and if we require to add to the weight it sustains 10 lbs. before it gives way, we know that there must be in reserve a force represented by this 10 lbs. When an eye is made to look at any object we can always determine the amount of accommodation still at its command by placing before it the strongest concave lens which allows it still to see the object distinctly. To neutralise the effect of this glass the eye is obliged to call into action all the accommodation at its disposal, and thus this glass comes to be the measure of the *positive accommodation. The greater the amount of the positive accommodation, the longer will the eye be able to see at the same distance.*

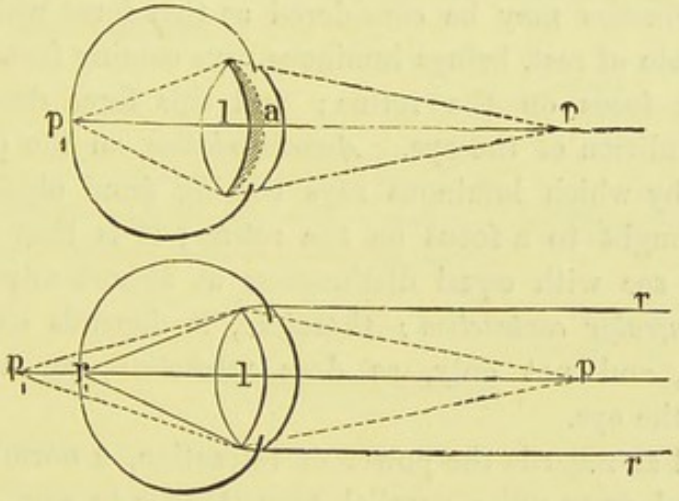


Fig. 156*a*.—Condition of refraction in the normal *passive* eye and during *accommodation.*

ANOMALIES OF REFRACTION AND OF ACCOMMODATION.

ART. I.—General Considerations.

The physiological considerations which have occupied our attention, show that *refraction* may be considered as that force which, when the eye is in a state of rest, brings luminous rays coming from very distant objects to a focus on the retina; and this force depends on the *anatomical* condition of the eye. *Accommodation*, on the other hand, is that power by which luminous rays coming from objects nearer at hand are brought to a focus on the retina; it is that power which allows us to see with equal distinctness at almost any distance. It is due to *muscular contraction;* therefore, it depends on the activity of a muscle, and not only, as does refraction, on an anatomical condition of the eye.

Considered as regards the power of refraction, a normal eye will be so constructed as to unite parallel rays, that is to say, those coming from a great distance, upon the retina. *Donders*, whose researches have thrown great light on these questions, has used the word *emmetropia* to

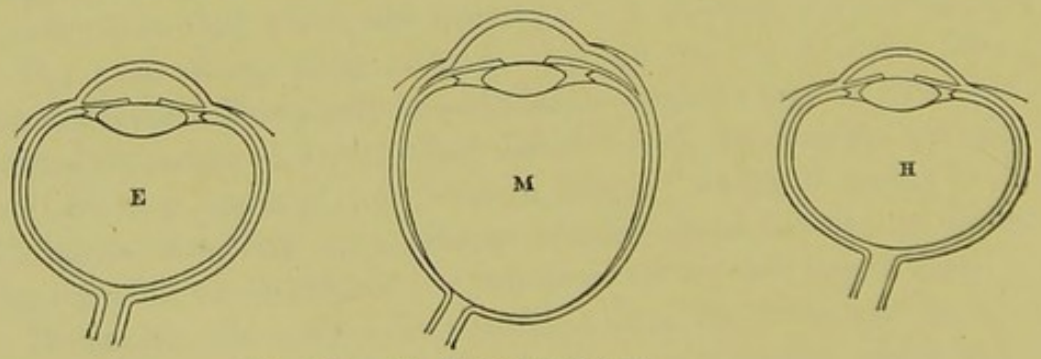


Fig. 157.—E, Emmetropic eye.
M, Myopic eye.
H, Hypermetropic eye.

signify in this respect the normal condition of eye (from ἔμμετρος, being the exact measure, ὤψ, the eye—Fig. 157, E). Besides the normal eye we meet with two kinds of anomalies (*ametropia*):—1st, Eyes in which luminous rays coming from a distance unite *in front of* the retina (Fig. 157, M); 2nd, eyes in which luminous rays unite *behind* the retina (Fig. 157, H).

In the first case, the refraction being too strong, or the eye too long, the point at which the luminous rays intersect is too near the cornea (Fig. 158); the distance is too short. *Donders* called such an eye *brachy*-metropic (*βραχύς*, short); but, as we shall see, this anomaly is the same as that to which the term *myopia* has always been applied, and an eye thus formed has preserved its classical name *myopic* (*μυεῖν*, to close).

In the second case the refractive power is too weak, or the organ too short, so that the point at which parallel rays of light intersect is behind the retina (Fig. 159); it is beyond the proper distance, and the eye is said to be *hypermetropic* (*ὑπερ*, above, beyond, *μετρον*, *ωψ*).

Considered then as regards refraction, *myopia* is the opposite condition to *hypermetropia*.

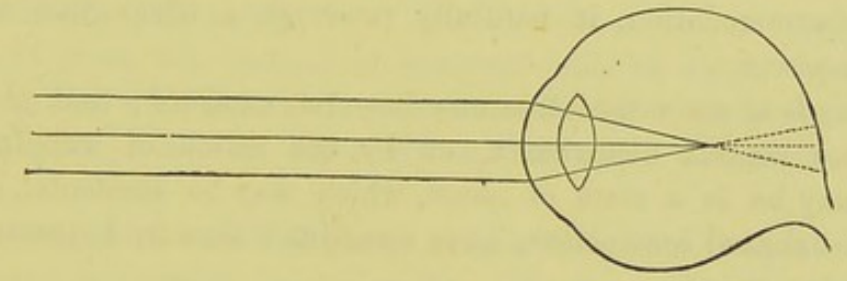


Fig. 158.—Myopic eye.

Accommodation, as we have seen, depends on a muscular effort. As age advances, the muscular powers diminish, and the lens becomes more resistant, and its curvature less easily changed. These two causes acting together gradually put the near point of distinct vision (*punctum proximum*, P P) to a greater distance from the eye (Fig. 160). When P P recedes beyond a certain distance, the condition is called *presbytia*, or better, *presbyopia* (*πρεσβύς*, old).

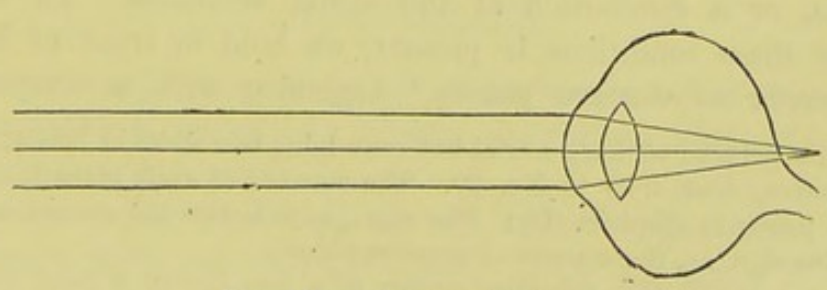


Fig. 159.—Hypermetropic eye.

Presbyopia is the normal condition in old age. It is not, properly speaking, an anomaly; it is a normal, physiological weakening; and we shall speak of it, when discussing the normal eye, as one of the phenomena of senile change in this organ.

As to *anomalies of accommodation*, properly so called, they may be situated in either of the two organs on which this function depends—

viz., the lens or ciliary muscle. The *lens* may, from disturbance of the nutrition, lose its elasticity; it may also be entirely absent (in the large majority of cases, after cataract extraction). This last condition

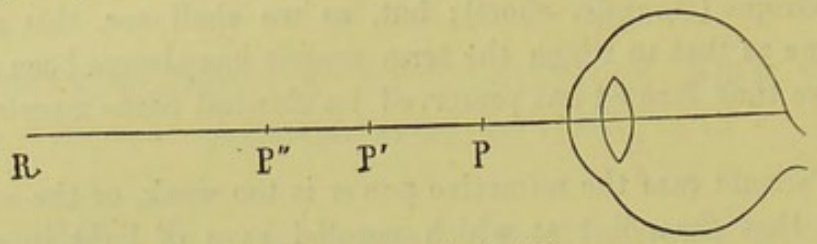


Fig. 160.—P, near point at 15 years.
P′, ,, 30 ,,
P″, ,, 40 ,,

has received the name of *aphakia* (*a*, privative, and *φακή*, lens), and will be discussed in connection with hypermetropia, since, besides the loss of accommodation, it naturally produces a diminution of the refractive power.

The *muscle* of accommodation may be—1st, *weakened;* 2nd, *paralysed* from some central disturbance, or by the action of atropine; or 3rd, it may be in a state of *spasm*, which may be accidental, or the result of habitual contraction, as is sometimes seen in hypermetropic and myopic persons.

What, then, are the means at our disposal for the diagnosis of these anomalies; for detecting and determining the nature of any ametropia; for the examination of the accommodation?

We have two methods of diagnosis—1st, trial made with a *series of glasses*, or convex and concave lenses; 2nd, *ophthalmoscopic examination.*

If we place the test-types at 6 metres in front of the patient, and if at this distance he is unable to read No. VI., there may be some ametropia, or a diminution of the visual acuteness. To find out which of these conditions is present, we hold in front of his eyes weak convex or concave glasses,* beginning with a comparatively

* For this purpose we have a trial-box containing two series of lenses, biconvex and biconcave, from 0·25 to No. 20. The number of each glass indicates its refractive power in dioptries (D); The sign, +, indicates the convex or positive glasses; the sign, —, the concave or negative glasses.

A *Dioptrie* equals the refraction power of *a lens having a focal distance of* 1 *metre*, and has been adopted as the unit of refraction in accordance with the metric system. 2 D indicates a lens having two units of refractive power, that is, a focal distance of 50 centimetres. 3 D is a lens having three units, that is, a focal distance of about 33 centimetres. 20 D equals a lens of 20 units and a focal distance of 5 centimetres. 0·25 D is a lens having only a quarter of a unit, that is, a focal distance of 4 metres; 0·50 D is half a unit, or a focal distance of 2 metres.

At the end of this book will be found a table of lenses in dioptries with the corresponding numbers of the old system.

weak glass, say 0·50 D (half a dioptrie). If a convex glass does not impair but even improves the vision, the person examined must be hypermetropic; if it is improved by a concave glass, then we are dealing with myopia.

To ascertain the degree of the anomaly, we try successively the glasses of the series, proceeding from the weaker to the stronger. The glass which gives the greatest distinctness of vision, and allows the patient to see No. VI. at 6 metres, indicates the amount of anomaly present. It is convenient to represent the amount of ametropia by the refractive power of the glass which must be added to an ametropic eye in order to bring parallel rays to a focus on the retina. Thus H 12 D means that there is a hypermetropia requiring a convex glass of 12 D (+ 12 D) to read No. VI. at 6 metres; M 20 D indicates a myopic eye, which requires a concave glass, No. 20 D (– 20 D), to obtain the same result.

To diagnose the amount of *hypermetropia*, we must stop with the *strongest glass* with which the person sees best at a distance; in *myopia*, on the other hand, we must choose the *weakest* which gives distinct vision.

The second method of diagnosis consists in *ophthalmoscopic examination*. This method is quite indispensable. We have already explained its principle (p. 11). In practice we use a *refracting ophthalmoscope*, which has, at the back of the reflecting mirror, the series of convex and concave glasses necessary for determining the refraction.

ART. II.—The Various Kinds of Spectacles.

Before pursuing further the study of ametropia and of the anomalies of accommodation, we wish to explain the various kinds of spectacles used in ophthalmic practice.

1. Glasses suited to protect the eye from foreign bodies, or from too strong a light, are called *preserves*. They are made of ordinary plain glass, and are hence neutral. Most frequently they are of a bluish tint, or of a shade called *smoked*. These glasses are merely for the purpose of diminishing the brightness of objects. The glasses should be as large as possible, to prevent peripheral rays entering the eye beyond their margins. For this purpose we sometimes use glasses shaped like a watch-glass, or protect the lateral parts with pieces of taffeta.

Such spectacles should only be worn out of doors, in broad daylight, or in artificial light. If the glasses are too dark they make the eyes very sensitive to light, and may also produce discomfort from the great amount of heat which they absorb.

2. *Stenopaic glasses* (στενος, narrow, and ὀπή, a slit), are of various forms. The trial glasses used in the diagnosis of astigmatism, which are also of great use in improving vision in cases of permanent corneal opacity consist of a metallic disc with a handle. This disc is provided with a slit, which can be increased or diminished at pleasure (Fig. 161); moreover, the disc can be rotated in its frame, so that we may turn the slit in every direction. Other stenopaic glasses are provided with holes of various sizes (Fig. 162). Ordinary spectacles may be arranged on this principle by partially covering them with black varnish, so as to leave a round hole or a slit of a given size free for vision.

3. *Prismatic glasses* are also used in ophthalmology. Luminous rays entering a prism are deviated towards its base (Fig. 163). When, therefore, a prism is put before an eye, luminous rays will be displaced on the retina towards the base of the prism. As the retina projects

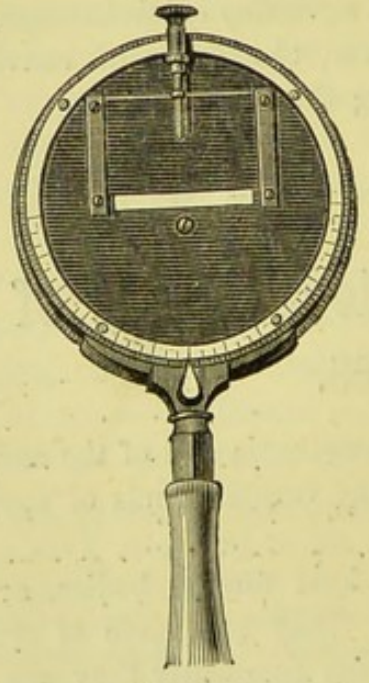


Fig. 161.

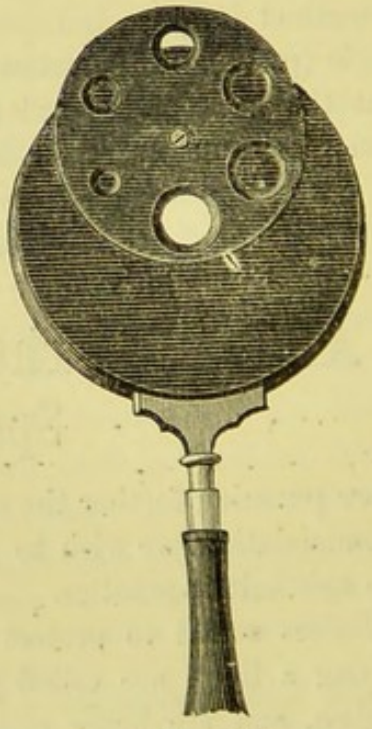


Fig. 162.

its impressions outwards in the same direction in which luminous rays approach it, the object seems to be displaced outwards in the direction of the prolongation of the deviated luminous rays, that is to say, towards the same side as the apex of the prism. If, therefore, one eye is provided with a prism, there must be binocular diplopia. The

free eye sees the object in its true position, the other sees it situated to the same side as the apex of the prism.

Consequently, when a prism is placed in front of the left eye, with its base outwards, the object is seen by this eye towards the

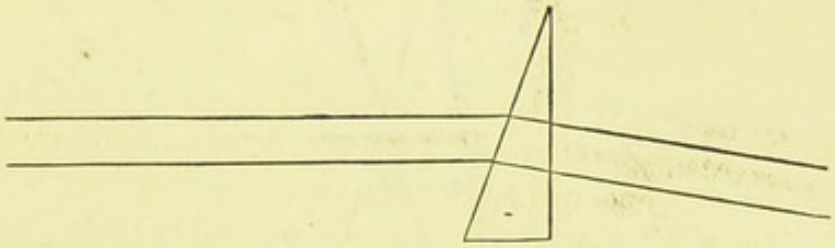


Fig. 163.—Luminous rays deviated towards the base of a prism.

right, the *diplopia is crossed* (Fig. 165). On the other hand, when the base is inwards, the double image is formed to the left of the object, and the diplopia is *homonymous* (Fig. 166). If the base is turned upwards or downwards, one of the images is superimposed.

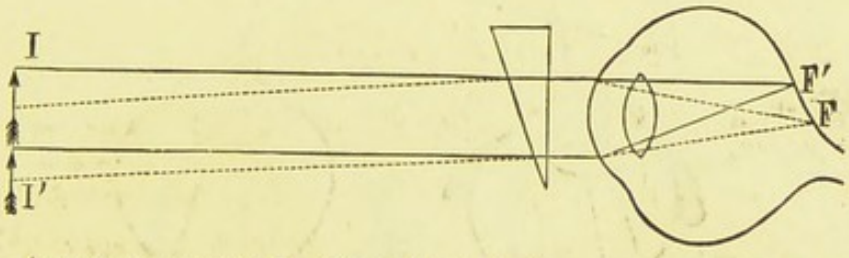


Fig. 164.—Apparent position, I′, of an object, I, to an eye provided with a prism.

We find that when the prism is not of a high degree, and is put with its base outwards before an eye, the diplopia only lasts for a moment; the second image approaches the object, and becomes fused with it. When this has taken place, if we examine the eye behind the prism, we shall find that it squints, and is turned inwards. What then has taken place? The explanation is contained in a few words. We have a natural antipathy to double images, and instinctively try to bring them as far as possible into one. To obtain this fusion, so that the object may be seen singly, each of the two images must be formed at the fovea centralis of the eye to which it belongs, or at least at an identical and corresponding point of the retina. The image in the eye provided with a prism, the base of which is turned outwards, is formed externally to the fovea centralis; to bring the fovea to coincide with the position of the image, the posterior pole of the eye must be turned outwards, consequently the anterior pole is turned inwards by an *isolated contraction* of the internal rectus muscle.

It is evident that the muscular contraction must be in proportion to the strength of the prism placed in front of the eye.

The same thing takes place with the external rectus when the base is turned towards the inner angle of the eye. Only, whilst the internal muscle can overcome a prism of more than 30° by its contractions,

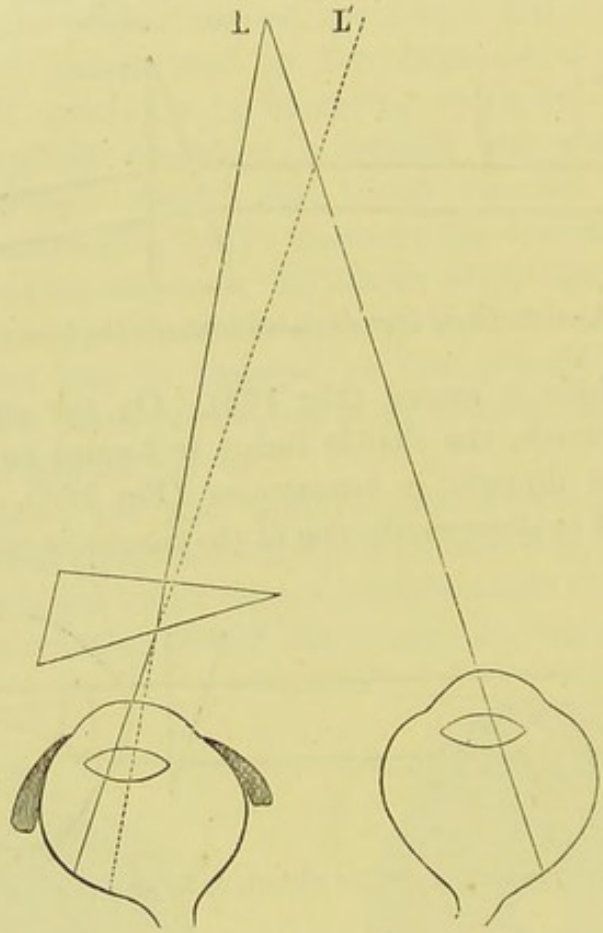


Fig. 165.—Effect of a prism with its base outwards: the object L is seen at L′ by the left eye. There is therefore diplopia, and since the right image comes from the left eye, and the left from the right, the diplopia is crossed.

the external rectus, in normal conditions, can scarcely counteract a prism of 8°. To make a superimposed diplopia permanent, a prism of 2° or 3° with its base upwards or downwards is sufficient.

4. It now remains for us to say something about spectacle glasses properly so-called, that is to say, about *convex* and *concave lenses*. We must here recall the optical law which says that *parallel rays entering a biconvex lens emerge as convergent rays*, and form a *real* but *inverted* image of the luminous object at a point on the axis of the lens at the distance of its centre of curvature, which point is called the *principal focus* of the lens (Fig. 167, F). Reciprocally, rays coming from the principal focus emerge parallel.

Parallel rays entering a biconcave lens emerge divergent, and, if projected backwards in the direction of the incident rays, they also meet at the *principal focus* (Fig. 168, F). In this case the focus is virtual, as is also

the image, which is erect. Reciprocally, rays coming from the focus (or rather converging rays whose prolongations intersect at the principal focus) emerge parallel to each other.

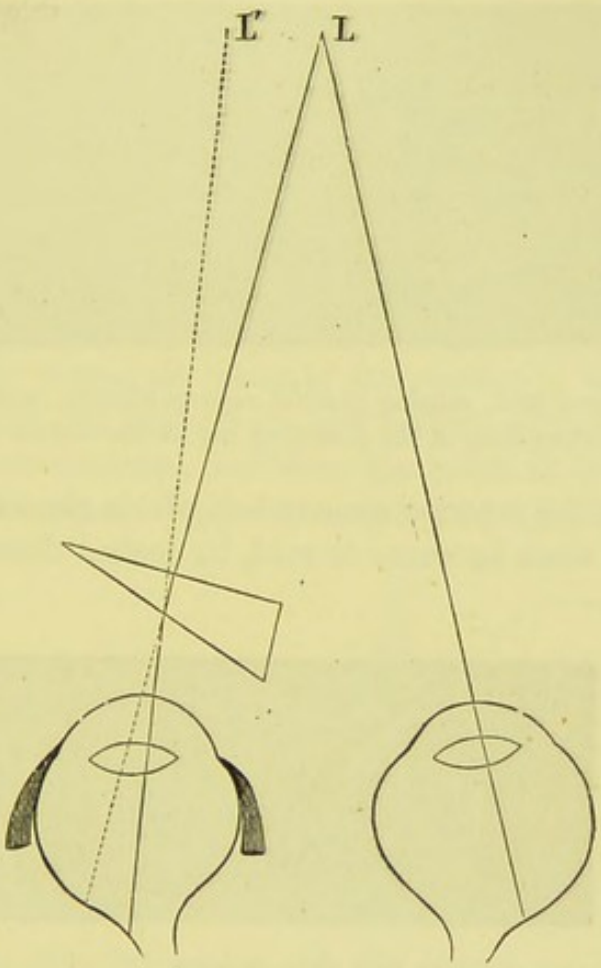


Fig. 166.—Action of a prism with its base inwards: the object L is seen at L' by the left eye; there is thus diplopia, and since the left image is seen by the left eye, and the right by the right, the diplopia is *homonymous*.

In addition to these lenses, there are also plano-convex and plano-concave (Fig. 169, B and E); but, on account of the strong *aberration* which they possess, they are seldom used in ophthalmology. *Meniscus*, or, as they are sometimes called, *periscopic*, glasses are more convenient (Fig. 169, C and F). They possess the advantage of refracting rays at some distance from the centre in the same way as they refract rays at the centre itself, so that persons using these glasses can see obliquely through them.

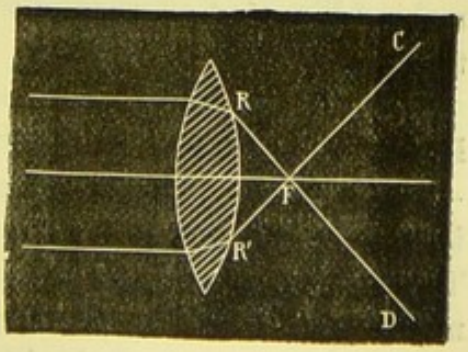


Fig. 167.—F, principal focus of the lens.

Franklin's glasses are seldom used. They are composed of two half lenses, the superior half being concave and the inferior convex. Franklin was myopic and presbyopic, so, when he looked at a distance,

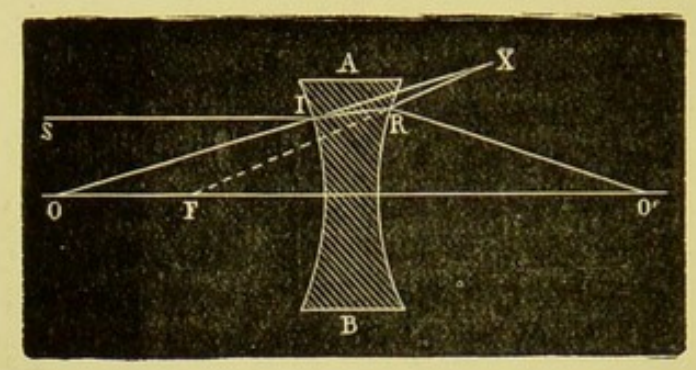


Fig. 168.—Biconcave lens, causing parallel rays to diverge, and uniting the backward prolongation of the diverging ray at the virtual focus, F.

he saw through the superior concave half of his glasses and his myopia was corrected; when he wrote or read, he looked through the inferior convex half.

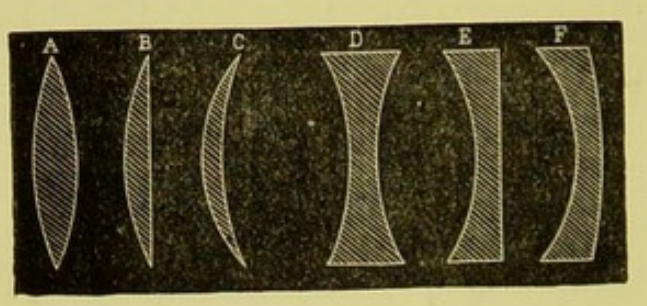


Fig. 169.—Lenses.

Such spectacles are very useful, and may be employed to measure roughly the positive and negative accommodation (p. 396); the convex glass indicates the amount of accommodation already expended, and the concave the amount still in reserve. The patient is examined by making him read alternately with the superior and inferior portions of the glasses.

On the same principles glasses of *double focus* have been constructed. For example, the superior half may have a refracting power equal to + 3 D, whilst the inferior is equal to + 6 D; or, again, we may have in the upper half a refraction of − 4 D, and in the lower of + 4 D. The two halves of these glasses are ground in a single piece, and are not composed of two separate pieces as are Franklin's.

When we come to deal with *astigmatism*, we shall speak of *cylindrical* and *conical glasses*.

In treating of each anomaly in particular, we shall see that the choice of proper glasses is one of the most important, as it is also

one of the most difficult parts of ocular therapeutics; at present we shall only speak of the influence exerted by glasses upon vision.

Convex glasses bring the near (P) and the remote (R) points of distinct vision nearer to the eye.

Concave glasses have the opposite effect; they cause rays to diverge, and remove the point R to a greater distance from the eye.

The change in the positions of P and R brought about by using glasses naturally alters the accommodation for any point, convex glasses diminishing the amount of accommodation required, whilst concave increase it; the absolute amplitude is, however, not perceptibly altered by spectacles. Again, glasses modify the size of an image on the retina, which depends on the arc of the retina subtended by the image; and the farther the point of intersection of the luminous rays is from the retina, the larger is the arc. Thus, as we have already seen, by making rays converge, we bring the point of intersection (nodal point) forwards; consequently, the nodal point (K, Fig. 170) is at a

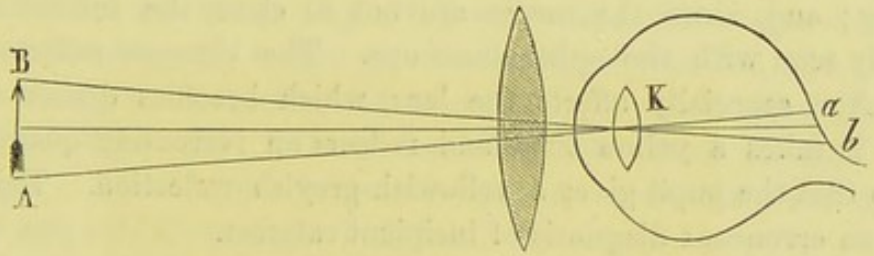


Fig. 170.—The point K is the nodal point.

greater distance from the retina, and the images are larger. Concave glasses on the other hand displace the nodal point backwards (Fig. 171),

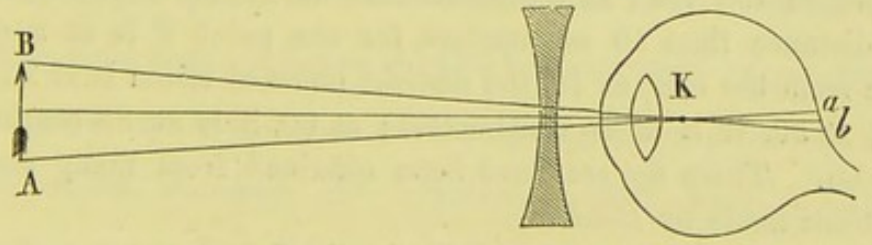


Fig. 171.

because they diminish the convergence of the rays; therefore the nodal point is brought nearer the retina and objects appear smaller.

ART. III.—Influence of Age on Vision—Presbyopia.

As age advances there is a *diminution of the visual acuteness* and a *gradual loss of the power of accommodation.*

The anatomical changes which accompany these functional disturbances are the following:—The cornea and conjunctiva lose their brilliancy; the anterior chamber becomes shallower; the pupil contracts; and the iris loses some of its pigment, becoming more transparent. The hyaloid membranes are thickened by the addition of fresh layers of hyaline substance, so that they also lose their normal transparency; indeed sometimes condylomatous excrescences are formed, which encroach upon the adjacent tissues (*Donders*). The sclerotic loses its elasticity; and, since the media are not so clear, the fundus is less distinctly seen with the ophthalmoscope. The vitreous reflects more light. Age especially affects the lens, which becomes denser at the centre; it takes a yellow tinge and reflects an increasing quantity of light, so that the pupil gives a yellowish-greyish reflection. This may lead to an erroneous diagnosis of incipient cataract.

All such changes must naturally influence the *visual acuteness* (V). At the age of 50, the visual acuteness is diminished by about $\frac{1}{5}$, $V = \frac{4}{5}$; at 60, $V = \frac{3}{4}$; at 70, $V = \frac{2}{3}$; at 90, $V = \frac{1}{2}$.

Again, the *power of accommodation is also diminished*, the near point of distinct vision receding gradually from the eye. At 10 years of age, a person can read at 7 centimetres; at 20, he cannot read at a nearer distance than 10 centimetres, for the point P is at a greater distance from the eye; at 40, the distinct point of vision is at 22 centimetres; at 50, it is at 45 centimetres; at 60, it is at 85 centimetres, and so on. These figures have been obtained from many series of observations made by *Donders.*

Is the **cause** of this gradual diminution of the power of accommodation to be sought for in the ciliary muscle alone, or is it to some extent due to changes in the lens? The power of Brücke's muscle, so far as its capacity grows and decreases with the general muscular powers, does not diminish at the age at which we find a diminution of the power of accommodation; but the lens, becoming more and more dense, presents a greater resistance to the action of this muscle. Again, we find that the diminution of the accommodation keeps pace with the sclerosis of the lens. For the same reason, the refractive

power of the eye also decreases, so that at about 70 years of age the point R is at a greater distance from the eye, in normal conditions it is beyond infinity, causing a slight amount of hypermetropia.

But in enumerating the physiological causes of the diminished range of accommodation, we must, in the second place, add to the loss of elasticity in the lens a diminution in the power of the muscle of accommodation. This diminution of power, which only comes on at an advanced period of life, as a part of the general decline of the muscular strength, is of all the greater importance, that the sclerosis of the lens requires then a much greater force to produce the accommodative changes.

When the loss of power of accommodation is so great that the near point of distinct vision is at least at 22 centimetres from the eye, we say that the person is affected with *presbyopia*.

A person so affected generally finds that he cannot read so easily as formerly, especially in the evening, when the eye is fatigued or the light bad, and he is obliged to hold the book at a greater distance whilst he tries to let the light fall on it as much as possible. At the new distance, the letters are less easily recognised, and reading becomes disagreeable at first in artificial light, and before long, in ordinary daylight also. From this time the person is said to be presbyopic. This begins in emmetropia at about forty-five or fifty years of age, subject to slight individual differences.

The **degree** of presbyopia is indicated by the Number of the convex glass which brings the near point of the person's distinct vision to about 22 centimetres. Let this point be 40 centimetres; if we wish to find what glass will allow him to see at 22, we must make the following calculations:—

An emmetropic eye, without accommodation, to be adapted for 22 centimetres, must have its power of refraction increased by $\frac{1}{0{\cdot}22} = 4{\cdot}5$ D. The presbyopic eye with which we are dealing has a power of accommodation which increases its refractive power by $\frac{1}{0{\cdot}40} = 2{\cdot}5$ D. Consequently, there is a difference between the power of accommodation which it still possesses and that which is required, equal to a convex lens of $4{\cdot}5\text{ D} - 2{\cdot}5\text{ D} = 2\text{ D}$. No. + 2 D, therefore, indicates the convex glass which is necessary, as also the degree of presbyopia.

Let us now consider the effect of presbyopia in hypermetropia and myopia.

A hypermetropic eye becomes sooner presbyopic than an emmetropic one. It already requires a part of its accommodation to see at a

distance; and, therefore, at an early age has not a sufficient range of accommodation for near vision. In hypermetropic eyes, the presbyopia is measured after the hypermetropia has been corrected; and the glass which is required for work must correct both the defective refraction and the loss of accommodation. For example, if the hypermetropia be 3 D, when the punctum proximum is at 40 centimetres (presb. = 2 D), the glass required for distinct vision near at hand is 3 + 2 = 5 D.

There are some cases of myopia which never become presbyopic. In such cases, the point R, the remote point of distinct vision, is never beyond 22 centimetres. But when the degree of myopia is less, the eye becomes presbyopic with age, although at a more advanced age than in emmetropia, and this circumstance has led people to suppose that they were getting less myopic. In reality, the myopia does not diminish, for the distant point of distinct vision, R, remains the same, only the near point, P, is at a greater distance from the eye. The degree of presbyopia is measured in myopia in the same way as in emmetropia.

Treatment of Presbyopia.—When we detect the first symptoms of presbyopia, by the patient complaining that his eyes become easily fatigued, especially with reading at night, that letters appear to him less distinct, and that small objects are no longer seen distinctly, as they have to be held at some distance from the eyes, we should prescribe such *convex glasses* as will allow him to see near at hand for a longer time, and without fatigue.

We must not in these cases allow the patient to do without his glasses, and so fatigue his eyes under the vain pretext of strengthening them by exercising them; experience shows that such exercise, far from strengthening the eyes, serves only to weaken them.

At first, a presbyopic person will use a very weak convex glass, No. 0·50 D, for example, and will find the need of so doing, especially in the evening. When the patient can work in daylight without fatigue, it is then better to abstain from wearing glasses, reserving them for work done by artificial light. As age advances, and as the accommodation of the eyes decreases, the presbyopia requires to be corrected by stronger and stronger convex glasses; and the question comes to be, how do we, in each individual case, determine the lenses necessary to correct the amount of presbyopia? These glasses may be found by trial with the series of convex glasses, beginning with the weakest. We select the first glass, which allows a patient to read with comfort at 22 centimetres from his eyes, for it is evident that with this glass he can work still more easily at 30 or 35 centimetres, which is the distance generally preferred for reading or writing.

As the range of accommodation of emmetropic eyes decreases, all

other things being equal, proportionately with the age of the person, it has been possible to construct a table which approximately gives the glass required to correct the presbyopia for any given age.

Age.		Number of Glass.
45	+	0·75 D
50	+	1·50
55	+	2·25
60	+	3
65	+	4
70	+	5
75	+	6
80	+	7

Although the convex glasses indicated in the above table may suffice in emmetropia as the starting point of our examination, we must also take into account in our ultimate selection any special circumstances in the case. When a presbyopic person is obliged, by the nature of his occupation, to work at very small objects and, therefore, at very short distances, we must then select a stronger glass than that which a person at his age ordinarily requires. On the other hand, weaker glasses suffice for persons who work at a greater distance than that at which a book is held (for example, artists, musicians, &c.) Proper glasses may easily be chosen, according to the principles already established, by direct trial with convex glasses.

As a general rule, we must avoid giving too strong glasses at first. Although the patient may be able to see well with them for the moment, he will not be able to use them constantly on account of the sensations of dizziness, twitching, and even nausea, which are occasioned. The same thing occurs when much stronger glasses are given than the patient has been in the habit of wearing. Hence, it is better for the first time to prescribe glasses which are rather too weak, and afterwards gradually to replace them by stronger ones.

Little need be said as to the *form of spectacles* which a presbyopic person should use. Round or oval glasses are most generally used, and are the most suitable. For persons who, while at work, wish occasionally to look at a distance without removing their glasses, we may make a special form of spectacle frame (flattened above), so that they can see over the tops of the glasses. In like manner, when persons are hypermetropic or myopic, we may give glasses with a double focus.

When we order strong convex glasses, the two glasses should be fixed nearer each other than when we order weaker spectacles; for a presbyopic person must look as much as possible through the external parts of the lenses, for the following reason:—The use of strong convex glasses for near objects notably deranges the accommodative

functions and the convergence of the eyes, the former being weakened, and the latter augmented, in a marked degree, according to the distance of the object.

This convergence, if it exceed a certain amount, becomes the source of the fatigue which persons complain of who have begun to wear convex glasses, or have made a change in the strength of the lenses, or are using them too strong. We may supply this convergence by prismatic glasses with the base turned inwards, which, therefore, deviate inwards rays of light coming from an object, and outwards the image as seen by the eye. If now we look at a biconvex lens, we see that it may be considered as composed of two prisms with their bases in opposition to each other; the summit of one is outwards, and the presbyopic person must look through this external part of the biconvex glass, if he would save the muscles of his eye the effort of extreme convergence. In cases of true insufficiency of the internal recti, convex glasses must be combined with prisms, as will be fully explained in our chapter on diseases of the muscles of the eye. (See chapter on Muscular Affections of the Eye.)

ART. IV.—Hypermetropia.

Any eye is said to be hypermetropic in which rays from a distance, instead of uniting on the retina, unite behind that membrane (Fig. 172).

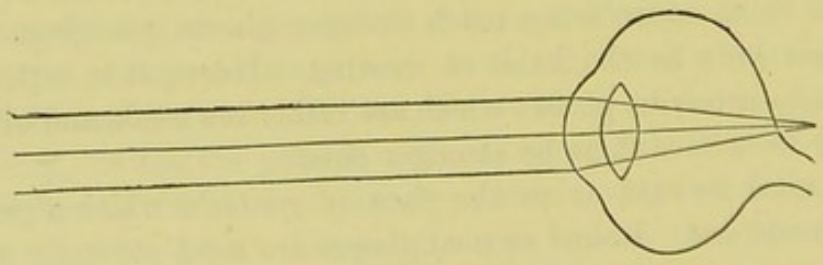


Fig. 172.—Hypermetropic eye at rest; the focus is placed behind the retina.

Instead of being brought to a focus on the retina, they produce on it only diffuse circles of light. The refractive power of a hypermetropic eye is insufficient in proportion to its length. To unite on the retina of such an eye, luminous rays must be convergent previous to entering it. All light emitted by a luminous point strikes the eye in parallel or divergent rays, according to the distance of the luminous point from the eye. For this reason hypermetropic eyes, being unable to bring to a focus on the retina the rays which exist in nature, cannot, by means of

their refraction alone, see distinctly any objects, whatever be their distance.

But parallel or even divergent rays may be rendered convergent by means of a biconvex lens. If then we wish to procure for the hypermetropic eye convergent rays which it can bring to a focus, we must place before it a convex glass (Fig. 173). The refractive power of

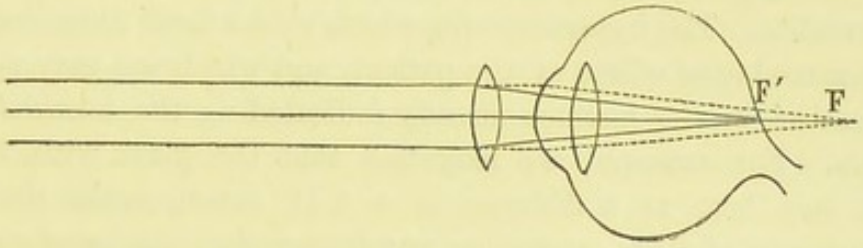


Fig. 173.—Focus F of a hypermetropic eye brought to F′ on the retina by a convex lens.

this glass, that is to say, the number of dioptries which must be added to place the hypermetropic eye in a suitable condition for focusing parallel rays on the retina, will indicate the degree of hypermetropia. Thus, if a convex glass of 4 D allows the patient to read No. VI. of the test scale at 6 metres, the hypermetropia is 4 D (H = 4 D); if it is 2·50 D, the hypermetropia is 2·50 D (H 2·50 D).

A convex glass acts by bringing the focus of the luminous rays from behind the retina on to its surface, and the number of dioptries which must be added to the refractive power of the eye to do so, expresses the degree of hypermetropia. The Number of the *strongest* convex glass with which we can attain the greatest visual acuteness is the number of dioptries which must be so added.

A very important distinction must be drawn between two different kinds of hypermetropia—viz., *latent* hypermetropia (Hl), and *manifest* hypermetropia (Hm). The hypermetropic eye, as we have already

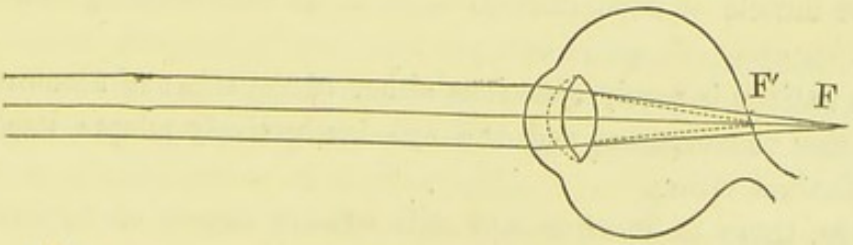


Fig. 174.—Hypermetropic eye; parallel rays are brought from the focus F to the retina at F′ by an effort of accommodation.

seen, cannot in its static condition bring parallel rays to a focus on the retina; but if such an eye makes an effort of accommodation, the lens is rendered more convex, and its refractive power is increased;

and if the increased refractive power of the lens is equal to the glass which is the measure of the hypermetropia, this last is corrected, and parallel rays are brought to a focus on the retina (Fig. 174).

At the first glance, it might seem to us that an eye, in which the defective refraction is concealed by its power of accommodation, was normal, or, at least, when the accommodation is not sufficient to correct the hypermetropia, that the hypermetropia was much less than it is in reality. The hypermetropia which shows itself notwithstanding the accommodative efforts of the patient, and which we may recognise and measure in the manner already indicated, is the *manifest* hypermetropia. For example, we may find that the glass with which a patient sees best at a distance is + 2 D, consequently there is a hypermetropia of 2 D; again, on paralysing the accommodation with atropine, we find that a glass of 6 D is required to bring parallel rays to a focus on the retina; therefore the *total* hypermetropia is 6 D. The increase of hypermetropia which is found after the action of the atropine, is the *latent* hypermetropia; in our example it is 6 − 2 = 4 D.

Hypermetropia in general embraces three varieties, which, as we shall presently see, are only different *degrees* of the same. They are—*absolute hypermetropia, relative hypermetropia* and *facultative hypermetropia.*

Absolute hypermetropia is the highest degree. In this case the eye is in such a condition that, with the greatest possible effort of accommodation, it cannot neutralise the defect in its refraction so as to bring parallel rays to a focus on the retina. It always requires convex glasses for distant vision.

In **relative hypermetropia,** the defect of refraction is less, and the patient may succeed in bringing parallel rays to a focus on his retina by a great effort of accommodation. But, in exercising this amount of accommodation, he makes his eyes converge, in consequence of the physiological relations which subsist between the internal recti and the muscle of accommodation, as if he were looking at some near object.

The patient is rarely conscious either of the effort of accommodation, or of the convergence, and the eye instinctively adapts itself for the most distinct vision.

Again, there is another and still weaker degree of hypermetropia, which has received the name of **facultative.** In it the patient can focus parallel rays by a very simple effort, without using a large amount of his accommodation, so that his optic axes preserve their parallelism. At the same time the patient sees as clearly with a convex glass as without it, which would not be the case were his eye normal (emmetropic).

When we examine any patient as to the state of his refraction, in the manner already indicated, we cannot fail in our diagnosis of hypermetropia; but other circumstances may have already led us to suspect its presence. These circumstances, however, will be more easily understood when we speak of the *causes of hypermetropia.*

Hypermetropia is generally congenital; but it may also be acquired, as in cases where the lens is absent, and, again, when ulcerative processes lead to cicatricial flattening of the cornea. The flatter the cornea the less does it refract luminous rays. Further, senile changes produce a certain flattening of the lens, and thus diminish the power of refraction. Lastly, we find a certain disposition to hypermetropia in cases of glaucoma.

But **congenital hypermetropia** is by far the most common, and is caused by the anatomical form of the eyeball. Hypermetropic eyes are smaller and rounder, and have a shorter antero-posterior diameter than normal eyes. By making such an eye turn as far as possible inwards, we see that the eyeball is relatively flatter from before backwards. There seems to have been some delay in the development of these eyes. This arrest of development is also observed in the orbits, which are narrower, and sometimes also in the entire face.

The faces of hypermetropic people are, as a rule, flatter, and the eyes seem to be farther apart, especially if the degree of hypermetropia is high.

Again, owing to the form of the eye the fovea centralis is at a greater distance from the optic nerve, and consequently the axis of vision passes more to the inner side of the centre of the cornea than in the normal eye. Thus it happens that in hypermetropic persons the eyes are turned slightly outwards when they wish to bring any object at which they may be looking into the axis of vision. Hence persons who have a very high degree of hypermetropia may even appear to be affected with divergent strabismus. We need scarcely say that in such cases the strabismus is only apparent.

Much more frequently we find hypermetropia associated with convergent strabismus; and so generally is this the case that when we have a convergent strabismus we should always suspect the presence of hypermetropia (see chapter on Strabismus).

Thus, by simple inspection, without having recourse to examination with glasses, we can often detect a pronounced hypermetropia. Again, patients never fail to tell us that they do not see so well near at hand as at a distance, and that their eyes get very easily tired when their work requires close application. This feeling of fatigue in the eyes is accompanied with pains in the periorbital region, and sometimes with headache. This is a symptom which at once sets us on the track of

the diagnosis. Hypermetropic people, especially if they work on objects close at hand, and if their hypermetropia is high or the power of accommodation disminished, cannot be assiduous at their work; they are obliged to stop it from time to time to take rest.

When we place a feeble convex glass before a hypermetropic eye, the patient sees at least quite as well at a distance with it as he did without it, because part of the accommodation which he required to see at a distance is now relieved. If the degree of hypermetropia is so great that his unaided accommodation cannot neutralise it, he will even see better at a distance. This one fact, that *distant* vision is as good with the convex glass before the eye, or even better, renders the diagnosis of hypermetropia certain. Its degree is expressed, as we have already said, by the strongest convex glass which gives the maximum of visual power.

On ophthalmoscopic examination by the *direct method*, the accommodation of both the surgeon and the patient being perfectly at rest, the emmetropic examiner can distinctly see the fundus only by using a convex glass. The strongest convex which he can use for this purpose indicates the amount of hypermetropia.

If the examiner replaces the convex glass by calling into action his own accommodation, he will be able to see the fundus, and, if he can estimate the effort of accommodation which he makes, he may even determine the amount of hypermetropia. On the other hand, it must be remarked that when the eye which is being examined is highly hypermetropic, we can at a greater distance see some of the details of the fundus by simply illuminating it with a mirror without using the correcting lens. The image thus perceived is a direct image, as may easily be ascertained by causing the patient to make slight lateral movements with the head, or by rotating the mirror, for the image is then displaced in the same direction.

Mention must here be made of a peculiar state of vision which has been described by various authors under the names of *hebetudo visus*, *kopiopia* and *presbyobic amblyopia*, and for which the term *asthenopia* has now been adopted. Let us pause for a moment on this important symptom which so generally accompanies hypermetropia. We have already seen that what distinguishes an emmetropic person from a hypermetropic, is that the latter must use some of his accommodation to see at a distance. An emmetropic person has, during youth, ordinarily at his disposal a great power of accommodation, which allows of his seeing distinctly from great distances to within 10 or 15 centimetres (4 or 6 inches) of his eye. As a rule, for his usual occupations he only uses a portion of this power, perhaps a half; consequently he holds in reserve a quantity sufficient to permit of a long continuance of the

muscular work. The hypermetropic person, on the other hand, has already used some of his accommodation to see at a distance, and when he wishes to look near at hand, he has not so much more at his disposal. Thus, after a certain time, the hypermetropic eye becomes tired and even incapable of continuing its work notwithstanding all its efforts. We have then a group of symptoms, which have been united under the name of *asthenopia* (*a*, privative, *σθένος*, force, *ὤψ*, the eye). The patient affected with this weakness tells us—"When I begin to read or write, at first I see very well; but, after using my eyes for some time, I suffer from a feeling of heaviness in them and of pressure on the forehead; the letters of the book which I am reading get mixed together, and I am obliged to stop. After a short rest, after rubbing my eyes, I can begin anew, only to feel again fatigued; and, having struggled on for a short time, at last I feel quite unable to continue my work. In the morning, I am less easily fatigued; the same is true on Monday after the rest of Sunday."

Sooner or later, any hypermetropia is complicated with asthenopia. Again, in a great number of cases of facultative hypermetropia, as long as the individual is young, and his power of accommodation good, there is no asthenopia; but when he becomes older, presbyopia supervenes, the quantity of reserve accommodation is diminished, and asthenopia shows itself.*

The age at which asthenopia appears in cases of facultative hypermetropia is in proportion to the degree of hypermetropia, and asthenopia is met with sometimes still earlier, but only in a passing form, among those hypermetropic persons who have suffered from general debility, loss of blood, serious disease, &c., preferably amongst those who require to see very near at hand, as, for example, those who do fine needle work in the evening.

Since this accommodative asthenopia must be connected with the existence of hypermetropia, naturally it will be relieved by those means which neutralise the hypermetropia—namely, by convex glasses. Whenever the first symptoms of asthenopia show themselves, convex glasses must be given, before the more troublesome nervous symptoms have time to appear. These symptoms are supra-orbital neuralgia, hyperæsthesia of the retina, with sometimes photophobia and lachrymation. The patients must be warned to wear their spectacles constantly whilst at work, under pain, if they neglect to do so, of being again seized with the same symptoms. The treatment of accommodative asthenopia is now inseparably connected with that of hypermetropia.

* Asthenopia, which we consider here in connection with hypermetropia and accommodation (*accommodative asthenopia*), may also be produced by weakness of the internal recti muscles (muscular asthenopia) or by hyperæsthesia of the retina (retinal asthenopia).

Treatment of Hypermetropia.—It may happen that the hypermetropia diminishes spontaneously, as when a posterior staphyloma or pellucid staphyloma of the cornea is formed. In both cases the eyeball is elongated. In staphyloma of the cornea, the membrane becomes more convex, and consequently the refractive power of the eye is increased; these staphylomata may even change a hypermetropic into a myopic eye.

The only remedy, which cannot be said to cure, but neutralises the hypermetropia, is the use of convex glasses, which add to the ocular dioptric apparatus the refractive power wanting. Should we then always prescribe convex glasses, and how should they be used?

In cases of simple facultative hypermetropia, there is no occasion to order glasses. The accommodation of itself is sufficient. To give glasses under the pretext of preserving the accommodation for a longer period is irrational, for a muscle is certainly not weakened by exercise. Besides, with advancing years presbyopia will show itself, and then it will be time to order glasses. The need of spectacles will be naturally somewhat sooner felt than in an emmetropic eye.

We must then select a convex glass with which the patient can see to read without difficulty at the ordinary distance, 8 or 10 inches, and we must make him read with this glass for some length of time. If there is still fatigue, the glass selected is too weak. As we are always liable in such cases to give glasses which, owing to the latent hypermetropia, are insufficient, we first give that glass whose number corresponds with the amount of manifest hypermetropia; after which we give stronger glasses if the patient still complains of asthenopia. In short, it is the patient's sensations which finally determine which glass is to be used.

Again, ought we also from the first to give glasses for distant vision? This question was at first answered in the affirmative, on the ground that a convex glass places the eye in the normal condition. But the patient does not feel the need of glasses, since, with the help of his accommodation, he sees perfectly at a distance; he may even object to wearing spectacles when not at work. Later, when the accommodation has become so weak that all, or nearly all, the hypermetropia is manifest, he will require hypermetropic glasses to see even at a distance.

Thus, to recapitulate, in *facultative hypermetropia* we must give glasses for near objects if the patient suffers from asthenopia, glasses for distant objects if the patient feels fatigue or does not any longer distinguish objects when looking at a distance.

In absolute or relative hypermetropia matters are somewhat different. We have seen that in *relative* hypermetropia patients cannot see distinctly, even at a distance, unless they sacrifice binocular vision. Such

persons cannot avoid using glasses. The convex glass with which the patient can see best at a distance should be chosen, for it is the one which neutralises the manifest hypermetropia. If the patient still possess a great portion of his power of accommodation, he may then be able to work near at hand with the same glasses that suit him for distance. Later, when presbyopia is added to the existing hypermetropia, patients who have relative hypermetropia require stronger convex glasses for near at hand work.

In cases of *absolute* hypermetropia, when the accommodation cannot completely neutralise the defect of the refraction, we also give the strongest convex glass with which the patient sees best at a distance, and if with this glass his accommodation does not allow him to work close at hand, we must give him stronger glasses for near at hand. In these cases, we need have no fear of giving too strong convex glasses, for behind the manifest hypermetropia there still is the latent hypermetropia, which gradually becomes apparent as presbyopia advances. Thus, after forty-five years of age, we will be forced to give increasingly strong glasses, even for distant objects.

The relations of hypermetropia to *convergent strabismus* will be explained in the chapter on muscular affections of the eyes.

Hypermetropia from Absence of the Lens (Aphakia).

There is a variety of hypermetropia which is artificially produced on removing the crystalline lens from the pupillary field in operations for cataract. The absence of the lens (*aphakia*) may also be caused by its dislocation.

No matter in what way the lens is lost, its absence always determines a very high degree of hypermetropia, since the refractive power of an eye deprived of its lens, according to an approximate calculation, brings parallel rays to a focus at 30 millimetres behind the cornea; thus the antero-posterior axis of the eye being from 20 to 22 millimetres, parallel rays are brought to a focus at 8 or 10 millimetres behind the retina. This excessive form of hypermetropia requires to be neutralised by very strongly convex glasses, called cataract glasses, to enable the patient to see at a distance. Then, as there is no longer any accommodation, different glasses will be needful, varying with the distance at which he wishes to see distinctly. It would, therefore, be necessary to give to a person who has undergone an operation for cataract, a separate pair of glasses for every distance at which it may be necessary for him to see. Yet we do not order an indefinite number of glasses. The patient may make up for his want of accommodation by removing

the spectacles farther from his eyes. This is the reason why it is sufficient to give two or three pairs of glasses; one pair to see at a great distance, another to enable him to see at 5 or 6 yards, and a third, for reading and writing at 20 to 25 centimetres = 10 inches. For intermediate points, he must vary the distance between the eye and the spectacle.

Naturally, any defects of refraction which existed before the operation must be taken into account. Thus, a hypermetropic person deprived of the crystalline lens, will require a stronger glass than an emmetropic in the same condition. Myopic people, on the other hand, require a feebler glass. So much so is this the case, that some myopic patients, after operation, do not require any glass, as they see better at a distance after the operation than they ever did before. Cases are also recorded of myopia where concave glasses were required after the operation for distant vision. Such could only be cases of exceedingly high myopia, and they are quite exceptional.

To determine the glasses which a person who has undergone the operation for cataract requires, we may, after repeated trials, choose the three glasses with which he sees best—1, at a great distance; 2, at 6 yards; 3, near at hand. But, if we have found the glass with which he can see best at a distance, we may, by a very simple calculation, determine from it the glass which will be required for any given distance. For example, our patient sees distant objects with a convex glass of 12 D; with what glass will he be able to see at 25 centimetres? We must add to the 12 D a glass equal to the accommodation force necessary to bring distinct vision from infinity to 25 centimetres. According to what was said in speaking of accommodation, we know that that glass is one of $4\,\mathrm{D} = \frac{1}{0{\cdot}25}$ of a metre. Consequently, we must order a glass of $12 + 4 = 16$ D. In the same way we may give a glass for any required distance. Our patient sees well with 8 D at a distance; at 30 centimetres he will see well with a glass of $8 + \frac{1}{0{\cdot}30} = 8 + 3$ D—*i.e.*, with a convex glass of 11 D.

Or we may begin by ascertaining the distance at which he sees with a strong convex glass, for example, with No. 16 D. By calculation we can then find the proper glass for any given distance. If with 16 D he reads at 25 centimetres, this glass represents the amount of hypermetropia and power of accommodation necessary for this distance—*i.e.*, a power of $\frac{1}{0{\cdot}25} = 4$ D. If we deduct this figure from 16 D, we shall obtain 12 D, and a glass of 12 D will therefore be required for distance. In the same way, suppose with 18 D the patient sees at 30 centimetres,

the glass which will allow him to see at a distance ought to be $18 - \frac{1}{0{\cdot}30} = 18 - 3 = 15$ D.

Often the maximum visual acuteness which we can obtain from convex glasses does not by any means reach the normal. This is frequently due to the presence of astigmatism, and must then be corrected by cylindrical glasses, selected according to the principles which will be laid down in speaking of astigmatism.

ART. V.—Myopia.

The word **myopia** (*μυεὶν*, to close, and *ὤψ*, the eye) is not so well chosen as the word **hypermetropia.** Myopia indicates a secondary symptom, viz., the partial shutting of the lids, which, as we shall see, allows myopic people to distinguish distant objects better. *Donders* proposed to replace it by the word *brachymetropia* (*βραχὺς*, short, *μὲτνον*, a measure, *ὤψ*, the eye), which better indicates the state of refraction in myopia. The condition of refraction is such, that rays coming from a distance are united in front of the retina (Fig. 175), which renders distinct distant vision impossible, as the retina is occupied with circles of light, which produce an indistinct and diffuse image. As the object is brought nearer, the focus, according to a well-known optical law, comes nearer and nearer the retina, until at last it coincides with it; the object is then distinctly seen. This is the explanation of a characteristic symptom of myopia—viz., that near objects are distinctly seen, whilst distant objects seem to be diffuse.

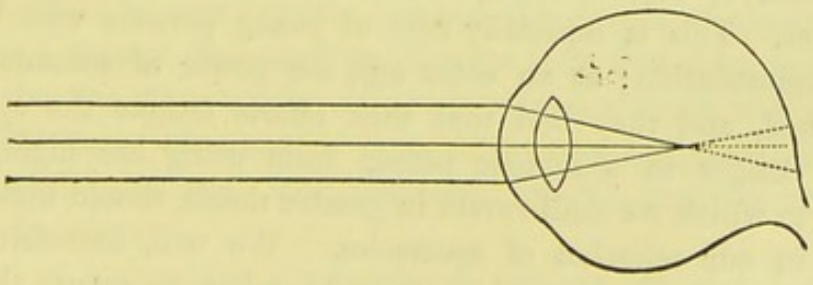


Fig. 175.—Myopic Eye.

This condition of the refraction explains another constant phenomenon of myopia—namely, that *concave glasses* improve distant vision. These glasses, in fact, cause parallel rays to diverge, and thus they are brought to a focus at a point behind that at which they meet in the unaided eye. If then these glasses are of sufficient strength, parallel

rays will come to form their focus on the retina. Again, it is evident that, if the glasses are too strong, or if they are very weak when the degree of myopia is very strong, we shall not attain the object in view. Consequently, we may ask ourselves with what glass we must begin

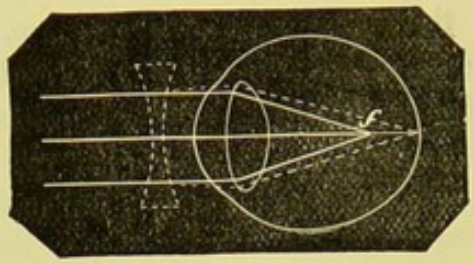


Fig. 176.—Focus F of a myopic eye brought to F′ on the retina by a concave glass.

in examining a patient to ascertain the presence or absence of myopia. We can find very nearly the correct glass by observing at what distance the patient reads ordinary writing, and if this distance is about that of the normal eye, we may conclude that the myopia is slight, and begin the examination with the weak glasses—0·50 to 0·75; but if, for example, we find that at 20 centimetres the patient reads No. 1 of the test-types of Jæger or Snellen, but is unable to do so at any greater distance, so that his *punctum remotissimum*, or remote point, is about 20 centimetres, we may begin by trying stronger concave glasses—2 or 3 D.

To determine the *degree* of myopia, we must always choose the *weakest* glass with which the patient sees best at a distance. It is nevertheless very difficult in myopic cases to eliminate from the examination the influence of accommodation which impels the patient to select a glass a little stronger than is necessary, because it renders the contour of objects more distinct although it diminishes their size somewhat. This is especially true of young persons who have their full accommodation; at an older age, the power of accommodation is diminished, and they find that such efforts fatigue the eyes. The serious danger to a myopic person from using too highly concave glasses, to which we shall revert in greater detail, should make us very careful in our selection of spectacles. We will, therefore, indicate minutely the precautions which must be taken to ensure that proper glasses are given.

We can ascertain whether any particular concave glass is too strong or too weak by alternately removing it farther from, and bringing it nearer to, the eye. For, on increasing the distance between the eye and the glass, we cause the glass to have a feebler divergent effect on rays entering the eye; so, if there is on removing the glass farther from

the eye any improvement in vision, we know that we have chosen too strong a glass, and *vice versâ*. But such an experiment only gives an approximate idea and cannot be held as sufficient. To make sure that the result obtained by this examination is accurate, we place the patient at about 6 metres from Snellen's test-types, and select the letters which should be seen from LX. to VI. metres. We then begin to examine the vision with the glass which we have selected by the first method, and proceed till we have found the weakest glass which gives the greatest visual acuteness. Putting these glasses in a trial frame, we ask the patient to read the test-types through them. Then, raising the glasses on to the forehead, we place a weaker pair before the eyes. We ascertain next if the patient sees still as clearly or even better. If the reply is affirmative we try still weaker glasses, and so on till the letters on the scale are decidedly less distinctly seen. Our choice must then remain on this last glass—*i.e.*, on the weakest which gives distinct vision. In order to make sure that the glass so chosen is in reality exact, we place weak convexes and concaves (0·50 D) alternately before the spectacles, and if the convex glasses still further improve the distinctness of vision the spectacles selected are too strong. It is only when by trial we find that the addition of a very weak convex glass diminishes the distinctness of vision, that we may rest satisfied with our choice. These precautions may seem too particular, but they will be seen to be of the greatest importance, when we consider the danger of wearing too strong glasses.

Ophthalmoscopic examination by the direct method may also be of assistance in diagnosing myopia, and in estimating its degree. If the surgeon is himself emmetropic, he must use a concave glass to see distinctly the fundus of a myopic eye, and the weakest concave glass which enables him to see it indicates the degree of myopia. Besides, it should be noticed that when an eye which is being examined is very myopic, some of the details of the fundus can be seen at a greater distance from the eye than that usual in examination, by the use of a simple reflecting mirror without any correcting glass. The image thus seen is inverted, as may be proved by making slight lateral movements with the head, for the image moves in the opposite direction.

Instead of looking for the fundus of the eye, we may look for the direction in which the shadow replaces the light when we rotate slightly the (plane) mirror with which we illuminate the pupil (*Skiaskopia* of *Parent*). If this shadow appears in an opposite direction the eye is myopic, and the degree of its myopia is indicated by the distance to which we must approach our eye to see the direction of this shadow change to the opposite one (*Chibret*).

In certain cases the glasses which we have chosen perfectly correct the myopia, and restore normal acuteness of vision. But it frequently happens that the myopia is complicated with diminution of the acuteness of vision, so that no glass gives normal vision for distant objects to the patient, although he may often be able to see very distinctly close at hand; the state of his refraction allowing him to bring the smallest objects very near, thus increasing the size of the retinal image.

For objects situated beyond the punctum remotissimum, the farther the object is from the eye, and the greater the size of the pupil, the worse does a myopic person see it: in short, the more the rays of light pass through the periphery of the lens, the larger are the diffused retinal circles. This is the reason why myopics bring their eyelids together and look as through a slit. They partially close their eyes, and hence the origin of the name Myopia. We also take advantage of this natural indication, and sometimes use stenopaic glasses in cases of very high myopia.

If a myopic person works much in the evening without giving his eyes rest—if he fatigues his eyes in any way—he soon begins to suffer from the phenomena of irritation. The external parts of the eye, the lids and conjunctiva, are often congested. There is frequently slight pericorneal injection. Myopic patients complain, especially when at a certain period of life the myopia becomes progressive, of fatigue and pain in the eyes, which become sensitive to touch and very irritable to strong day or artificial light. The prognosis of this weakness of myopic eyes is still favourable, inasmuch as all these symptoms will disappear if a good therapeutic and rational hygiene interpose in time to stay the congestion of the eye.

However, the diagnosis of myopia is only certain by the improvement of vision for distant objects produced by concave lenses. The *degree* of myopia is measured by *the number* of the weakest glass with which the patient *sees best at a distance.* Thus we say that there is a myopia of 10 D when a concave glass of 10 D is the weakest which allows the patient to see distant objects clearly.

We meet myopia in all degrees, varying from the most feeble, where the patient is not aware of the defect, to the strongest, where concave glasses of 20 D, or even higher, are required to neutralise it. In general we call the myopia *weak* when the correcting glass is not above 2 or 3 D (M = 2 or 3 D); *medium* where it is from 3 to 6 D; and *strong* when the myopic person requires glasses stronger than 6 D.

Close observation has shown that for any myopic person the degree of myopia does not remain the same throughout life, and the variations oblige us to distinguish between cases of progressive myopia and those where the anomaly of refraction remains always the same.

When the myopia remains the same, or nearly the same, during the entire life of an individual, it is called *stationary myopia.* More frequently the myopia increases at certain periods of life, and under the influence of different ocular affections, although remaining stationary at the degree of myopia acquired for sometime after the exacerbation. This is called *periodically progressive myopia.* Again, the myopia may in other cases steadily increase, and it is then called *absolutely progressive myopia.*

Even *stationary myopia* undergoes slight variations—for example, at the age of fifteen it may be about 1·5 D; at twenty-five, about 2 or 2·5 D; and at sixty it may have receded to 2 or even 1 D.

Thus, towards the end of life, probably from some change in the refraction of the lens, the myopia decreases; but not in the way which was formerly supposed, when the degree of myopia was measured by the nearest point of distinct vision, which indeed, by age and an enfeebled accommodation, is removed to a greater distance from the eye. This effect is due, however, to the supervention of presbyopia, and not to a diminution of the myopia.

Periodically progressive myopia is that form in which a patient who has, say, 2·50 D at twelve years of age, will attain, by periodic augmentation, to 6 D at twenty. This increase of myopia takes place during puberty; after which it remains stationary, and diminishes towards the end of life. In other cases, this periodic increase is due to a diseased condition of the eye, which may supervene at any age, especially where there is a congenital or hereditary disposition. In the course of this disease, the antero-posterior axis of the eyeball is elongated by the formation of a posterior staphyloma. If the progress of the disease is once checked, the progress of the myopia is also arrested. Again, we observe in cases of *absolutely progressive myopia* a steady increase, so that, if the myopia is 2 D at the age of eight, it will be 8 D at twenty; then it increases less rapidly till it reaches 12 D, or even more. In such cases, there are some periods when the progress is more rapid, others when it is more slow.

Stationary myopia is not attended with any danger; periodically progressive myopia is dangerous during the period of increase; absolutely progressive myopia is, as a rule, followed by a sensible diminution of visual acuteness, and even the more or less complete loss of vision. It is often difficult, when the patient cannot control the conditions of his life, to procure almost complete rest for his eye, and to get him to submit to the treatment requisite to stop the progress of the disease, or to prevent troublesome complications, such as effusion into the vitreous, and detachment of the retina.

This defect in vision is met much more frequently amongst the

inhabitants of towns than of villages, amongst men devoted to study than amongst labourers. Again, it is very common in any nation where education is very extensive (*Donders*).

Nevertheless, many persons study during their entire life without becoming myopic; which fact would seem to indicate, *a priori*, that we must suppose a special predisposition to the development of myopia. And, indeed, such a predisposition exists, and is, moreover, hereditary and congenital. This being the case, the development of myopia and its ulterior course depend on the manner of life of those who are hereditarily subject to it. If during youth, especially at the period of puberty, the individual does not use his eyes on any fatiguing work, if he only reads or writes under good hygienic conditions, the myopia may not be developed, or at least, it will never be of great amount. On the other hand, it will become progressive if, at an early age, the eyes are used under bad conditions over any fine work which involves prolonged efforts of accommodation.

The fundamental *cause* of myopia—*i.e.*, the anatomical basis—is the peculiar form of the myopic eye; it is too long to allow of parallel rays being brought to a focus on the retina if it is of normal refractive power.

Donders at various times has examined and carefully measured 2500 myopic eyes. From these researches, which were undertaken to confirm the previous observations of *Arlt*, it has been ascertained that in myopic eyes the antero-posterior diameter may be increased to 33 millimetres, the normal being from 22 to 25.

This elongation of the eyeball (staphyloma posticum), as also the alterations of the choroid and sclerotic, with which it is connected, have been fully described in speaking of affections of these membranes.

If the elongation of the optical axis by the formation of a staphyloma posticum—*i.e.*, if the development of the congenital predisposition constitutes by far the greater number of myopic cases (*axial myopia*), there are also cases in which the disproportion depends entirely upon the excessive refractive power (*myopia of the lens*). Again, there are also cases of *acquired* myopia. Thus, myopia is found to follow changes in the curvature of the cornea. For instance, in ulcerative processes the cornea can no longer present its normal resistance to the intraocular pressure, and thus becomes more convex; hence the myopia. The same thing occurs when there is a disturbance of the nutrition of the cornea. There is no loss of transparency, but there is a distension, sometimes very considerable, of the membrane (keratoconus, or clear staphyloma of the cornea). These changes in the form of the cornea, besides the myopia, always give rise to a more or less pronounced degree of astigmatism. The crystalline lens

is often a source of acquired myopia. If its refractive power increases (as in the early stages of some forms of cataract) or if, in consequence of lesions of its suspensory ligament (zonule of Zinn), it becomes more convex or displaced forwards, there will always be a displacement of its principal focus, so that luminous rays will be brought to a focus in front of the retina, and thus there will be myopia. Again, apparent myopia may be temporarily produced by spasm of the accommodation (see Article on Diseases of the Accommodation). The muscle of accommodation may be thrown into a state of tonic spasm, like any other muscle of the body. The lens will then be at its maximum of curvature, and its refractive power will also be increased, so that distant objects are no longer distinctly seen. Concave glasses improve the vision in this class of cases also; but, on the other hand, atropine, which has no influence on true myopia, allays the spasm of accommodation, and causes the functional disturbance to disappear. We, therefore, have here an affection of the accommodation, which will be discussed in another chapter.

A common complication of myopia, insufficiency of the internal recti (muscular asthenopia), and its connection with divergent strabismus, must be reserved for the chapter on muscular affections of the eye.

Treatment.—The rational treatment of myopia should correspond with the following indications :—

1st. To prevent the progress of the myopia and its complications.

2nd. To neutralise the refractive defect by suitable glasses.

3rd. To counteract any muscular asthenopia.

4th. To treat the complications.

1st. To prevent the progress of the myopia and its complications.

We have seen that, given in any individual the predisposition to myopia, its further development depends on his mode of life, and on the nature of his occupation. Under this aspect, we must specially mention congestions of the eyes or efforts of accommodation as being particularly hurtful to myopic persons, because they favour the formation of the staphyloma posticum. We must also bear in mind two conditions which almost invariably accompany the efforts of accommodation—viz., bent positions of the head, and great convergence of the eyes, which still further aid the accommodation to increase the intraocular pressure. Such considerations teach us to prevent myopic persons from stooping over their work and making great efforts of convergence, by causing them to keep the objects at which they may be looking as far from them as possible. Above everything, it is of great importance to require the patient to place his work at a convenient distance, 20 to 30 centimetres, according to the degree of myopia, the back being supported by a chair and the light good.

These precautions being taken, if the patient seems to require glasses, they should only be prescribed under certain conditions, which we shall explain again, for, with such glasses, the myopic is exposed to a great danger—viz., he is apt to bring objects unnecessarily near so as to have a greater retinal image: thus the focus of the rays is brought behind the retina, and he is obliged to call his accommodation into play to bring it to the retinal surface. To prevent this danger we must make him keep his head at the proper distance from his book by some mechanical means, and, besides, advise him to stop his work now and then so as to give his eyes a few minutes rest.

He ought to bestow the greatest care on the illumination, which must be strong, although not dazzling, and must come from the left side. If we wish to avoid useless and exaggerated efforts of accommodation, we apply atropine for some weeks or even longer.

Myopic people should also avoid every condition which is likely to cause an increased flow of blood to the head, everything which increases the heart's action, excesses of the table, excessive smoking, and prolonged work. Should the myopia seem to have become progressive, we must advise them to give their eyes frequent rest while reading or writing. They ought never to work for several consecutive hours continuously without intervals of rest; but, after half an hour of work, they should rest for five or six minutes, then begin again, and stop after the next half hour, and so on. The periods of work should be shorter and further apart, in proportion to the amount of myopia and the fineness of the work. We must for a similar reason remedy cold extremities and constipation, two conditions which are often observed in myopia.

The treatment of progressive myopia and its complications has been explained with that of sclerotico-choroiditis posterior (staphyloma posterior, p. 219).

2nd. The second indication which we have to satisfy in the treatment of myopia is to neutralise the defect of refraction by prescribing suitable glasses. This is one of the most difficult points in practical ophthalmology. There is no absolute law to help us in the choice of the glasses, but only some indications, which we must now group together.

At first we may completely neutralise the myopia, when the patient only uses the glasses to see at a distance. We must warn him of the danger which he runs when, by using them to see near objects, he calls the accommodation into action. The danger does not, however, exist when the defect in refraction is relatively small, the accommodation normal and the eye healthy. In these cases there is little danger, even although the patient uses his glasses constantly.

Donders is of opinion that, in such cases, the use of glasses is one of the surest means of preventing the progress of the myopia; he advises that they should be used even while reading or writing. The patient may do so when the myopia is, let us say, about 2 D, when the accommodation amounts to 8 or 10 D, and when the acuteness of vision is absolutely normal. Here then a concave glass of 2 D will allow a patient to see at a distance, and his power of accommodation will permit him to see objects at 12 or 15 centimetres from his eye; in other words, he will have been made emmetropic. The patient may continue to use the same glasses till he attains the age at which his power of accommodation is diminished to an appreciable extent; at about forty or fifty he must stop using the glasses whilst at work; and at a still more advanced age, a person whose myopia is only 2 D will require, on account of his presbyopia, convex glasses for work, using the concave glasses corresponding to the degree of his myopia only when looking at a distance.

At the time of puberty, at which period the majority of myopic persons suffer from irritable eyes, whilst allowing them to wear suitable glasses for near or distant vision, we must make the patient observe all the rules which we have indicated. If, notwithstanding these precautions, the myopia makes progress, if there is anything causing congestion of the head which a properly directed hygiene is powerless to counteract, or if, for example, notwithstanding the use of glasses, the myopic person is unable to overcome his tendency to bring objects closer to him than is necessary, and to stoop over his work, we must order him to give up wearing glasses for near at hand.

Excepting in cases where the eye is healthy, the myopia weak and the accommodation good, in which we may completely neutralise the myopia with glasses, the choice of glasses for myopic people chiefly depends on the degree of myopia, on the power of accommodation, on the acuteness of vision and on the occupation of the patient.

In cases of feeble myopia (0·75 D to 2 D), the need of glasses for reading is scarcely felt; where there is a moderate degree of myopia and a normal visual acuteness, we must act according to the laws already enunciated. Again, to persons affected with a high degree of myopia, we may give strong glasses to enable them to see at a distance, but we must forbid their use for reading. These strong glasses diminish the size of the retinal images of objects, for example, the images of letters, and the patient, to see them distinctly, is obliged to hold the book very near his eyes, which he cannot do without great efforts of accommodation and strong convergence of the eyes. How should we act in such cases? When the acuteness of vision has already suffered, as it almost always does in cases of high and progressive myopia with

posterior staphyloma, we must forbid the use of glasses for near objects, as also in the meantime all reading and fine work. This is often indispensable if we wish to prevent the progress and pernicious complications of the myopia and of the accompanying amblyopia; we can only mitigate this absolute prohibition in cases where the insufficiency of the internal recti is such that the person can only work with one eye. We may then allow him to read a little without glasses and with the ordinary precautions, because the efforts of convergence at least are not now to be feared.

When in cases of high degrees of myopia, the acuteness of vision is not impaired, and when there is no alteration in the fundus of the eye, *Donders* prescribes concave glasses which will allow the person to work at 30 to 35 centimetres. This distance depends on the size of the objects on which he works. The glasses, in this case, are thus much weaker than those which would be required to neutralise the myopia completely. They are easily calculated by deducting from the figure which expresses the degree of myopia in dioptries, that of the distance at which he wishes to work. Thus, a person who has, let us say, myopia = 6 D, will require concave 6 D to see at a distance, and we should give him, if we wish to let him see at 40 centimetres, a concave 3·50 D ($6 - \frac{1}{0{\cdot}40} = 6 - 2{\cdot}50$); if he requires to see at 25 centimetres, we shall order him a glass of 2 D ($6 - \frac{1}{0{\cdot}25} = 6 - 4$), taking care that he does not bring his book nearer than 40 or 25 centimetres respectively.

We cannot deny that there is some advantage to be obtained from using glasses which only partially correct the myopia. In truth, they put the patient in a more favourable position for reading and writing, so far as the convergence of the eyes and position of the head are concerned. But, on the other hand, the use of such glasses is a great source of danger when a myopic person uses them to enable him to bring his book, whilst reading, nearer his eyes than the prescribed distance. The necessity which then arises of counteracting the dispersive power of the concave glass, causes an increased effort of the accommodation, and a still greater convergence of the eyes, which is what we are very anxious to avoid. In such cases, we shall find the staphyloma increasing in size, and the myopia becoming progressive.

This danger is more imminent and almost inevitable when the visual acuteness is diminished, as is nearly always the case in high degrees of myopia. For these reasons, *von Graefe* advises us never to give concave glasses for reading and writing, or only very weak ones, to persons affected with myopia and who no longer possess normal acuteness of

vision. If, however, in any such case, from muscular insufficiency, binocular vision and, therefore, efforts of convergence are impossible, the use of glasses is admissible. But even then they must be most cautiously selected, weak concave glasses being given, which, without completely neutralising the myopia, will nevertheless improve the patient's vision. At the same time, we should tell him at what distance from his eye he must keep his work, forbidding him to bring it any nearer, which involves that he gives up all minute work; and, if the dimness of vision be very great, and accompanied with inflammatory symptoms, we must even order him to give his eyes complete rest.

But, again, we may give relatively stronger glasses to a young myopic person, who still possesses all his power of accommodation, changing them for weaker as the accommodation diminishes. If this last precaution is neglected, we will find that, at the age of forty-five, a myopic person, who, when young, could see at a distance with a concave glass of 4 D, and could use the same glass for his work, will now experience great difficulty in continuing to work with this glass, and will even complain of the efforts which he must make to see persons clearly with whom he may be conversing whilst wearing his spectacles. In such cases we may adopt one of two courses. Still retaining No. 4 D glasses, which correspond to the degree of myopia for very distant vision, we may make the patient do his work without glasses, or give him a weaker pair; but should he prefer to use only one pair, we may order glasses which only imperfectly correct the myopia, No. 2 D, for example, sacrificing to some extent distant vision, so as to allow him to work with the same glasses without fatigue and without danger. If he requires to see distinctly at a distance, he must hold an eye-glass of 2 D temporarily before the spectacles.

The nature of the work on which he is employed and the distance at which he wishes to work also considerably influence us in the choice of glasses. Although it is true that the relative amplitude of the accommodation of myopic persons who have been early accustomed to concave glasses is nearly that which exists in emmetropia, it is also true that, in the majority of myopic patients who work without glasses and only use them to see at a great distance, the relative accommodation is such that they cannot use their ordinary spectacles to see near at hand. Thus, for example, a myopic person uses concave glasses of 4 D to see at a distance, but does not require any glass whilst reading or writing. Suppose now he wishes to play the piano, he cannot see the music without spectacles, and if he uses his ordinary ones they cause fatigue. For such, and for any analogous cases (as for painters, or

professors who use manuscript), we must select glasses adapted for the distance at which the person wishes to see distinctly. To a person who has 4 D of myopia, and who wishes to read his notes at 50 centimetres, we must give a concave glass of 2 D ($4 - \frac{1}{0{\cdot}50} = 4 - 2$). To a painter whose myopia is completely neutralised by a concave lens of 5 D, if he wishes to paint at 50 centimetres, we must give a glass of 3 D ($5 - \frac{1}{0{\cdot}50} = 5 - 2$), and if he occasionally requires to look at a model at some distance from him, we should advise him to place before his spectacles an eye-glass provided with concave glasses of 2 D.

When the myopic person gets older, his visual acuteness and his accommodation are both diminished; we must then carefully take into account the preceding considerations. In cases where the myopia is small, at fifty or fifty-five years of age, the punctum proximum is already placed at a greater distance than 22 centimetres. Presbyopia comes into play and the person requires convex glasses to see at his work. The method of choosing these convex glasses has already been explained (p. 410). When there is myopia of 4·5 D, presbyopia cannot prevent the patient seeing near at hand, for in this case the punctum proximum can never be beyond 22 centimetres, but suitable concave glasses must be given to let the patient see at 30 or 35 centimetres. In selecting these glasses, we must not forget the diminished accommodation consequent on the patient's age, and we must observe all the precautions which have been already laid down for such cases. Yet we must not forget that, if our patient is already well advanced in life, we chiefly seek to improve his vision for the time being, although, when selecting glasses for a young person, we strive especially to preserve normal acuteness of vision, and to prevent the myopia from becoming progressive. We may influence a young person in the choice of his profession. In a case where the person is old, we no longer take into consideration the future, but, if the visual acuteness is diminished, we give glasses which allow him to read or to do any other work at the proper distance.

In cases of moderate myopia it will very often happen, that if we wish to allow a person, who is old and affected with a considerable diminution of visual acuteness, to read, we can only do so by giving him convex glasses, which will enable him to bring his book within a few inches of his eyes. But, as it is very disagreeable to look at a distance with a convex glass, especially when one is myopic, producing as it does headache and even giddiness with sickness, we should in such cases place convex glasses in special frames which make the glasses so low that they are only used when the person looks somewhat down-

wards, and which permit him readily to look over their top. Further, we give the patient concave glasses for distant vision.

There are also cases of myopia where the acuteness of vision is so diminished that distant objects can only be seen with an opera glass. Other cases require a stenopaic slit which only leaves the central portion of the concave glass free. The cones of *Steinheil* are also of great value when the amount of myopia is very great.

As a rule, we prefer that the concave glasses used by myopics in the open air should be slightly bluish, so as to prevent the dazzling influence of strong light.

As to the third indication which we have to fulfil in treating myopia, namely, that of correcting the *insufficiency of the internal recti*, we shall give full details of the means employed in the article on muscular asthenopia. These means include, as we shall then see, the use of simple or decentric concave glasses or prisms, or concave prisms, also muscular displacement alone or combined with the use of glasses.

The treatment of the complications of myopia has already been explained when speaking of sclerotico-choroiditis posterior.

ART. VI.—Astigmatism.

We have till now been occupied with those anomalies of refraction which depend on an excess or deficiency in the refractive power when viewed as a whole. We have, under this aspect, considered myopia, in which luminous rays coming from a distance are brought to a focus at a point in front of the retina, and hypermetropia, in which similar rays are brought to a focus at a point behind the retina. But we also meet a form of eye in which all the rays of light are no longer brought to a focus at a single point, because the refractive power is not the same in all the meridians of the eye, and in the various sections of the same meridian. Although they are all meridians of the same surface, they sometimes vary very considerably in curvature; so it naturally follows that the rays of light which enter in the direction of a meridian of greater curvature converge sooner, and form their focus at a point nearer the refracting surface, than the rays which enter in the direction of a meridian of less curvature.

This difference in the refractive power of the meridians of the eye constitutes what is called *astigmatism* (*a*, privative, and *στίγμα*, a point), and is the cause of a more or less considerable aberration of light.

Before we discuss astigmatism further, it is necessary for us to explain what is meant by *aberration of light*. Every luminous point emits divergent rays which,

as they come from the same point, are said to be homocentric. When a pencil of these rays encounters a refractive system, the surfaces of which are portions of spheres, it is refracted, and the focus is formed at a single point.

This law of homocentric rays is, however, not absolutely accurate, inasmuch as, after refraction, luminous rays do not come together exactly at the same point, but some are brought to a focus at a point nearer the refractive surface than others (see Fig. 177), so that the focus instead of being a point is a line (focal line of *Sturm*). This irregular union depends on two causes, which we may, therefore, consider as producing two kinds of aberration of light, the subject of our present study.

Firstly, the light, solar light for example, may not be homogeneous, but composed of rays varying in their index of refraction and wave length, so that some are more quickly bent towards the axis, others more slowly; the violet and blue are more quickly united, the red more slowly. This is what is known as *chromatic aberration*. It also exists in the eye, as has been proved by different experiments; yet the acuteness of our vision is not diminished by it to any perceptible extent.

If now we take a homogeneous and homocentric light, red for example, we shall find that any pencil which strikes a spherical surface will be liable to a second kind of aberration. In a word, the rays which pass near the centre of the lens will be refracted in a different way from those which pass through the periphery, and the difference of refraction will become greater the farther we go from the axis.

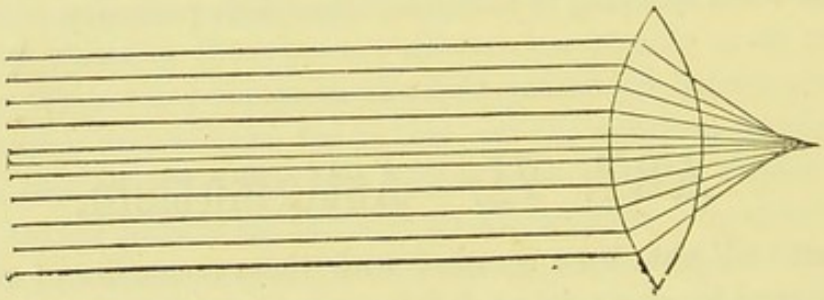


Fig. 177.

It is only those rays which pass through points symmetrically situated round the axis which are brought to a focus exactly at the same point. A pencil of homogeneous and homocentric light, therefore, forms various foci and not one: this is what is called *spherical aberration*. This aberration is found in every eye, and it would be a very serious inconvenience to vision were it not in great part corrected by the special structure of the lens, and by the presence of the iris, which cuts off the marginal rays.

Any form of aberration which causes homocentric light to be brought to a focus at several points, instead of at one, may be called astigmatism; but this name is confined to that variety of astigmatism which depends on the form of the refractive surfaces of the eye being imperfectly spherical. When the refraction varies in the different sectors of the same meridian, the astigmatism is said to be *irregular*. When the different meridians of the eye have a dissimilar power of refraction, homocentric rays undergo a different refraction according as they traverse one or other of these meridians; thus they cannot be brought to a focus at one single point. We have then to deal with *regular* astigmatism, which will, in the first place, occupy our attention.

No two meridians may have exactly the same refraction; but the difference is not so great on comparing meridians which are near each other as on comparing those which are farther apart. The maximum difference is obtained when the meridians are perpendicular to each other. The two meridians which have the greatest difference of refraction are called the *principal meridians.*

Thus it is impossible for the astigmatic eye by its refractive power to bring to a focus on the retina at one and the same time the rays of light which traverse the different meridians. When the two principal meridians are the horizontal and perpendicular, as is often the case, the astigmatic eye cannot clearly distinguish horizontal and vertical lines placed at the same distance from the eye. At the distance at which one set can be seen and counted without difficulty, the other set appears quite confused, and *vice versâ.*

To get a clear idea of the consequences of astigmatism, let us recall the following experiment, which we owe to *Donders*:—Let a small round hole be made in a pasteboard card, and let us place it between our eye and the light. At a certain point we see the hole as a luminous point; but if, without changing the tension of the accommodation, we bring the card nearer the eye, or remove it to a greater distance, the opening appears oval alternately in the transverse and perpendicular directions. If we pursue the experiment farther, we shall find that the opening assumes successively the forms indicated in Fig. 178.

Let us briefly explain this experiment—

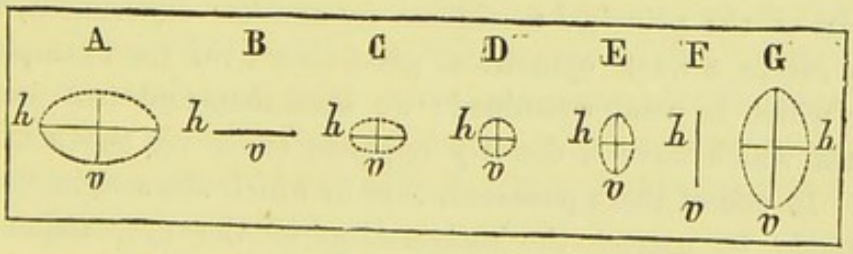


Fig. 178.

At A, the distance is such that neither the horizontal (*h*) nor the perpendicular (*v*) rays are brought to a focus, but the latter are more nearly so than the former, which proves that the vertical meridian is of stronger refractive power than the horizontal.

At B, the vertical lines are brought to a focus, and the opening now appears as a transverse line.

At C, the vertical rays, having crossed each other, diverge.

At D and E, the relations are the same, the vertical rays have crossed each other, whilst the horizontal rays are more and more

nearly approaching their focus. They attain it at F, and the opening once more appears as a line, but this time it is in the vertical direction.

At G, both sets of rays, horizontal and vertical, having crossed each other, diverge.

From these diagrams we see that the opening appears round only at one distance, D, where the vertical rays diverge at the same angle at which the horizontal converge. The distance between the two points where there is, first, a distinct image of the vertical rays, B, and second, where there is a distinct image of the horizontal, F, has been called by *Sturm* the *focal interval.* It is exactly at the middle point of the focal interval that the hole appears round, and probably also it is for this point that the astigmatic eye accommodates.

The phenomenon which we have just described, and which depends on the astigmatism of the eye, becomes much more apparent when we place a weak convex glass (No. 0·75 D) before the eye, and then cause a stronger concave to pass before the same eye (say concave No. 1·50 D). According as the second glass is in front of the other or not, the luminous point (being at the same distance from the eye) will appear sometimes as a vertical, and sometimes as a horizontal line; if the successive passages of the second glass in front of the first are sufficiently rapid, the eye, from the persistance of the retinal images, may even perceive a cross. The direction in which the luminous point is prolonged corresponds with the principal meridians of the refractive surfaces.

If we wish to verify our results by ascertaining what are the directions of the principal meridians by another experiment, we have only to rotate a weak cylindrical glass (No. 0·50 for example) before the eye which is being examined; we shall then find two positions of the glass which have a directly opposite effect on the acuteness of vision. In one of these positions, that in which the astigmatism of the glass tends to correct the astigmatism of the eye, vision will be improved; in the other, in which the glass adds to the astigmatism, the eye-sight will be much worse.

Experience shows that the two meridians in which refraction is at a minimum and maximum are always perpendicular to each other, a fact which is taken advantage of, both in detecting and in correcting the astigmatism. But again, it is not always the vertical meridian and the horizontal which are the principal meridians, they are more frequently two of the meridians which are somewhat oblique in one direction or another.

The **functional disturbance** which must necessarily ensue from such a state of matters, may be readily deduced from the explanation

which we have just given of the optical effect of astigmatism. If we remember that letterpress is composed for the most part of horizontal and vertical lines, that the image of any object surrounding us may be resolved into straight or curved lines, that the astigmatic eye is neither able clearly to recognise at the same moment vertical and horizontal lines in the same plain, nor to distinguish any round object, because it seems to be elongated in one direction or another; if we remember, we say, the influence of this anomaly of refraction on the form of the retinal image, we may easily form an idea of the difficulty in vision which will ensue from astigmatism. We must never forget that an astigmatic eye can only form diffused images. Whilst a myopic person may remedy his defect by bringing objects nearer him, and a hypermetropic by calling in his power of accommodation, and both, by these means, or by the use of appropriate spherical glasses, may succeed in getting distinct images formed on the retina, the astigmatic eye is not completely corrected as to its anomaly by any of these means.

The impairment of vision is especially evident when the astigmatic eye requires to distinguish vertical and horizontal lines situated in the same plain and very near each other. The circles of diffusion which form in one direction, cover the distinct images which are formed in the other, for which the eye is adapted, and the vision becomes indistinct; this takes place in looking at almost any of the Roman capital letters.

If we wish to neutralise this anomaly by means of ordinary spherical glasses, we may successively use several of different refractive power, which will improve the vision, without bringing it up to the normal standard. Thus, if there is M 5 D in the vertical direction and M 3 D in the horizontal, with a concave glass of 5 D there will be an improvement of vision in one direction, with a concave of 3 D in the other, and with concave of 4 D in both, although the defect of refraction is not completely neutralised.

It is natural that astigmatic people should see best through a stenopaic slit (see p. 402). In fact, they only see distinctly in the direction of one meridian, whilst the rays entering by the others only cause confusion of the retinal image. It is this which chiefly disturbs the vision, and if the portions of the eye which cause this confusion are covered with a stenopaic slit, vision will be improved.

Astigmatic persons of their own accord often use their eyelids as a stenopaic apparatus; they close them so that the palpebral opening becomes a slit, then they incline their head to one side or other till this slit corresponds with one of the principal meridians. Others again try to obtain the desired result by drawing the skin near the external angle

of the eye outwards with their forefinger; this traction causes a narrowing of the palpebral fissure, and gives it that direction which the patient knows to be the best for vision.

A certain number of persons who are hypermetropically astigmatic are in the habit of bringing objects at which they may be looking, *e.g.*, books which they are reading, very near their eyes, and thus appearing as if they were highly myopic. By so doing they increase the visual angle, which, according to *von Graefe*, increases more quickly than the diameter of the circles of diffusion. After the astigmatism has been corrected they naturally prefer to hold the book at a greater distance.

Lines of the same length, some of which are vertical, others horizontal, seem to the astigmatic person to differ in length, and this phenomenon may falsify his judgment as to the form of an object. Thus a square may seem to him to be a rectangle.

Again, we find in astigmatic persons another peculiarity in vision; they see the prismatic colours otherwise arranged than they are to the normal eye. In such cases, chromatic aberration is manifest; at the margin of an object they see colours which are invisible to the emmetropic eye. *Helmholtz* has made some very instructive experiments on the use of coloured glasses in diagnosing the various kinds of ametropia; but a discussion of his experiments would occupy too much of our space.

Diagnosis of Astigmatism.—We have here several points to consider:—

1. Does the difficulty of vision of which the patient complains *depend on the astigmatism?*

2. If there is astigmatism, what are the *directions of the principal meridians?*

3. What is the *state of the refraction* in each of the *principal meridians;* and what are the *nature* and *amount* of the existing astigmatism?

To enable us to reply to these various questions, there are several means at our command; we must now indicate the most practical. Let us at once say, what after the preceding statement does not require any explanation, that a person affected with astigmatism exceeding a certain amount never has the normal acuteness of vision, and, what is of great importance, that this defect in the visual power has always existed. Such patients state that they never have seen as well as persons who have normal eyes, or, at least, they find that they have inferior sight when they come to use their eyes for any constant work. By placing such patients before the test scales we can immediately tell how much their visual power is below the normal standard of acuteness, and by experiment we can ascertain if convex or concave glasses improve their

sight. We generally find, when we are dealing with astigmatism, several glasses of different strengths which improve the vision to the same extent, but yet do not bring it up to the normal. Thus we know that there exists, not only hypermetropia or myopia, but some other complication which prevents the acuteness reaching the standard.

Very often, the existence of astigmatism is revealed by the form of the cornea, and *Donders* has proposed a method of ascertaining its presence, without any other measurement, from the image, reflected by the cornea, of a casement or some other square and shining object in front of the eye which is being examined. When the asymmetry is very marked, such an image, instead of being square like its object, is elongated in one direction or another, and the direction of this deformity corresponds with the meridian of the cornea which is of least curvature. Hence the keratoscope becomes a valuable means of diagnosing astigmatism of the cornea. For that of the entire eye, the ophthalmoscope gives us more exact results. Just as an eye which is astigmatic cannot see horizontal and vertical lines simultaneously with the same distinctness, neither can we, on examining by the direct method the retina of such an eye, simultaneously see both the vertical and horizontal vessels. We can only see with perfect distinctness the vessels which run in one direction, and we must change our accommodation, or the correcting glass which we are using, to see as perfectly those which lie in the opposite direction (*Donders*). It is perhaps still easier to diagnose the existence of astigmatism in the eye ophthalmoscopically, by observing the shape of the optic papilla. If it were perfectly round it ought to appear oval in an astigmatic eye (*Knapp*); but it often happens that the papilla is in reality oval, and the astigmatism of the eye is more surely ascertained by the following method:—The optic papilla, elongated in one direction when we examine by the direct method, is, on account of the astigmatism, elongated in the other to the indirect method (*Schweigger*).

From amongst a great number of means devised for the diagnosis of astigmatism, we shall only mention two, which we consider the most practical of application, for they give us information, not only as to the presence of astigmatism, but also as to the directions of the principal axes.

When a normal eye looks at lines drawn, as in Fig. 179, on a piece of cardboard, they all appear equally distinct; and if, from the extreme limits of distinct vision, the card is slowly brought nearer the eye, or put farther away from it, then they all become at one and the same time indistinct at a nearer distance than the punctum proximum, or at a greater than the punctum remotum. An astigmatic eye

looking at the lines of Fig. 179 cannot see them all equally well, especially when they are held near the extremities of distinct vision. When the card is so placed that the lines begin to grow indistinct, one will remain clear for a longer time than the others; and, if the card has been moved towards or past the punctum remotum in making the observation, the direction of this line will indicate the direction of the principal meridian in which the refraction is weakest. If this line be vertical, the principal meridian of least refractive power will be horizontal; for, if the refractive power of the horizontal meridian is exact, it will cause the vertical line to appear clear and distinct, but if the refraction is excessive, or too little, the vertical line will appear as a diffuse colour band. The other principal meridian, that in which the refraction is strongest, is at right angles to the first, as has been already explained. It is evident that this experiment is more easily made with a myopic eye, since then we do not need to place the test card (Fig. 179), at any great distance. For this reason we often place a strong convex glass before the eye which is to be examined, because it is then rendered artificially myopic. *Javal* uses an instrument constructed on this principle, which at once determines the astigmatism and the glass required to correct it.

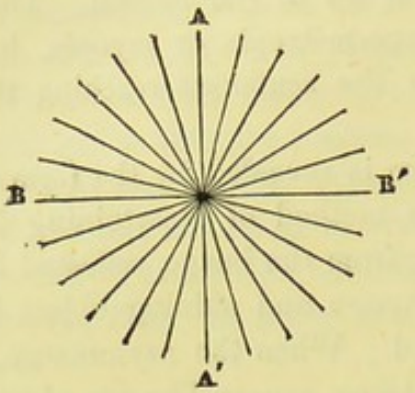


Fig. 179.

The second method consists in making the patient look steadily at a luminous point, similar to the one which we have already described (see p. 435). On placing alternately before his eye a convex and concave glass, the point will appear elongated successively in two directions, perpendicular to each other, which directions coincide with the maximum and minimum curvatures of the cornea. These are, therefore, the directions of the principal meridians, and thus the diagnosis is easily made.

Having ascertained the presence of astigmatism and the directions of the principal meridians, it now remains for us to determine the state of refraction in each of those meridians. For this purpose, having placed the patient before the test-types, we put a stenopaic spectacle before one eye, the slit being placed in the direction of one of the ascertained meridians. If the visual acuteness be normal ($V = 1$), in this direction, the eye is emmetropic for this meridian; if not, we endeavour to determine, by trial with convex and concave glasses placed behind the slit, the degree of myopia or of hypermetropia which exists in this meridian. Thus, we determine successively the

refraction of both meridians in a similar manner, and with the same precautions as we have indicated in speaking generally of myopia and hypermetropia. The *weakest concave glass* with which the patient sees best will indicate the amount of myopia for any meridian. On the other hand, the *strongest convex glass* with which the patient sees best indicates the degree of hypermetropia. When we find that there is hypermetropia in one or other meridian, we are apt to fall into error in determining its amount, for the patient may easily counteract a portion of his hypermetropia by efforts of accommodation. It may, therefore, be necessary, in order to measure the hypermetropic astigmatism exactly, especially in young children, previously to paralyse the accommodation with atropine.

The refraction of the two principal meridians having been ascertained, how can we express the degree of astigmatism? Astigmatism, according to our definition, is produced by the asymmetry of the corneal meridians; its degree will, therefore, be expressed by the difference of curvature of the two most asymmetrical meridians, comparing one with another—*i.e.*, by the difference of the two principal meridians. As to the respective curvature of these two meridians, it is measured by the refractive power which exists in each. The degree of astigmatism is, therefore, expressed by the *difference of refraction of the two principal meridians.*

This being understood, it remains for us to indicate the different forms which astigmatism may assume. Three varieties have been recognised, to which *Donders* has assigned the following names:—

1. Simple astigmatism.
2. Compound astigmatism.
3. Mixed astigmatism.

1. In **simple astigmatism,** one of the meridians is emmetropic, the other is myopic or hypermetropic. Hence we must distinguish two kinds of simple astigmatism—viz., *simple myopic astigmatism,* and *simple hypermetropic astigmatism.*

Examples.—(*a.*) In the horizontal meridian, the stenopaic slit renders the vision normal; in the vertical meridian we must use a concave glass of 4 D; the difference of refraction of the two meridians is 4 D, and as one of the meridians is myopic, we have to deal with simple myopic astigmatism, which is expressed by the formula—

A *m* 4 D.

(*b.*) It may be that the eye is emmetropic in the vertical meridian, and hypermetropic in the horizontal. If the hypermetropia amounts

to 4 D, we have a simple hypermetropic astigmatism, expressed by the formula—

A *h* 4 D.

2. In **compound astigmatism,** the two principal meridians are both myopic or hypermetropic, but the hypermetropia or myopia is greater in one than in the other. The difference between the degree of myopia or hypermetropia found for each meridian measures the amount of astigmatism.

Examples.—(*a.*) An eye has 3 D of myopia in the vertical meridian, and 2 D in the horizontal. The difference between them is 1 D, and the amount of astigmatism is also expressed by the same figure. But simply naming the degree of compound astigmatism does not give us any accurate idea of the condition of the refraction of the eye. To state it more precisely we must indicate the factors of which this astigmatism is composed. In our example, there is a general myopia of 2 D, and in the vertical meridian there is an additional myopia of 1 D. It is this which constitutes the astigmatism. Therefore we say—this eye is affected with *compound myopic astigmatism; general myopia* 2 D *plus myopic astigmatism of* 1 D, which is expressed by the formula—

M 2 D + A *m* 1 D.

(*b.*) Similarly for compound hypermetropic astigmatism. The eye is considered as absolutely hypermetropic; the amount of general hypermetropia corresponding with the degree of hypermetropia in the meridian in which the ametropia is least. The astigmatism is measured by the difference of refraction of the two meridians. Suppose there is hypermetropia of 1 D in the vertical meridian and 2 D in the horizontal, we have to deal with a *compound hypermetropic astigmatism; general hypermetropia* of 1 D *plus hypermetropic astigmatism* of 1 D, expressed by the formula—

H 1 D + A *h* 1 D.

3. In **mixed astigmatism** one of the principal meridians is myopic, the other is hypermetropic. If the amount of the myopia be greater than that of the hypermetropia, we indicate the astigmatism by the formula A *m h;* when the hypermetropia predominates, we express it by A *h m.* The amount of astigmation is expressed by the sum of the figures which signify the ametropia in each meridian.

Examples:—(*a.*) Let us take the case of an eye with 3 D myopia in the vertical meridian, and 1·50 D of hypermetropia in the horizontal. The astigmatism in this case is expressed by the formula—

A *m h* 4·50 D = M 3 D + H 1·50 D.

(*b.*) If the eye has 2 D of hypermetropia in the horizontal direction, and myopia of 0·75 D in the vertical, we express the astigmatism by the formula—

$$A\,h\,m\ 2{\cdot}75\ D = H\ 2\ D + M\ 0{\cdot}75\ D.$$

The best method of diagnosing astigmatism and of stating precisely its form, a method also of great value in verifying the results obtained by such an examination as we have described, is the use of *cylindrical glasses*. When we come to speak of the correction of astigmatism, we shall describe these glasses and speak of their optical peculiarities. At present we would indicate their use in the diagnosis of astigmatism.

When we have found, by means of test-types placed at 6 inches from the patient, the concave or convex glass which most improves the visual acuteness, but yet does not make it normal, we rotate before the eye which is being examined a positive or negative cylindrical glass of 0·75 D. If this glass produce the same modification of vision in every position, then there is no astigmatism; in other cases we soon find that, in a given position of the glass, the visual acuteness is diminished considerably, whilst it is increased when the cylindrical glass is placed at right angles to the previous position. We thus ascertain that there is astigmatism, and the direction of the principal meridians; we must now put before the eye positive and negative cylindrical glasses, at first of low power but gradually of stronger, until we find the glass, and the position in which it must be placed, which give the eye we are examining the greatest visual acuteness.

This mode of examination, to which we give the preference, and which we cannot too highly recommend when a rapid and exact result is required, becomes rather inconvenient when we require to turn the cylindrical glass before the eye with the hand. To obviate this objec-

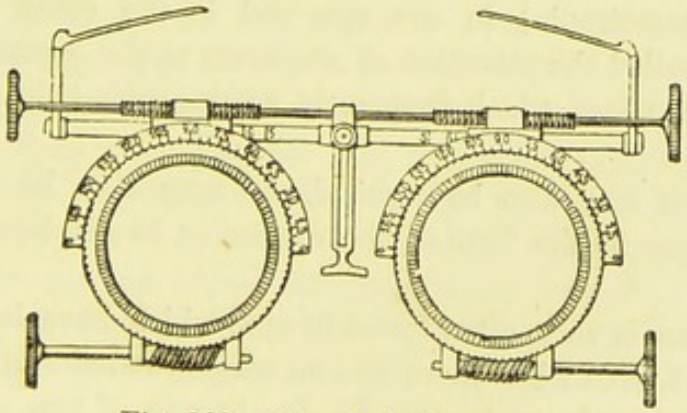


Fig. 180.—Unger's Astigmometer.

tion, we may advantageously use the apparatus constructed by *Unger* (*Astigmometer*, Fig. 180), in which the cylindrical glasses, added to the convexes or concaves, are made mechanically mobile and capable

of being turned in any direction, by means of two lateral buttons, which may be moved either by the surgeon or by the patient himself.

Again, various instruments have been devised for the purpose of diagnosing and measuring the astigmatism, three of which deserve to be mentioned on account of their ingenuity—viz., the binocular optometer of *Javal*, the ophthalmometer of *Javal-Schiötz*, and the double spectacles of *Snellen*, constructed on the principle of Stokes' lens.

Ætiology.—The numerous measurements taken by *Knapp* and *Donders*, by means of Helmholtz's ophthalmometer, show that regular astigmatism is produced almost exclusively by the asymmetry of the cornea, which, as a rule, is more convex in the vertical meridian than in the horizontal; yet in some cases the asymmetry of the cornea does not correspond with the degree of astigmatism. From this it must be concluded that the lens also may be asymmetrical; but, according to various measurements, it is most generally so in the opposite direction to the cornea. The asymmetry of the lens thus tends to correct the corneal astigmatism; rarely does it help to increase it, and more rarely still is the seat of astigmatism in the lens alone.

Since, as we have seen, astigmatism is caused exclusively by defects of the refractive surfaces of the eye, it is not astonishing to find that this anomaly is almost always congenital.

Astigmatism, or at least regular astigmatism, is most frequently *congenital*. Sometimes it appears to be hereditary, one or other of the parents being affected with it, or several children of the same family having the anomaly in the same form and degree. As a rule, the amount of astigmatism and the direction of the principal meridians are nearly the same in both eyes of an astigmatic person; yet cases are often seen where the state of refraction in the two eyes is very different. Thus, for example, we find in the same individual, a normal state of refraction (emmetropia) in one eye, and in the other astigmatism. *Donders* has called the attention of observers to the asymmetry of the two sides of the face which frequently accompanies this difference of the two eyes.

Astigmatism may also be *acquired*, and may then be secondary to morbid changes in the form of the cornea, or to displacement of the lens.

Astigmatism is very often found in eyes which have been operated on for cataract, even when there was no trace of it before the operation. The anomaly may in such cases be due to one of two causes:—The asymmetry of the corneal meridians may have already existed before the operation, but have been corrected by an asymmetry of the lens in the opposite direction, or at least so far corrected that it did not cause the patient any disturbance of vision (*von Graefe*). Oftener, the operation

itself leads to astigmatism. The cicatricial tissue, in contracting, flattens the cornea, and thus produces an asymmetry of that membrane. The same thing may follow iridectomy or sclerotomy.

Treatment.—Just as myopia is corrected by concave glasses, and hypermetropia by convex, so astigmatism is neutralised by cylindrical glasses. A cylindrical lens is cut in such a manner that the rays of light which penetrate it in one direction (that of the axis of the cylinder) do not deviate in their course; whilst the rays of light which enter it in the opposite direction (perpendicular to the axis of the cylinder) are refracted. If the cylinder is convex, they are made more convergent; but if it is concave, then they are made more divergent. We thus distinguish cylindrical glasses as concave or convex, according to the positive or negative value of their refractive power, and we denote them in the same manner as we do spherical lenses, only adding the letter *c*. So a concave cylindrical glass of 1 metre focal length will be written $c - 1$ D; a convex cylindrical of 1 metre focus, by $c + 1$ D.

It will easily be understood how suitable cylindrical glasses correct any degree of *simple astigmatism*, myopic or hypermetropic. It suffices to use concave cylindrical glasses for the first, convex for the second, always placing the axis of the cylinder to coincide with the emmetropic axis.

To correct A *m* 4 D (myopic astigmatism of 4 D), we use $c - 4$ D, that is a concave cylindrical glass of 4 D.

To correct A *h* 2 D (hypermetropic astigmatism of 2 D), we use $c + 2$ D—*i.e.*, a convex cylindrical glass of 2 D.

In either of these cases, it now only remains to determine the position in which the cylindrical glass must be put in the spectacle frame. For this purpose, we find the angle which the axis of the cylinder should make with the vertical, which can easily be done in the process of diagnosing astigmatism, either with Unger's astigmometer, where the angles are all marked as in Fig. 180, or directly, by cylindrical glasses placed in a trial frame each side of which is provided with a limb marked with gradations of 15 degrees from the horizontal. Again, to avoid all chance of error, the optician may leave the glasses movable in their frame; the surgeon can then try the glasses on the patient, adjust the direction of the cylindrical axis, and permanently fix the glass determined upon in its mounting.

To correct *compound astigmatism*, spherical glasses must be combined with cylindrical. Opticians manufacture sphero-cylindrical glasses, the axis of each glass possessing a certain amount of refraction, and the directions perpendicular to the axis a still higher degree. On one side, these glasses are ground like spherical glasses, and on the other like cylindrical. For a case of compound astigmatism of M 3 D + A *m* 1 D,

we require a concave spherical glass of 3 D combined with a concave cylindrical, and in ordering it from an optician, it may be briefly written thus :—

$$s - 3\,\text{D} \supset c - 1\,\text{D}.$$

For a case of compound astigmatism of H 2 D + A*h* 1·25 D, we require a spherical convex of 2 D combined with a cylindrical convex of 1·25 D, which is expressed by the formula—

$$s + 2\,\text{D} \supset c + 1{\cdot}25\,\text{D}.$$

Mixed Astigmatism is, as will be remembered, that variety of astigmatism in which one of the meridians is myopic, the other hypermetropic. To correct this anomaly, simple cylindrical glasses are of little use; and sphero-cylindrical glasses present, when we attempt to use them, great disadvantages, which, however, are easily avoided by using bi-cylindrical glasses. These glasses have two cylindrical surfaces, the axes of which are at right angles to each other. One of the surfaces is convex, the other concave. A bi-cylindrical lens, which should have in one direction the effect of a convex glass of 3 D, and in the other (perpendicular to the first) the effect of a concave of 2 D, would be expressed by the formula $c + 3\,\text{D} \supset c - 2\,\text{D}$. Such a glass must, therefore, be prescribed in any case of mixed astigmatism where there is hypermetropia of 3 D in one meridian, and myopia of 2 D in the other.

In a case of mixed astigmatism with a predominating myopia, say A *m h* 5 D, compounded of M 3 D + H 2 D, the correcting glass would be—

$$c - 3\,\text{D} \supset c + 2\,\text{D}.$$

In all these cases we must place the axis of the negative surface to correspond with the hypermetropic meridian, and *vice versâ* for the axis of the convex surface.

Till now we have spoken only of glasses which are suitable for distant vision. When we wish to give glasses to a hypermetropically astigmatic person affected with presbyopia, or to a myopic astigmatic patient (in the conditions described on p. 410), we do not change the strength of the cylindrical glass, but combine with the same cylindrical glass a stronger convex spherical where there is presbyopia along with hypermetropia, and a weaker concave in myopia.

Thus, if a patient has hypermetropic astigmatism of H 3 D + A*h* 1·50, and at the same time has presbyopia of 1 D, we must add to the glass which corrects the hypermetropia (+ 3 D) another which is equal to the amount of presbyopia—viz., + 1 D. This gives us a glass of

+ 4 D, and the arrangement which we must give for reading and writing in this case is $s + 4\,D \frown c + 1{\cdot}5\,D$.

If we wish to enable a myopic person, who has M 6 D + A *m* 3 D, to read at 25 centimetres, we must deduct from the glass which corrects his myopia a lens having for its focal distance the distance at which we wish him to see. In the example which we have cited, the glass with which he ought to read at 25 centimetres is a concave of 2 D $\left(6 - \frac{1}{0{\cdot}25} = 6 - 4\right)$ combined with a concave cylindrical of 3 D. Such a glass is expressed by the formula $s - 2\,D \frown c - 3\,D$.

Let us add that in using spherico-cylindrical glasses, they must be so placed that the surface of greatest curvature is towards the cornea; if one of the surfaces is convex, the other concave, the latter should be next to the cornea.

Irregular Astigmatism.

Irregular Astigmatism is produced, as we have already seen, by a difference of refraction in the various sectors of the same meridian. It gives rise to a considerable decrease in the acuteness of vision and sometimes to monocular polyopia. The **cause** of irregular astigmatism is to be sought for in some irregularity of the curvature of the cornea, secondary to corneitis, staphyloma and operations, or in some change in the index of refraction of the lens substance, as is often seen in the earlier stages of the development of certain forms of cataract. Irregular astigmatism cannot be corrected by glasses, but the vision is often improved by the use of spherical or stenopaic glasses which partially correct the anomaly of refraction. Concerning operation in kerato-conus consult p. 132.

ART VII.—Difference of Refraction in the two Eyes (Anisometropia).

Anomalies of refraction are found, as a rule, to the same extent in both eyes. But, although this is the rule, there are nevertheless numerous exceptions. The refractive power may not be the same in both eyes; and in this respect we may find every possible variety of difference.

Whilst one eye is normal (emmetropic), the other may be myopic, hypermetropic or astigmatic; and, again, there may be myopia, hypermetropia or astigmatism in both eyes but in different degrees, or one eye may be myopic whilst the other is hypermetropic or astigmatic. If there is astigmatism of one side only, it is almost invariably myopic if the other eye is myopic, or hypermetropic if the other eye is hypermetropic.

This difference in refraction of the two eyes is, as a rule, congenital; yet, it may also be acquired, as, for example, after operation for unilateral cataract.

As to the functions of the two eyes when they differ in their refraction, there are three possibilities.

1st. The two eyes, although different, co-operate together in vision, and permit of *simple binocular vision.*

2nd. The two eyes are *never used together;* but, according to circumstances, one or other is used.

3rd. One of the two eyes is permanently *excluded* from vision.

To ascertain whether binocular vision exists, the patient is made to look steadily at a candle flame, and a prism is placed before one eye, with its base either upwards or downwards. If vision is binocular, this will produce diplopia and one of the images will be superimposed.

In another class of cases in which there is a difference in the refractive power of the two eyes, we find that the patient uses sometimes one eye, sometimes the other, but never both at once. There is no binocular vision. As a rule, one eye is used for near vision, the other for distant; and this is specially true if one of the eyes is myopic, the other hypermetropic or emmetropic. The patient works with the one or with the other according to the requirements of the moment.

In a third series of cases, where there is a difference in the refraction of the two eyes, the patient uses only one eye, and always the same one, the other being excluded from vision. This condition is most frequently found where there is a very high degree of ametropia, especially when there is high myopia, and when there is some other cause (speck on the cornea, opacity of the lens, amblyopia) producing special indistinctness of the retinal images. In such a case, one of the eyes often deviates (strabismus).

When we speak of the anomalies of accommodation, we shall have something to say as to those cases in which the difference of adaptation is due to an enfeeblement or paralysis of the accommodation power of one eye.

What **remedial measures** must be taken in cases in which we have a difference of refraction? The reply to this question depends, in the

first place, on the presence or absence of binocular vision. When, by the methods already explained, we are satisfied that it exists, the first indication is to preserve it; and if, perchance, it only exists for a certain distance, to extend it as much as possible.

In choosing glasses, we must be guided by the effect which they have on the patient. If one of the eyes be emmetropic and have normal acuteness, and the other be slightly ametropic, corrective glasses are uncalled for. When both eyes are ametropic, we always begin with the eye which sees most distinctly. For this eye we choose the glass which the refraction requires, according to the rules which we have laid down. If the ametropia of the other eye is the same in kind, and if the same glass that is used for the better eye preserves binocular vision and affords good visual acuteness, there is no reason why different glasses should be given to the two eyes. In other cases, where the visual force obtained by the complete correction of only one eye is insufficient, we must try how far a pair of glasses, in which each lens more perfectly corrects the anomaly of each eye, will improve matters. If, notwithstanding the difference of the lenses, the patients do not complain of a certain difficulty of vision, due to a manifest or latent diplopia, and if there is, at the same time, a marked improvement in the vision, we may allow the glasses to be used. This result is, as a rule, only obtained when there is no great difference in the strength of the lenses.

It also frequently happens that the use of glasses of equal strength does not satisfy the patient; and, on the other hand, we cannot give glasses, each lens of which corresponds with the degree of ametropia, because binocular vision would then be destroyed. We must, therefore, for the more ametropic eye try a glass somewhat stronger than is required for the other eye, and prescribe the spectacles which give the greatest visual acuteness and still preserve binocular vision.

When we are dealing with myopia, we generally first prescribe the glass which corresponds with the weakest degree of myopia, then, if necessary, we order a somewhat stronger glass for the other eye. In hypermetropia, a glass slightly too strong on one side should not have the same disadvantages as in the case of myopia.

In the other two series of cases, that is to say, when binocular vision is destroyed, our task is much more easy. The eye which the patient habitually uses should, in the first place, be put in the best conditions for vision by a glass suited to its state of refraction; our attention should then be directed to the other eye, so as to give it such exercise as will preserve its visual acuteness.

If our patient is still young, and if, in consequence of a difference of refraction in the two eyes, binocular vision does not exist, we must try

to restore it; and, should our patient possess a sufficient amount of patience, we often succeed. For this purpose, we begin by making him exercise only the eye which is not habitually used in vision, and which, in consequence of this exclusion, has lost its visual acuteness. When the acuteness of vision is sufficiently restored by these means, it is very easy to excite vision in the two eyes, that is to say, diplopia. Frequently this condition is established spontaneously; if not, it may be excited by special exercises with a stereoscope or prismatic glasses. (See Orthop. Treatment of Strabismus.)

When the vision of both eyes has thus acquired the necessary power, we must inquire as to the condition which prevents binocular vision. Is it the strabismic deviation, aided by the difference of the refractive power in the two eyes, or is it this difference alone? In the latter case, we correct the defect in refraction at once, according to the principles which we have already established; whilst, in the other series of cases, the importance of the deviation compels us first of all to re-establish the muscular equilibrium, according to the laws which are applicable for strabismus operations. In both sets of cases which have been mentioned, it is always necessary to continue, after the optical defects have been corrected, such regular orthopedic exercises as help to perfect binocular vision, until it ceases to cause the slightest difficulty.

ANOMALIES OF THE ACCOMMODATION.

ART. I.—Paralysis of the Accommodation.

There is a form of paralysis of the ciliary muscle which can be produced at pleasure by the use of mydriatics; that is to say, by those remedies which cause dilatation of the pupil. Since, in this artificially-produced paralysis, we can study at leisure all the phenomena of the disease which now occupies our attention, it will be beneficial to enter into a few details as to the action of mydriatics.

The action of atropine or of duboisine shows itself in two phenomena: 1, dilatation of the pupil; 2, paralysis of the accommodation, which supervenes somewhat later. This action is more rapid and more lasting the stronger the solution. The effects of atropine are also more marked in children than in adults. Duboisine is more powerful than atropine.

What, then, are the symptoms of the artificial paralysis produced by atropine? The first to attract the observer's attention is the dilatation of the pupil, the *mydriasis* (see p. 169). The pupil becomes immobile also, and no longer reacts to the ordinary stimuli, such as light; it may be so dilated as to render the iris almost invisible.

The second symptom, **paralysis of the accommodation,** can only be recognised by an examination of the functions of the eye, and its symptoms vary with the refractive power of the eye—*i.e.*, according as the patient is myopic, hypermetropic, or emmetropic. When it takes place in an emmetropic person, vision for distant objects is distinct, whilst vision for near objects is confused. Convex glasses improve vision for near objects, but each glass is only of use for one distance (that of its focus). For distinct vision at various distances, different glasses must be used; but there is no great latitude of vision with any of them. To a myopic person, paralysis of the accommodation causes less inconvenience in proportion as the degree of myopia is high, for the patient can still read and write at the distance of his punctum remotissimum, which has not changed its distance. In hypermetropic persons who, as we have already seen, cannot see distinctly without an effort of accommodation, paralysis of the accommodation produces a disturbance of vision, such that they cannot see, even at a distance, without convex glasses. Consequently, they suffer much more from the suppression of accommodation than those who have normal or myopic eyes.

Besides these phenomena, there is another symptom of paralysis of the accommodation—viz., *micropsia;* such objects as require an effort of the accommodation in the normal condition appear smaller, because we think them to be nearer than they are. To an eye under the influence of atropine, objects appear much more highly illuminated, on account of the unusual size of the pupil, and this unusual brightness is the cause of the dazzling.

This paralysis, which till now we have regarded as due to the action of atropine, may also appear, independently of mydriatics, secondary to various affections. It is a symptom of paralysis of the third pair. The motor oculi nerve supplies, besides the ciliary muscle, the levator palpebræ superioris, the internal, superior and inferior recti, the inferior oblique, and the sphincter of the iris. Thus, simultaneously with the loss of accommodation power, we often find paralysis of the ocular movements corresponding to one or more of these muscles. But the pupil or accommodation may alone be more or less completely paralysed.

When the sphincter of the iris and the accommodation are alone paralysed, the most striking objective symptom is the *dilatation of the*

pupil. This form of mydriasis is, however, never so great as that produced by atropine, and the dilatation is not always in direct proportion to the paralysis of the accommodation. As to the subjective symptoms in this form of dilatation, they are the same as in artificial paralysis produced by atropine. From what has already been said, it will be gathered that the patients complain more or less of the effects of this disease, according to the state of their refraction.

All these phenomena are naturally less marked when the paralysis is incomplete; in such cases the muscle is more easily fatigued than in the normal state, the patient requires to hold his book at a greater distance from his eyes, and a group of symptoms supervene which we have described under the head of asthenopia and presbyopia (see p. 408).

Ætiology.—The causes of paralysis of the accommodation are very varied and often very obscure. We may see it after a chill; it may be therefore one of the *rheumatic paralyses,* which supervene suddenly and are very variable in their duration. Again, it may be of *syphilitic* origin, the syphilitic poison setting up a periostitis which compromises the nerves in the sphenoidal fissure, or extending to the nerve sheath; or a syphilitic tumour may be the source of pressure; or, again, there may be a syphilitic inflammation of the nerve itself (syphilitic neuritis).

Whilst the paralysis of the accommodation is sometimes temporary and of slight importance, it is also often one of the first symptoms of deep seated and serious affections.

There is always reason to believe it to be of central origin when the disease takes hold of both sides at the same time, and we may find very various *cerebral affections* as the cause of the mydriasis which before long is complicated with paralysis of other branches of the third nerve and of other cranial nerves, as also by disturbance of the general health. Again, we have observed that unilateral dilatation of the pupil and diminution of the accommodation, especially when these symptoms persist or frequently occur, sometimes precede by several years an attack of mental aberration (hypochondria), or of general paralysis. A peculiar and extreme sensitiveness of the head to percussion often coincides in such cases with the mydriasis.

Diphtheria is much more frequently than is generally supposed a cause of paralysis of the accommodation. This form of paralysis of the accommodation is almost always present in both eyes, although in different degrees. *Donders* was the first to observe that double paralysis of the accommodation, without paralysis of some of the other muscles of the eye, is, at least in adults, exceedingly rare, and should at once cause us to suspect its diphtheritic origin. The prognosis in this kind of paresis is very favourable, and in treating

such cases, it is always well to ascertain if along with the paralysis of accommodation there has been any previous disease of the throat.

A more or less considerable diminution of the accommodation of one eye supervenes after *contusion*, and of both during convalescence from any serious illness which has produced *exhaustion of the general strength*, such as typhoid fever, pneumonia, and pleurisy of long duration. It is also common in *lactation*.

Treatment.—The treatment will vary with the cause of the disease. For rheumatic paralysis, which frequently yields spontaneously in the course of a few weeks or months, we are in the habit of using vesicants or veratria ointment, rubbed on the parts in the neighbourhood of the orbit, and in conjunction with this we give salicylate of soda, iodide of potassium or ergot of rye internally. If it is of syphilitic origin we use specific remedies, and if the nervous system is affected in a more general manner, we must regulate the patient's mode of life and the treatment according to the general principles applicable to the special case. In cases of diphtheritic paralysis, strengthening regimen and tonics should be ordered.

In addition to this, we must treat the condition of the eyes—that is to say, the mydriasis and the paralysis of the accommodation. As to the first, we can easily cause contraction of the pupil by using eserine or pilocarpine. Yet, we must instil eserine with a certain degree of caution, since it is apt to set up conjunctival irritation if used for a length of time.

Hypodermic injections of strychnia in the temple, and the constant current, have also been used with success.

In order to obviate the disturbance of vision which results from paralysis of the accommodation, we must prescribe *convex glasses;* the number of the glasses ordered necessarily depends on the state of refraction, and on the nature of the patient's occupation. When he is emmetropic, and from some special circumstance requires to see objects at 25 or 30 centimetres from his eyes, the convex glasses required will be of 4 D $\left(\frac{1}{0{\cdot}25}\right)$ or 3 D $\left(\frac{1}{0{\cdot}30}\right)$, or weaker glasses when the accommodation is not completely paralysed. Thus, at first we make the patient read with convex glasses which entirely replace the power of accommodation. By small degrees, we use weaker and weaker glasses, which oblige him to make slight efforts of accommodation—a most beneficial exercise if we take care not to cause fatigue. Thus, at first, we make the patient read at 30 centimetres with convex glasses of 3 D, after a time we give him 2·5 D or 2 D, and so on, always using weaker and weaker glasses. If the paralysis exists only in one eye, we must be guided in our choice of convex glasses by the sensations of the

patient. Often he prefers to use both eyes for reading and writing, and he then puts a convex glass, sometimes very weak, before the affected eye. The exclusion of the eye is very seldom necessary—at least, if there be not paralysis of the other muscles of the eye and diplopia.

It need scarcely be said that, in selecting glasses, we must take into account any hypermetropia or myopia that may be present.

ART. II.—Spasm of the Accommodation.

Since it was found that spasm of the accommodation could be produced at will by the use of pilocarpine or eserine, it has become very easy to study its phenomena.

A drop of an ordinary solution of eserine (2 centigrammes to 10 grammes) or of pilocarpine (10 centigrammes to 10 grammes) put into the conjunctival sac produces a well-marked contraction of the pupil (myosis), accompanied with spasm of the ciliary muscle. The distant and near points are displaced, and brought nearer the eye. In a word, the eye becomes suddenly myopic. A very important symptom is the intensity with which the accommodation responds to the least impulse of the will (*Donders*). Again, objects appear enlarged (macropsia).

Spasm of the accommodation, apart from the use of myotics, shows itself under various forms. Thus, whenever anything—for example, a little dust or other foreign body—falls into the conjunctival sac or upon the cornea, setting up an irritation of the eye, we find a certain amount of myosis and spasm of the accommodation, which soon pass off. Another form of spasm of the accommodation is due to excessive and too prolonged exertion of the ciliary muscle, which we find in that class of cases where the patient for some reason or other (amblyopia, astigmatism) has to bring small objects as near as possible to his eyes, so as to increase the size of the retinal image. In cases of myopia we frequently find a slight amount of spasm of the accommodation. This is due to the well-known predilection of these patients to look at small objects, which they are obliged to bring very near their eyes, especially when working in deficient light. But a predisposition to excessive tonicity of the ciliary muscle is peculiarly an affection of hypermetropic persons.

Indeed, they cannot see at any distance without exercising their

accommodation, and this ultimately produces a state of permanent tension of the ciliary muscle; and, where the work performed by the muscle is excessive, it is thrown into a state of spasm. We also know that, under certain conditions, muscular fatigue produces tetanic contraction—as, for example, in writer's cramp.

Again, spasm of the accommodation is seen as a reflex symptom in affections of other nerves, such as the facial and ophthalmic (*von Graefe*).

The symptoms of this affection, besides the myosis, which is almost always present, vary with the state of the refraction of the person affected. In a normal eye, spasm of the accommodation produces sudden myopia; in a myopic eye, the myopia suddenly increases; in a hypermetropic eye, the hypermetropia is diminished, so that the refraction may seem normal. Further, the hypermetropia may give place to an apparent myopia. Thus, if the spasm of the accommodation is sufficiently great, it may suffice to bring the focus of the luminous rays formed by the hypermetropic eye on the retina, or even to a point in front of that membrane.

We find that severe ocular and periorbital pains accompany every effort which a person affected with spasm of the accommodation may make to see near at hand, and sometimes in hypermetropia even for distant vision. These symptoms are often so striking that they cannot but attract our attention. If we wish to make sure that they depend on spasm of the ciliary muscle, it is sufficient to try the effect of mydriatics (atropine or duboisine), which ought to be repeatedly used, for the ciliary muscle does not always yield at once to these remedies. The myopia is then observed to diminish or disappear, or may even pass into hypermetropia.

The **treatment** specially consists in giving the eyes rest, and in paralysing the ciliary muscle with atropine or duboisine. It is sometimes necessary to continue this treatment for a long time before the spasm yields. At other times it reappears as soon as we stop using atropine, and therefore we sometimes require to keep up its action for several months together.

When we have completely paralysed the accommodation with mydriatics, we may prescribe suitable glasses, and allow the patients to use their eyes, unless there is some special contra-indication, such as retinal hyperæsthesia, progressive myopia, &c. If there is hypermetropia, it must be entirely corrected by glasses, which should be constantly worn (a smoked pair being used in the streets). For work, we give the patient a glass which enables him to see at 35 centimetres. Even after we have stopped the mydriasis, glasses must be worn by the patient whilst at work.

CHAPTER XI.

MUSCLES OF THE EYE.

Anatomy and Physiology.—The eyeball is a spheroid, and the movements which it executes are only those of revolution around a centre whose position never varies.

In the normal condition the position of the eyeball itself does not vary.

The six muscles which are concerned in its movements form two groups—viz., 1, the four recti; 2, the two obliques. The conjoined action of the two latter is to draw the eye forwards; the recti, antagonistic to the obliques in this respect, draw it backwards, and thus the eye is in a state of equilibrium when these muscles are acting together normally. When they are not, the ball can be turned by them in any direction around its fixed centre, without changing its situation.

To determine the position of such a sphere, it is not sufficient to indicate the changes in position of any single point; for should this point be the pole of any axis, the sphere may change its position by rotation around that axis, the point itself remaining fixed. It is, therefore, necessary to determine another point or line. On the eyeball we take as points of precision the *centre of the cornea*, and the vertical meridian passing through this centre. In this way, we determine the rotation of the eye by indicating the direction in which the centre of the cornea is carried, and the inclination which is communicated to the vertical meridian.

The direction in which a muscle acts is given by a line which joins the middle points of its two insertions. The plane which unites this line to the centre of revolution of the eyeball, which is at the same time its spherical centre, is called the *plane of the muscle*. *The axis of revolution* of the muscle is the line perpendicular to its plane at the point of rotation.

Let us now consider the anatomical relations of the eyeball with the oculo-motor muscles. The recti muscles take their origin from the fundus of the orbit in the fibrous ring which surrounds the optic nerve; their course to their terminal insertion is rectilinear till they reach the greatest circumference of the ball. From their point of

contact, before they have pierced Tenon's capsule, to their terminal insertion, they describe a curve similar to that of the structure which they cover. In the rest of their course, except where their tendons are inserted into the sclerotic, these muscles are free till they reach the equator of the eyeball; their internal surface is lined with a smooth membrane, which is a prolongation of the fibrous envelope. The

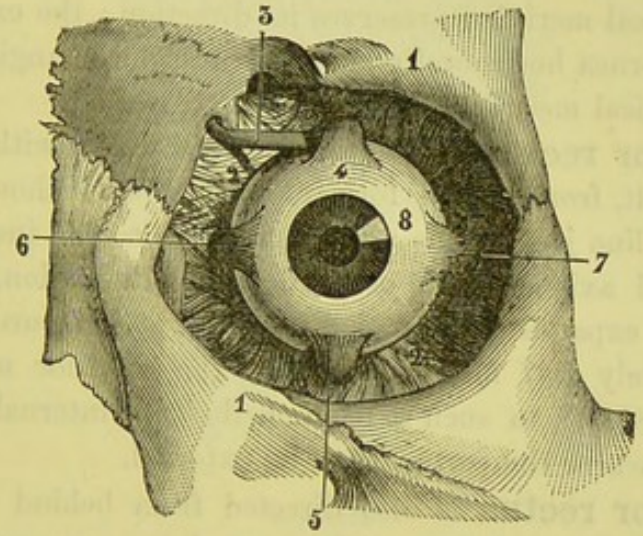


Fig. 181.—1, 1, Bone surrounding orbit; 2, 2, palpebro-ocular aponeurosis; 3, superior oblique; 4, superior rectus; 5, inferior rectus; 6, internal rectus; 7, external rectus; 8, eyeball. The figure is taken from Richet's *Anatomie Chirurgicale.*

anterior insertions must be studied separately (Fig 181). Before their insertion the muscles of the eye pierce the fibrous envelope of the eyeball, and wherever they pierce it, it forms a sheath around them, which is gradually lost in the perimysium. These prolongations are of great importance in the modern operation of strabotomy. They appear as two thin membranes (lateral sheaths) in the margins of the muscles, whose internal surface is covered by them with dense and close-set fascia. We thus see that, by these prolongations, the muscles may act on the eyeball, even when their insertion is cut near the sclerotic.

The **internal rectus** (Fig. 182, 5), the strongest of all the muscles of the eye, runs parallel to the internal wall of the orbit, and is inserted in front by an aponeurosis, 8 millimetres in breadth, the middle point of which is on a level with the centre of the cornea and about 5 millimetres from the corneal margin (Fig. 181, 6).

The **external rectus** (Fig. 182, 3), the longest of the recti muscles of the eyeball, for the greatest part of its course runs along the external wall of the orbit, and to a large extent covers the ball; it is inserted in front by a tendon 6 millimetres broad, at the level of the centre of the cornea and at about 7 millimetres from its margin (Fig. 181, 7).

It follows from what has been said, that the plane of these two muscles is horizontal, and is the same for both. Their axis of revolution is, therefore, vertical, and coincides with the vertical axis of the eye, which forms a right angle with the optical axis. Let us now suppose that the eye is in its initial position, that is to say, let the optical axis be horizontal, and the centre of the cornea be directed forwards; the internal rectus will turn the eye horizontally inwards, whilst the vertical meridian preserves its direction; the external rectus will turn the cornea horizontally outwards without changing the direction of the vertical meridian.

The **superior rectus** (Fig. 182, 4) runs parallel with the superior wall of the orbit, from behind forwards, and from without inwards, so that a straight line joining the middle point of its two insertions forms with the optical axis an angle of 20 degrees; its tendon, 7 or 8 millimetres broad, expands into a slightly convex aponeurosis, which is inserted obliquely at 7 millimetres from the superior margin of the cornea (Fig. 181, 4), in such a manner that its internal extremity is 2 millimetres nearer the cornea than its external.

The **inferior rectus** is also directed from behind forwards, and from without inwards; the middle part of its aponeurotic insertion, 7 millimetres broad, is inserted at 5 millimetres from the inferior margin of the cornea, and 1 millimetre within the vertical meridian. This insertion is oblique (Fig. 181, 5) and so placed that its internal extremity is 2 millimetres nearer the cornea than the external.

For greater simplicity, let us suppose that these two muscles have the same plane; it will be vertical and run obliquely forwards and outwards, making an angle of 20 degrees with the optical axis. The axis of revolution of these two muscles will then be horizontal, running from before backwards, and from within outwards, and will make an angle of 70 degrees with the optical axis (Fig. 182, *aa*).

Let us suppose that the eye is now moved from its initial position by rotation round this axis.

The superior rectus turns the eye upwards and inwards, and inclines its vertical meridian slightly inwards.

The inferior rectus rotates the cornea downwards and inwards, and inclines its vertical meridian slightly outwards.

The displacement of the cornea by the action of these two muscles will be greater the nearer it is to the external angle; and the alteration in the inclination of the meridian will be greater the nearer it is to the internal angle.

The **superior oblique** (Fig. 182, 6) arises at the bottom of the orbit, and is directed at first forwards; then it diminishes to a tendon which passes over a pulley (Fig. 182, 9), after which it expands, and

passing beneath the superior rectus from within outwards (Fig. 182, 10), it is inserted in the sclerotic, on the temporal side of the posterior circumference of the ball, by an aponeurosis 6 millimetres broad, the

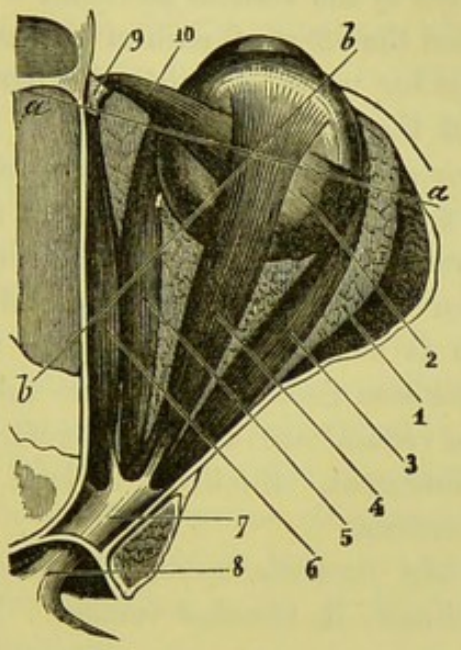


Fig. 182.

convexity of which is directed backwards and outwards, whilst its posterior extremity is about 7 millimetres, and its anterior 12 or 14 millimetres, from the optic nerve.

The **inferior oblique** arising from the internal and anterior aspect of the orbital floor, external to the lachrymal sac, first passes backwards and outwards beneath the inferior rectus. Soon, after running about 5 millimetres in this direction, it turns abruptly upwards and backwards, so as to pass between the external rectus and the eyeball; then, becoming broader and thinner, it is inserted by a short tendon near the superior oblique (Fig. 182, 2). Its insertion, 10 millimetres broad, presents a convexity upwards and forwards, the superior extremity of which is 14 millimetres from the optic nerve, whilst the inferior is only 4.

The plane of the two oblique muscles is vertical, and is directed from behind forwards and from within outwards, forming with the optical axis an angle of 55 degrees. It follows from this, that the axis of revolution for these two muscles is horizontal, and passes from before backwards, meeting the optical axis at an angle of 35 degrees (Fig. 182, *bb*).

The superior oblique rotates the cornea downwards and outwards, and inclines the vertical meridian of the cornea inwards. The inferior oblique rotates the cornea upwards and outwards, and inclines the vertical meridian outwards.

The more the eye is turned towards the nose, the greater will be the effect of these muscles on the displacement of the cornea, and the more the eye is turned towards the temporal side, the greater will be their effect on the inclination of the vertical meridian.

Having thus studied the effect of each of the muscles of the eyeball separately, it remains for us to examine the part each plays in the various movements of the eye (laws of *Donders*).

1. In looking *horizontally straight forwards, outwards* or *inwards*, the vertical meridian of the cornea is not inclined; it remains vertical. In looking straight forwards all the muscles of the eye are in equilibrium; there is no deviation of the cornea or inclination of the meridian. The external rectus is sufficient to enable us to look horizontally outwards, for we have seen that its action is to turn the eye outwards without inclining the vertical meridian; it therefore fulfils the necessary conditions of this movement. Similarly, to look horizontally inwards the internal muscle suffices.

2. To look *vertically forwards, upwards* or *downwards*, the vertical meridian is not inclined; it remains vertical. In looking vertically upwards, the superior rectus must come into play; but, as we have already seen, its contraction not only turns the eyeball upwards but also inwards, and it inclines the vertical meridian inwards. Therefore, in turning the eye vertically upwards, there must be a second force which counterbalances the subsidiary effects of the rectus superior; the inferior oblique alone does so, directing the eye upwards and slightly outwards, whilst it inclines the vertical meridian slightly outwards, and thus counteracts the subsidiary movements of the superior rectus. Therefore, in looking vertically upwards, the movement is executed by the combined action of the superior rectus and inferior oblique, which acting together lift the eye straight upwards. Similarly, in looking vertically downwards, for reasons which need not be repeated, we combine the actions of the inferior rectus and superior oblique muscles.

3. In looking *obliquely upwards and to the left*, the vertical meridians of both eyes are inclined parallel to each other and to the left; that of the left eye outwards; that of the right inwards. For the execution of this upward and outward movement of the left eye, we must first take into account the superior and external recti muscles; but the combined action of the two cannot incline the vertical meridian outwards, for, whilst the external rectus does not influence the inclination of the meridian, the superior rectus, on the other hand, turns it inwards. In this movement, therefore, some other muscle must be brought into action, which not only counteracts the internal inclination of the superior rectus, but also inclines it outwards, and thus procures the parallelism of the meridians in both eyes. The inferior oblique

alone can have this effect, since it turns the eye upwards, and so far is associated with the superior rectus. But, in addition, it inclines the vertical meridian outwards, which latter effect is all the more marked when the eye is turned outwards by the external rectus, for in that position the influence of the oblique muscles on the inclination of the vertical meridian is more pronounced. In looking obliquely outwards and upwards the eye is moved by the combined action of the external and superior recti and the inferior oblique.

4. In looking *obliquely downwards and to the left*, the vertical meridians are inclined in parallel lines to the right; that of the left eye inwards, that of the right outwards. To execute this movement with the left eye, we have first of all the action of the external and inferior recti; but, as the first of these muscles has no influence on the meridian, and as the other inclines it outwards, there must be, as in the preceding case, a third muscle which produces the necessary inclination of the meridian; this muscle is the superior oblique, which alone has this effect. The movement necessary to look downwards and outwards is then executed by the combined action of the inferior and external recti and the superior oblique.

5. In looking *obliquely upwards and to the right*, the vertical meridians are inclined in parallel lines to the right; that of the right eye outwards, that of the left inwards. To perform this upward and inward movement, we have first of all the superior and internal recti; but the inclination of the meridian inwards, produced by the action of the first, would be too great compared with the outward inclination of the other eye to allow the necessary parallelism to be preserved. A third muscle, therefore, must control the action of the superior rectus. It is the small oblique which exerts this influence on the meridian, and as the eye is in such a position (inwards) that the action of the oblique muscles on the vertical meridian is very slight, the effect of the inferior oblique cannot be too great. To look upwards and inwards we then require the combined action of three muscles—viz., the superior rectus, the internal rectus and the inferior oblique.

6. To look *obliquely to the right and downwards*, the vertical meridians of the two eyes are inclined in parallel lines to the left; that of the right eye inwards and that of the left outwards. To execute this movement of the left eye downwards and inwards we have the inferior and internal recti; but the action of the first on the inclination of the meridian would be too great to allow the meridians to remain parallel to each other: this action is limited, however, to the superior oblique. To look obliquely downwards and inwards the combined action of three muscles is then required—viz., the inferior and superior recti and the superior oblique.

Innervation.—The external recti are supplied by the sixth pair of cranial nerves, the superior obliques by the fourth pair, and the other muscles by the third pair. The anterior corpora quadrigemina are supposed to be of special importance as regards the associated movements of the eye; they are, according to *Adamueck's* experiments, the centre of innervation common to both eyes.

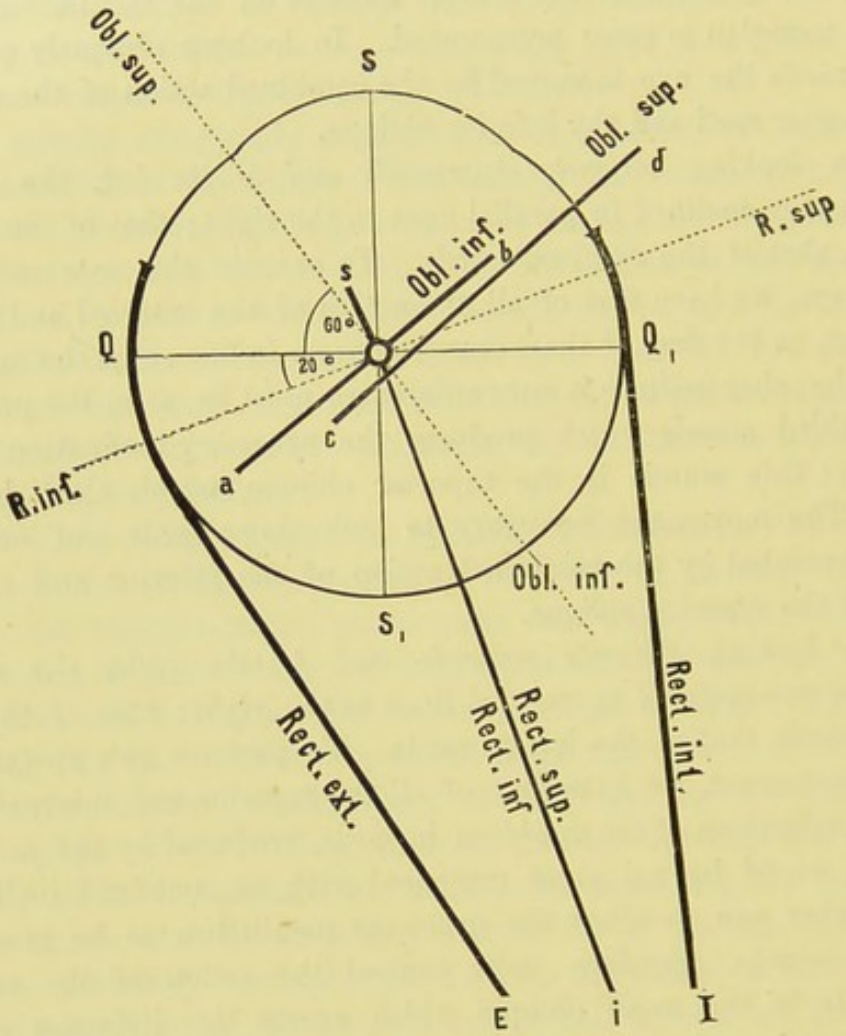


Fig. 182*a*.—Scheme of the action of the ocular muscles.

ART. I.—Paralysis of the Muscles of the Eye.

A. General Considerations.

Affections of the innervation show themselves by a diminution of the muscular contractility, which may be only diminished or totally destroyed: hence we may distinguish various degrees in this affection, varying from a simple insufficiency to a complete paralysis. The number of muscles affected differs according to the number of nerves affected. If the disease takes hold of the sixth pair, the symptoms are manifested

in the external recti; if the fourth pair be attacked, the superior oblique alone will be paralysed; if the third pair, either one, or several, or even all the muscles supplied by this pair will be affected. In some cases the paralysis supervenes simultaneously in several pairs of nerves.

Every paralysis of a muscle is at first manifested by a *diminution of the mobility* of the eye in the direction in which that muscle acts in the normal condition. Yet we must not forget that there may be a loss of mobility without paralysis (as in cases of orbital tumour and symblepharon), and an incomplete paralysis without *apparent* loss of mobility. The absolute and normal mobility of the eye is subject to considerable physiological variation. As a general rule, we estimate that, in a healthy eye, the strongest adduction (rotation of the eye towards the nose) will turn the eye so far in, that the internal margin of the pupil is hidden behind the caruncle, whilst in extreme abduction (rotation of the eye towards the temple) only the margin of the cornea reaches to the external commissure.

We, therefore, begin by examining the absolute mobility of the eye which is supposed to be affected, verifying our observation by comparing it with the mobility of the other.

On making this examination, when one muscle is completely paralysed we shall find that the eyeball can no longer be turned in the direction in which that muscle acts. If the paralysis is less complete, the eye may be more or less directed in this direction; when it attains the limit of its movement, we shall find that its efforts are terminated by a spasmodic movement which rapidly exhausts the muscular power still available. We must distinguish the spasms which take place in the direction of the affected muscle from those by which the other muscles strive to replace the function of the enfeebled one.

A second important sign is obtained by the examination of the associated movements of the two eyes. To move in a given direction, the same nervous impulse is given to the two eyes. If, then, there exists a muscular paralysis in one eye, the degree of innervation which suffices for the healthy side does not suffice for the diseased one. The optical axis of this eye is no longer directed towards the object of fixation; it deviates towards the side opposite to the paralysed muscle; thus we have a *paralytic strabismus*. This deviation of the eye will naturally be the more marked the farther the patient looks in the direction in which the muscular power is absent. If, then, we cover the healthy eye with the hand, the other will be obliged to fix itself by making a more or less extensive movement of rotation in the direction of the paralysed muscle; this symptom is decisive in any case where it is difficult to determine which is the abnormal side.

In performing this experiment, we notice in the second place another characteristic phenomenon. After having hidden the healthy eye behind the hand, and brought the affected one to a point of fixation, if we examine the position of the healthy eye under the hand, we notice that it has also moved in the same direction as the paralysed eye, but that the amount of its movement is twice, thrice, or four times greater (secondary deviation). In order to adjust the eye, the paralysed muscle must make a certain effort. This effort, which is accompanied in the healthy eye by the identical nervous impulse, must necessarily produce on it a much greater effect, and the more complete the paralysis of the affected eye the greater will be the effect on the healthy side.

A third symptom of every muscular paralysis of the eye is a marked deficiency in *the projection of fixed objects*, that is to say, an inability to determine their exact situation in space. Thus, if, shutting the healthy eye, we ask the patient to place the tip of his finger very rapidly on any object whatsoever (the surgeon's finger, for example) situated on the side of the paralysed muscle, without turning his head, the patient's finger will always pass on the side corresponding to the paralysed eye; a circumstance which is easily understood. For we judge of the position of objects in space by the amount of effort necessary to direct the optical axis on any object; thus, if a muscle is paralysed, the nervous impulse necessary to fix an object is greater than in the normal condition. Consequently, the patient estimates it at a greater distance on the paralysed side than it is in reality. It is well to remember that these movements must be performed rapidly, for, if not, the patient can correct his judgment as he advances his finger. On this false projection depends the *vertigo*, of which such patients complain when they close the healthy eye, which form of vertigo must be carefully distinguished from that other which is felt when both eyes are used, and which depends on the presence of diplopia. Monocular vertigo, if we may so express it, is much more marked when several muscles are affected.

Diplopia—that is, a disturbance of binocular vision—is another important symptom of muscular paralysis. If the deviation is one of convergence, the two images are *homonymous;* the image situated on the right hand is seen by the right eye, and the image on the left, by the eye of the same side. Thus, in excessive convergence of one eye (see Fig. 183), the image of the object, a, is formed on the internal side of the right retina at a', and is projected, according to the laws of reflection, at a''. If the deviation is divergent (Fig. 184), the images are *crossed*, that is to say, the right image is perceived by the left eye, and the left image by the right eye, for (Fig. 184) the image of the point, a, formed on the external part of the right retina at a',

is projected to a''. For the same reasons a deviation downwards will produce a more elevated image than is perceived by the eye at the normal level, as also a deviation upwards must produce an image at a lower level. When the deviation is in a diagonal direction—for example, upwards and outwards—the respective position of the double image is analogous.

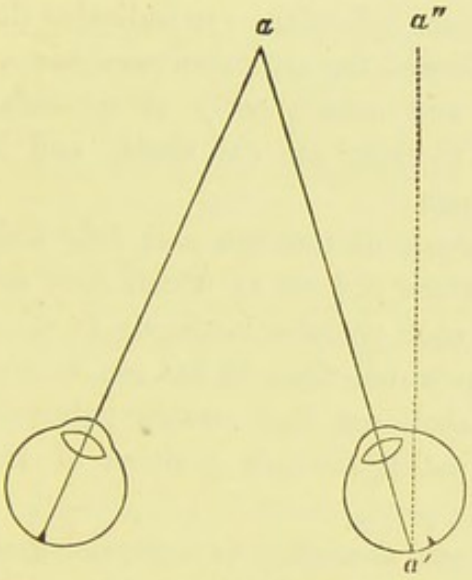


Fig. 183.

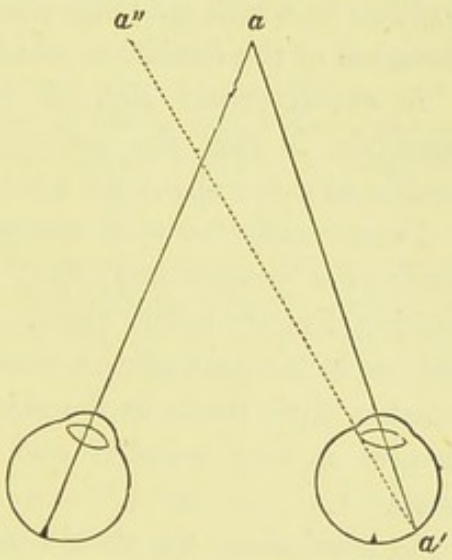


Fig. 184.

The distance which separates the two images will be in direct proportion to the distance separating the macula from the image in the deviating eye. Consequently, this distance depends on the degree of deviation, and will *increase the farther the patient tries to look in the direction of the paralysed muscle.*

When the deviation is very small, as in cases of slight muscular insufficiency, the diplopia is often concealed, because the images are in part blended with each other; only objects appear larger than they are in reality, and their margins present diffusion circles, which destroys the definition of their outlines. As the deviation increases, the image of the affected eye becomes further separated from that of the other, and the separation may be so great that the patient entirely suppresses the impression in the deviating eye; which impression, moreover, becomes less intense as it approaches the periphery of the retina. When this takes place the patient no longer complains of diplopia.

To aid the patient in distinguishing the two objects and the distance which separates them, it is well to place a piece of coloured glass before the healthy eye. We may also make use of prismatic glasses in detecting a concealed diplopia. Thus, if we place a prism so that it refracts vertically, one of the two images is superimposed, and the

patient can then easily indicate their lateral distance from each other. Prisms are also of great use, in cases of muscular paralysis of the eye, in verifying a diagnosis which has been founded on the symptoms indicated. When we have detected binocular diplopia, a prismatic glass diminishes the distance between the two images, or unites them, by bringing the luminous rays into the neighbourhood of the fovea centralis, or even on to it. It is easily seen that the exact position in which we must place the prism before the eye indicates the direction of the deviation which has followed the muscular paralysis.

A characteristic sign of diplopia, and consequently of muscular paralysis, is that the patient prefers to keep *one eye closed*, and is unable to move about with both eyes open.

Persons affected with muscular paralysis of the eye also *hold their heads in a peculiar way;* they do not place objects at which they are looking directly before them. In fact, such patients instinctively place objects in the part of the visual field in which they do not see double, turning their heads to the side. We shall see that certain paralyses involve a very peculiar and almost pathognomonic position of the head.

In conclusion, we should mention that, according to a physiological law based on custom, our eyes converge if we look downwards, whilst they diverge when we look upwards. Consequently the symptoms of muscular paralysis will be modified according to the direction of the eyes. If the paralysis cause divergence, the divergence will be increased when the patient looks upwards, and, conversely, a pathological convergence will increase when he looks downwards.

B. Symptoms of the Various Forms of Muscular Paralysis of the Eye.

1. Paralysis of the Sixth Pair.

(*External Rectus.*)

[In the succeeding sections we shall speak of the left eye; the deductions which we are about to make may easily be applied to the right eye.]

(*a.*) **Complete Paralysis.**—Beginning with the median line, the eye remains completely immobile if we attempt to make it move towards the temple. Yet, on careful observation, we generally find a slight movement of abduction; only, this movement does not take place directly outwards, but either outwards and upwards, or outwards and downwards. This movement is the product of the contractions of the

oblique muscles, which thus seek to supply the place of the external rectus. If now we cause both eyes to fix on an object held to the left, and to the outside of the median line, the right eye will follow it perfectly, but the left will remain behind; we, therefore, have a convergent strabismus, which increases the farther the object is carried to the left; and along with this there is homonymous diplopia.

In studying the phenomena arising from diplopia, we generally use with great advantage a deep violet glass, which is held before the healthy eye; the patient looking with both eyes at a lighted candle, placed three or four feet in front of him. This glass serves a triple purpose:—1st, It clearly differentiates the two images, so that it is always easy for the surgeon to know which is the image seen by the left eye and which by the right, and thus he makes sure of their respective positions; 2nd, the image of the paralysed eye, being formed on an eccentric part of the retina, is not so easily seen as that of the normal eye, so that the coloured glass, by diminishing the intensity of the image of the healthy eye, renders the perception of the two images more easy; 3rd, again, the glass considerably obscures the visual field, and thus allows the eye to concentrate its attention on the candle flame.

On placing a violet coloured glass before the right eye, the patient will see a violet flame to the right and a white one to the left. The distance between the two flames is increased as we carry the candle to the left, but both remain exactly in the same plane, at the same height.

We may cause the distance between the two objects to disappear, by using a prism with its base turned outwards; for, as we have seen, the retinal image of the affected eye is formed internally to the yellow spot; consequently a prism, with its base outwards, turning luminous rays outwards brings them on to the macula. In making this examination, we may also place before the other eye a prism having its base upwards or downwards, so as to make a difference in the height of the two images, for by so doing we prevent the patient from making any effort of fusion; the prism, which brings the one image exactly on the top of the other, gives the correct measurement of the degree of deviation.

By reason of the physiological convergence and divergence, which, as we have said, take place when the patient looks upwards and downwards, the line which separates that portion of the visual field in which the vision is simple from that in which it is double, will be inclined from above downwards, and from within outwards. In cases of partial paralysis, moreover, the line of demarcation of which we speak, will vary with the point at which we begin our examination. If we begin with a point at which vision is simple, the tendency to fusion will be more felt, and the paralysed eye will make every effort,

until a point is reached at which it is obliged to yield. If, on the other hand, we begin at a point where the diplopia is already manifest, the muscle in question does not experience any special stimulus to contraction, and the diplopia will be present at a line somewhat nearer the median line than in the former case.

Sometimes we find a contraction of the muscle antagonistic to the paralysed one. That contraction of the internal rectus which accompanies the paralysis of the external is sometimes developed in the early stages of the disease, sometimes later; in other cases it is never present. Its presence is detected by the abnormal increase of the convergence, as well as by the extension of diplopia into the other part of the field of vision.

The special symptoms of secondary deviation and false projection manifest themselves in the following way :—If we cover the eye which is supposed to be healthy with the hand or a piece of ground glass, whilst the left eye is directed to a point situated on the left, we notice great convergence of the right eye, much more considerable than that of the left one when the healthy eye fixes the same point. This very pronounced strabismus is at once observed in cases where the non-paralysed eye was previously affected with amblyopia, and in which the paralysed eye was used for purposes of fixation.

The false projection always takes place to the outside of the fixed object (on the same side as the paralysed muscle).

Again, the patient will rotate his head outwards (to the left) round its vertical axis, and will hold objects at which he is looking to the right. He will thus replace the action of the paralysed muscle by the rotation of his head, and will at the same time bring in front of him the part of the visual field in which he sees objects single.

(*b.*) **Incomplete Paralysis.**—In this, the symptoms are fundamentally the same as in complete paralysis, but not so well marked. The mobility of the eye is only reduced, and towards the external limit of its movement we shall find the jerking contractions of which we have spoken.

We may more particularly notice the characteristic movements of re-adjustment which take place when, causing both eyes to fix on some object, we cover the healthy one: the diseased eye, in order to keep the object fixed, makes a small excursion outwards, and the other eye undergoes a secondary deviation to a much greater extent.

Diplopia occurs only when the point of fixation is at the extreme left. It is important to measure the amount of deviation in this class of cases with the prism, so that we may ascertain any improvement or aggravation of the paralysis.

2. Paralysis of the Third Pair.

[Muscles affected:—Internal rectus, superior rectus, inferior rectus, inferior oblique, levator of the upper eyelid, sphincter of the iris and ciliary muscle.]

(*a.*) **Paralysis of the Internal Rectus.**—When this muscle is paralysed, we find an inability to move the eye inwards, divergent strabismus and crossed diplopia affecting the entire internal (right) portion of the field of vision. When we cover the healthy eye, the diseased one makes an inward movement of re-adjustment, and at the same time we may notice the secondary deviation of the right eye outwards. The false projection takes place inwards (to the right) of the object. To avoid the diplopia, the patient rotates his head to the right, and also holds objects at which he is looking to his left. The distance between the two images diminishes when a prism is placed before the eye with its base inwards, and if the prism is of the proper strength, the diplopia entirely disappears.

(*b.*) **Paralysis of the Superior Rectus.**—When this muscle is paralysed, we have, conformably with its physiological action, a deficiency in the movements upwards and inwards, and a loss of power in the rotation of the vertical meridian inwards. Consequently, when the patient looks upwards, the eye will deviate downwards and outwards, and the vertical meridian will turn outwards.

On placing an object in the superior half of the field of vision, we shall find a cross diplopia, and the image belonging to the diseased eye will be at a higher level than that of the other one. The superior extremities of the two images diverge.

When the healthy eye is hidden, the secondary deviation takes place upwards and outwards, since the affected eye is forced to make a considerable effort upwards and inwards to gain the fixation point.

The patient rotates his head on the horizontal axis backwards, and holds objects in the inferior half of the field of vision.

A prism, with its base upwards and slightly inwards, will bring the two images closer together, and, if of sufficient power, will cause their union.

The influence of the paralysis on the height and on the inclination of the meridian varies with the position of the eye; if the eye is directed outwards, the axis of rotation corresponds with the transverse diameter of the eye, and therefore the influence of the paralysis on the height of objects will be at a maximum, but on the inclination of the meridian will be nil; the opposite is the case if the eye is directed inwards. In looking upwards and inwards, the distance between the two images is

much diminished, but the inclination of the image belonging to the left eye is very marked. This point is of great importance in distinguishing paralysis of the superior rectus from that of the inferior oblique.

(*c.*) **Paralysis of the Inferior Rectus.**—We find a deficiency of movement downwards and inwards, and an inability to rotate the meridian outwards. If the healthy eye be hidden, the other makes a movement of re-adjustment upwards and inwards; and the secondary deviation takes place upwards and outwards. The diplopia is crossed, the image of the affected eye is the lower of the two, and the extremities of the images converge towards each other. The image belonging to the affected eye seems to be nearer the patient than the image of the healthy side. The lateral distance between the two images increases as the fixed object is carried directly from above downwards; the difference in height increases when the object is carried towards the side of the paralysed eye; lastly, the obliquity of the images increases when the object is carried towards the side of the healthy eye.

This form of paralysis is very troublesome to the patient, as he has to keep his head down and hold objects above him.

A prism, with its base downwards and slightly inwards, will bring the double images nearer each other, and, if of proper strength, will unite them.

(*d.*) **Paralysis of the Inferior Oblique.**—The affected eye deviates downwards and inwards. When the healthy eye is covered, the other re-adjusts itself by a movement upwards and outwards. Consequently, the secondary deviation of the healthy eye takes place upwards and inwards. The double images are situated in the superior part of the visual field, their superior extremities diverge and the diplopia is homonymous. The divergence of the images increases if the patient looks upwards and outwards, the difference in their height is specially marked when he looks upwards and inwards. A prism, with its base upwards and outwards, will bring the two images together, and unite them into one.

Paralysis of this muscle alone is moreover exceedingly rare.

When the **paralysis of the third pair is complete,** we have, in addition to the signs already mentioned, drooping of the superior eyelid, due to paralysis of the levator muscle. If we raise up the lid, the pupil is found to be partially dilated (see article Mydriasis, p. 169), and immobile from paralysis of the sphincter of the iris. Lastly, the accommodation of the eye is reduced, being sometimes altogether absent (paralysis of the ciliary muscle, p. 393). Sometimes we find a slight exophthalmos which is caused by the diminished tension of the muscles which draw the eyeball backwards, of which three are supplied by the motor-oculi nerve.

In the early stages of the paralysis the eyeball does not seem to be deviated when the patient looks directly before him, but soon the predominating action of the external rectus draws it towards the temple. The eye can be directed inwards only very imperfectly, and scarcely beyond the middle point of the palpebral fissure. The eye cannot be turned upwards at all, and can only be turned downwards by the superior oblique; consequently the movement is very imperfect, and is accompanied by a well-marked inclination of the vertical meridian inwards.

The objective symptoms of complete paralysis of the third pair are so characteristic that it is almost superfluous to examine the diplopia. The images are crossed, and the distance between them increases the farther the fixed object is held to the side of the healthy eye. When the patient looks upwards, the image of the diseased eye is above the other, but is below it when he looks downwards.

If the patient attempt to walk with only his affected eye open, he will suffer from vertigo (caused by false projection of his field of vision) to such an extent that he will stumble and be obliged to stop; generally, however, the drooping of the upper eyelid will protect him from the inconveniences of this vertigo, as well as from diplopia supervening when both eyes are open.

3. Paralysis of the Fourth Pair.

(Superior Oblique.)

The deviation of the affected eye is only felt when the fixed object is situated in the inferior half of the field of vision. The eye is turned upwards and inwards. When the healthy eye is covered, the other is rotated from above downwards and from within outwards; and this will increase in proportion as the fixed object is carried farther to the side of the healthy eye. The secondary deviation takes place downwards and inwards.

Diplopia is only manifest in the inferior portion of the field of vision, and is, consequently, very annoying when the patient ascends or descends a staircase, or walks on a narrow footpath. The double images are homonymous; the image belonging to the healthy eye is found above the other, and their superior extremities converge. This obliquity increases when the fixed object is carried towards the side of the diseased eye, whilst the lateral distance between the two images and the difference of their level diminish. When the fixed object is held on the same side as the diseased eye, the lateral distance between the two images decreases, whilst the difference in height is greater.

The image coming from the affected eye always seems nearer the patient than that coming from the healthy eye.

A prism with its base downwards and outwards will bring the double images nearer each other. The patient keeps his head down and inclined towards the side of the healthy eye, in order to avoid, as far as possible, the inconveniences of the diplopia.

When, at a later period, paralysis of the superior oblique is complicated with retraction of its antagonist, the inferior oblique, the diplopia extends to the superior half of the field of vision. The images in this situation, however, are crossed, which circumstance is due to the excessive action of the inferior oblique increasing the outward deviation of the healthy eye. The difference in height of the two images increases when the fixed object is carried toward the healthy side; their obliquity increases in the opposite direction.

C. Progress and Termination of Paralysis of the Ocular Muscles.

The progress of the different forms of paralysis varies with the degree of the paralysis and with its cause. The forms which are of central origin are, as a rule, slower in passing off and more difficult to treat successfully than those which are due to some peripheral influence.

Paralysis may end in various conditions, in the enumeration of which we shall begin with the most favourable—

1. Complete restoration of mobility.
2. Incomplete restoration of the muscular power.

In these two sets of cases, the disease, during its entire course, may be restricted to the paralysed muscle. But it may occur also that its antagonist, freed from a portion of the resistance which it generally encounters, tends to retract. If this muscular tension lasts for a certain time, it may produce a permanent contraction, with all the symptoms of concomitant strabismus. We may then have to deal with one of the following conditions:—

(*a.*) The paralysis is cured; but while it lasted, the antagonist of the paralysed muscle has become shorter, which causes a slight deviation in the direction of that muscle. This deviation, being very slight, may be overcome by muscular exercise (dynamical strabismus).

(*b.*) The shortening of the antagonistic muscle which has supervened during the period of the paralysis may be so great that the patient, even after the paralysis has quite passed off, is no longer able to overcome the contraction by muscular effort. We have, therefore, a permanent deviation with all the symptoms of concomitant strabismus.

(*c.*) The contraction of the antagonist may take place although the paralysis is not completely cured; so that we have at the same time the symptoms of paralysis of one muscle and those of contraction of its antagonist.

(*d.*) The last condition consists in complete paralysis of one muscle and exceedingly firm contraction of the other. The eye then follows the latter, and remains immovable in the angle of the same side. This condition is called *paralytic contraction.*

D. Prognosis of Paralysis of the Ocular Muscles.

The prognosis is much more favourable when the paralysis is of peripheral origin than when of central. In the former case, it often completely disappears, except in cases where there is a lesion of the nerve or other cause which cannot be expected to be cured or pass off—*e.g.*, a tumour invading or pressing on the nerve.

The prognosis of paralysis of the third pair is less serious if the disease is of recent origin, and if it does not involve many muscles.

Paralysis of the sixth pair, although as a rule easily cured, often produces a contraction of the internal rectus, which leaves a permanent convergent strabismus.

When the paralysis is not due to some peripheral condition, we must be much more guarded in our prognosis; for it must not be forgotten that such ocular affections are often prodromatic, or appear in the course of serious diseases of the nervous system.

E. Ætiology of Paralysis of the Ocular Muscles.

The causes of paralysis of the muscles of the eyeball are either peripheral or central. The first are of two kinds, affecting the motor nerves either directly, or secondarily to neuralgia of the orbit and its neighbourhood, in which case the motor nerves are influenced in a reflex manner. The want of exercise in a paralysed muscle may then give rise to some disturbance of its nutrition, to atrophy with or without fatty degeneration, which may so modify the structure of the muscle that it is unable to perform its functions, even after the primary cause has disappeared. It has not yet been proved that inflammation or over exertion has ever produced symptoms of paralysis of an ocular muscle.

If we leave aside influences which only exceptionally give rise to muscular paralysis, such as alcoholism, diphtheria, hysteria, facial

neuralgia, &c., we find that the others may be grouped into three great classes :—

1. Rheumatic affections.
2. Syphilis.
3. Affections of the nervous centres.

1. The rheumatic origin of the paralysis is easily recognised, when there are also present other affections produced by the same diathesis, or there is a history of a sudden and prolonged chill.

2. We must suspect a syphilitic origin when we detect specific symptoms in the previous history of the case. Paralysis of the ocular muscles is generally a tertiary symptom, rarely a secondary. A common cause of the paralysis is periostitis, exostosis or gummatous tumours, and still more frequently granular tubercles in the course of the nerve. Paralysis of syphilitic origin is relatively more frequent in the third pair.

3. In paralysis of cerebral origin the diagnosis is rendered easy by the presence of other concomitant symptoms. We often find an affection involving several muscles of the eye supplied by different nerves; while, at the same time, there is hemiplegia, characteristic headaches, vertigo, or a diminution of the intelligence. Besides, experience shows that the diplopia of paralysis of central origin persists, notwithstanding the means used to produce fusion of the images. If, after a very careful selection of the proper prism, we succeed in uniting the images, the least displacement or the slightest difference in the angle of the prism brings back the diplopia.

Paralysis of the muscles of the eye is often met with in locomotor ataxy, and it is not unfrequently one of the first symptoms of cerebro-spinal disease. The amount of paralysis is sometimes so slight that it can only be detected by the diplopia which accompanies it. A proper application of the physiological laws, relative to the action of the muscles and to the projection of the images, allows us to determine easily, from the position of the double images, the presence of incipient affections; and their clinical significance, in certain cases, is of great assistance in the diagnosis of the general affection.

As to the localisation of the cerebral disease, it cannot always be indisputably settled by the special form of muscular paralysis present; still there are certain rules, deduced from the observation of a great number of cases, which are of great use. Paralysis of the external rectus and the superior oblique, of central origin, generally depends on an affection of the opposite hemisphere; whilst paralysis of the third pair is connected with the hemisphere of the same side. Paralysis of

the muscles of both eyes is due to affections of the corpora quadrigemina and of the pons.

Complete paralysis of a nerve indicates that the lesion is situated at a point where the nerve fibres are already united into one trunk, that is to say, near the base of the cranium; if the cause is situated in the central parts, or near the origin of the nerve, the disease must be very extensive to involve all the fibres of the nerve. Again, it must not be forgotten that cerebral hyperæmia, either active or passive, may of itself be sufficient to produce paralysis of the ocular muscles. It is also often due to basilar tubercular meningitis and pachymeningitis.

Paralysis of the muscles of the eye is frequently a symptom of disease of the spinal cord, often appearing long before the other symptoms. It is then characterised by a passing disturbance, sometimes in one muscle, sometimes in another; sometimes even the two eyes are affected alternately.

Lastly, we should mention *congenital paralysis* and the isolated cases of *complete paralysis of all the ocular muscles* (nuclear paralysis).

F. Treatment of Paralysis of the Ocular Muscles.

The treatment employed must be a natural sequence of the cause of the disease. It consists of: 1, The administration of suitable remedies; 2, the use of prismatic glasses and orthopedic treatment; 3, surgical interference. If the disease be of rheumatic origin, this primarily involves that the patient should avoid everything which may cause a chill, and should protect the affected side of the head. In the early stages, the treatment must be antiphlogistic and derivative (antimony in nauseating doses, salicylate of soda, iodide of potassium, sudorifics, fly-blisters in the neighbourhood of the affected eye). After the inflammatory symptoms have subsided, electricity may be of great service. In syphilitic paralysis, all the anti-syphilitic remedies, beginning with mercurials and iodide of potassium, are of use. The treatment of cases originating in cerebral disease includes the administration of such remedies as are suitable in that affection.

To prevent the diplopia which is so annoying to the patient, and which may occasion severe headache and vertigo, spectacles may be worn in which the diseased eye is protected by a piece of ground glass.

Prismatic glasses may be used for a twofold purpose: 1, To relieve the patient temporarily of the diplopia; 2, to exercise, and thus to strengthen, the weakened muscles. In dealing with diplopia, the strength of the prism and its direction must naturally depend on the amount of deviation and on the muscle which is paralysed.

Speaking generally, the prism should be placed before the eye so that its apex is in the same direction as the deviation, pointing outwards in divergence, inwards in convergence, upwards when the eye deviates upwards, and *vice versâ*. If the double images show both a vertical and horizontal deviation, it may be corrected by putting a prism horizontally before one eye, and another prism vertically before the other.

In the same way, when we are dealing with a lateral deviation which requires a prism of 10° for its correction, we may divide the effect of this prism by placing before each eye one of 5°. In no case should we use a prism of more than 6° or 7° for each eye. This difficulty, and the variation in the two images according to the direction in which the patient looks, explain why, in most cases, it is impossible permanently to give prismatic glasses for the purpose of correcting the diplopia.

To strengthen the paralysed muscle by means of prisms, we must first ascertain the prism required to completely neutralise the diplopia. This being found, we must try the effect of placing a somewhat weaker prism before the eye. The two images are then brought very near each other, and the patient may be able to obtain single vision by uniting them with an effort of the affected muscle. This is the very effort which we wish to excite in order to give exercise to the muscle in question. If the fusion of the two images, when placed near each other, does not take place, we must give up the idea of orthopædic treatment. If, however, fusion is produced, we leave the patient to exercise his eye with this prism, which will soon of itself be sufficient to counteract the diplopia without any muscular effort. We then exchange it for a weaker prism, and so on till the deviation is cured. The selection of prisms requires great care; a prism which is too weak fatigues the muscle instead of strengthening it, and one which is too strong will increase the contractions of the antagonist, and, consequently, the deviation of the eye.

Michel recommends orthopædic treatment consisting of passive movements of the paralysed muscle. A fold of the conjunctiva, near the cornea and scleral intersection, is held with the fixation forceps, and the eye drawn as far as possible, several times in succession for about two minutes, in the direction of the muscle. These manipulations are intended to counteract the contraction of the opposing muscle, and to prevent atrophy of the diseased one by imitating its natural contractions. We frequently make use of it after anæsthetising the conjunctiva with cocaine. Electricity may be used in connection with this treatment.

When the treatment has given all the relief which can be expected

from it, and there remains a certain amount of deviation and diplopia, *surgical interference* may be required. In the most simple cases, in which the loss of mobility does not exceed 3 or 4 millimetres, we may rectify it by advancing the affected muscle; when the loss of mobility is about 5 or 6 millimetres, muscular advancement, combined with tenotomy of the antagonist, and, if necessary, followed by tenotomy of the internal or external rectus of the other eye, brings the two eyes parallel, and restores simple binocular vision. Vertical deviations should be rectified by advancement of the muscle affected or by tenotomy of those muscles of the *healthy* eye which contract simultaneously with the affected muscles. If the deviation be very great, this operation must be followed by tenotomy of the antagonistic muscle. In no case should the oblique muscles be divided. The details of the operation will be explained when we speak of the operations for strabismus.

Any surgical interference of this kind should only be had recourse to when the paralysis is already of old standing, and when the deviation and diplopia have been stationary for a length of time. An operation performed too soon or inadvisedly, although at first apparently satisfactory, will soon be found to be insufficient, or still worse, if the paralysed eye recover, it will give rise to a deviation in the opposite direction.

ART. II.—Spasm of the Ocular Muscles. Nystagmus.

Tonic spasm of the ocular muscles is one of the rarest affections of the eye. It almost never occurs idiopathically, but only as a symptom of certain cerebral diseases. The same is true of conjugated spasmodic deviations of both eyes (and of the head). The deviation is towards the same side as the disease in affections of the hemispheres, and to the opposite side in affections of the pons and cerebellar peduncles (*Prévost*).

Nystagmus consists of constant oscillatory movements of the eyeball, most frequently in the direction of the lines of action of the external and internal recti muscles. In a few cases the movement is rotatory, and still more rarely is it vertical. It has sometimes been found that the movement is slower, or even stopped, when the patient looks in a given direction. Nystagmus disappears during sleep, but

the movement increases or, when periodic, rapidly supervenes under the stimulus of emotion.

Vision is almost always very weak in cases of nystagmus. Still, cases are met with where it is sufficiently good to allow the patient to follow his ordinary work, or even to read. Sometimes the patient tries to compensate the effect of the ocular movement, by movements of the head in the opposite direction.

The **ætiology** of this affection is not perfectly understood. It most frequently comes on in the first years of life with congenital amblyopia, microphthalmia, coloboma of the choroid, albinism, opacities of the cornea, cataract, &c.

In all such cases, the predisposing cause seems to be a loss of the power of fixation. Yet the number of observed cases of congenital amblyopia without nystagmus evidently shows that it is not of itself sufficient to produce the disease. It is more than probable that there must also be some disturbance of the muscular equilibrium, most likely of the internal and external recti. Thus nystagmus has been seen to attack colliers, whose work in a defective light often necessitates a very inclined position of the head, so that they can only use one eye; at the same time this eye is kept at extreme abduction, which rapidly fatigues the external rectus, and obliges it to perform rythmical movements, in order to bring the eye as often as possible into the lateral position which the collier's work requires. These rythmical movements are accompanied by similar movements of the other eye, and if this condition lasts for some length of time the nystagmus is found to be perfectly established.

Whilst in cases of congenital nystagmus, or in nystagmus supervening in infancy, the displacement of the retinal images is not perceived by the patient, this phenomenon forms a prominent feature in collier's nystagmus, especially in the early stages. Objects seem to dance before the patient, causing a disagreeable vertigo and a sensation of nausea akin to sea-sickness.

Another cause of acquired nystagmus has been shown to be cerebral sclerosis (*Charcot*), and this symptom may be compared to the trembling movements of the hands which are seen when the patient attempts to perform any given movement. These symptoms are not present when the patient is at rest.

Congenital nystagmus, or nystagmus supervening in the early years of life, is often accompanied by strabismus.

Treatment.—Various attempts have been made, with little success, to treat nystagmus by regular exercise of the ocular movements, beginning with the direction in which the nystagmus disappears, or is considerably reduced. These exercises should be preceded by the use

of such glasses as are adapted to the anomaly of refraction with which the eyes are affected (frequently astigmatism). If there are opacities of the cornea or of the lens, we must make a passage sufficient for the transmission of luminous rays. In cases complicated with strabismus, and even in certain cases where there is no strabismus, tenotomy of the muscles which are affected with chronic contractions has been proposed (*Boehm*). The constant current, as also injections of strychnia, have likewise been recommended. The wearing of blue tinted glasses often seems beneficial. But, in estimating the efficacy of such remedies, we must not forget that nystagmus often becomes much less in adult life, and may even completely subside.

ART. III.—Strabismus.

A. General Symptoms and Differential Diagnosis.

In normal circumstances, the two eyes are so directed that the optical axes meet on the object at which we may be looking; but if a person affected with strabismus looks at an object, one of his eyes will be directed towards it, but the prolongation of the optical axis of the other will pass to its side.

In many cases the false direction is so obvious that it can be detected at a glance; but there are other cases in which we can detect the want of symmetry without being able to say which is the deviating eye. We must then ask the patient to fix a point—for instance, the tip of the finger—and close one eye after the other. The eye which retains its previous position was normally directed on the fixed object; the other, compelled to fix the object, re-adjusts itself—that is to say, brings its optical axis into the necessary position for distinct vision of the object placed before it. The direction in which it moves also indicates in what direction the eye was deviated; if it moves inwards, the eye deviates outwards; if upwards, then the eye is displaced downwards, and *vice versâ*.

We have just seen that, a point of fixation being given, on covering the healthy eye with the hand the squinting eye re-adjusts itself. If we watch the healthy eye behind the hand, we find that it changes its direction, and moves in conjunction with the other eye. Thus, if we are dealing with a convergent strabismus of the left eye, and cover the right one with our hand, the left re-adjusts itself by moving outwards, and we can at the same time see an associated inward movement

of the right. It will also then present a convergent strabismus, which has received the name of *secondary deviation.* The degree of the secondary deviation is exactly the same as that of the primary strabismus.

In paralytic strabismus, the secondary deviation is much greater than the strabismus, for reasons explained in speaking of that affection.

If we now continue to keep the healthy eye closed, and cause the other to rotate in all directions, we shall find that it moves perfectly freely; its *mobility* is only slightly increased towards the deviation, and a little diminished in the opposite direction, but is in amount exactly the same as that of the healthy eye.

Let us suppose, for example, a case of convergent strabismus of the left eye (Fig. 185), and let us measure the mobility of each eye

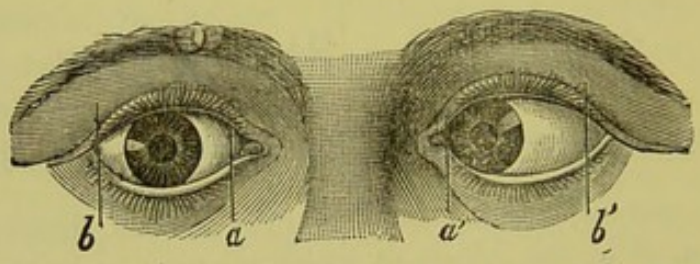


Fig. 185.—Mobility of the healthy eye and of the squinting eye; in the latter, the mobility, although of the same extent, is displaced in the direction of the strabismus.

separately. We find that the healthy eye can be directed inwards till the external margin of the cornea reaches the point, *a*, and that it may be turned outwards till this margin reaches the point, *b*. The left eye, which is squinting, in extreme inward rotation goes a little farther than the point, *a'*, but in the opposite direction it stops a little sooner than the other, its corneal margin falling short of the point, *b'*. We may therefore say that the mobility of the squinting eye is slightly displaced in the direction of the strabismus, but its extent is the same as in the normal eye.

In paralytic strabismus, the mobility is diminished on account of the deficient action of the paralysed muscle.

When the patient, keeping both eyes open, looks in various directions, the squinting eye moves with perfect freedom in conjunction with the healthy eye.

On studying this symptom, which has caused this variety of strabismus to be called *concomitant*, we also find that the *degree* of deviation is the same for all movements.

In the normal condition, the two eyes, having their optical axes at

first perfectly parallel, preserve this parallelism for all lateral movements, because the same amount of nerve influence acts on the muscles which set the eyes in motion. Hence, there is a perfect harmony of all associated movements. Thus, for example, if (Fig. 186)

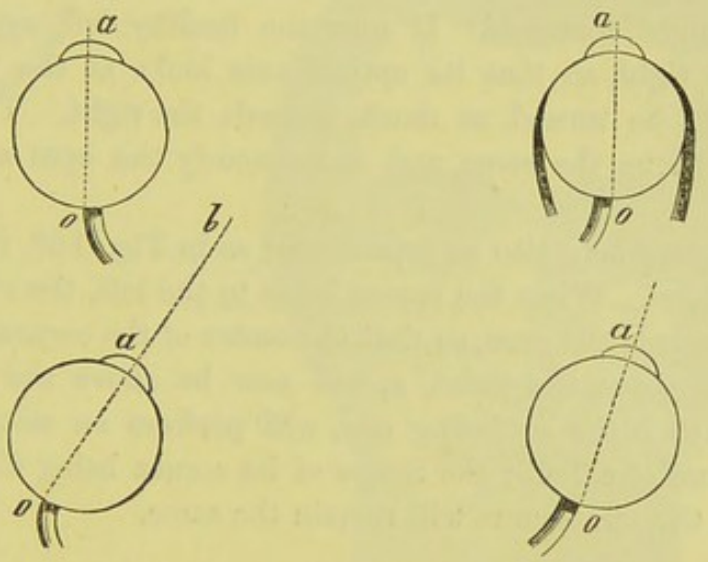


Fig. 186.—Parallelism of the associated movements of the normal eyes; the left eye turns its optical axis on the distant point, *b*, the other eye moves in a similar manner.

the left eye be turned so that the anterior pole of its optical axis (*a*, *o*) is directed towards the distant point, *b*, the other eye will accompany

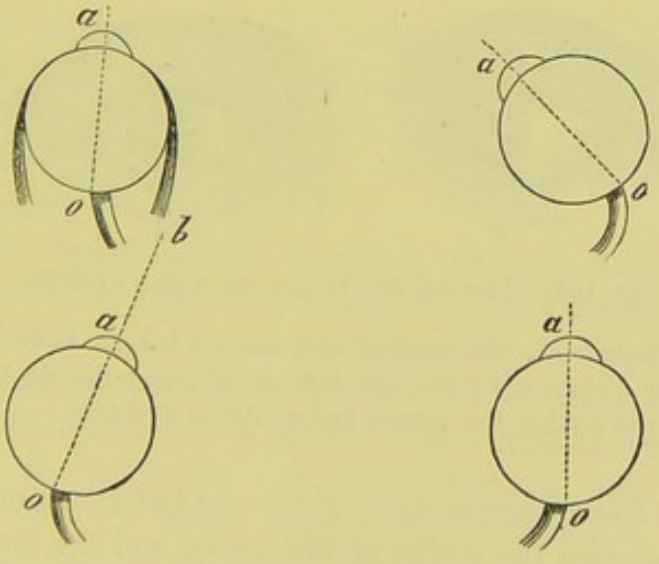


Fig. 187.—Convergent strabismus of the right eye. When the healthy eye turns towards the distant point, *b*, the other moves to a like extent, and the strabismus remains the same.

this rotation by a similar movement, which preserves the parallelism of the two eyes.

In concomitant strabismus, the squinting eye accompanies the

movements of its fellow, and to a like extent (the innervation being intact). But since the optical axes are not parallel before the movement begins, they are no more so when it is completed. For example, in the variety of strabismus represented in Fig. 187, the vertical axis of the right eye is deviated inwards, whilst that of the left eye is directed straight forwards. If now the healthy left eye be turned towards the right, so that its optical axis looks at the point, *b*, the other eye will be turned as much towards the right. The extent of movement will be the same, and consequently the eyes will squint as previously.

This symptom may also be represented as in Fig. 188, in which the left eye deviates. When the person looks to the left, the right eye will be turned towards the nose, so that the centre of the cornea, which is at first situated above the point, *a*, will now be above the point, *b*, the left eye, which is the squinting one, will perform an associated movement to a similar extent; the centre of its cornea being displaced from *a'* to *b'*, and the strabismus will remain the same.

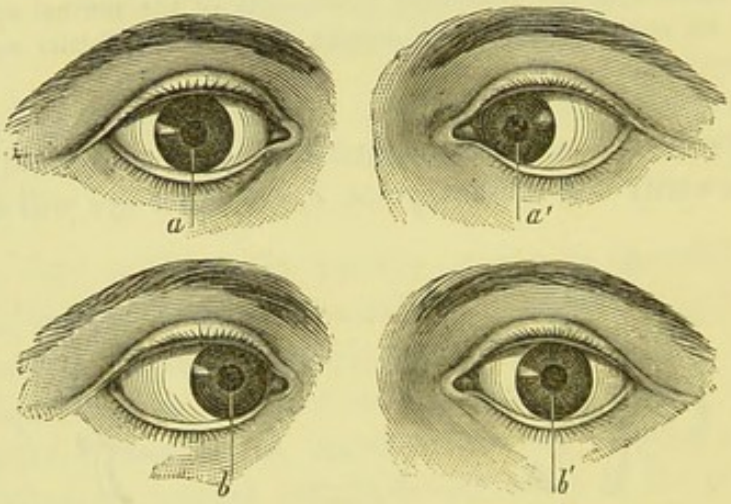


Fig. 188.—The left eye is the one which squints.

In paralytic strabismus, the affected eye can no longer move conjointly with the other in the direction of the affected muscle, and the degree of deviation becomes greater the farther the person looks in that direction.

To take the *linear measurement* of the deviation, we must determine the distance between the centre of the cornea and the internal angle in convergent strabismus, and between the centre of the cornea and the external angle in divergent strabismus. Let us suppose that in the healthy eye this distance is 15 millimetres, in the other 7 millimetres, the deviation is then 8 millimetres. We may also, according to *von Graefe's* advice, measure with a pair of compasses the distance on the free margin of the lid between the point situated just below the

cornea, and the point above which the centre of the cornea should be if normally directed.

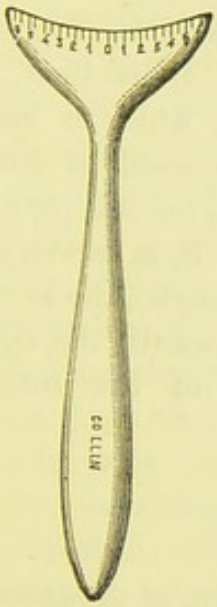


Fig. 189.—*Laurence's* Strabometer.

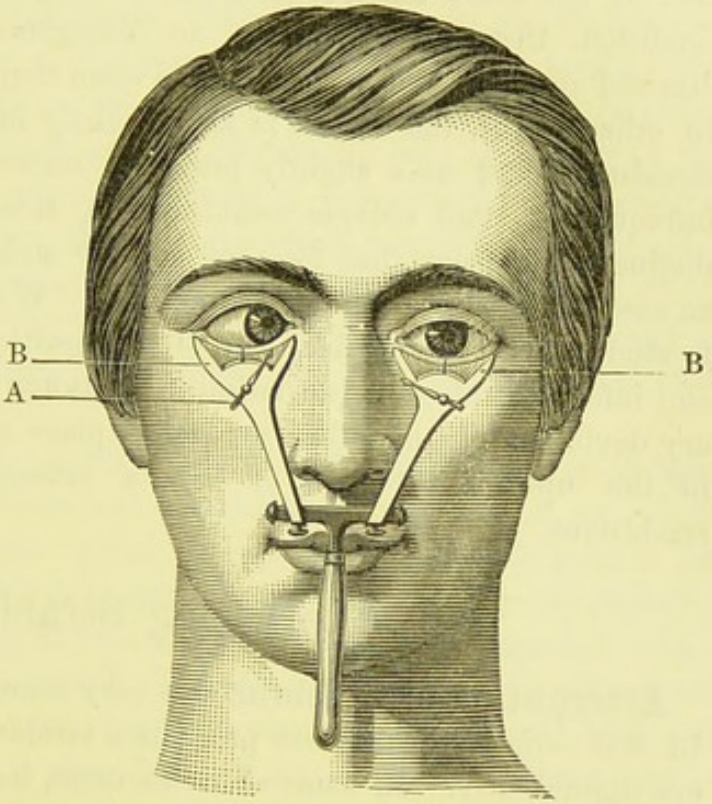


Fig. 190.—*Meyer's* Strabometer. The distance between the point of the needle, A, and the point, B, is the linear measurement of the strabismus.

Amongst the various instruments adapted for linear measurement of strabismus we have figured *Mr. Laurence's* strabometer and the one which has been constructed to our own order.

The subjoined figures (189 and 190) are sufficiently plain, and require no detailed description.

The angle of strabismus, that is to say, the angle formed by the two optic axes, may be ascertained by means of the perimeter. The patient, whose head should be fixed in such a way that the centre of rotation of the deviated eye is situated at the centre of the perimetric arc, should be made to look steadily at a distant object, and in the direction of the middle of the perimeter. A candle flame is then moved along the perimeter until its image appears in the centre of the deviated cornea. The position of the flame will then indicate the angle sought for.

Strabismus may take place in any direction, most frequently, however, it is either convergent or divergent; most rarely it is diagonal. We often find, along with a pronounced lateral deviation, a slight deviation upwards or downwards. This deviation is due to the physiological superiority of one muscle over its antagonist, which,

in the normal condition, is held in check by the muscular co-ordination, but which becomes manifest as soon as the co-ordination is destroyed. But, on the other hand, it must not be forgotten that, in the natural condition, there is a tendency to divergence when the eyes are directed upwards, and to convergence when they are turned downwards. In other words, the cornea is at a slightly higher level in divergent strabismus, and at a slightly lower in convergent. It is thus not infrequent to find oblique strabismus of this kind, which is easily distinguished from that form of oblique strabismus which is due to an essential modification of two muscles. We ought, for this purpose, to study the secondary deviation of the healthy eye; if, in convergent and inferior strabismus (deviation inwards and downwards), the secondary deviation of the other eye takes place only inwards, the defect in the upward direction is only a consequence of the internal strabismus.

B. Alternating Strabismus.

Alternating strabismus is a very common form of the affection. In this variety, the patient presents a strabismus of the left or right eye indifferently. In some of these cases, he can at once, and of his own accord, select with which eye he will fix an object; in the remainder, one eye squints habitually, and is only straightened by a momentary impulse of the will while the other deviates. This form is generally developed after a monolateral strabismus, when the analogous muscle of the other eye shows a pronounced tendency to co-ordinate contraction, which tendency greatly interferes with the fixation of objects not directly in front of the eyes. In convergent strabismus, for example, of the left eye, the internal rectus of the other eye will before long tend to become contracted also; so that, if the patient wish to fix an object to his right, he often experiences some difficulty in relaxing the muscle so as to rotate his right eye outwards. He will prefer to fix the object with his left eye, which is then better adapted for that purpose, and the right eye will thus be allowed to deviate.

Thus we see that in alternating convergent strabismus, each eye fixes objects on the opposite side, and in divergent alternating strabismus, those on the same side.

C. Effect of Strabismus on Vision.

Theoretically all persons suffering from strabismus ought to have diplopia; but, as a matter of fact, we only find this phenomenon in recent cases, as, for example, when the strabismus is due to paralysis,

or when it is only present for certain portions of the range of vision. In such cases, the image belonging to the squinting eye is more feeble and much less distinct than that of the other; hence it has been called, although wrongly, the *false image*. This inequality in the distinctness of the two images is due to the fact that whereas, in the healthy eye, the impression is made at the centre of the retina, on the most sensitive part; in the other eye, the impression falls on a point of the retina which is farther from the centre in proportion to the amount of deviation. Apart from this, the eye which received the impression at the centre of the retina is well adapted for the distance at which the object is situated; but in the other, the adaptation not being so perfect, the image will be less distinct and will be surrounded with diffusion circles.

This inequality of the two images accounts for the absence of diplopia in the great majority of cases of concomitant strabismus, if we admit that, by some unconscious mental process, no attention is paid to the weaker impression, which is transmitted to the brain by the deviated eye, so that after a time it comes to be entirely disregarded. This abstraction, which, so to speak, is made by the brain, is not at all surprising, for it occurs often to the retinal impressions of both our eyes when our attention is strongly occupied otherwise. The power of transmission remains intact, as may easily be found on closing the healthy eye; and, although direct perception only takes place through the eye which is normally directed, yet the deviating eye, even in cases where there is no diplopia, contributes something to vision in so far as it helps to extend the visual field.

Diplopia may be present in the early stages of the affection, and disappear in the course of time on account of an increase of the deviation; for then the image of objects is formed at a greater distance from the macula, and we know that the sensibility of the retina decreases in proportion as we approach the periphery. We may, as we shall presently see, sometimes reproduce the diplopia, by forcing upon the attention of the patient the presence of two images, and at the same time bringing, by a prism, the retinal image nearer to the macula.

We have already said that in alternating strabismus the patient uses both eyes alternately, and thus preserves the visual power of each. This is not the case in monolateral strabismus. The squinting eye always loses some of its visual acuteness, and soon becomes amblyopic. We should, however, add that the acuteness is never lost over the entire retina, but only on certain parts. The central vision is the first to become affected, and the diminution extends from the macula to the external part of the retina, whilst the internal part retains its

sensibility for a longer period. This amblyopia presents three successive forms.

(*a.*) The first is met with apart from strabismus, whenever an eye from any cause no longer participates in direct vision. In such cases, the central vision is more or less enfeebled, but the eccentric vision is normal; the limits of the visual field are preserved, and the clearness of the images diminishes towards the periphery as in the usual condition. It is in these cases that such optical means as increase the size of the image in proportion to the enfeeblement of vision are of great utility. (Treatment by methodical exercises of the eye with convex glasses.)

(*b.*) In the second period the special sensibility of the fovea is extinguished. The eye no longer exactly fixes its optical axis on the object at which it is directed. It makes uncertain movements, seeking the point of the retina most favourable for vision (uncertain fixation). Generally this point is on the internal surface of the membrane.

(*c.*) In the third period, the internal part of the retina alone remains sensitive to qualitative perceptions, and the patient, in order to see with the affected eye, directs it so that the optical axis does not fall on the object, but very considerably to the inside of it (eccentric fixation). In none of these cases does the ophthalmoscope show any alteration of the retina or of the optic nerve.

D. Ætiology of Concomitant Strabismus.

Strabismus rarely exists at birth, it is developed only when the child begins to observe attentively. At first, the deviation is only occasional (periodic strabismus), but later it becomes permanent. The deviation causes diplopia, and, as the double images disturb vision, if it be impossible to fuse them, the child involuntarily separates the one from the other, thus increasing the pre-existing deviation. In most cases a predisposition to strabismus is due to a want of balance in the relative powers of the muscles. This defect is caused by a congenital preponderance either in the external or internal recti. It is probable that this defect is very often present, but that the requirements of simple binocular vision, which demands parallelism of the optical axis, suffice to overcome the muscular inequality. The predisposing cause being present, any condition rendering binocular vision difficult or impossible, will allow the eyeball to obey without resistance that muscle which is strongest.

Such conditions are found in—

1. Those ophthalmiæ of youth, in which the affected eye takes no part in vision.

2. In everything which diminishes the acuteness of vision in one or

both eyes—*e.g.*, specks on the cornea, congenital cataract, diseases of the fundus of the eye, anomalies of refraction. This last cause is so important that we shall return to it in detail.

3. In muscular paralysis, and in all circumstances which force the young child to look in a particular direction, in which it is difficult to keep the eyes (position of the crib as regards the light), especially when such a circumstance is present for a length of time or is often repeated.

In all these conditions strabismus may supervene, and it is convergent when the internal rectus is the stronger, divergent when the external.

The development of strabismus is very greatly promoted when there is some anomaly of refraction. *Donders* has found seventy-seven cases of hypermetropia in one hundred cases of convergent strabismus, and two cases of myopia in three of divergent strabismus.

The connection between strabismus and these anomalies of refraction is as follows :—

We have already seen (p. 414) that the distinctive character of the hypermetropic eye is that it requires to use a part of its accommodation even for distant vision. From physiological considerations we know that every effort of accommodation involves an effort of convergence of the eyes. When, therefore, a hypermetropic person looks at a distance, he uses a considerable amount of his accommodation, and there is consequently a certain convergence. Thus, if he looks at an object 6 metres distant, he makes an effort of accommodation to see distinctly, and at the same time the axes of both eyes converge, so that they intersect at a point somewhat nearer. Hence, there is homonymous diplopia, the position of the eyes not being adjusted for the distance of the object.

Again, the double images give rise to such a disturbance of vision that the patient soon suppresses his effort of accommodation, and consents to see indistinctly in order to avoid the diplopia. This takes place when the binocular vision is in perfect equilibrium, and when the visual acuteness is as good in one eye as in the other. If we cover one eye with the hand, and make diplopia impossible, the hypermetropic patient uses the accommodation necessary to make the object distinct. We then see, on looking behind the hand, that a strong convergence of the covered eye accompanies this effort of accommodation, and that it squints internally.

What we did here artificially, nature does in a certain number of cases. Should one eye be weaker than the other from some such cause as difference of refraction, amblyopia, leucoma of the cornea, &c., binocular vision is destroyed, or the image coming from the

weaker eye is easily effaced at the moment of the diplopia. Hence, the healthy eye can make any effort of accommodation necessary for distinct vision, and the other will deviate inwards. There will thus be established a convergent strabismus.

This form of strabismus is, as a rule, at first only manifested when the hypermetropic person looks fixedly at a given distance, as in reading, eating, &c., whilst for other distances the eyes preserve the normal position. It is, therefore, a periodical strabismus; but, should the patient require often to see at that special distance, it will soon become permanent.

What has just been said as to the inequality of the visual acuteness of the two eyes is also true for any other cause which temporarily but totally suppresses binocular vision—*e.g.*, any ophthalmia which causes occlusion of the lids, or the prolonged application of a bandage to one eye. If even some trivial but constant condition compel a child to look only with one eye at a time (a lock of hair on the forehead, or the position of the couch to the light being such that the child can only see the full light with one eye at a time), and if this child be hypermetropic, the efforts of accommodation may produce strabismus.

The connection between divergent strabismus and myopia is easily understood. A person affected with this anomaly of refraction is obliged to bring any object at which he is looking very near, and has to converge both eyes for that distance. There is thus a very considerable strain on the internal recti which may exceed their strength. When, therefore, he requires to maintain this convergence for a long period over any work requiring close application of the eyes, the internal recti become rapidly fatigued (insufficiency of the internal recti). If, however, he continue his work, one of the eyes will yield to the muscular fatigue; it will deviate a little outwards, and hence there will be a disturbance of vision, which will give rise to diplopia as soon as the divergence of the optical axes amounts to anything. This diplopia considerably annoys the patient, who, to get rid of it, makes greater and greater efforts to overcome the insufficiency of the internal recti, and to preserve the necessary convergence. Having found it impossible to converge for the distance of distinct vision, he gives up efforts at binocular vision, and shuts one eye. The eye thus excluded from vision follows, behind the closed eyelids, the movements of its neighbour in an associated movement; it deviates outwards. If we wish to demonstrate this phenomenon, we have only, in such a case, to cover one eye with the hand, behind which we can observe the position of the eyeball, whilst with the other eye the patient looks steadily at an object brought to the distance of distinct vision.

It is for this reason that so many people who are highly myopic shut one of their eyes after they have been working for some time, or hold the object at which they are looking, for example a book, to the side, so that they only use one eye for reading. These movements are instinctive, and by them the patient avoids those efforts of convergence which fatigue the eyes, and which may even cause periorbital pains. On the other hand, this instinctive and involuntary exclusion of one eye, which is accompanied by an outward deviation, as we have already seen, is very apt to end in a permanent divergent strabismus: especially if the patient is obliged to work in such conditions for a long time without interruption, or if he is forced by the state of his refraction to look very near.

This explains why divergent strabismus is met with much more frequently in myopic than in emmetropic people. The latter are able to hold objects at a sufficiently great distance from their eyes to avoid a degree of convergence greater than the power of their internal recti. In myopia, on the other hand, it is absolutely necessary to bring objects very near the eyes, to the distance of distinct vision; and the internal recti must be brought into play if binocular vision is not to be sacrificed. It is true that often the strength of these muscles suffices, so long at least as the myopia remains stationary; but if the degree of the myopia increases rapidly, and if a greater nearness of objects, and consequently a greater convergence of the eyes, becomes necessary, the strength of the internal recti does not increase to the same amount, and insufficiency is established.

Myopia, especially of high degree, may also produce a convergent strabismus. Vision only being distinct for near objects, it requires a strong convergence of the eyes to bring both optical axes on to the fixation point. This convergence can only be effected by strong contraction of the internal recti. If this contraction is kept up too long it becomes more or less stable, and ultimately it is found to be impossible simultaneously to relax both internal muscles. Such relaxation is, however, necessary for distant objects, for the optical axes should be parallel for distance. One of the eyes thus remains deviating inwards. This gives rise to double images, the dispersion of which excites the internal rectus to still greater contractions, and convergent strabismus is established.

E. Progress and Termination of Strabismus.

In certain cases of strabismus, the deviation may spontaneously disappear. Such are cases of periodic strabismus, secondary to spasms or paralysis, or depending upon hypermetropia. Periodic strabismus

may terminate of itself after the exciting disease has passed away, or the error of refraction has been corrected. If, however, the strabismus has become permanent, it cannot be cured without medical interference.

Again, in some cases the strabismus becomes transformed into the alternating variety, the symptoms and development of which have already been described. This result is so far favourable, for, as both eyes are used alternately, there is no enfeeblement of vision, the so-called amblyopia by exclusion. In all cases in which we must put off operating, we should also try, for these reasons, to change a simple strabismus into the alternating variety, by regularly covering the healthy eye, so as to force the other to readjust itself and call into play the muscular activity necessary for the fixation of objects. For this purpose we order the patient to wear for several hours every day a pair of spectacles in which an opaque glass is placed in front of the good eye, and a neutral glass (in cases of emmetropia), or a glass which corrects any existing defect of refraction before the other.

Thirdly, there may be a change in the structure of the contracted muscle, and in its antagonist which is relaxed. The former very gradually undergoes a fibrous modification, which may even affect the cellular tissue in its neighbourhood. This change is easily recognised, because it alters the muscular activity, so that the eye no longer turns in the direction of the affected muscle with a uniform movement, but with a series of jerks produced by the repeated contractions of the muscle. The antagonist, more and more relaxed, becomes less powerful, and, as a consequence, the mobility of the eye in the direction of this muscle gradually decreases till it becomes nil. This termination is relatively rare.

F. Treatment of Strabismus.

When concomitant strabismus is recent, as yet purely dynamical, and due to some obvious cause, we should in the first place try to remove such determining cause. Thus, if the strabismus is a symptom of some error in refraction, either myopia or hypermetropia, we should correct the ametropia by proper concave or convex glasses. In hypermetropia we must at first give glasses which will allow the patient to see distinctly at a distance, and if necessary somewhat stronger glasses for work. If, notwithstanding such correction, strabismus still supervene, we may for a certain length of time keep the accommodation at perfect rest by using atropine or duboisine. We must, in addition, prescribe glasses which will totally correct the hypermetropia, and also a stronger pair to enable the patient to see at 12 or 14 inches.

In myopia, we give glasses which will enable the person to read and write at 12 or 14 inches. (Details as to the selection of glasses in myopia and hypermetropia have been given in the chapter on Anomalies of Refraction.)

1. Orthopædic Treatment.

The first condition of success in this form of treatment is the possibility of restoring binocular vision. In a few cases (5 per 100) binocular vision is present from the time we begin our treatment; in a greater number of cases (15 per 100) it can be aroused; and in others (25 per 100) it can only be obtained after operation. Binocular vision is revealed by the presence of diplopia, of which the patient complains, or which we may excite by several means at our disposal. We may easily detect it by using a prism. Having examined each eye separately, and noted its manner of fixing any object (with central or eccentric fixation), its visual acuteness, and its condition as to refraction and accommodation, we make the patient look with both eyes at a candle placed 2 or 3 metres in front of him. It rarely happens that the patient complains at once of diplopia (a sure sign of binocular vision). In other cases we succeed in making the image coming from each of the two eyes visible to the patient, by placing a piece of coloured glass before the eye which he is in the habit of using, or by means of prisms which either displace one of the images upwards or downwards, or bring that of the deviated eye nearer the macula. If we cannot by any means obtain the perception of the two images, binocular vision is absent.

The exercises which we are in the habit of recommending for the restoration of binocular vision interest partly the squinting eye alone and partly both eyes. The primary object is to exercise the deviating eye so as to overcome the enfeeblement of vision which always occurs in that eye when the patient is not in the habit of using it. For this purpose we cover the normal eye with a bandage which should be worn for several hours each day. In the second place we make the patient read with the squinting eye such large type as the eye can distinguish with ease. If there be any difficulty in seeing the type, a magnifying glass may be used. These exercises should be continued for a few minutes at a time, and repeated several times a day. Gradually, as the vision improves, we should pass to smaller letters and weaker convex glasses, at the same time prolonging the duration of the exercise.

When the acuteness of vision of the squinting eye is sufficiently recovered, the next question is to obtain simultaneous vision with both eyes, that is to say, diplopia. This, if the strabismus is not far

advanced, may be established spontaneously; if not, it may be aroused by special exercises performed with the stereoscope or with prismatic glasses. If prisms are used, a coloured glass (violet) should be placed in front of the normal eye; and a candle flame held at 2 or 3 metres from the patient forms a suitable fixation object. By placing a prism refracting vertically before the deviating eye, we enable the patient to see the two differently coloured images coming from his two eyes, especially if we momentarily hide one of his eyes and then suddenly uncover it. At other times it is necessary to bring the retinal image nearer the macula of the squinting eye, by placing before it a prism with the base turned toward the temple in case of convergent, or toward the nose in divergent strabismus. After this experiment has been repeated several times, the patient becomes conscious of his diplopia, even without the interposition of glasses.

Having so far attained our object, we select the prismatic glass which is adapted to unite the two images into one. If this glass is stronger than 12°, we must give up all idea of treating the strabismus by prisms, for, on account of their weight and the chromatic aberration they produce, the patient could not wear them constantly. If the correcting prism is less than 12°, we make the patient wear the prisms constantly in the following manner:—We divide the effect between the two eyes, placing before each a prism of half the strength of the correcting prism, the base outwards for convergent strabismus and inwards for divergent. After a certain time (fifteen days to three weeks) we can change these glasses for weaker ones, and so on, till the deviation is corrected. This effect is due to the isolated contraction caused by the prism in the muscle which is the antagonist to the one on which the deviation depends (p. 403).

Orthopædic treatment requires both care and attention on the part of the physician, and great patience on the part of the patient.

The use of the stereoscope in the treatment of strabismus, at first proposed by *Du Bois-Reymond*, has been specially developed by *Javal*. In each field of the stereoscope a card is placed, at the centre of which there is a black wafer about 2 centimetres in diameter. On the same vertical line, on one side above the wafer, on the other beneath it, are smaller points, the one red, the other green. The patient must then try to unite the two fields so that he sees three wafers in the same vertical line. According as the strabismus is convergent or divergent, the distance between the wafers will vary from 3 to 12 centimetres. When union of the two fields has been obtained for a certain distance, we change the distance, till the eyes are once more made parallel. The exercises are at first continued with wafers, then with objects increasingly difficult to unite (letters and words).

2. Operation for Strabismus.

(*a.*) **General Considerations.**—In order that we may be better able to understand the mechanism by which the operation for strabismus produces the desired effect, it seems necessary, before describing the operation, to enter into some theoretical considerations as regards the principles which govern it.

If we consider a spherical body suspended in space by two threads, as in Fig. 191, so that its axis is vertical, it is easy to understand by

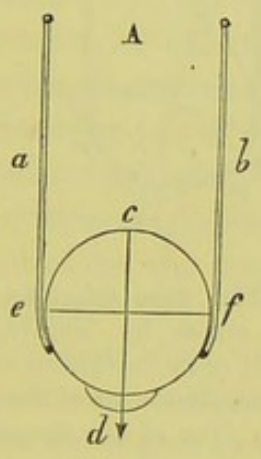


Fig. 191.—*a* and *b* are two threads whose equilibrium keeps the axis, *c d*, vertical.

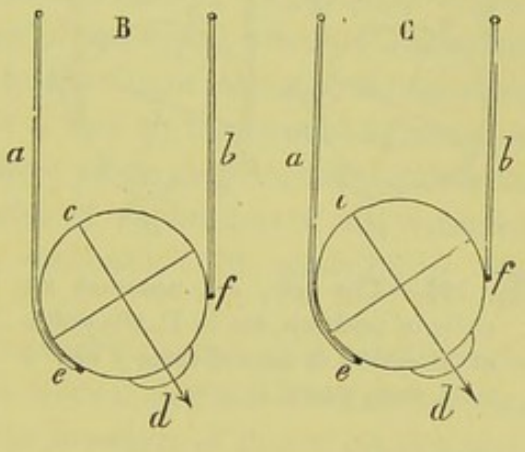


Fig. 192.—The axis, *c d*, is oblique because in B the thread, *a*, has been lengthened, in C the thread, *b*, has been shortened.

what means the equilibrium of a body thus suspended can be disarranged. Thus, if we lengthen the thread, *a*, the spherical body will immediately assume a position as in Fig. 192, B—that is to say, its axis will be no longer perpendicular but oblique. The same effect is produced if we shorten the thread, *b* (Fig. 192, C).

Again, if the threads are allowed to remain at their original length, we may change the equilibrium of the spherical body by altering the insertion of the threads. Thus, having detached the inferior extremity of the thread, *b* (Fig 193, D), from the point, *f*, and inserted it at the point, *f'*, that is to say, at a point nearer to the inferior pole, *d*, it is evident that the body will be turned with its inferior pole towards the thread, *b*, and the nearer the thread is attached to the pole, *d*, the greater is the amount of turning. The same result is obtained by moving the thread, *a*, from *e* to *e'* (Fig 193, E). The thread loses some of its power over the spherical body, because its point of attachment is at a greater distance from the pole on which it acts.

It will readily be understood, that when a body, primarily in equilibrium, as in Figure 191, A, has lost its first position, we may restore it, either by modifying the length of the threads by which it is suspended, or by changing their point of insertion. For example, if we

wish to give the spherical body represented in Figure 194 a position such that its axis, *c d*, be vertical, we may do so, either by shortening the thread, *a*, or by lengthening the thread, *b*, or by taking the inferior end of the thread, *b*, from *f* to *f'*, or that of the thread, *a*, from *e* to *e'*.

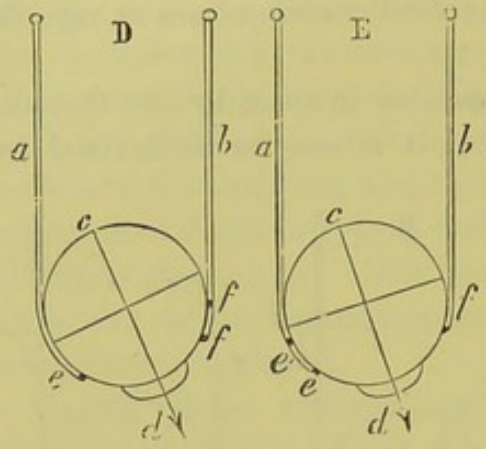


Fig. 193.—The axis, *c d*, assumes an oblique position, for in D, the point of insertion is moved from *f* to *f'*; in E, from *e* to *e'*.

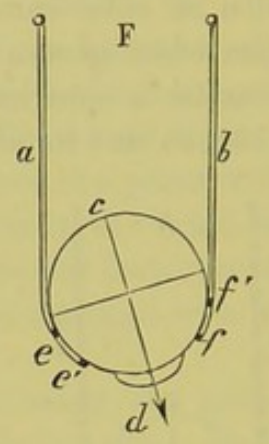


Fig. 194.—The axis, *c d*, may be made vertical either by lengthening the thread, *b*, or by shortening the thread, *a*, or by displacement of the thread, *b*, from *f* to *f'* or of the thread, *a*, from *e* to *e'*.

So far for theoretical considerations; we must now apply these mechanical laws to the eyeball, which is kept in equilibrium by muscular forces acting as antagonists, inasmuch as one muscle draws it inwards, another outwards, a third upwards and a fourth downwards.

When the parallelism of the optical axes has been disturbed, we should have at our disposal, according to the foregoing considerations, different mechanical means for restoring it—viz., either the alteration of the length of the muscles or of their point of insertion. The second of these two methods is the one exclusively employed, and we effect our purpose by changing the place of the tendinous insertion of the muscle whose increased or diminished action has caused the ocular deviation. Generally, in cases of concomitant strabismus, we remove the insertion of the internal rectus *backwards* in convergent strabismus, and that of the external in divergent. In another class of cases, we bring the muscular insertion *nearer* to the corneal margin.

The first method of strabotomy, proposed by *Stromeyer* (1838), and soon after executed by *Dieffenbach* (1839), was the elongation of the muscle which by its shortening had produced the deviation. The muscle was cut in his continuity, and it was supposed that the two ends would unite by means of an intermediary portion. This hypothesis, however, was never confirmed, or at least only in exceptional cases. Immediately after the section, the muscle retracted, and the separation

between its two divided ends was increased by the action of the opposing muscle. The anterior portion usually atrophied, while the posterior, lost in the cellular tissue which surrounds the eye-ball, was not directly reunited to the sclerotic, or, when it did attach itself, the new insertion was so far backwards that the muscle lost all its effect upon the movements of the eye. The consequence was that the eye, although straightened, could no longer move in the direction of the divided muscle, or more frequently became deviated in the opposite direction by the action of the antagonist. This is not merely a theoretical view, but has been demonstrated in autopsies as well as by observation of unsuccessful cases of myotomy, where a secondary operation became necessary.—Latterly, the idea of *shortening* the opposing muscle has been put in practice with a view to the re-establishment of the muscular equilibrium (*Noyes, Driver*), as we shall explain further on.

The principle of displacing the point of application of the muscular force applied to the eye is easily understood by referring to the subjoined figure (195).

Let us suppose that we have to correct a pathological convergence, which measures x millimetres, in the median position of the eyes; we shall attain our object by removing the insertion of the rectus internus, i, x millimetres backwards. In short, by removing the muscular insertion to i', the eye will be able to adjust itself for the arc subtended by the distance $i\,i'$. If this distance measure x millimetres, the eye will occupy the median position, and the deviation will be corrected. Thus, for this position at least, we make the optical axis of the eye operated on parallel with that of the other.

To determine our method of operation, it is necessary here to indicate how this displacement modifies the effect of the contraction of the displaced muscle on the eyeball, during its movements. It is evident that this displacement will diminish the action of the muscle in virtue of a mechanical principle already explained, and which may be formulated as follows:—Given a sphere, and a force applied to a point on its surface, the force has so much less effect on the rotation of the sphere the farther its point of action is removed from the point which it is destined to displace.

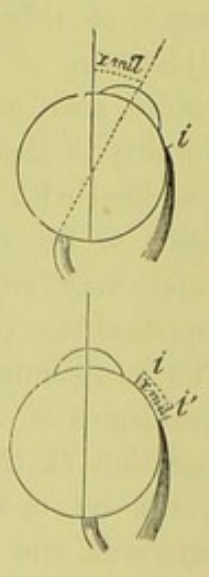


Fig. 195.—Correction of a deviation of x millimetres by removing the insertion i to i'.

This mechanical principle applied to the eye shows that the displacement of the muscular insertion backwards primarily produces the adjustment of the cornea in the direction of the opponent muscle; but

at the same time there ensues a diminution in the mobility of the eye in the direction of the muscle operated on (muscular insufficiency).

This loss of mobility resulting from the displacement of the muscle is partly compensated by the excess of mobility which has been found in every squinting eye. Besides, every eye can admit of a slight loss of mobility in one direction or another, for we can replace the extremes of the rotation of the eyes by slight movements of the head.

Yet the backward displacement which we give to a muscle should not exceed a certain limit, for we may interfere too much with its action. If this limit be exceeded, we produce an excessive muscular insufficiency, and consequently an asymmetry of the associated movements of the two eyes. If the internal rectus has been divided, there will thus be an outward deviation of the eye operated on during the simultaneous convergence of the two eyes for the fixation of near objects. From this we may deduct the law, that *the operation for strabismus ought to be so performed as to give the least amount of muscular insufficiency possible.*

The limit of the correction permissible would thus be fixed by the measure of the excess of mobility in the direction of the deviation of the squinting eye. How then can we correct a strabismus greater than the measure indicated? We must make up the overplus by operating on the other eye. This may be done in the following manner:—Let us suppose that we have to operate on an inward deviation of the left eye of 10 millimetres. By displacing the internal rectus of this eye 10 millimetres, we could certainly attain the adjustment of the eye and also the parallelism of the eyes for the middle position. Yet this would be followed by such a loss in the mobility of the eye operated on that the harmony of the movements combined with those of the other eye, either for direct vision to the right, or for convergence of the two eyes for near at hand, would suffer very considerably. To avoid this danger, we begin in our supposed case (Fig. 196), by straightening the left eye by 5 millimetres. The strabismus will be reduced by the same amount, leaving only a strabismus of 5 millimetres in the left eye, B. If now we remove the insertion of the internal rectus of the right eye 5 millimetres backwards by operation, the right eye will be directed 5 millimetres outwards, and its optical axis must be parallel with that of the other eye, C. Since the mobility of the two eyes in concomitant strabismus is the same, when once we have produced the parallelism of the two optical axes, there will be nothing further to desire as regards the harmony of their movements, provided neither eye has been weakened beyond a proper amount. Hence we have an absolute rule, that the

correction should be divided between the two eyes whenever the deviation exceeds a certain degree.

From these preliminary considerations, which show that the operation for strabismus has for its object to modify the action of the muscle on the rotation of the eye, by changing its point of insertion, it follows that in strabotomy as practised at present we detach the tendinous insertion of the muscle, so that it may again become fixed either in front of or behind its original attachment.

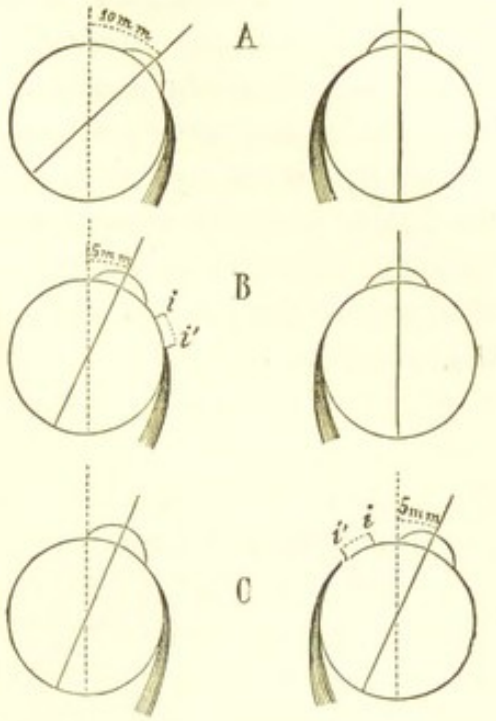


Fig. 196.—A represents a convergent strabismus of the left eye of 10 millimetres. On B, the insertion of the internal rectus of the left eye has been moved backwards from *i* to *i'*, and the strabismus has been corrected 5 millimetres. In C, the insertion of the internal rectus of the right eye has been moved from *i* to *i'*, and the two optical axes are now parallel.

According to the mechanical laws already explained, this displacement of the muscular insertion ought to be in proportion to the amount of the deviation. Thus, the theoretical principles of the operation being admitted, the question comes to be—*can the surgeon produce at pleasure an effect proportionate to the deviation*, that is to say, can he by operation produce the amount of correction which may be required? The affirmative reply which we are about to give to this question is explained by the anatomical relations which exist between the muscles and the sclerotic, which relations we shall sum up in a few lines. At the same time the truth of the affirmation is proved by the large number of strabotomies performed according to these principles.

The recti muscles, which we must specially consider (for on them only is the operation performed), besides their tendinous insertion (Fig. 197, *i*) which attaches them directly to the sclerotic, are also attached to it indirectly—1st, by the cellular tissue which binds the inferior surface of the muscle to the sclerotic (*a*); 2nd, by the cellular tissue which binds the superior surface of the muscle to the conjunctiva, which in turn is inserted into the sclerotic (*b*); 3rd, by the capsule of Tenon (*t*), which, at the point where it is pierced by the muscle, sends off prolongations forming lateral sheaths to the muscle. Thus we see that, if it were possible to detach the muscular insertion from the sclerotic without any other lesion, the muscle would not to any great extent

slip backwards, being held in position by the conjunctiva, the cellular tissue, and the anterior and lateral expansions of the capsule of Tenon, which unite it to the sclerotic. Its displacement will, therefore, more or less depend on the extent to which we destroy the indirect attachments which keep it in position.

The muscle, as soon as it is free to contract, will evidently slip all the farther back the more its antagonist draws the eye to its own side. Still, any defective action of the antagonist may be replaced, as we shall see, by the position which we may cause the eye to assume after the operation.

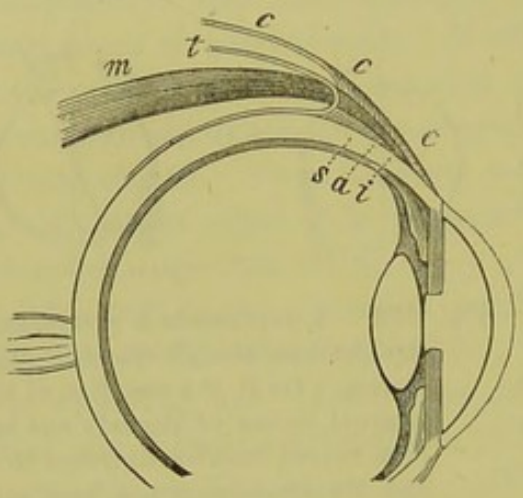


Fig. 197.—Diagram of the muscular insertion—*i*, tendinous insertion; *a*, cellular tissue between the muscle and the sclerotic; *t*, capsule of Tenon; *m*, muscle; *s*, sclerotic; *c*, conjunctiva.

The effect of the operation therefore depends, partly on the retraction of the muscle detached from its insertion, and partly on the action of its antagonist or on the mechanical traction which replaces that.

The experience of many thousand operations (*von Graefe's* alone amounting to several thousands), shows that the operation, performed according to the exact laws which we shall presently lay down, always produces very nearly the same degree of adjustment of the deviating eye. In order to apply this operation to every case of advancement, we have at our disposal certain means of increasing or diminishing the effect of the operation. After describing the operation we shall give a detailed account of these means.

(b.) Strabotomy by Backward Displacement of the Muscle.

We shall, in the first place, describe *tenotomy of the internal rectus*, which is the operation most frequently performed for convergent strabismus. The necessary instruments are—

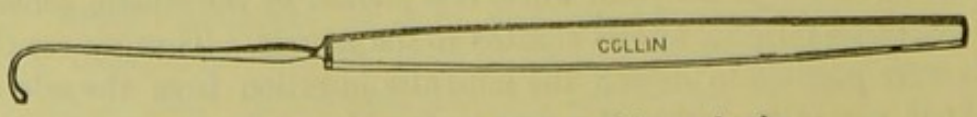


Fig. 198.—The smaller of the strabismus hooks.

1, A lid speculum; 2, fixation forceps; 3, curved scissors with blunt points; 4, two strabismus hooks of different size; 5, a needle

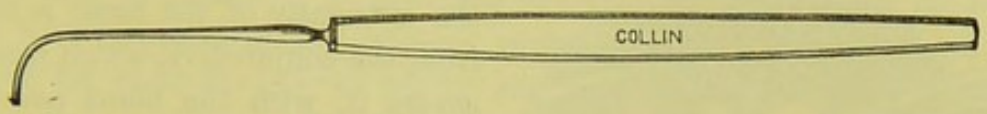


Fig. 199.—The larger of the strabismus hooks.

provided with a silk or catgut thread, for cases which require conjunctival suture.

First Step: Section of the Conjunctiva (Fig. 200).—A fold of the conjunctiva is raised with the forceps held in the left hand close to the internal margin of the cornea. This small fold is incised vertically with the points of the curved scissors, the concave surface of which is turned towards the eyeball, and the point directed towards the internal angle of the eye. Then the scissors are introduced into the conjunctival opening, and the subjacent tissue is freed by small snips to about one and a half centimetres from the margin of the cornea obliquely towards the border of the muscle. This freeing of the cellular tissue destroys the adhesions which exist between the conjunctiva and the tendon which we wish to displace.

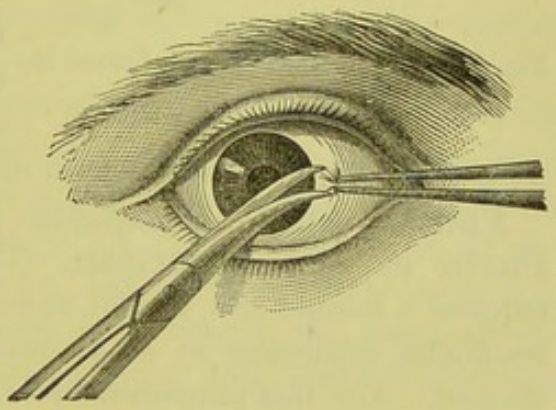


Fig. 200.—Incision of the conjunctiva.

It is advantageous to make the conjunctival section as near the cornea as possible. By so doing there is only slight hæmorrhage and the caruncle is not displaced. *Boyer* has proposed a horizontal incision either at the superior or inferior border of the muscle, instead of the vertical, as this involves less displacement of the caruncle.

Second Step: Introduction of the Hook.—Holding the larger of the strabismus hooks like a pen, and raising the conjunctiva, so as to make the opening gape, the surgeon introduces the hook with its blunt point turned towards the border of the muscle. He lays the hook flatly on the muscle, so that its point slightly extends beyond its margin, and by a movement of rotation he makes the point slip beneath it. The hook held against the sclerotic is passed beneath the entire muscle. In introducing the hook, it should be directed as nearly as possible parallel with the sclerotic, so that its point does not pierce the muscle in the breadth of its continuity.

Third Step: Division of the Tendinous Insertion

(Fig. 201).—Transferring the hook to the left hand, and holding it so that the convexity of the instrument is turned towards the cornea, the extremity of the hook is freed from the conjunctiva, which usually covers it, with the blunt point of the scissors, and the tendinous insertion is divided by a series of small cuts, beginning the section with the portion of the tendon nearest to the point of the hook. This section ought to be neatly made through the entire breadth of the tendon and as near the sclerotic as possible, for it is only thus that we can preserve the entire length of the muscle.

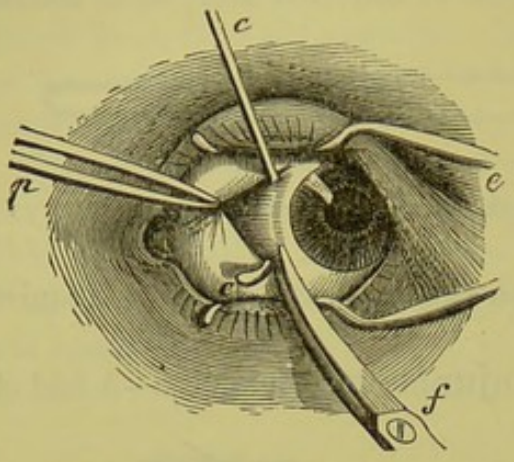


Fig. 201.—Section of the tendinous insertion.

Fourth Step: Complete Liberation of the Lateral Parts of the Insertion.—The fourth step in the operation requires a minute and careful examination of the lateral parts of the tendinous expansion, so as to make sure that they are completely divided. For this purpose we raise the conjunctival wound with the point of the hook and introduce a smaller hook under the conjunctiva, searching towards the inferior and superior margins of the tendinous insertion, and taking care that the blunt point is always kept in contact with the sclerotic. If any fibres still remain uncut, they must be divided, and we must ascertain that no others are adherent to the sclerotic, for even a few peripheral fibres may suffice to destroy the effect of the operation.

Tenotomy of the external rectus is perfectly similar to that just described; only, as the insertion of this muscle is at a greater distance from the corneal margin than that of the internal, it is well to incise the conjunctiva at 4 or 5 millimetres from the external margin of the cornea.

Tenotomy of the *superior or inferior rectus muscle* requires a greater degree of care than in the preceding cases. The conjunctival incision should be made very small and very near the corneal limb. We must injure the subconjunctival tissue as little as possible, and use every precaution in slipping the hook beneath the muscle on which we are operating, so as to obviate as far as possible any great separation of the cellular tissue. Besides, it is dangerous in the fourth step of the operation to search too thoroughly for fibres which the section of the muscle may have left intact near the extremities of its tendinous expansion. If this precaution is overlooked, we run the risk of having,

from a too extensive separation of the cellular tissue, a marked alteration in the width of the palpebral fissure after the operation. This may be caused by an abnormal elevation of the superior lid when we have operated on the superior rectus, or by a falling down of the lower lid when the inferior rectus has been divided. If the operator notices immediately after the operation that any such accident has happened, he must without delay suture the conjunctival wound.

It is absolutely necessary to examine after each operation the immediate effect which it has produced. In making this examination special attention should be directed to the amount of readjustment of the eye operated on, and to the mobility of the eye in the direction of the detached muscle, as also to the lateral and convergent movements of the two eyes.

The degree of *straightening* and the relations of the two eyes to each other ought to be studied first for the median position—that is to say, when the eyes are fixed on an object placed 3 metres straight in front of them. Then, after the tenotomy of the internal rectus, the combined movements of convergence of the two eyes may be examined, by making the patient fix an object, for example, the point of the finger held at 30 or 35 centimetres in front of him, which is gradually brought nearer to his eyes.

The *loss of mobility* (*muscular insufficiency*) which naturally follows every tenotomy ought to be measured—1st, in relation to the pre-existing mobility of the eye operated on; 2nd, in relation to the mobility of the other eye. These measurements are made as follows:—When, for example, we are dealing with a convergent strabismus of the right eye, we have, previous to the operation, measured the mobility of this eye inwards, ascertaining how far the centre of the pupil or the margin of the cornea is turned inwards in the strongest adduction of the eye. We usually select, as the mark to judge by, the inferior lachrymal punctum. Let us suppose that in this examination we have found that it is the external border of the cornea which, during the strongest adduction, is situated above the lachrymal opening. If now immediately after the operation we find that this position is occupied by the centre of the pupil, the loss of mobility produced by the operation is equal to the distance which separates the centre of the pupil from the external border of the cornea—*i.e.*, in linear measurement about $4\frac{1}{2}$ or 5 millimetres. When the tenotomy is of the external rectus, we measure, in a similar manner, the distance in extreme abduction between the external margin of the cornea and the external commissure before and after the operation.

In the second place, we must take into account the muscular insufficiency, comparing the mobility of the eye which has been

operated on in the direction of the divided muscle with that of the other eye in the same direction. Let us again suppose that we are dealing with a tenotomy of the internal rectus of the right eye; we might find that, whilst on the operated side the strongest adduction would bring the centre of the pupil above the lachrymal punctum, the left eye would turn further in by 2 or 3 millimetres; the muscular insufficiency would in this case measure 2 or 3 millimetres when compared with the other eye—that is, in the normal condition.

If we were dealing with a tenotomy of the external rectus, we should make the same investigation as to the relative position of the external margin of the cornea during extreme abduction.

Having thus, in a general way, explained the method of conducting the examination which should be made after every operation for strabismus, both as regards the straightening of the eye and the loss of mobility, it remains for us to indicate the usual results obtained by this examination after the performance of the operation already described.

The results vary, as may be expected, with the more or less strict observance of the rules laid down, and with the functional condition of the detached muscle and its antagonist. The greater the power of the former before the operation, the less will be the influence of the contractions of the antagonist on the rotation of the eyeball, which rotation, to some extent, determines the distance of the new place of muscular insertion from the primary attachment. Again, it may be said, that an operation on the internal rectus, according to the rules already described, gives a readjustment of 3 or 4 millimetres. It may even be 5 if the opening in the conjunctiva has been large and the cellular tissue detached for the entire breadth of its tendinous insertion above and below the muscle.

In children these figures are increased by 1 or 2 millimetres.

When we have divided the external rectus, we obtain, even after extensive liberation of the insertion, a readjustment of only 3 or 4 millimetres at most; the usual effect, after a small conjunctival opening, will only be about 2 millimetres. The effect is not greater after a tenotomy of the superior and inferior rectus muscles.

Let it here be noted that errors in examining a patient after a tenotomy of the internal and external recti are apt to occur when he is under the influence of chloroform. During its action, the eyes tend to turn outwards, so that a convergence is diminished, a divergence increased.

The muscular insufficiency which immediately follows a tenotomy is in direct proportion to the extent to which the prolongations of Tenon's capsule, which attach the muscle to the sclerotic, have been

destroyed. After complete tenotomy of an internal rectus, the mobility of the eye, compared with its mobility prior to the operation, ought always to be diminished by 4 or 5 millimetres, and the muscular insufficiency, compared with the same muscle of the other eye, ought to be about 2 or 3 millimetres. After tenotomy of the external rectus, the muscular insufficiency ought always to be from 3 to 4 millimetres, compared with the normal condition as judged by the other eye.

If, in either case, this degree of insufficiency is not found, it is certain that the tendinous insertion has not been completely divided. Should this be the case, the surgeon must not hesitate to reopen the conjunctival wound, to search once more with the small hook for the lateral fibres which still remain, and carefully to divide them.

If, on the other hand, insufficiency exists and readjustment fails, the reason must be sought for in the defective action of the opponent muscle, which we must replace by means to be described hereafter.

(c.) Methods of Modifying the Effect of the Operation.

We have already said that the method of operation which we have described produces in very nearly all cases the same result, and is only available for strabismus of a certain degree. In order to apply this method to all cases of strabismus coming before us, whatever be their degree, we must have at our disposal certain methods of increasing or diminishing the effect of the operation. The means employed are—

1st. The division of the cellular adhesions which indirectly unite the muscle to the eyeball.

2nd. Suture of the conjunctiva.

3rd. Giving to the eye a proper direction after the operation.

The effect of the operation is diminished.

1. By restricting, after a very small incision of the conjunctiva, the liberation of the subjacent tissue to the extent absolutely necessary for the introduction of a small hook. In this case, it is well to incise the conjunctiva near the inferior or superior margin of the muscular insertion rather than at the centre; for by so doing the introduction of the hook requires a much smaller opening in the conjunctiva, and a much less extensive division of the subjacent tissue.

2. By suturing the conjunctiva after the operation. With the suture we draw together the margins of the conjunctival wound, and thus bring the muscle nearer the margin of the cornea. The suture is applied in a diagonal direction from without inwards; it is evident that the degree of its effect depends on the size of the piece of

conjunctiva included in the knot. It is the most certain method of graduating the effect of the displacement, so that we can always detach the entire muscle from all its adhesions to the sclerotic and capsule, and afterwards, by conjunctival suture, fix it in the place at which we wish the new insertion to be formed. Still, the application of the suture and its removal a few days later increase the duration and the difficulty of the operation. This difficulty, which should not hinder the operation when the application of the suture is necessary, would be a drawback to the operation if we wished to generalise it needlessly.

The conjunctival suture is indicated—1st, when the degree of deviation is inferior to the amount of correction obtained by the operation which we have described; 2nd, when the effect of the operation has been too great either in regard to the readjustment or muscular insufficiency.

The diminution of the correction which is obtained from the conjunctival suture depends, in the first place, as we have already said, on the size of the portion of conjunctiva included in the suture. It also depends on the length of time we allow the suture to remain *in situ*.

3. By making the patient look to the side of the detached muscle after the operation. This position rotates the eyeball towards the detached muscle, and prevents it sliding too far backwards on the sclerotic. For patients who cannot voluntarily keep their eyes in the direction required (especially for children) it is beneficial, after the operation, to use spectacles in which the lenses are replaced by vulcanite plates, one of which without any opening is placed before the eye that has not been operated on, whilst the one before the other eye has a small opening placed either at its external or internal side, according as the eye should be kept in extreme abduction or adduction.

To increase the effect of the operation we have the following means at our disposal:—

1. We can, within the limit already indicated, carefully dissect the tissue which unites the muscle to the conjunctiva and sclerotic, as also the lateral expansions which connect Tenon's capsule with the muscle and sclerotic. To perform this operation, we are obliged to make a larger conjunctival incision, which, when we are dealing with the internal rectus, may cause a sinking down of the caruncle. This inconvenience may be avoided by uniting the lips of the conjunctival wound by a suture which includes very little of the mucous membrane.

2. After the operation, we can cause the patient to look to the side opposite to the divided muscle, and by this rotation of the eyeball we help the detached muscle to slip farther back from its original point of insertion.

To make the effect of this rotation still more constant, *Knapp** has proposed to maintain the rotation of the eyeball in the direction indicated, by piercing the conjunctiva with a needle and silk thread, and then carrying the thread through the corresponding palpebral commissure. The ends of the thread can be so tied as to bring the cornea as much nearer the commissure as desired.

This ingenious and efficacious device seems to us to complicate the operation; its application is very painful, and may easily be replaced by a conjunctival ligature extending from the external commissure to near the external margin of the cornea, whenever, after the tenotomy of the internal rectus, we wish to produce a momentary abducting rotation of the eyeball.

To apply this ligature, we introduce a needle provided with a silk or catgut thread beneath the conjunctiva, near the external commissure, and run it horizontally forwards under the conjunctiva, till it nearly reaches the external margin of the cornea, where it is again brought to the surface, carrying the thread with it. The needle being cut off, the ligature is tied by a double knot in such a manner as to cause a strong abduction of the eye. The effect of the ligature is all the greater the larger the portion of conjunctiva which it includes. On the second or third day after the operation it should be removed.

In cases of divergent strabismus, with marked loss of mobility in the direction of the internal rectus, the internal muscle should be advanced.

(d.) Various Modifications in the Operation.

Liebreich has indicated an operation by which he obtains a great amount of correction, and which he describes as follows:—

Should he desire to divide the internal rectus, he raises, with a pair of forceps, a fold of conjunctiva at the inferior extremity of the muscular insertion; he incises it with scissors, and through the small opening gets in between the conjunctiva and capsule of Tenon—these two membranes are carefully separated from each other, as far back as the semi-lunar fold, which, with the caruncle, is detached from the subjacent structures. Having thus completely separated the conjunctiva and capsule, he detaches the muscular insertion from the sclerotic in the usual manner, and enlarges the vertical incision made in the capsule for the tenotomy both above and below, making the opening all the greater the farther he wishes the muscle to slip backwards. He always finishes the operation by suturing the conjunctival wound.†

* *Zehender's Klinische Monatsblaetter*, 1865.

† *Snellen* advises that the scissors be kept close to the internal surface of the conjunctiva and away from the sclerotic; otherwise, several vessels of considerable

The same method is applicable for tenotomy of the external rectus; the separation should be carried to the portion at the external angle, which is firmly drawn backwards when the eye is turned outwards.

Critchett's method, as described by *Sœlberg Wells*, is as follows:—"The patient having been placed under the influence of chloroform, and the eyelids kept apart by the stop speculum, the surgeon seizes a small fold of the conjunctiva and subconjunctival tissue at the lower edge of the insertion of the rectus muscle, and, with a pair of blunt pointed straight scissors, makes a small incision at this point through these structures. The lower edge of the tendon, close to the insertion, is now exposed. A blunt hook is next passed through the opening in the subconjunctival tissue beneath the tendon, so as to catch up the latter and make it tense. The points of the scissors (but slightly opened) are then introduced into the aperture, and one point passed along the hook behind the tendon, the other in front of the tendon, between it and the conjunctiva, and the tendon is then divided close to its insertion by small snips of the scissors. A small counter puncture may be made at the upper edge of the tendon to permit of the escape of any effused blood, and thus prevent its diffusion beneath the conjunctiva" (*Bowman*).

Snellen lays down as an essential condition of success that the detached tendon should not become attached to the eyeball obliquely, an accident which is sure to happen if Tenon's capsule be incised in one direction more than another. To avoid this inconvenience, he operates in the following manner:—

He makes, with a pair of pointed scissors, a large horizontal incision in the conjunctiva right over and parallel with the course of the tendon; then he successively lifts, by means of forceps, both margins of the conjunctival wound, and frees the cellular tissue to an equal extent above and below. The caruncle is also detached from the subjacent structures, all the precautions detailed in the note already given being strictly observed. The shut forceps are then introduced into the conjunctival incision at the middle of the tendon; on opening the forceps, the margins of the incision are separated from each other, and, on applying their points lightly to the sclerotic and shutting them, the tendon is certain to be taken hold of. The operator again takes the scissors and makes an opening in the tendon as near the sclerotic as possible, and through this opening he introduces one branch of the scissors between the tendon and sclerotic, the other between the tendon and conjunctiva. In this way it is easy to operate in both directions

size near the sclerotic may be wounded, thereby causing a considerable escape of blood into Tenon's capsule, and the protrusion of the eyeball. (*Zehender's Monatsblaetter*, 1870.)

to an equal extent, ascertaining by the introduction of a strabismus hook if any tendon fibres are left undivided, an event which sometimes happens, especially when operating on the external rectus.

The horizontal direction of the wound allows of our making the incision as large as we may wish, and we may also apply a suture without diminishing the effect of the operation, as in *von Graefe's* method.

The exact amount of effect is regulated by the more or less extensive division of Tenon's capsule. Still it seems to us that the effect is more readily adjusted by the conjunctival suture than by this method.

Snellen believes that his method of operation is less painful than the ordinary method, which necessitates the introduction of a hook beneath the tendon. Also, he never administers chloroform to the patients, that he may be the better able to judge of the effect produced immediately after the operation. He advises that only one eye be operated on at a time, so as to modify the result by causing the patient to look in a proper direction. He also insists that, in cases of hypermetropia, the patient should wear, immediately after the operation, glasses suited to correct his hypermetropia, so that the amount of correction may not be diminished by the efforts of convergence which always accompany accommodation in hypermetropia. It seems to us that the same result may be more surely attained by instilling atropine.

Noyes and *Driver* have suggested a method of excising a portion from the antagonist of the muscle on which the strabismus depends—*i.e.*, from the external in convergent, and from the internal in divergent, strabismus. After having divided the muscle in its continuity, *Noyes** places the two ends one over the other in such a manner as to shorten the muscle in proportion to the deviation, and unites them by a suture. He claims for this method the advantage of curing by a single operation any deviation, even exceeding 11 millimetres. The same principle has been applied independently by *Driver*,† who proposes his operation for any convergent strabismus exceeding 7 millimetres, and for all cases of divergent strabismus. After division of the muscle, he cuts off the anterior end a portion equal in length to the deviation, and unites the two ends by two sutures, one of which has to be put in place before the section is made. He publishes fifty-three successful operations.

* *Transaction of the American Ophthalm. Society*, vol. ii., pt. 2.

† *Zehender's Klin. Monatsblaetter*, p, 133, 1876.

(e.) The Method of Operating in the Various Degrees of Strabismus.

Having in the previous sections described the immediate usual effect of tenotomy, and the means at our disposal of increasing or diminishing that effect, in order to complete the sketch it remains for us to say something as to the methods to be employed in the different cases of strabismus, which present such various degrees of deviation.

The following is the rule which we follow in **convergent strabismus:**—When the deviation *measures less than* 3 *millimetres*, we divide the internal rectus of the deviating eye, making a very small conjunctival incision, and freeing the muscle from its areolar adhesions only to a very limited extent. Immediately after the operation we make certain, by examining the mobility of the eye inwards, that the tendinous insertion has been completely divided, and we regulate the degree of re-adjustment by a conjunctival suture, which, according to the effect we wish to produce, should embrace a greater or less amount of conjunctiva. The time during which we leave the suture in position (six to forty-eight hours) has also some influence on the result.

If the deviation *measures* 3 *or* 4 *millimetres*, it suffices to make the tenotomy on the internal rectus of the deviating eye in the manner already described; if examination of the eyes, immediately after the operation, shows that the adjustment is not altogether sufficient, we have only to free the sub-conjunctival cellular tissue to a greater extent with the small hook; or, should this be insufficient, we must carefully incise, by a few snips of the scissors, the lateral prolongations of Tenon's capsule which accompany the muscle to the sclerotic.

According to the result obtained, we direct the eye of the patient for the first twenty-four hours after the operation to the internal side when we are afraid that the effect is too great, to the external when we wish the muscle to contract as much as possible.

We may in this way, especially when the patient is a child, obtain a displacement of nearly 5 millimetres. Still, when the deviation *is from* 5 *to* 6 *millimetres*, we prefer to perform tenotomy on both sides, dividing the effect between the two eyes. In this case, we at first perform an ordinary tenotomy on the internal rectus of the deviating eye, and, when cicatrisation is complete, we get the ultimate result by operating on the other eye with or without conjunctival suture, according to the amount of correction which is still required. By acting in this way, we are more certain of re-establishing the normal muscular equilibrium, by distributing between the two eyes, not merely

the correction, but also the insufficiency which inevitably follows any tenotomy. It is only by a rigorous observation of these laws that we can obtain perfect results in the operation for strabismus, that we can make the optical axes parallel, and have perfect symmetry of the eyes in lateral movements as well as in convergence.

When the deviation *amounts to* 6 *or* 8 *millimetres*, we act as in the preceding cases—that is to say, we divide the muscle of the deviating eye so as to obtain a re-adjustment of 4 or 5 millimetres. After the operation, if the outward movement of the eye is deficient, we keep it in extreme abduction by the conjunctival ligature on the external side of the cornea. Having obtained our purpose, we make, when the cicatrisation of the first eye is complete, a tenotomy on the other; in the second operation observing all the rules applicable to the amount of deviation which is still to be corrected.

When the deviation *is greater than* 8 *millimetres*, we perform the classical tenotomy simultaneously on both eyes, increasing within the prescribed limits, or diminishing, according to the result of the immediate examination, the effect on one or other eye by the methods indicated. When the amount of correction thus obtained is insufficient, we can, at a later period, again operate on the eye which has the greatest mobility inwards; but we are very much averse to performing this additional operation soon after the first. We shall see that the necessity of this last correction depends on the manner in which the eyes perform the movements of convergence, on the state of their refraction, and especially on the presence of binocular vision, which allows us to treat very small deviations with optical appliances (convex or concave glasses), and exercises with the stereoscope.

In **divergent strabismus,** we may look for complete correction by ordinary tenotomy only when the deviation is not more than 2 or 3 millimetres. If the strabismus amount to 4 millimetres, we are obliged to perform tenotomy on both external recti, keeping the eye after each operation in extreme adduction, so that the muscle may slip as far back as possible.

In higher degrees of deviation, when the eye has lost a portion of its mobility inwards, simple tenotomy of the external rectus is no longer sufficient—it must be combined with advancement of the internal rectus, of which operation we shall speak in a special chapter.

(f.) Treatment after the Operation.

When the effect which we desire to obtain does not require the immediate use of glasses or other apparatus, we first cool the eye by

applying a cold compress for a few minutes, and then put on a light compress and bandage. This bandage is generally sufficient to check any pain the patient may feel after the operation; it should, therefore, be used for the first few days, and, in all cases, till the sutures are removed, if such have been inserted.

During cicatrisation we sometimes find on the surface of the wound red sprouting granulations, more or less prominent. They occur only after tenotomy of the internal rectus, and we should wait till the small tumour is pediculated before excising it, which may be done with one cut of the scissors (the application of caustic to these granulations does not seem to be efficacious).

As to the shrinking of the caruncle which formerly so frequently followed tenotomy of the internal rectus, it was due more particularly to the extensive division of the tissues and to the deep sections which were the rule in former times. It is generally avoided by observing the precautions which we have indicated. If, however, excessive shrinking cause an appreciable deformity, it is easy to make the caruncle appear in the internal angle by the following small operation, devised by *von Graefe*:—The conjunctiva is lifted with a pair of forceps a few lines in front of the caruncle, and a vertical incision, 6 millimetres long, is made in it. Then, lifting the internal lip of the wound, we penetrate, with a pair of scissors curved on the flat and with the concavity turned towards the eyeball, into the subjacent tissue, which is detached from the surface of the muscle without wounding the latter. In the same way we prepare the flap of the conjunctiva which intervenes between the incision and the margin of the cornea, and we then unite the two flaps by a point of suture which should take in a sufficient amount of conjunctiva to raise the caruncle and to bring it forwards.

When an *exophthalmos* supervenes after the operation, we must distinguish those cases in which it is real—that is to say, in which there is a true propulsion of the eyeball—from those in which it is only apparent from the unusual separation of the lids from each other. In most persons affected with strabismus there is, as has been proved by repeated measurements both before and after the operation, a greater separation on the side of the deviating eye than on the other. This asymmetry which, before the operation, did not attract the attention of the observer, that having been wholly taken up with the reciprocal position of the eyes, becomes more apparent when the patient no longer squints. Perhaps the cause of it should be sought for in the height of the palpebral fissure, and in the deviation itself; since the cornea, in the abnormal position which it occupies inwards or outwards, tends, by its convexity, to separate the lids from each other.

In a very few cases there is a slight degree of propulsion of the eye after the operation, which is due to an extensive division of the cellular prolongations of the capsule, or to a large opening in the capsule itself.

Whatever it may be, if we wish to remedy this apparent or real propulsion of the eye, we can only do so by modifying the height of the palpebral fissure by means of an operation.

When there is only a difference in the size of the palpebral fissures, it is better for the patient's appearance to obtain the symmetry of the two eyes by enlarging the fissure on the side on which the eye seems smaller. This may be done by the operation for blepharophimosis, which will be described in another chapter.

Not unfrequently, even after a perfectly successful operation, we find the patient unable to give up the bad habit of holding his head in an oblique direction, corresponding to the direction of the previous strabismus. The remedy is to wear such apparatus as has already been described to make him look in one particular direction. Thus, suppose the patient turns his head to the right, we give him spectacles with vulcanite plates instead of lenses, and make a small opening near the nose for the left eye, and on the temporal side for the right eye. The patient using such an apparatus is obliged to turn his head to the left if he wishes to see before him, and, by persevering in its use, he will cause the faulty position of the head to disappear entirely.

(g.) Immediate and Final Results of the Operation.

Careful examination of the eyes after the operation has shown that there is a certain difference between the immediate effect of the strabotomy and its ultimate result. Under this aspect we have to distinguish three periods. In the *first*, immediately following the tenotomy, the effect is the most considerable, for the rotation of the eyeball in the direction of the detached muscle is only effected by the indirect attachments which still unite the muscle to the sclerotic. The *second period*, which begins about three or four days later, is characterised by a diminution of the immediate effect, for the muscle has acquired a new insertion, and now exercises a direct influence on the movements of the eye.

There is still a *third* modification in the position of the eye which has been operated on, generally observed six weeks or two months after the operation. This third period is characterised by a slight increase in the effect of the operation. This augmentation is due to

the action of the antagonist, which exerts a greater influence on the position and movements of the eyeball proportionately to the length of time the divided muscle has been inactive, and to the loss of power sustained by that muscle owing to the operation.

We can easily understand how the effect produced during this period by the power of the antagonist must vary in different cases of strabismus, and with the special disposition of each individual for the movements of accommodation, which dispositions have a special connection with the state of refraction of the eyes. Thus, in a certain number of cases, after operation for convergent strabismus we find that the ultimate correction is greater than the immediate result; but in others we see the opposite condition of matters—viz., a progressive convergence of the eye operated on, when there is hypermetropia, and when the patient does not use such glasses as will correct it.

In divergent strabismus, the almost constant diminution of the result of the operation is very considerable during the period of cicatrisation. This must not be lost sight of at the time of the operation, the first effect of which should be greater than the amount required, so that it not only corrects the divergence, but causes a convergence of 1 or 2 millimetres, which will disappear during cicatrisation.

In studying the movements of convergence of the eyes while they fix some object (say the point of the finger) which is brought nearer in the median line till it is only 12 or 15 centimetres from them, we have an invaluable method of forming, immediately after the operation, an opinion as to the ultimate result.

The ultimate result of the operation may be foreseen from the manner in which the eye whose muscle has been divided behaves itself during this examination. If its movements stop as soon as the object is at 18 or 20 centimetres, so that there is a divergence of the eyes if the object is brought nearer, we may expect that at a later period our operation will be followed by a divergent strabismus, although, at the time of the operation, the symmetry of the eyes for the median position has been perfect. An ultimate divergence is still more certain if the eye, at the afore-mentioned distance, not only stops, but begins to make a movement associated with that of the other—that is to say, begins to turn outwards, the outward movement being greater the nearer the fixed object is brought to the eyes. In such cases, it is absolutely necessary to restrict the effect of the operation by conjunctival suture, even at the risk of thereby annulling to some extent the correction of the strabismus, which we can always rectify, if necessary, at a later period by operating on the other eye.

We must also have recourse to conjunctival suture after operation,

when the patient, although able to converge for 12 or 15 centimetres, is unable to maintain this convergence. This condition is best detected by covering the operated eye with the hand, whilst the patient looks steadily at our finger held at the above distance. We shall then find that the operated eye does not keep its normal position when looked at behind the hand, but turns outwards. The muscular insufficiency which this state of matters reveals would in the end lead to muscular asthenopia, if the patient were affected with such a degree of myopia as to be obliged to hold objects nearer than the above-mentioned distance, or if his occupation obliged him to read and write much. It is true that we may be able to complete the treatment by optical means (spherical and prismatic glasses), and by exercises with the stereoscope. Still, these latter are only of use when there is binocular vision, and are not easily employed in dealing with children.

In another series of cases, the patient can easily converge his eyes to 12 or 15 centimetres, but, should he continue to fix an object at that distance, we shall find that suddenly the eye which was operated on moves inwards—that is to say, the deviation is momentarily reproduced under our eyes. Even when the strabismus is perfectly corrected, we have reason to fear a relapse, which must, if possible, be prevented by the use of atropine, by suitable glasses (if the patient is hypermetropic), and by making him carefully exercise binocular vision till it is perfectly established. If these obvious precautions are neglected, the strabismus is very liable to return.

When the necessary correction has been obtained, and when the patient can converge for 10 or 12 centimetres without the operated eye deviating perceptibly behind the hand which covers it, we may expect a thoroughly satisfactory result, although we must not lose sight of the predisposition to strabismus (ametropia) which has been the first determining cause of the deviation, and which, if we wish to prevent a return of the strabismus, should be corrected by suitable glasses. In short, we cannot insist too much on the necessity of considering the use of convex glasses in hypermetropia, after a strabismus operation, as an indispensable condition of success; as also of regulating for a considerable period the time during which the patient should work. We should in like manner see to it that the methodical exercises above described are regularly performed, as they are necessary for the re-establishment and preservation of binocular vision.

(h.) Strabotomy by Advancement of the Tendon (Muscular Advancement).

The older method of performing strabotomy, which, in addition to the very extensive division of the subconjunctival tissue, often involved

multiple sections of the muscle, sometimes led to disastrous results. The bad plan of cutting a muscle in its continuity far from its insertion, or even of excising a portion of its tendon in order to produce a greater effect, often led to a deviation of the eye in a direction opposite to that which we wished to correct. Such deviation has received the name of *secondary* strabismus. It is characterised by a considerable loss of mobility of the eyeball, which is the inevitable result of the faulty insertion which the cut muscle contracts with the sclerotic.

The same set of symptoms are found in certain cases of strabismus following muscular paralysis. In these cases of want of power in the antagonist, simple tenotomy is not sufficient to establish the normal conditions, and we adopt the principle of displacing the muscular insertion forwards—*i.e.*, of bringing it nearer to the cornea.

Jules Guérin was the first who tried, in cases of divergent strabismus brought about by too great retraction of the internal rectus, to advance the tendon of that muscle towards the cornea; but the method of operation adopted by this able surgeon had certain inconveniences. After dissecting the mucous membrane and the ocular fascia, he sought for the internal rectus muscle. For this purpose he laid bare the internal portion of the sclerotic, and subjected the cellular structures which surround the retracted muscle to a careful dissection, and thus he prepared the muscle which he wished to bring nearer to the cornea. He then passed a thread through the sclerotic on the external side of the cornea, and was able by drawing both ends of the thread to cause complete rotation of the eye inwards. Strips of adhesive plaster kept the eye in extreme adduction, and thus favoured the formation of the new attachment of the muscle to the sclerotic, quite close to the internal margin of the cornea.

This operation, to which will always belong the credit of having been the first to make the principle of muscular advancement available, underwent very important modifications in *von Graefe's* hands. His method avoids the careful dissection necessary in looking for a single muscle, a dissection difficult to perform, sometimes uncertain, and which experience has shown not to be required. In fact, the presence of the cellular layer which surrounds the muscle, far from being objectionable, only adds strength to the new insertion. His principal modification is, however, in the insertion of the thread. By passing it through the sclerotic as *Guérin* suggested, and allowing it to remain for several days, we may set up a dangerous amount of inflammation, all the more so that we cannot attach the thread in the superficial structures, as these might give way and thus spoil the success of the operation. *Von Graefe* attached the thread to the tendon

of the antagonist of the muscle which he wished to displace, and performed tenotomy on the antagonist itself. He thus facilitated the forced rotation of the eye by the thread, making it less painful for the patient, and promoted the re-establishment of the muscular equilibrium.

The greatest inconvenience of this procedure, which has now only a historical interest, consisted in the impossibility of modifying the effect according to the peculiarities of each case. Each time we were obliged to keep the eye entirely in the angle of the palpebral fissure, thus causing a displacement which might exceed the necessary amount.

It was, therefore, necessary to find a method of operation which should not cause such a great displacement of the tendon, and should allow the surgeon to regulate the amount of muscular advancement with greater precision by a simple suture, without the use of the traction thread. *Critchett** recommended and put in practice a new method as being generally useful; his method has been beneficially modified by *von Graefe*.†

It is as follows:—

First Step: Section of the Muscle.—Supposing we wish to advance the internal rectus, we very accurately detach the conjunctiva from the cornea by an incision nearly 1 centimetre long; then we also carefully separate it from the subjacent tissue up to the caruncle. Having done so, we cut the muscular insertion close to the sclerotic, previously introducing a strabismus hook, or, still better, de Wecker's double hook, which holds the divided muscle between its two branches.

Second Step: Application of the Sutures.—The surgeon now takes hold of a large portion of the conjunctiva above the cornea, and pierces it with a threaded needle at 4 millimetres above the cornea and 5 or 6 millimetres from the external margin of the conjunctival wound. Then, whilst an assistant raises the conjunctiva, he draws the internal rectus forwards, and runs the needle through its tendon at 4 millimetres from its margin near its middle part; he then pierces the conjunctiva above the muscle at 5 or 6 millimetres from the wound. To consolidate the effect, and to keep the muscle in the horizontal direction, a second suture is inserted in a similar manner at the inferior aspect of the cornea, piercing the tendon beside the first. Both sutures should be tied at the same time.

If the ordinary strabismus hook be used instead of the double one, it is better to pierce the muscle before detaching it from its insertion, with a thread furnished with a needle at both ends.

* *Reports of the Heidelberg Congress*, 1862.
† *Archiv für Ophthal.* p. 1892. 1863.

The insertion of the sutures may be simplified by using a thread with three needles, one at the centre and one at each end. The needle at the centre is first passed through the muscle and conjunctiva from within outwards; then the other two needles are introduced above and below the cornea, through the conjunctiva and subconjunctival tissue. The thread behind the first needle having been cut, the two sutures are firmly tied.

Ad. Weber applies the following suture:—He takes a long thread with a needle at each end, doubles it, and passes the doubled extremity through a third needle. This needle is then run through the muscle and conjunctiva from within outwards. Having passed the two other threads through the conjunctiva at the superior and inferior aspects of the cornea, he slips them through the loop formed by the first thread in front of the muscle and conjunctiva.

On drawing the two threads, the muscle is brought nearer to the cornea, and, when the desired effect is obtained, the two extremities of the thread are made into a knot, sufficiently thick to prevent its slipping through the loop.

Third Step: Section of the Antagonist.—The third step consists of the usual tenotomy of the antagonistic muscle.

The amount of tendon included in the suture should be proportionate to the effect which we desire to obtain, for in this lies one of the great advantages of this method of operation. We may even excise a greater or smaller piece of the muscle (*Agnew*), and thus obtain the maximum effect.

Immediately after the operation, we find an increased mobility of the eye in the direction of the advanced muscle, and we see that the deviation has been corrected. We must not forget that, in divergent strabismus, the immediate effect should be somewhat excessive, for it diminishes a little as the antagonist gains in power. Keeping the lids at absolute rest by means of a compress and bandage is the surest way of preventing or checking any symptoms of irritation. The sutures may be removed in from twenty-four to forty-eight hours, at the end of which time the new insertion is usually firm. Still, when the eyes are not irritable, the sutures may be left in for a longer period.

The method recommended by *Liebreich* differs from the usual method in two particulars:—He makes his incision near the muscular insertion at a few millimetres from the cornea, and detaches the conjunctiva from the subjacent tissue both towards the cornea and caruncle. The other difference is in his method of fixing the extremity of the muscle which he wishes to advance towards the cornea. He applies his sutures by means of a thread provided with a needle at each end. He enters both needles at the superior margin of the muscular extremity, inserting them at 2 millimetres from each other; then he pierces the conjunctiva from before backwards near the corneal margin with both needles, and ties the suture; lastly, he makes a second suture, in a similar manner, at the inferior margin of the muscle. He unites the conjunctival wound with ordinary suture points.

The indications for muscular advancement with tenotomy of the antagonist are as follows:—

1. Cases of secondary divergent strabismus with loss of mobility inwards of from 5 to 6 millimetres.

2. Deviations consequent on paralysis, where the loss of mobility is about 5 or 6 millimetres.

3. Cases of pronounced divergence with slight loss of mobility inwards.

4. Certain cases of convergent strabismus of a very high degree, with fibrous degeneration of the internal rectus and loss of outward mobility, as sometimes occurs in cases of congenital strabismus.

Muscular advancement by a suture *without tenotomy of the antagonist* is applicable to cases of strabismus with a slight loss of mobility in the direction opposite to the deviation. In these, however, we prefer to practise tenotomy, and apply the conjunctival ligature over the antagonist (p. 505).

M. de Wecker generally replaces muscular advancement by an operation to which he has given the name of *capsular advancement*, and which he describes in the following way:—In convergent strabismus, we excise near the external margin of the cornea a crescent-shaped flap of the conjunctiva, from 3 to 4 millimetres in width, its concavity turned to the cornea. The retraction of the conjunctiva exposes the tendinous insertion of the external rectus, and permits of an opening in the capsule near the two extremities of the tendon, liberating at the same time the capsule beneath the muscle and sidewards. We then place two sutures, one above and one below the vertical meridian of the cornea and near its margin. Each suture embraces a small portion of the conjunctiva and the subconjunctival layer, and is drawn out through the conjunctival wound. The needle is then introduced into the opening of the capsule, glides under the tendon, and transfixes the tendon, the capsule and the conjunctiva, at a point somewhat behind the insertion of the external rectus, near the middle of its tendon. The ends of both sutures being momentarily placed on the temple, we perform the tenotomy of the internal rectus, and finish the operation by closing the sutures. The author adds that the effect of the operation depends chiefly upon the liberation of the indirect attachments of the internal rectus to the sclerotic, in accordance with the classical rules established by *von Graefe*. What he designates as capsular advancement seems to be a temporary folding of the muscle and the capsule, which, in our opinion, may be obtained more easily and better by the conjunctival ligature described at p. 505. Also, out of 140 operations published by *Wecker*, we find more than 80 with a deviation left of from 5° to 33°, 15 where the

operation had scarcely any effect at all, and only about a dozen with complete correction.

ART. IV.—Insufficiency of the Internal Recti, Muscular Asthenopia. Latent Strabismus.

The name *asthenopia* has been given to a weakness of sight which depends on a want of energy in the exercise of vision. Thus, we may find in patients affected with this disease perfect acuteness of vision, although they are not able to use their eyes over any fine work. We know, however, that this asthenopia sometimes depends on a hyperæsthesia of the retina (retinal asthenopia), sometimes on a relative loss of accommodation (accommodative asthenopia), and sometimes on an insufficiency of the internal recti (muscular asthenopia). It is only with this last that we have here to deal.

The asthenopia caused by insufficiency of the internal recti is characterised by the following symptoms:—At first, the patients generally complain that when they have read for some time the letters become mixed, appearing larger or double, that the pages intercross, and that they suffer from such a sense of fatigue that they are obliged to stop reading. There is also a painful feeling of tension in the eyes, accompanied with supra-orbital pain whenever they work for any length of time.

When we wish to find out whether these symptoms depend on insufficiency of the internal recti, we should ascertain to within what distance the eyes can converge. For this purpose, we make the patient fix the end of the finger at 35 or 40 centimetres, for which distance the eyes can easily converge. If we now bring the finger nearer, the eyes follow it to a certain point at which the movement of convergence ceases, and we may observe the following phenomena:—One of the eyes continues to fix the end of the finger; the other stops, sometimes after a few oscillations due to the efforts which the internal rectus makes to maintain the convergence; or it accompanies the movement of its neighbour by an associated movement, turning slowly outwards; or this outward deviation takes place suddenly and spasmodically.

If at the beginning we hold the finger at 15 or 20 centimetres from the eyes, the divergence takes place at once. If we cover one eye with the hand and make the other fix a near object, we can observe that the

eye behind the hand becomes divergent. If we cause the object to be fixed alternately by one eye and then by the other, we can make the movement of adjustment manifest as the eyes turn towards the object.

To diagnose the muscular insufficiency with still greater precision and to determine its amount, a prismatic glass is of great service.

If we destroy simple binocular vision by holding a prism with its base upwards or downwards in front of the eye, we set the eye at liberty to adopt any position its muscular power may give it.

Let us place before one eye a prism of 10 or 12 degrees with its base upwards or downwards, and make the patient look with both eyes at a straight line with a point in its middle (Fig. 202) drawn on a piece of paper, and held at 20 or 25 centimetres in front of him; he will at once become diplopic, and two points will be seen one above the other. If these two points are situated in the same vertical line, we may feel certain that the equilibrium of the muscular forces is the same for both eyes. But in eyes affected with muscular insufficiency, the two points are no longer exactly in perpendicular line, one of them will have undergone a lateral deviation. This deviation, being divergent, causes a crossed diplopia, and we can readily express the degree of the insufficiency by the number of the prism which, placed in front of the eye with its base inwards, brings the two points into the same vertical line. It sometimes happens that the line interferes with a correct judgment, and it is then better to use a point without any line for the experiment in question.

Fig. 202.

When we have thus ascertained the presence of the insufficiency and determined its amount, we must always also measure the relative power of the internal and external recti muscles, by finding out the strongest prismatic glass which they can overcome. For this purpose, we cause the patient to look at a candle flame placed at 3 or 4 metres in front of him, and make a number of prisms of various degrees, with their bases turned towards the temple, pass before one eye, so as to determine the strongest prism with which he can still see simply. This prism indicates the strength of the internal rectus (adduction). We try in the same way the power of the external (abduction) by turning the base of the prism towards the nose.*

Weakness of the internal recti may be observed either in hypermetropic, emmetropic, or myopic eyes. It is, however, most annoying

* To obtain an exact result, it is necessary that the two images be formed at the same height; and if they are not, we turn the base of the prism slightly upwards or downwards, according to the difference in level, till both images are in the same horizontal line.

to persons having the last, for, as they are obliged to bring objects very close to them, they must make their eyes converge for very short distances.

With this insufficiency, whether it occur in emmetropia, hypermetropia, or myopia, the patient soon begins to feel uncomfortable, for he can no longer use both his eyes for any special work. It is also of great importance that the surgeon should carefully study the true cause of such discomfort, for, by neglecting or misinterpretating the symptoms, he either leaves his patient in a most disagreeable position or submits him to a course of treatment in no way calculated to relieve the disease. In myopia, the correction of muscular insufficiency is of all the greater importance that its presence materially helps the progress of the posterior staphyloma.

Treatment.—In certain cases of myopia, and in the early stages of the disease, the symptoms of asthenopia may be overcome by concave glasses, which, by allowing the patient to hold his book at a greater distance from his eyes, prevent the need of great efforts of

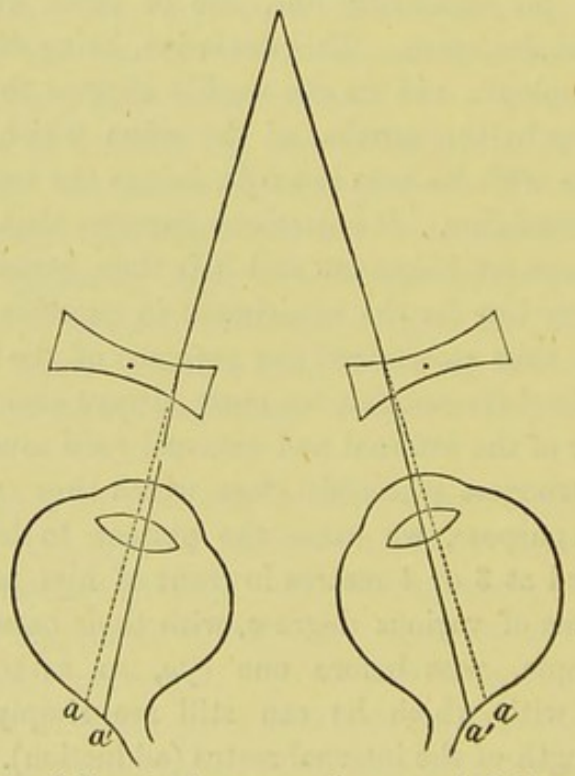


Fig. 203.—Position of decentred concave glasses and their action on the course of luminous rays.

convergence. If, for example, a myopic person is obliged to converge for 20 centimetres, concave glasses which enable him to see at 35 or 40 centimetres will considerably relieve the contractions of the internal recti. Still, this method cannot be used in many cases; for the use of concave glasses ought always to be subject to the conditions which have been laid down in speaking of the choice of glasses in myopia.

When concave glasses are admissible, and necessary to overcome the symptoms of asthenopia, we may increase their effect and aid the muscles if it seem necessary, by altering the distance of the two glasses of the spectacles—*i.e.*, by *decentring* the lenses. When we look at a concave glass we see that it may be considered as composed of two prisms united by their angles, so that the external portion of the glass resembles a prism with its base towards the temple, and the internal a prism with its base towards the nose. Now, in insufficiency of the internal recti, one of the eyes, after a certain amount of work, deviates outwards, and, by this rotation, carries the fovea centralis inwards. To remedy this defect, if we are not able to make the eyeball take its natural position, we can at least, by means of a prism, turn the course of luminous rays towards the nasal side of the retina, so that the retinal image is formed on the fovea. A prism strong enough to produce this effect ought, therefore, to be placed before the eye with its base turned towards the nose, and as we have already seen that the internal portion of the concave glass has a similar effect, we can take advantage of this fact, by separating the concave glasses from each other, that is to say, by placing their centres externally to the visual axis.

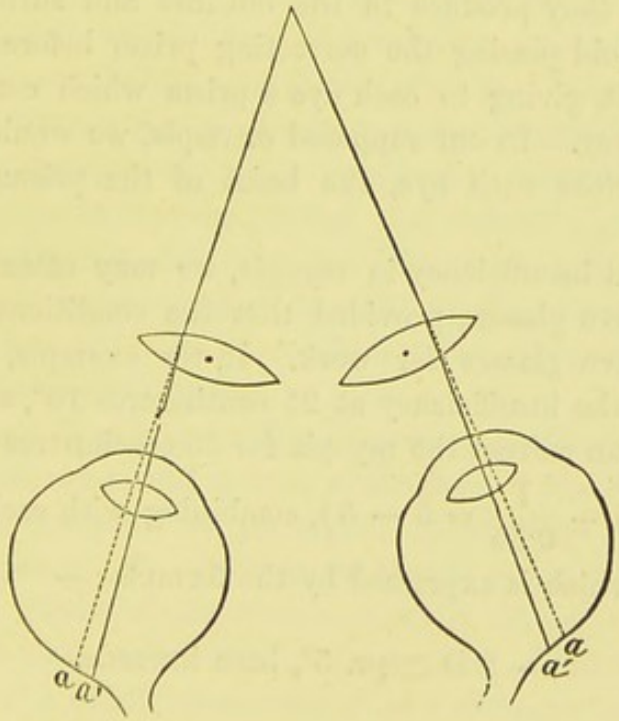


Fig. 204.—Position of decentred convex glasses and their action on the course of luminous rays.

When we wish, in similar circumstances, to relieve muscular asthenopia in a hypermetropic person who uses convex glasses, we must *decentre* the lenses inwards, that is to say, bring the lenses nearer

each other, so that the visual axis passes through the external portion of each lens, which has the same action as a prism with the base towards the nose.

Still, the prismatic effect of *decentred* glasses is always very slight, and we can only hope by their use to prevent the fatigue which arises from too prolonged convergence of the eyes. When there already is muscular asthenopia, we prefer to give for work *prismatic glasses*, either simple or combined with concave or convex glasses.

The prismatic glass, in order to give the desired result, should, as nearly as possible, neutralise the insufficiency for the distance at which the patient reads or writes. Our measurements already given are for this distance (see p. 519), and we must prescribe as nearly as possible the prism which has been found by examination to correct the insufficiency exactly. When, for example, we have found that it requires a prism of 10° to bring the retinal image on to the fovea of the deviating eye (insufficiency = 10°), we must order the patient to wear whilst working a pair of spectacles, having on one side a plain glass, and on the other a prism of 10°, with the base inwards. Still, very strong prisms placed before one eye disturb vision by their power of dispersion, by the reflections from their surfaces, and by the change of form which they produce in the outlines and surfaces of objects. We therefore avoid placing the correcting prism before one eye only; we rather half it, giving to each eye a prism which corrects the half of the insufficiency. In our supposed example, we would thus place a prism of 5° before each eye, the bases of the prisms being turned inwards.

When we find insufficiency in myopia, we may often combine prismatic and concave glasses, provided that the conditions are such as to admit of concave glasses for work. If, for example, the degree of myopia is 5 D, the insufficiency at 25 centimetres 10°, and at 35 centimetres 6°, we can correct the myopia for 35 centimetres with a concave glass of $2\ \mathrm{D}\left(5 - \frac{1}{0{\cdot}35} = 5 - 3\right)$, combining with each concave glass a prism of 3°, which is expressed by the formula :—

$$-\ 2\ \mathrm{D} \supset \text{pr. } 3°, \text{ base inwards.}$$

Up to this point we have chiefly been dealing rather with palliative measures in asthenopia than with the means which are suited to re-establish the muscular equilibrium, which has been upset by the relative weakness of the internal recti. We now come to speak of such means as are curative.

In the first place, we may mention exercises suited to strengthen the

internal recti. These are performed by placing weak prisms in front of the eyes, with their bases outwards, when the patient looks at a distance; such an arrangement necessitating a slight contraction of the internal recti, which are in this way strengthened. This plan of treatment requires a considerable time, and can only give satisfactory results when the degree of insufficiency is insignificant. It does not seem to be entirely free from danger in cases of myopia (in which the prisms are combined with concaves), as in these cases we are very desirous of avoiding muscular tension.

The last method of treating internal insufficiency we would mention is to aid the muscles, either by bringing their insertion nearer to the cornea, or by diminishing the action of their antagonists. This latter result may be obtained by tenotomy of the external rectus.

Still, we can only have recourse to tenotomy when we are sure that it will not produce convergent strabismus for distance, of which we can be sure only after a most careful examination, according to the prescribed rules, of the power of abduction of the eye. If this power is excessive, there will be a divergent strabismus when the patient looks at a distance, or at least this divergence will be produced behind the prism with which we determine the power of the external rectus.

It is this divergence which we wish to overcome by the tenotomy of the external rectus, without fear of producing a convergent strabismus and a homonymous diplopia for distant objects. It is evident that our operation may correct the insufficiency of the internal recti all the more completely the stronger the prism required to overcome the abduction of the eye, that is to say, the greater the abductive power of the eye. The prism expressing this force will, therefore, indicate the limit of correction which we are entitled to make by the operation. Generally we regard a prism of 10° as the weakest which allows of our performing tenotomy of the external rectus.

This tenotomy should, in the disease under consideration, be performed with every precaution, and minute observance of the rules already laid down; for an operation so performed ensures the exact amount of correction necessary. In addition, we should never neglect to examine the immediate result of the tenotomy, which in cases of insufficiency should, as soon as the operation is finished, be as follows :—When the patient looks at a candle flame placed at a distance of 2 or 3 metres, there should be a homonymous diplopia, which should be corrected by a prism of 10°, corresponding to a convergence of 1 or 2 millimetres. This convergence disappears on the cicatrisation of the wound during the first few weeks after the operation.

When the patient looks at a candle placed at the same distance from him and 15 or 20 degrees to the nasal side of the eye operated on, all

trace of the diplopia should disappear. If a prism with its base upwards or downwards be put before one eye, the two images should be seen, the one exactly over the other.

If these experiments show that the effect of the operation is not sufficient, that effect can always be increased by freeing the cellular tissue which prevents the muscle from slipping backwards; by directing inwards with properly constructed spectacles the eye operated on; or by performing the same operation on the other eye at a later period.

When, on the other hand, the convergence exceeds the desired amount, we can always limit it immediately after the operation by a conjunctival suture, and by directing the eye to the side of the divided muscle.

The advancement of the internal rectus without tenotomy of its antagonist has also been proposed in treating muscular insufficiency, and is certainly a very rational mode of treatment.

In practice, it must, however, be kept in mind that, if examination immediately after the operation shows an insufficient or excessive effect, the means of correcting it are less numerous and more uncertain after advancement of the internal rectus than after tenotomy of the external.

In a certain number of cases, we succeed by these means in correcting the insufficiency of the internal recti, and, consequently, in curing the muscular asthenopia and preventing its dangers. In other cases in which the deviation of the eye for near vision is greater than the amount of divergence which we are at liberty to correct by operation, there will still remain a degree of insufficiency, for which we may prescribe prismatic glasses, either alone or combined with sphericals (concaves or convexes).

CHAPTER XII.

EYELIDS, LACHRYMAL PASSAGES AND ORBIT.

Anatomy and Physiology.

1. The **orbit** may be compared, as regards its form, to a four-sided pyramid. The base of this pyramid is the anterior opening of the orbit, at which the superior, inferior, internal and external walls terminate. Three of these walls have a sharp margin, making an acute angle with the bones of the forehead and cheek, but the internal wall imperceptibly becomes continuous with the bone of the nose.

The walls of the orbit are composed of very thin osseous plates, the superior wall being formed by the orbital plate of the frontal bone; the inferior wall by the orbital process of the superior maxillary; the external wall by the anterior surface of the great wing of the sphenoid and the posterior surface of the malar bone; the internal wall by the os planum of the ethmoid, the os unguis, and the nasal process of the superior maxilla.

At the junction of the internal and middle thirds of the superior margin, we find the supraorbital foramen, which gives passage to the nerve and artery of the same name. The infraorbital foramen runs obliquely from before backwards through the inferior wall, and contains the infraorbital vessels and nerve. The optic foramen is situated at the posterior extremity of the superior and internal walls; the optic nerve and ophthalmic artery pass through it from the cranial cavity into the orbit. To the outside of and below this opening, between the superior and external walls, is the opening of the sphenoidal fissure; it contains the third, fourth and sixth pairs of cranial nerves, the first branch of the fifth, and the ophthalmic vein. Between the external and internal walls, we find the spheno-maxillary fissure, which is crossed by the infraorbital nerve, as also by the cutaneous branch to the cheek.

The walls of the orbit are covered by a periosteum, which is closely adherent only at the foramina, the margins of the fissures, and the anterior opening of the orbit. This periosteum is in direct communication with the periosteum of the cranium and face, and also with the cranial dura mater.

2. The **eyelids**, as they lie in contact with the anterior convexity of the eyeball, which contact is maintained by the action of the muscles

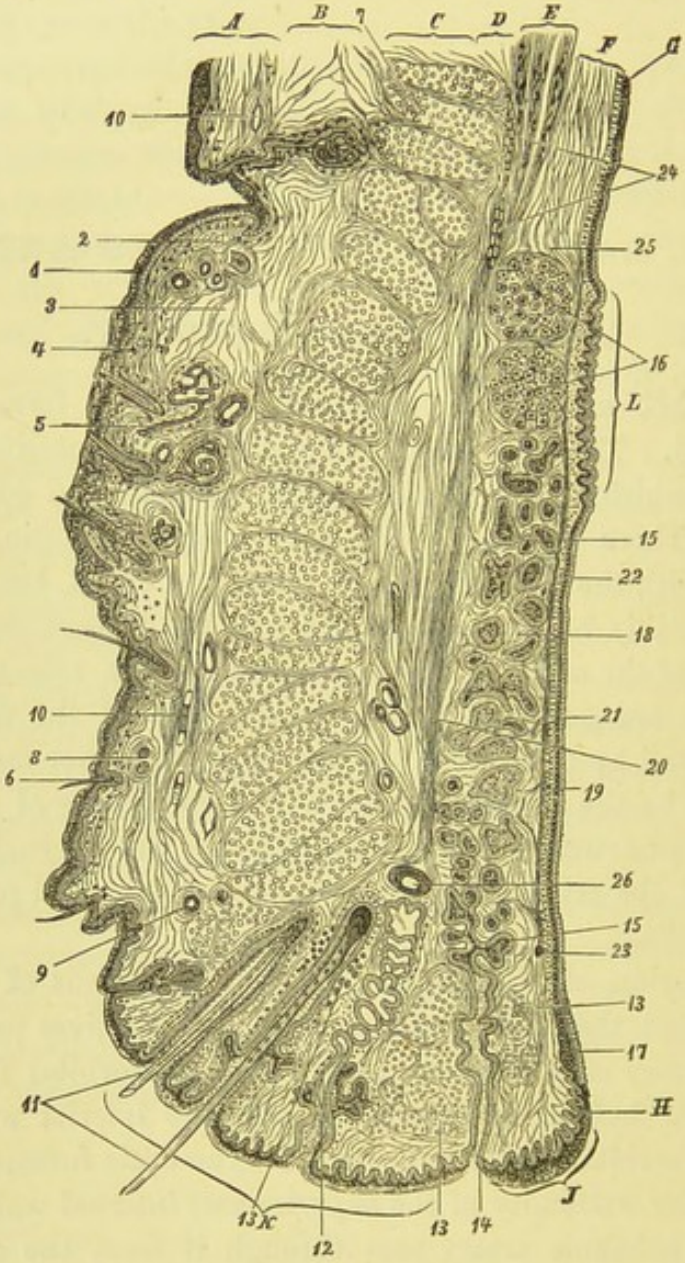


Fig. 204*a*.—*From Landois and Stirling.*—Vertical section through the upper eyelid, after Waldeyer—*A*, cutis ; 1, epidermis ; 2, chorium ; *B* and 3, subcutaneous connective-tissue ; *C* and 7, orbicularis muscle and its bundles ; *D*, loose sub-muscular connective-tissue ; *E*, insertion of H. Müller's muscle ; *F*, tarsus ; *G*, conjunctiva ; *J*, inner edge of the lid ; *K*, outer edge ; 4, pigment cells in the cutis ; 5, sweat glands ; 6, hair follicles with hairs ; 8 and 23, sections of nerves ; 9, arteries ; 10, veins ; 11, cilia ; 12, modified sweat glands ; 13, circular muscle of Riolan ; 14, opening of a Meibomian gland ; 15, section of an acinus of the same ; 16, posterior tarsal glands ; 18 and 19, tissue of the tarsus ; 20, pretarsal or sub-muscular connective-tissue ; 21 and 22, conjunctiva, with its epithelium ; 24, fat ; 25, loosely woven posterior end of the tarsus ; 26, section of a palpebral artery.

and by the atmospheric pressure, close the orbital opening. Their free margins form the palpebral fissure, and are united at the two

angles, called respectively the external and internal commissures; the internal commissure is sometimes called the great angle of the lids. This commissure is occupied by a small raphe, the *internal palpebral ligament.* The margin of the lid presents an anterior and posterior lip; between the two lips is situated the intramarginal space, which is from 2 to 3 millimetres broad. The anterior lip is rounded off, and is pierced by the eyelashes; on the posterior we have the openings of the Meibomian glands arranged in a row, and near the internal angle the openings of the lachrymal canals.

The lids are composed of different layers which are superimposed from the conjunctiva to the external integument.

(*a.*) The **skin** which covers the lids presents a delicacy of texture which is not found in almost any other part of the body. It is connected with the subjacent structures by a very loose cellular tissue, in which are found a great number of sudoriferous glands and the bulbs of the very fine hairs with which the skin of the lid is furnished.

(*b.*) The **orbicularis muscle** is arranged in concentric fasciculi round the palpebral fissure. Its palpebral portion covers the fibro-cartilages and the palpebral fascia to the orbital margins, and extends beyond the external commissure of the lids for more than a centimetre and a half. It is composed of muscular fibres, which arise from the crest of the lachrymal bone, and from the internal palpebral ligament and the neighbourhood of the lachrymal sac.

The fibres of the first portion, also called the *posterior lachrymal muscle* or muscle of *Horner*, at first cover the lachrymal sac, and are directed towards the great angle of the eye. At this point the muscle divides into two portions—one part entering the superior eyelid, the other the inferior, where they form expansions on the tarsal cartilages.

The second part, which forms the *anterior lachrymal muscle*, surrounds the fibro-cartilage, and extends to that portion of the lid where it is absent.

(*c.*) Beneath the muscle there is a *layer of cellular tissue*, which contains the *follicles of the cilia* and the small sebaceous glands which open into these follicles. The cilia, whose roots are situated near the margin of the tarsal cartilage, are renewed, like all other hairs, in about a hundred and fifty days.

(*d.*) The **tarsal** or **fibro-cartilages** form the solid groundwork of the lids. At their palpebral margin they are somewhat thick, but become thinner at their periphery, and are finally lost in the orbital fascia. At this point the levator muscle is inserted in the superior lid. This muscle arises at the bottom of the orbit, and its fibres run forwards beneath the orbital arch. The tendon thus turns downwards over an aponeurosis, which extends from the trochlea of the superior

oblique to the external extremity of the superior orbital margin. Thence it expands as a thin membrane beneath the orbital fascia, and is inserted, as we have said, at the thin margin of the fibro-cartilage of the superior lid. In each fibro-cartilage we find a series of sebaceous glands (the *Meibomian glands*), which are arranged vertically. Their excretory ducts are situated near the posterior lip of the thick margin of the cartilages, and supply a fatty secretion, which lubricates the free margin of the lids.

(*c.*) The **conjunctiva** is in close union with the posterior surface of the cartilages and of the tarso-orbital fascia.

The palpebral *arteries* are branches of the ophthalmic artery, and are situated near the free margin of the lid; they anastomose with the angular, lachrymal, and superficial temporal arteries, thus forming arterial circles, which surround the palpebral fissure. The *veins* unite in forming the superior and inferior palpebral veins, which join the veins of the temple and face.

The *nerves* of the lid come from the fifth pair; the elevator of the superior eyelid receives a branch from the third pair; the orbicularis muscle a branch of the facial nerve.

3. The **lachrymal apparatus** consists (*a*) of organs which are connected with the secretion of the lachrymal fluid—these organs are the lachrymal gland and the conjunctiva; (*b*) of the passages which convey the secretion into the nose—the passages are the lachrymal canals, the lachrymal sac, and the nasal duct.

(*a.*) The **lachrymal gland** is divided into two portions, one of which is much larger than the other. The larger of the two occupies a depression situated at the superior and external lateral part of the orbital vault, to which it is attached by an aponeurosis which comes from the tarso-orbital fascia. The smaller portion lies beneath this aponeurosis. The gland is composed of a collection of racemose glands, which in structure resemble the salivary and mammary glands. It communicates by a number of small ducts, six to a dozen, with the external extremity of the superior conjunctival cul-de-sac.

(*b.*) The **lachrymal canals** are from 8 to 10 millimetres long. They begin with two small openings, the **puncta lachrymalia,** situated on the prominent angles of the free margin of the lids, near to the caruncle. Starting at the lachrymal openings, the superior canal rises, while the inferior descends, perpendicularly into the thickness of the tissue of the lids. They then turn abruptly into the horizontal direction and run along the internal margin of the lids. They thus converge at the angle of the eye to open into the lachrymal sac, which they do nearly at the level of the palpebral ligament. Before entering they may unite, or they may enter separately.

(*c.*) The **lachrymal sac** is situated between the lachrymal bone and the nasal process of the superior maxilla, so that its inferior half is found beneath the level of the internal and inferior angle of the margin of the orbit. The superior extremity of the sac is formed by a sort of dome extending to about 4 millimetres above the palpebral ligament which is stretched horizontally in front of the sac. It is, therefore, everywhere surrounded by soft structures, except on the internal side, where it is in close proximity to the bone. This side descends perpendicularly towards the nasal canal, there being frequently no line of demarcation between the two, although sometimes they are separated by a fold of mucous membrane.

(*d.*) The **nasal duct** is enclosed in a bony canal in the partition which separates the maxillary sinus from the nasal fossæ. It does not run directly from above downwards, but somewhat obliquely from within outwards, and slightly from before backwards. Moreover there are considerable variations in the convexity of this curve depending on the individual conformation of the nose. At the inferior extremity of the bony canal, the nasal mucous canal is often continued between the external wall of the nasal cavity and the pituitary membrane which covers it. The inferior orifice of the canal is occasionally very small; it is sometimes round or oval; sometimes like a slit, the external lip of which, or, in its place, a prominent fold of the mucous membrane, forms a valve which opens towards the nose and closes the canal from below upwards.

The **mucous membrane** is covered with a simple layer of pavemented epithelium in the lachrymal canals; in the sac and nasal duct the epithelium is ciliated like that of the nose; the membrane also contains small racemose glands. The lachrymal sac being generally very narrow, the membrane of the internal and external walls is usually in close apposition. The membrane of the duct is intimately connected with the bone, and its walls do not come into contact, so that the duct is constantly filled with liquid.

The **innervation** of the lachrymal gland is derived from the lachrymal branch of the first division of the fifth pair. To its influence is due the copious secretion of tears which follows certain emotions or the irritation of the eye. In ordinary circumstances, the secretion of the gland is inconsiderable, the liquid which constantly lubricates the eyeball being in great part a product of the conjunctiva.

The mechanism by which the tears pass from the conjunctival sac into the lachrymal passages is not perfectly understood. Yet it seems to be beyond doubt that the contractions of the orbicular muscle and the consequent movements of the lids propel the liquid contained in the conjunctival sac into the puncta, when the palpebral fissure is closed by the shutting of the lids.

DISEASES OF THE LIDS.

ART. I.—Erythema of the Lids.

Diagnosis.—The skin of the lids is of a bright scarlet, which disappears on pressure; the lids are slightly swollen. The superficial veins seem more dilated, and are more easily seen than in the normal condition. The patients do not complain of pain, or at most of a slight sensation of heat.

Ætiology.—This disease, although somewhat rare, frequently accompanies affections of the general circulation.

Treatment.—The best results are obtained from the application of compresses steeped in a solution of lead acetate (1 to 100), or of nitrate of silver (1 to 300).

There is frequently observed in persons who have undergone a physical or mental strain a *greyish-blue coloration of the lid*, especially of the inferior lid and of the integument beneath it. This leaden tint, which is often only transitory, sometimes extends round the orbit, and is accompanied with slight œdema of the subcutaneous tissue.

Persons who are subject to these symptoms have frequently a delicate skin, and their general health is, as a rule, not robust. To relieve them of the symptoms in question, we must advise them to avoid any deviation from a strictly regular life, *e.g.*, excessive work, and we may prescribe, as a topical application, a solution of tannin (1 to 100), as also eau de Cologne lotions.

ART. II.—Erysipelas of the Lids.

Diagnosis.—The lids are very much swollen, and are of a rose-coloured and shining appearance. The epidermis is sometimes raised in patches under the form of vesicles filled with serum. The swelling of the eyelids, which is most frequently accompanied with swelling of the face, prevents the patient from opening them; the conjunctiva is injected and chemotic. All the parts affected are hot to the touch.

The disease is not painful, but it is often accompanied by disturbance of the digestion, shiverings, and fever.

Progress and Termination.—Erysipelas may end in resolution or in suppuration. In the latter case it sets up diffuse phlegmon, giving to the lid an œdematous and somewhat fluctuating sensation. The skin then takes on a deep red colour, and becomes the seat of a very painful distension. The abscess if left to itself may produce very extensive destruction of the cellular tissue. The inflammation may also extend to the cellular tissue of the orbit, placing the eye in extreme danger, and may even prove fatal to the patient, by extending to the membranes of the brain.

Ætiology.—Erysipelas of the lids, although sometimes due to a chill, is most frequently set up by some traumatic lesion, by a purulent focus in the neighbourhood of the lid, or by an affection of the lachrymal sac.

Treatment.—An emetic or a purgative is generally administered. The lids are covered with a layer of collodion and wadding. Every abscess should be freely opened, and hot and emollient cataplasms must then be ordered.

ART. III.—Phlegmon of the Lids, Abscess.

Diagnosis.—The eyelid is red and swollen, and its temperature is considerably increased; the conjunctiva is generally injected, and there is frequently considerable chemosis. On palpation, we find a hard point in the lid, which gradually increases in size, becomes soft, and then gives the sensation of fluctuation, whilst at the same time its summit becomes yellowish. The pain is, as a rule, very severe, preventing sleep, and, in delicate persons, is accompanied with headache and fever. At last the abscess opens, the pus escapes, and the swelling of the lid subsides.

When the abscess is situated near the internal angle (*anchilops*), it is not always easily distinguished from acute inflammation of the lachrymal sac.

Ætiology.—The most frequent causes of phlegmon are contusions or similar injuries. It may also accompany phlegmon of the orbital tissues. Sometimes it appears to be produced as a result of cold, and sometimes without any apparent cause.

Treatment.—In the early stages we may attempt to arrest the inflammation by the application of cold. As soon as the induration is recognised, it is better to use hot cataplasms, and the abscess should be opened as soon as possible by a large incision parallel with the free margin of the lid. The hot compresses should then be continued, and may be advantageously made with a half per cent. solution of boracic acid. A compress and bandage may also be applied to prevent excessive separation of the skin.

Furuncle and Anthrax of the lids present the same symptoms as phlegmon, and are distinguished from it by the gangrene of the subcutaneous tissue and of the skin. The skin is livid, and its epidermis is elevated in vesicles, the parts affected form a pultaceous mass, and this gangrenous destruction causes considerable loss of substance. Anthrax chiefly occurs in aged and worn-out persons. The *treatment* consists in freeing the affected parts by a cruciform incision, and in the application of hot poultices to promote the separation of the gangrenous material. Nourishing food and tonics are necessary to support the strength of the patient.

Malignant pustule is due to the contact of the lids with decomposing animal matter, the virus of farcy or of glanders. It occurs in curriers, tanners, butchers, &c. On the swollen and slightly inflamed lid a serous pustule is formed, which speedily bursts and becomes the seat of a gangrenous ulceration which tends to spread to the neighbouring structures. The pain is very acute, and the patient suffers from fever, nausea, and shiverings. Before long there supervenes a great prostration of the patient's strength, and he succumbs to the disease. In the cases which recover, the gangrene may be arrested, and the disease terminate in the destruction of the eyelid. Frequently the eye and part of the face are also involved.

Deep incisions, followed by the application of the actual cautery, have been recommended in conjunction with a general treatment suited to sustain the patient's strength.

The pustules of small-pox which appear on the eyelid, either isolated or arranged in rows, or along the ciliary margin, may cause a destruction of the skin, the Meibomian glands and the hair follicles in this region. Hence will follow the loss of the eyelashes (madarosis), accompanied with persistent redness of the lids, and, in the later stages, cicatricial contraction, leading to ectropion and displacement of the inferior lachrymal openings, impeding the passage of the tears into the lachrymal sac. Cold compresses (*Hebra*) or a weak solution of bichloride of mercury (1 in 1000) constantly applied, have been recommended as a means of keeping the small-pox eruption away from the lids. The imbrication of the lids with small bands of Vigo's

plaster is objectionable, for it occasions considerable local heat (*Skoda*). Puncture of the pustules, followed by the application of collodion and caustic, is of no avail (*Hebra*). We must, however, carefully attend to the position of the lids, especially of the lachrymal opening, in order to avoid lachrymation (see Diseases of the Lachrymal Apparatus).

ART. IV.—Eczema of the Lids. Herpes Zoster Frontalis. Syphilitic Affections of the Lids.

1. **Eczema** may extend to the lids in cases of general eczema of the face, or it may be set up by the contact of the morbid secretions of the conjunctiva, which irritate the fine skin of the inferior eyelid. If this affection lasts for some time, the skin becomes contracted, and there follows eversion of the palpebral margin. The lachrymal opening not occupying its normal position, the overflowing tears add to the irritation which already exists.

The **treatment** of eczema in the early stages consists in the application of powdered starch, which may be mixed with a small quantity of zinc oxide. When using this powder as a dust for the lids, we must warn the patient to be careful not to allow any crusts to form on the palpebral margin. Once daily a weak astringent solution (sulphate of copper or acetate of lead 1–300) is applied to the skin of the lids. The eversion of the lachrymal opening, if it persist, must be met by a small incision of the lachrymal canal.

2. **Herpes Zoster Frontalis or Ophthalmic Zona** generally begins with violent neuralgic pains in the course of the frontal and naso-ciliary nerves. After a few days, the skin becomes red and swollen, and we find an eruption of herpetic vesicles in groups, which unite, become covered with adherent crusts, and often give rise to deep cicatrices, traces of which remain during life. The affected region, although insensible to the touch, may be for a long time the seat of very intense neuralgia. The disease in question never extends beyond the median line of the face. It is often complicated with corneal ulceration (*Hutchinson, Bowman*) and with iritis (*Horner*).

The **treatment** of the ocular affection is the same as in corneitis and iritis. To check the violent neuralgia which persists after the zona is cured, we may employ the ointment of morphine, the constant current, or, finally, subcutaneous neurotomy as proposed by *Bowman*.

3. **Syphilitic ulcerations** of the lids are sometimes met with as a primary, and sometimes as a secondary, symptom. These ulcers have a tendency to increase in size, but more especially in depth; so that their situation on the margin of the lid threatens it with deformity or even more or less complete destruction. Syphilitic ulcerations may also affect the conjunctiva, but they rarely begin in this situation as a primary affection.

The **treatment** of these ulcers at first requires an active and prolonged use of antisyphilitic remedies; locally, applications of nitrate of silver, and a dressing made with fine calomel powder or ointment of iodoform, or with a weak solution of corrosive sublimate (1 – 6000). When the ulcers begin to cicatrise, we may advantageously employ an ointment of the red precipitate (1 to 160 of lard).

ART. V.—Seborrhœa of the Lids. Ephidrosis and Chromidrosis.

(*a.*) The term **seborrhœa** is applied to an increase in the sebaceous secretion which covers the skin of the lids, as also the naso-labial folds and the commissures of the lips, with an oily layer or with small yellow pellicles. This affection is apt to become the starting point of an inflammation of the margins of the lids. It is, therfore, a matter of importance carefully to remove all sebaceous masses with hot soap and water lotions, having previously softened the yellowish crusts with a little glycerine and oil.

After these attentions to cleanliness, we should order the use of cold water douches or lotions, to which a few drops of eau de Cologne have been added.

(*b.*) **Ephidrosis** consists in a hypersecretion of the sudorific glands. The lids are covered with a layer of perspiration, which, as soon as removed, again gathers on their surface. Hence there is excoriation of the angles and margins of the palpebral fissure, accompanied with catarrhal conjunctivitis. This disease is not of common occurrence, and is found most frequently in persons who are subject to perspirations. As to local remedies, we must treat the excoriations with a half per cent. solution of nitrate of silver, and check the general predisposition to perspiration by hydro-therapeutics and a strengthening regimen.

(*c.*) In **chromidrosis**, the lids are of a dark blue or brownish colour,

which is easily removed with oil or glycerine, but resists pure water. The pigment, when removed, sooner or later reappears. This curious affection almost always occurs in women, and the large majority of persons affected with it are hysterical. Often we are able to convince ourselves that we are dealing with an artificial coloration; still, in other cases, the reality of the disease is beyond doubt. The disease disappears of itself, and no treatment seems to be of any efficacy.

(*d.*) The presence of **lice** in the eyelashes and eyebrows has been observed to cause irritation and prurigo. They can sometimes be detected by the naked eye or by means of a magnifying lens, and are easily destroyed by the careful use of mercurial ointment.

ART. VI.—Œdema and Emphysema of the Lids—Palpebral Ecchymoses.

1. **Œdema** of the eyelids often accompanies affections of the conjunctiva, as also inflammations of the eyeball and of the orbital tissues. This disease is also found as a consequence of contusion of the lids, or affections of the health in general (diseases of the heart and kidneys, trichinosis), in persons of weak constitution. It is, however, sometimes seen when it cannot be attributed to any direct cause. Sometimes this œdema is localised to the inferior lid, which then forms a kind of pendant pouch, more prominent in the morning and diminishing in size during the day; sometimes both lids are so swollen that the palpebral fissure cannot be opened.

The œdema symptomatic of an ocular affection disappears with the disease to which it is due: idiopathic œdema often resists every treatment.

Having in our treatment complied with the indications furnished by the patient's general condition, we try to overcome the œdema with a compress and bandage, or hot camomile applied in small bags; we should also have recourse to the repeated application of tincture of iodine, or iodine ointment. If the œdema persist and cause annoyance to the patient, the swelling of the lids may be reduced by the excision of a horizontal fold, or of several vertical folds, of the skin of the eyelid.

2. **Emphysema** of the lids, that is to say, the penetration of air into the cellular tissue, is easily diagnosed by the crepitation which the swollen lid gives to palpation. The swelling is often considerable and extensive. The skin is not changed, or presents only a few

ecchymotic spots. This affection is generally of traumatic origin; it is often due to fracture of the bony walls of the nose or frontal sinuses. Fracture of the latter allows air to penetrate also into the cellular tissue of the orbit. Again, it may be caused by rupture of the lachrymal canals. Emphysema disappears spontaneously in the course of a few days, especially if the patient avoid every great effort of expiration, such as blowing the nose violently, &c. The swelling of the lid may be made to disappear at once, by making a few small openings with the point of a needle.

3. **Palpebral Ecchymosis** comes on after contusions of the eye, after operations performed on the conjunctiva and in the subconjunctival tissue, after lesions of the orbital walls, after intracranial fractures, and sometimes, although rarely, it occurs as one of the prodromata of cerebral apoplexy (*Desmarres*). These ecchymotic spots are easily absorbed, but are more quickly so when treated with tincture of arnica fomentations, and the regular application of a tightly-fitting compress and bandage.

ART. VII.—Inflammation of the Margin of the Lid—Marginal Blepharitis.

Inflammation of the palpebral margin is characterised in its early stages and more benign form by a redness of the margin, more especially at the palpebral angles, accompanied by a feeling of heat, burning or itching. These symptoms are increased when the eyes are exposed to dust or smoke, and when the patient engages in any minute work. The affection may retain this form, or it may become aggravated by the hypersecretion of the sebaceous glands, and the formation of small acne pustules.

The part of the skin which supports the cilia is then slightly swollen and covered with crusts, beneath which are excoriations; and at the side of these crusts we can still distinguish the small acne pustules filled with matter. The crusts are formed by the desiccation of these pustules. The acne spots are found between the cilia, or at their base. In these situations we find numerous fine, soft pellicles, which cover the cilia and unite them into smaller or larger bundles. In the morning, before rising, the margins of the lids are glued together, so that the patient cannot open his eyes. When the crusts are torn off without due precautions, or the patient clears his eyes hastily, the

margins of the lids bleed, the hairs fall out, and in a short time the lids are again covered with fresh crusts.

When the inflammation increases still further, the entire palpebral margin is swollen and becomes ulcerated, the hairs fall out, and are replaced by others which are both weaker and finer; these latter do not grow in the normal direction, and the processes end in the margin being altogether deprived of cilia (madarosis); or we may find only a few very long, pale, isolated cilia bent either inwards or outwards. In such conditions, the hair follicles are atrophied, the cellular tissue which surrounds them is hypertrophied, and the entire margin is thickened and indurated with the cicatricial tissue which is left by the ulceration (tylosis).

The thickening of the lid increases the distance between the palpebral margin and the eyeball; thus the puncta lachrymalia do not occupy their normal position, and therefore cease to perform their usual functions. The tears remain in contact with the conjunctiva, which moreover is apt to participate in the inflammation of the palpebral margin; the Meibomian glands are also obliterated, and, in extreme cases of blepharitis, the entire lid is seen to become gradually inverted.

Progress.—Blepharitis is essentially a chronic disease. It begins with symptoms which, although at first slight, before a longer or shorter time become more severe, according to the surroundings of the person affected. There are also periods of remission and exacerbation. Judicious treatment may arrest the progress of the disease and bring about a favourable termination, as long as the glands of Meibomius perform their functions and their orifices are not obliterated. If, however, this period be passed, we may still relieve the patient, and improve the condition of the lids; but a complete restitution of the normal condition is no longer to be expected.

Ætiology.—Blepharitis is especially apt to occur in lymphatic persons, in those whose skin is very irritable and delicate, and in persons who are not of cleanly habits. Again, this disease is often a consequence of chronic conjunctivitis, and especially of anomalies of the lachrymal passages. It has also been frequently found to coincide with anomalies of refraction.

Treatment.—The first condition in treating blepharitis is to observe the most scrupulous cleanliness. The lids must be frequently washed with hot water, and if this does not suffice to remove the fine pellicles and adherent crusts, we must cause to be applied, especially in the morning, compresses dipped in a hot solution of lead acetate (1 to 100). If there are neither excoriations nor crusts, but only persistent redness of the palpebral margin, a camel-hair pencil dipped

in cade oil should be applied daily or every second day. Benefit may also be derived by removing such hairs as are liable to fall out. This may best be done by making them lightly slide between the index finger and thumb, or by means of small cilia forceps. In order to prevent the formation of crusts on the margins of the lids during the night, the patient should, on going to bed, cover his lids with a thin layer of the following ointment :—

White precipitate, ...	3 parts.
Subacetate of lead, ...	10 parts.
Oil of sweet almonds, ...	50 parts.
Vaseline, ...	500 parts.

The white precipitate may be replaced by oxide of zinc or red precipitate.

When the margins of the lids are already excoriated or are the seat of small ulcers, fatty matters are, as a rule, not well supported by the patient. We must then employ a solution of silver nitrate (1 to 100); the acne pustules should be opened, and their bases, or the bottom of the ulcers which they leave, touched with a very finely pointed mitigated nitrate of silver pencil. As soon as a layer of epidermis is re-established, we may again attempt to use the ointments which have just been mentioned. In such conditions, the cade oil and the tincture of iodine are of great service.

If the crusts be numerous and the thickening of the lid considerable, we must order hot cataplasms to be applied for an hour morning and evening. The closed eyelids should also be covered during the night with a lint compress, on which a little of the following ointment has been spread :—

Acetate of lead ointment, . . .	200 parts.
Linseed oil, ...	200 parts.
Balsam of Peru, ...	1 part.

We should also direct our attention to the complications of blepharitis, and bestow such care on the patient as his general health may require. Any form of conjunctivitis which may be present must be treated according to the principles laid down in our chapter on this affection, and diseases of the lachrymal passages according to the directions which we shall give in another chapter. Any anomaly of refraction must be counteracted by the proper glass. Patients affected with blepharitis should be as much as possible in a pure and fresh atmosphere; they should wear blue spectacles, and avoid any excessive work, as also any excess in their general regimen. A scrofulous or lymphatic diathesis should be held in check by suitable remedies.

ART. VIII.—Hordeolum, Stye.

The stye, which is an inflammation of the cellular tissue of the lid, appears near the cilia as a hard button, very painful to the touch, and accompanied with inflammation and swelling of the part of the lid in which it is situated, or of the entire lid. Sometimes patients suffer considerably and may even be feverish. The stye is developed in the course of a few days, its summit becomes yellowish, opens, and gives issue to a little necrosed cellular tissue.

This disease is very subject to relapse, so that a patient may have one stye after another during several weeks or even months.

In the very early stages we may try to stop the inflammation by cold compresses; still, should the inflammation have been present for any time, it is much better to use hot poultices and emollients to promote suppuration, and hot lotions of boracic acid.

We may leave the bursting of the small tumour to nature, or make a small incision at its apex. If the suppuration is prolonged we may apply the mitigated nitrate of silver pencil to its cavity.

The tendency to relapse is combatted by the use of the white precipitate ointment we have just mentioned.

ART. IX.—Tumours of the Lids.

1. The **chalazion** is a small, firm and immobile tumour which developes in the tarsal cartilage, and arises from alteration in the Meibomian gland. In fact, its envelope is formed by the walls of the gland, and its contents are the product of its secretion. Sometimes the contents are changed into a liquid or purulent material; sometimes into a gelatinous, fatty, and sebaceous mass mixed with newly formed cellular tissue.

This small cyst, which may vary from the size of a large pin's head or a lentil, to that of a bean, or even of a nut, sometimes protrudes towards the conjunctiva, so that its contents may be seen through the membrane, sometimes towards the external skin of the lid. Frequently several of these tumours are found in the same lid, or in both lids of the same side, and occasionally in the lids of both eyes. The consistency of the tumour depends as a matter of course on the nature of its contents.

The chalazion is almost always of slow growth and may stop at

any stage of its development. Rarely does the gradual distension of the cyst lead to the spontaneous perforation of its internal wall. Should this perforation take place, it may be followed by perfect recovery, or the contents of the chalazion may re-accumulate; and should the opening in the chalazion remain patent, it will be surrounded with fleshy granulations, which sometimes increase to such an extent as to become a source of irritation to the eye.

The **treatment** of chalazion almost always involves surgical interference, the application of iodine preparations being, as a rule, of little use. The operation required is either excision or incision with evacuation of the contents of the tumour, for which purpose a small steel curette with sharp edges may be used. The latter operation is to be preferred when the contents of the chalazion can be removed without much trouble, and when its walls are very thin. The lid is everted, and the small tumour which projects on the mucous surface is incised in its entire extent. To remove the contents of the tumour completely, slight pressure must be made on the everted lid from behind the tumour; any matter remaining may be lifted out with the curette.

Excision is generally made through the conjunctival surface; rarely through a cutaneous incision, which, however, is preferable when the small tumour is situated immediately below the skin. The tissues which cover the tumour are there incised transversely, to an extent sufficient to allow of the easy extraction of the cyst; care being taken

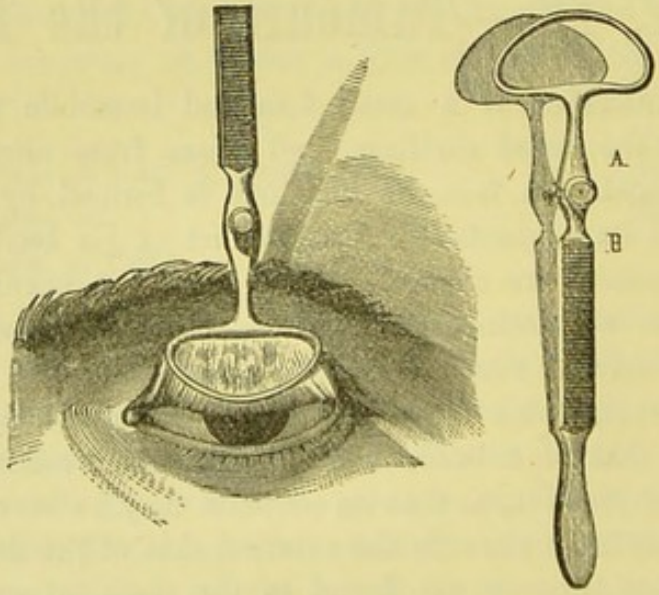


Fig. 205.—Desmarres' Forceps.

to expose the cyst in the wound. Then the adhesions of the tumour with the surrounding tissues are carefully broken down, and the excision effected; the mucous membrane or the skin, if the operation

be by a cutaneous incision, being left intact. In the latter case, we may unite the edges of the wound with a suture. No benefit is to be derived from the application of caustic to the sac. Desmarres' forceps, applied as in Fig. 205, will be found of use during this operation.

2. **Millium** or **millet** is a small pearly white tumour, about the size of a pin's head, situated on the skin in the neighbourhood of the cheek, where we frequently find a considerable number of such tumours together. If the patient wish the tumour removed, the epidermis which covers it is incised with a needle, or a small, finely pointed bistoury, and the small cyst is removed in its entirety. If the envelope has been previously opened, a small portion of it must be excised.

3. The **molluscum** is, like the millet, a cystic tumour, but is of much greater dimensions, for it sometimes attains the size of a pea, or may be even larger. Its apex is often more deeply pigmented, and we always see in it the dilated orifice of a hair follicle, which, by its distension and secondary alteration, has produced the molluscum. This orifice is occasionally hidden from sight by some brownish sebaceous matter, which seems to be sufficiently irritating to set up, when brought in contact with adjacent follicles, alterations in these follicles which end in the formation of similar tumours (molluscum contagiosum).

The molluscum may occur on any part of the skin of the lids, but is most frequently found near the periphery. It may become pediculated so as to form a kind of small horn, on the apex of which we can still see the orifice of the follicle. In children, we sometimes see a number of these small horns on the lids and in their neighbourhood. To remove them we may evacuate their contents with a pair of large forceps, at the same time taking away their envelope, which yields easily, or the entire tumour may be removed with scissors. If the molluscum is of somewhat greater dimensions, it is better to extract the entire tumour through a sufficiently large cutaneous incision.

4. Small transparent vesicles, known as **transparent cysts,** are met with on the margins of the lids. Their origin is not understood, but they may easily be removed by puncturing them with the point of a needle.

5. **Dacryops.**—This is an exceedingly rare tumour; it is situated near the external angle of the superior eyelid, and is due to the dilatation of one of the excretory ducts of the lachrymal gland. Thus, if its orifice be not occluded, on pressing the tumour a few drops of liquid escape. It rapidly disappears on incising the walls of the cyst, but immediate cicatrisation should be prevented by

opening the lips of the wound with a probe from time to time. With the same object in view, *von Graefe* operated as follows:—Having dilated the small opening of the cyst with a conical stylet, he introduced into it a curved needle furnished with a silk thread, and made a ligature which included about 4 millimetres of the cyst wall. After ten days, he removed the ligature, and cut, with a pair of scissors, the portion of the wall which had not been completely divided. Lastly, he kept the lips of the wound open, by means of a small sound, till he was assured by the cicatrisation of the margins that the cyst was finally destroyed.

6. **Erectile tumours** or **Nævi** sometimes appear as bright red warts, which, on palpation, give arterial pulsations; sometimes they occupy large patches of skin. They are almost always congenital, and occur most frequently at the periphery of the eyelid. They may remain stationary, or may gradually increase in size, invading the entire lid, and passing into the orbit, or extending to the forehead and cheek. Nævi may be dealt with in various ways.

When they are of small size, they sometimes disappear after the application of nitrate of silver, or nitric or hydrochloric acid. These acids may be conveniently applied to the tumour by means of a glass rod.

Good results have also been got by inoculating the small maternal nævi of young children with vaccine virus.

After the cases which have been published of a fatal termination following the injection of the perchloride of iron, this method is, we think, no longer admissible for the treatment of erectile tumours of the lids. Setons and ligatures are only suited to tumours of medium size. The ligature may be circular, in which case it strangles the tumour below two needles which have been previously inserted at its base. We may at first only include a portion of the tumour in the ligature, the entire structure being removed by several operations. Excellent results are often derived from electrolysis and the galvano-cautery, which may be applied either by means of a platinum thread or by needles inserted at various points in the tumour. The great advantages of electrolysis are the absence of pain, danger and cicatricial deformity.

When the erectile tumour is too large to admit of direct interference, compression or even ligature of the carotid artery on the diseased side may be attempted.

7. **Xanthelasma** is the name given to a slightly raised yellow patch which is found on the skin of the lids and in their neighbourhood. These patches vary much in size, and are often found in persons who are the subjects of some affection of the liver or who

suffer from migraine. To remove a xanthelasma we must excise it, and unite the edges of the wound with one or more points of suture.

8. **Fibromata** and **Sarcomata** are sometimes, although rarely, found on the lids. These tumours so resemble each other that they can only be distinguished by microscopical examination. The only differential sign is the rapidity of development and extension peculiar to sarcomatous growths (*Virchow*).

Sometimes these tumours extend towards the skin; at other times they form circumscribed and resistant tumours in the depth of the lids. Occasionally fibromata appear as cartilaginous, or even osseous, plates.

Fibromata should be made the object of treatment only when they become an intolerable annoyance to the patient. Sarcomata, on the other hand, demand immediate operation.

A few rare cases of **lipomata** of the eyelids have also been recorded. These are slightly mobile circumscribed tumours, which to palpation give a soft and elastic sensation, and present slight swellings on their surface. When the tumour, by its size, becomes a source of inconvenience to the patient, it is easily enucleated through a cutaneous incision.

9. **Lupus** may occur primarily on the lids, or it may extend to them from the cheek or conjunctiva. It is characterised by semi-transparent brownish nodosities, about the size of a pin's head, which surround the ulcerations. The part affected should be scraped clean with the sharp-edged steel curette; for if this be not done, the disease will cause extensive destruction of the lids, ending in entropion or ectropion or symblepharon and ankyloblepharon, and bringing about ulceration of the cornea and loss of the eyeball (see article on Lupus of the Conjunctiva). As to operations adapted to restore eyelids which have been destroyed by lupus, it is better to defer operating till the disease is cured, because transplanted flaps may also become affected by lupus.

10. **Epithelioma** as a rule begins on the ciliary margins of the lids, commonly on the internal half of the inferior lid. In this situation we first observe a small tubercle, resembling a small wart; it is almost transparent and is of a greyish colour. To the touch it appears nodulated and composed of several granulations: it increases rapidly in dimensions, and soon enters the period of ulceration. The ulcer is smooth, its base is indurated and its margins are irregular. It is covered with a sanious secretion, which becomes dry at the periphery and forms crusts. The ulcer increases in the surrounding tissue both in extent and depth. It may cease to extend for a certain time, after which it again begins to increase; or it may cease to extend in one direction but begin to grow in another.

This form of ulceration is distinguished from the syphilitic ulceration already mentioned by the slowness of its progress, by the condition of the adjacent integuments, but especially by the study of the patient's antecedents.

Epithelioma is rarely found before middle life: its progress is at first slow, but it becomes more rapid when the disease reaches the conjunctiva.

The **prognosis** of this disease is serious. In cases of operation, a return is more likely to occur if the diseased tissues have been imperfectly removed.

The **treatment** consists either in the extirpation of the diseased part by the knife, or in its destruction by caustics. When the tumour is of moderate extent and well defined, so that we may hope to remove it in its entirety, extirpation is indicated. We make our incisions in the healthy portions of the skin, and we should remove the tumour in such a way as to leave the parts suitable for the transplantation of a flap of skin (consult article on Blepharoplasty).

As a caustic, we often employ caustic potash, or a paste made of chloride of zinc and nitric acid.

Bergeron has used chloride of potassium, both locally and internally, with great success (see *Bulletin de Thérapeutic*, t. xlvi., p. 12). He applies to the tumour pledgets of lint impregnated with the following solution:—Distilled water, ℥ 4¼; chlorate of potash, ʒ 5. Internally he administers 30 grains of the chlorate per diem.

Dr. Broadbent has recommended acetic acid, which he uses, in the strength of 1 part of the acid to 4 of water, as an injection, or by painting on the tumour. Similar treatment has been tried with nitrate of silver, chloride of zinc, &c.

ART. X.—Blepharospasm.

Spasmodic contractions of the orbicular muscle of the eyelids assume very various forms.

Thus, we may have short contractions of a few fibres of the muscle, which cannot be attributed to any cause, and which as unaccountably disappear. In such cases the patients usually say that they feel something jerking in their eyelids, and they also notice that these jerking sensations supervene or increase as a consequence of emotion, or after anything which causes the eyes to be fatigued.

In other cases we find a constant winking of the lids, often more

disagreeable to those who see it than to the patients themselves. These winking movements are sometimes due primarily to an irritation of the conjunctiva, or to an excitation of the sensory nerve fibres supplying the integuments of the eye.

Such movements are also common after efforts of accommodation greater than the person is accustomed to, and thus they not infrequently affect children who have just begun their education. The accurate correction of any anomaly of refraction, and a good general regimen when the patient is weak or nervous, are sufficient to overcome this form of blepharospasm.

By the term blepharospasm, is generally meant the spasmodic occlusion of the palpebral fissure, whether it take place only intermittently or last for some length of time.

This form of blepharospasm may be due to various causes. Sometimes it is due to the presence of a foreign body in the conjunctival sac; at other times it is a concomitant of certain inflammations of the cornea and conjunctiva (scrofulous blepharospasm); again, it may be only a reflex symptom of a neurosis of the fifth pair.

In some cases it should be attributed to the presence of intestinal worms, whilst in others it is a hysterical manifestation. Whatever be its cause, the forced contractions of the lids often remain after the patient has recovered from the disease which has given rise to them.

Often the blepharospasm is at first only intermittent, but becomes continuous, and extends to the neighbouring muscles, and even to those at some distance. This chiefly occurs in cases of general neurosis. In these cases also it has been observed that in the region supplied by the fifth pair there is a point where, if the nerve be compressed against the bone, the blepharospasm is made to cease.

Prognosis.—Except in cases where the blepharospasm is the result of hysteria, injury, conjunctivitis, or a corneitis, recovery is uncertain, and the prolonged contraction of the lids may involve serious consequences to the eye; and, moreover, as the patient is not able to use his eyes, his spirits and general health are sure to suffer.

Treatment.—In treating this disease, it is of primary importance to ascertain its true cause. Formerly the examination of the conjunctival sac of the diseased eye necessitated the use of chloroform to overcome the muscular spasm. At present we often obtain the same result by instilling a few drops of cocaine. The duration of the effect of cocaine varies from a few minutes to many days (in hysterical subjects), and hence it is in many cases a useful adjunct in the discovery of the cause.

Should we find that the blepharospasm may be explained by the presence of a foreign body in the conjunctival sac, or by some disease of

the cornea, we must adapt our treatment to the removal of such a cause, if necessary enlarging the palpebral fissure by section of the external palpebral ligament. (Consult article on the Operation of Cantoplasty.)

If the blepharospasm remain even after the inflammatory concomitants have disappeared, or if it be determined by a neurosis of the fifth pair, we must ascertain whether compression on the course of one or other of the branches of that nerve does not modify the spasmodic contractions or cause them to cease altogether. The nerve which chiefly supplies the orbicularis with sensory fibres is the supraorbital, and we, therefore, should begin our attempts at compression with it; but experience has shown that we should not stop with it, but also try the effect of compression of the infraorbital, the temporal branch of the malar, and the inferior dental.

When we have thus determined the point at which compression seems to act favourably on the contractions, we generally try the effect of subcutaneous injections of morphia at that situation.

Nor should it be forgotten that the result often depends on the solution being injected exactly at that spot and in the centrifugal direction of the nerve. Several striking examples have convinced us that want of success is often the result of errors committed in these respects.

Sometimes morphia injections, if repeated often enough, succeed in curing the disease; in other cases, however, they only procure a transitory amelioration; and, again, in some cases they are only palliative; and then our treatment should be directed to the point at which the compression of the nerve and the injection of the narcotic have either modified the spasmodic contractions or caused them to cease. It is in such cases that we are authorised to have recourse to a neurotomy or neurectomy.

In choosing which nerve is to be divided, we must, as may naturally be supposed, take into account the results of our examination as to the effect of compression of the fifth pair in arresting the blepharospasm. Amongst these branches may be mentioned, beginning with the less common, the inferior dental, which is best divided in the mouth, the neurotome cutting the branch which comes from the inferior maxilla; the temporal branch of the malar division, which may be divided in the temporal fossa itself; the infraorbital and the supraorbital nerves, which have often been divided, with results varying with the exciting cause of the blepharospasm.

To perform this operation on the supraorbital branch with the required degree of exactness, the patient, especially if a child, should be put under chloroform. The surgeon, standing either in front of or behind the patient, puts his left hand on the eyebrow, and draws it

firmly upwards and outwards; he then inserts his tenotomy knife from without inwards under the skin and makes it glide along the orbital arch. When the knife is inserted to within 25 millimetres of the root of the nose, that is to say, about the union of the internal and middle thirds of the superior orbital margin, the edge is turned towards the bone, and an incision is made, extending down to the periosteum. If the cutaneous sensibility be examined immediately after the operation, we sometimes find only a very imperfect and restricted anæsthesia, even when the nerve has been completely divided; this anæsthesia, however, greatly increases in the course of the first two days succeeding the operation.

To prevent subcutaneous ecchymosis, it is well to put on a firm compress and bandage. As a rule, the patient may leave his room a few days after the operation. The cutaneous sensibility, which has been destroyed by the section of the supraorbital nerve, is not restored till after a lengthened period, but this partial anæsthesia does not annoy the patient to any considerable extent.

If we have not been able to find a point at which compression of the nerve causes the blepharospasm to cease, or if our neurotomy has not been followed with success, we must try the constant current, using a current of medium strength for a few minutes at a time, or else keeping on one or two elements for several hours during sleep. The negative pole is applied to the lids, and the positive over the fifth cervical vertebra. When there is a hysterical temperament we may also try the effect of metallo-therapeutics.

ART. XI.—Symblepharon and Ankyloblepharon. Blepharophimosis.

1. **Ankyloblepharon** is the union of the free margins of the lids, closing to a greater or less extent the palpebral fissure. It is sometimes found as a congenital deformity, sometimes as a consequence of traumatic lesions, especially burns, or again, it may be the result of an ulceration of the mucous membrane and of the ciliary margin.

Treatment.—The operation consists in dividing the adhesion with a bistoury, or, better, with one stroke of a pair of scissors. It is prudent to pass a grooved sound behind the part where the margins are adherent.

When the adhesions have been divided, the surgeon has to prevent

a re-union of the palpebral margins. For this purpose, many plans have been adopted with the view of overcoming the difficulty which is experienced in preventing the reproduction of these adhesions. Thus, attempts have been made to keep the lids separate by fixing them, either with strips of adhesive plaster, or by a thread passed through the skin of each lid and attached to the forehead or cheek. It has also been proposed to place foreign bodies between the palpebral margins, to cover the lips of the wound at short intervals with a layer of collodion, or, again, to cauterise one of the lids only with nitrate of silver. The very best remedy and the only reliable one, is to stitch the palpebral conjunctiva, previously dissected off and drawn out, to the skin of the inferior lid (*Ammon*). After twenty-four or forty-eight hours, the sutures are no longer required, and may therefore be withdrawn.

This re-union of the mucous membrane and the lips of the cutaneous wound is absolutely indispensable if we have to deal with cicatricial bands situated near the angles of the eye; for without it the angles of the wound always become united, and thus the palpebral fissure is made narrower. It is therefore necessary, after having incised the cicatricial band, or excised it, if it be of large dimensions, to perform the second part of the operation for blepharophimosis, or to make a true cantoplasty (consult description of these operations further on).

Ankyloblepharon is often complicated with adhesions of the lid to the globe, and it then becomes a matter of importance to ascertain the extent of the adhesion before undertaking any operation, which would be a fruitless task were the palpebral conjunctiva adherent to the entire surface of the cornea. Of the extent of the adhesion, we judge by the mobility of the eye behind the lids, and for this purpose we cause the patient to move the ball as far as possible, and make him attempt to open and shut the eye. We may also pass a probe into an opening at the internal and external angle, and find whether or not the instrument can be moved freely from above downwards in the oculo-palpebral space.

2. **Symblepharon** is the adhesion of the palpebral conjunctiva to that of eyeball, and may be either partial or entire. In the first case, we have to deal with a larger or smaller band uniting the palpebral conjunctiva to the ball, but leaving the cul-de-sac free; in the other form, the cul-de-sac also participates in the abnormal condition.

When the symblepharon forms a thick layer, it is called *sarcomatous* symblepharon; but if the conjunctiva is atrophied or destroyed, it is said to be a *membranous* or *fibrous* symblepharon. This condition supervenes after burns or ulcerations of the ocular and palpebral conjunctiva; it also accompanies xerophthalmia.

The **prognosis** of symblepharon is the more serious the greater its extent, the more the conjunctival cul-de-sac participates in the condition, and the greater the extent of surface transformed into cicatricial tissue.

Treatment.—Symblepharon becomes the object of treatment when its extent and position prevent the movements of the eye or of the lids, or when it covers a portion of the cornea so as to interfere with vision. The method of operation in symblepharon and the success of the operation depend, to a great degree, on the position and size of the band which connects the eyeball with the lid. Thus, when a simple band is stretched from the lid to the ocular conjunctiva, it can easily be separated by means of a ligature tied tightly round the cicatricial tissue. In the same way when the bridge is larger, we may succeed by using two ligatures, each of which encloses one half of the tissue which extends from the lid to the eyeball. As soon as the separation is complete, that part of the band which adheres to the cornea is removed, and the edges of the wound are united with a few points of suture. It is only when the wound is perfectly cicatrised that the portion adhering to the palpebral conjunctiva is taken away.

A similar method is employed in complete symblepharon. The base of the symblepharon is pierced with a triangular needle, parallel with the palpebral fold, and inserted as deeply as possible. Then a leaden thread is inserted in the wound made by the needle, and its two ends are moulded so as to fit the angles from which they emerge. Some surgeons unite the ends of the thread, and, from time to time, tighten the knot (Fig. 206). The thread is left *in situ* till the wound is cicatrised, when the adhesion is cut in the same way as for incomplete symblepharon.

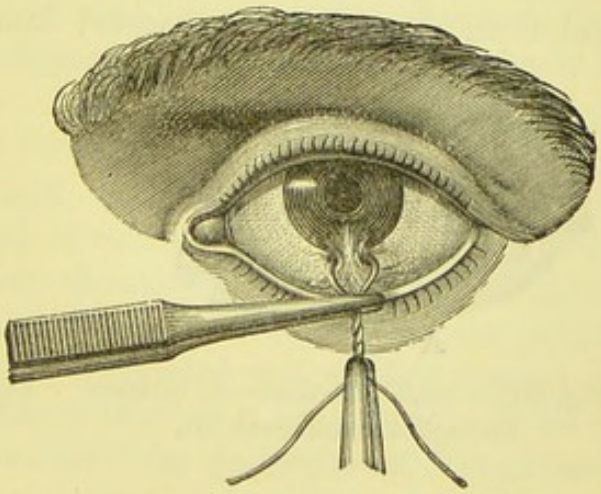


Fig. 206.—Operation for symblepharon by the introduction of a leaden thread.

A more rapid, but perhaps less certain, method of operating on a complete symblepharon is the following, recommended by *Arlt*:—Whilst an assistant separates the lid from the eyeball, so as to make the intermediate tissue tense, the surgeon passes a strong silken thread beneath the portion of the symblepharon which is next to the cornea; then, drawing on the thread, he cuts the tissue as near to the cornea as possible, and frees it with a bistoury or pair of

scissors from the eyeball right down to the bottom of the conjunctival sac. This being accomplished, and any bleeding thoroughly arrested, a needle is put on each end of the thread, and both ends are passed through the lid, from within outwards, near to the orbital margin. The two extremities of the thread are then drawn tight, so that the detached adhesion is brought in contact with the internal surface of the lid, and thus the membraneous surface of the flap is next to the conjunctival wound. The edges of the conjunctival wound are brought together by a few points of suture (Fig 207), and as soon as it is cicatrised, the flap left on the lid may be excised.

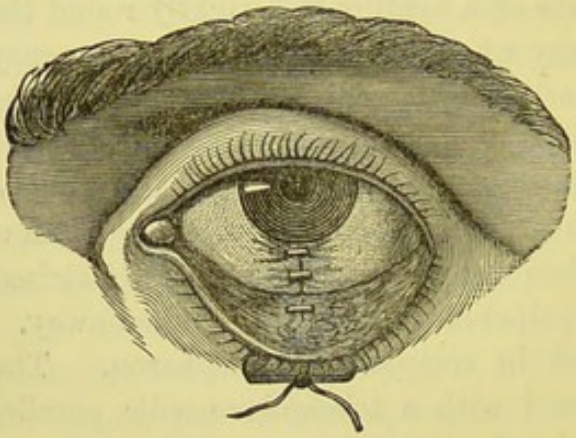


Fig. 207.—Arlt's Method.

Another very ingenious operation for symblepharon consists in transplantation. The following is a description of the operation as performed by its inventor, *Teale:*—Having made an incision through the adherent lid, in a line corresponding with the margin of the cornea (A, Fig. 208), the lid is dissected from the eyeball till the latter is as free as possible. Thus the apex of the symblepharon, formed by the palpebral skin, remains attached to the cornea.

This being accomplished, two flaps, in size and form resembling B and C in Fig. 209, are dissected from the ocular conjunctiva. In

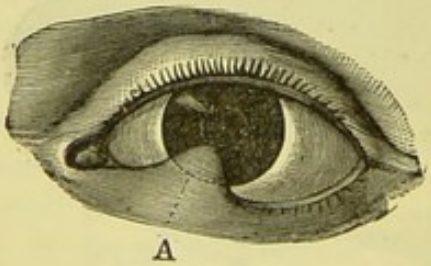


Fig. 208.—Teale's method—A, incision through the adherent lid.

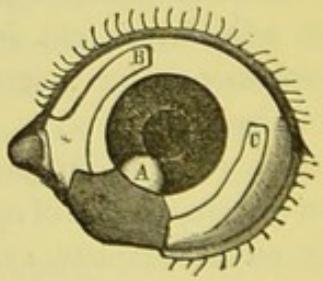


Fig. 209.—Teale's method—Dissection of the flaps B and C from the conjunctiva.

making these flaps we must take care to cut them in the conjunctiva only, leaving the subconjunctival tissue untouched; we must also see to it that they are sufficiently detached to be stretched over the place formerly occupied by the symblepharon, without difficulty and without tension.

The two flaps thus prepared are placed in their new situation in the

following manner (Fig. 210):—The internal flap, B, is stretched over the bare surface of the lid, and its apex is united to the healthy conjunctiva near the external angle of the wound. The external flap C should be placed over the denuded eyeball, and its apex should be attached to the conjunctiva near the base of the internal flap. If, when both flaps are in position, they seem to be under too great a strain, the defect may be remedied by several small incisions in the conjunctiva near their base.

In the last place, the conjunctiva is stitched together over the parts from which the flaps have been taken (D, E, Fig. 210), and the margin of the transplanted conjunctiva may also with advantage be sutured to each other, so as to prevent their rolling upon themselves. The portion of the symblepharon (A) which has been left on the cornea becomes atrophied and finally disappears.

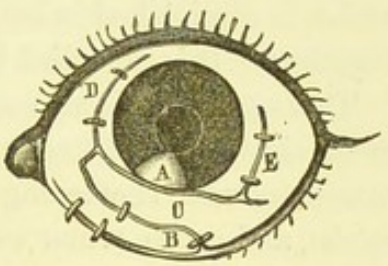


Fig. 210.

In other cases, *Teale** proposes to take the conjunctival flap from *above* the cornea; he makes the flap slide over the cornea downwards, like a bridge, to the position in which he wishes to attach it. It is advantageous to insert the threads before dissecting the flap.

Wolfe† has attempted to cure symblepharon by transplanting a piece of conjunctiva taken from a rabbit. *Illing*‡ has, for the same purpose, taken the buccal or vaginal mucous membrane.

Knapp § cuts for the same purpose two large flaps in the conjunctiva near the internal and external margin of the cornea, without detaching their superior bases, draws them firmly downwards and sutures them, so as to fill up the loss of substance produced by the oblation of the symblepharon.

Taylor‖ has proposed the following operation:—Having dissected the symblepharon, a horizontal flap is cut from the skin of the adherent lid, allowing the flap to remain attached to the surrounding tissue on the nasal side. Near the nasal extremity a vertical opening is made through the orbicularis, the tarsal cartilage, and the conjunctiva; the cutaneous flap is then introduced through this opening into the conjunctival opening, and fixed there by a few sutures, with its raw surface towards the palpebral wound of the symblepharon. The cutaneous flap which is placed in the conjunctival sac gradually becomes somewhat like the mucous membrane. *Nicati* has made a similar proposal.

* *Rapport du Congrès Opthalm.*, p. 143. London, 1873.
† *Annales d'Oculistique*, p. 121, 1873.
‡ *Allgem. Wiener Med. Zeitung*, 1874, No. 32.
§ *Arch. f. Ophth.*, xiv. 1, p. 270.
‖ *Med. Times and Gaz.*, 1876, vol. 52, p..183, and July 1, p. 4.

When a large symblepharon involves a considerable portion of the conjunctiva, and almost entirely covers the cornea, it would be wrong, no matter what method we adopt, to hope for complete and ultimate success. Neither must we indulge too soon in vain expectations, for the result is often less satisfactory some time after the operation. Consequently symblepharon should be considered as one of the lesions most difficult to remedy.

3. **Blepharophimosis** is a contraction of the palpebral fissure, which is diminished in length, the angles of the eye being brought closer together. It is remedied by an operation generally known as *cantoplasty*.

This operation is also available in certain cases of ankyloblepharon, or of cicatricial contraction of the palpebral fissure, in a few cases of ectropion with shortening of the free margin of the lid, in blepharospasm, and again, when we wish to diminish the pressure of the lids on the eyeball, as in granular conjunctivitis.

The operation is performed as follows:—The external commissure is divided in its entire thickness in a line with the direction of the palpebral fissure. This section may be made with a bistoury, the point being gently inserted between the eyeball and the external commissure.

The entire thickness of the integuments is then transfixed with the point of the knife from within outwards, and the whole commissure is easily divided by pushing the bistoury onwards.

The operation is still more easily performed with straight scissors, one blade being introduced behind the commissure; the wound in the skin should always be a few millimetres longer than that in the conjunctiva.

The section of the commissure being thus completed, an assistant draws the margins of the wound upwards and downwards, so as to change a horizontal into a vertical section. The surgeon takes hold of the conjunctiva near the centre of the section, and passes through it a very fine needle furnished with a silken thread; he then lets go the conjunctiva, and takes hold of the external skin also at the centre of the section; the needle is carried through the skin, and on tying the suture, the corresponding margins of the skin and mucous membrane are brought together. In like manner two sutures are also inserted near the angles of the wound (Fig. 211).

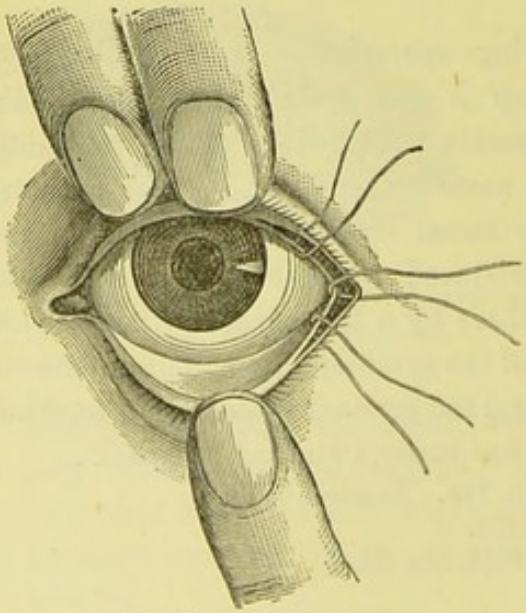


Fig. 211.—Cantoplasty.

When the operation is only intended to relieve the pressure of the lids on the eyeball, the last two sutures are not required. In such cases it is also beneficial after dividing the external commissure to divide the tarso-orbital fascia.

Cusco performs cantoplasty in the following manner:—He cuts out, by two incisions which diverge from the external palpebral commissure, a small cutaneous triangular flap, the base of which is turned outwards and the apex inwards. The two incisions should be from $1\frac{1}{2}$ to 2 centimetres long. The flap is dissected up to its base, and the external conjunctival cul-de-sac is divided with a probe-pointed bistoury from within outwards. Lastly, the apex of the flap is fixed by a single point of suture to the bottom of the wound, taking along with it the conjunctival cul-de-sac.

ART. XII.—Abnormally Wide Palpebral Fissure. Tarsoraphia.

The palpebral fissure may be enlarged, if either of the angles be torn, by paralysis of the orbicular muscle (lagophthalmos), by exophthalmos in Basedow's disease, or by anything which causes real or apparent protrusion of the eyeball.

When there is paralysis of the orbicular muscle (as in facial paralysis) our treatment must primarily be directed to the cause. If we are dealing with a rheumatic paralysis, we should order diaphoretics, either in the form of a vapour bath, or of pilocarpine injections repeated twice or thrice every week. In addition, we may administer iodide of potassium, which will also be found a useful remedy, in conjunction with mercurial inunctions, when we suspect a syphilitic taint. Locally, we may order veratria ointment, strychnia injections in the temple, and the application of the faradic current.

If the paralysis is already of long standing, and if medication has failed, we must by an operation diminish the palpebral opening so as to protect the cornea.

The palpebral fissure may be reduced to its normal size by the operation known as *tarsoraphia*.

This operation, proposed in the first place by *Walther* and modified by *von Graefe*,* should be performed in the following manner (Fig. 212):—

* *Arch. f. Opht.*, 1857, iii., 1, p. 249; and 1858, iv., 2, p. 201.

Having made the patient close his eyes, the external commissure is taken between the blades of a pair of forceps, or, better still, between the index finger and thumb of the left hand, so as to straighten the palpebral fissure to the required amount, and, for greater security, this point is marked in ink on both lids.

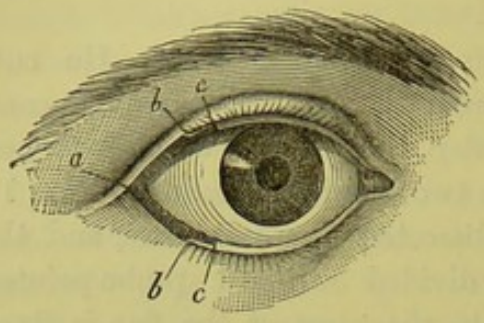


Fig. 212.—Tarsoraphia.

Having introduced an ivory shield between the lids, a flap, 1 millimetre broad and from 3 to 6 millimetres long according to circumstances, is removed from the free margin of each lid near the external commissure. The two wounds should meet behind the commissure at the point, *a*, and should terminate in front perpendicularly to the free margin of the lid at the point, *b*. The flap must include all the hair bulbs.

To ensure a closer union, the ciliary margin, for an extent of 2 or 3 millimetres, is denuded, care being taken to avoid the cilia. The edges of the wound are then brought together by one or two sutures; and a compress and bandage are applied. The sutures may be taken out on the second or third day, but the lids should be kept shut till cicatrisation is complete. The effect produced may in the first instance be too great, but it will soon decrease to the required dimensions.

To avoid any unsightly dragging on the new commissure when the eye is directed upwards, *von Graefe* has proposed to prolong the superior incision for about 3 or 6 millimetres towards the temple, inclining it slightly downwards; he then excises a triangular cutaneous flap from the superior lid, the base of this flap being formed by the prolongation of the superior incision.

When a protrusion of the eyeball has enlarged the palpebral fissure, and in certain cases of ectropion, it may become necessary to protect the cornea by bringing the margins of the lids together in their entire extent or nearly so (blepharoraphy of *Mirault*). With this object in view, we denude the whole of the superior and inferior intra-marginal spaces, carefully avoiding the cilia and the lachrymal points; and we then unite the lids by six or eight sutures, which should embrace the entire thickness of the lid, in order to prevent their separating too soon.

The ingenious operations devised by *Adolph Weber* for relaxation of the palpebral border will be described in our chapter on diseases of the lachrymal passages.

ART. XIII.—Distichiasis and Trichiasis.

These affections are characterised by an irregularity in the insertion and direction of the cilia. In trichiasis, the cilia are inverted towards the eyeball, whilst the free margin of the lid preserves its normal situation. In distichiasis there are two rows of cilia, the external in the usual position, the other nearer the eyeball. Sometimes these anomalies are restricted to a portion of one lid, but the entire lid may be affected. In other cases both lids are found to suffer, and in some cases all the four lids. The deviating cilia are sometimes few in number, and they are so pale and so minute that they readily escape detection.

Such anomalies keep up a constant irritation of the ocular conjunctiva, and may be the source of severe corneitis, and of complete loss of vision.

The most frequent cause of these affections is to be found in a deformity of the tarsal cartilage, which, by cicatricial contraction after granular ophthalmia, becomes more concave, and thus its free margin is drawn inwards towards the eyeball.

The object of our treatment should be—(1) Either to tear out the deviating hairs; or (2) to take away the portion of the margin of the lid in which the hairs or their roots are inserted; or (3) to displace the palpebral margin, so as to give to the hairs a better and more natural direction.

1. In tearing out cilia, we use a special kind of forceps (without teeth and with very broad extremities), with which, after the lid has been slightly everted with the left hand, each cilium is taken at its root and drawn out by gentle and steady traction. When we require to operate on both lids, it is better to begin with the superior. In our own practice, we always apply nitrate of silver after this epilation, as it seems to retard the growth of the cilia.

An attempt has been made to replace epilation by anointing the margin of the lid with the hydrated sulphide of calcium (*d'Argentan, Duval*),* the eyeball being previously protected from contact with the remedy by an ivory shield. The lids must be thoroughly cleansed a few minutes after the application of the remedy. *Dr. Williams* † has proposed to destroy the hair follicles by introducing a needle dipped in liquor potassæ at the point where the cilia are inserted. The same object may be accomplished by galvano-cautery.

* *Annales d'Oculistique*, vol. xxi., p. 155.

† *Royal London Ophthalmic Hospital Reports*, vol. iii., p. 219.

2. Operations for the removal of the portion of the lid in which the hairs are implanted consist in its ablation, which is so accomplished as to preserve the entire length of the lid.

In *Flarer's** method the margin of the lid is split into two portions by an incision in the intra-marginal space (Fig. 213); the anterior division should contain all the hair bulbs. A second incision, extending from the external surface of the lid to the tarsal cartilage, serves to

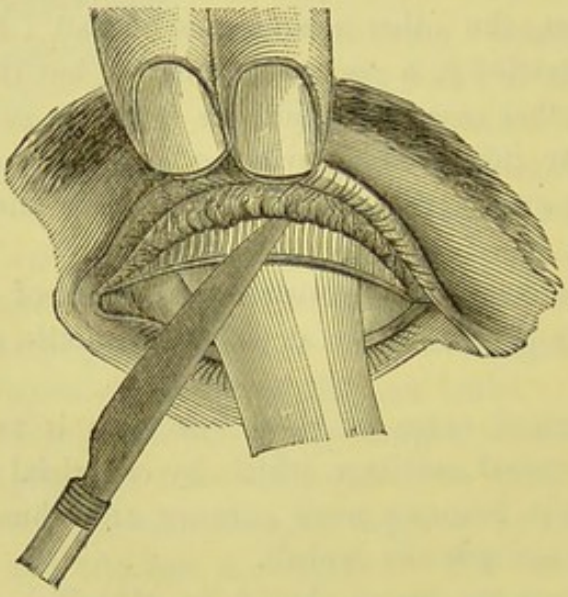


Fig. 213.—Flarer's operation.

circumscribe the external portion of the palpebral margin with the cilia and their follicles. When there are no deviating hairs at the external commissure, this incision should be made as indicated by the dotted line, *a*, in Fig. 214.

When, on the other hand, the misplaced cilia extend to the external commissure, it should be first of all divided by a horizontal incision,

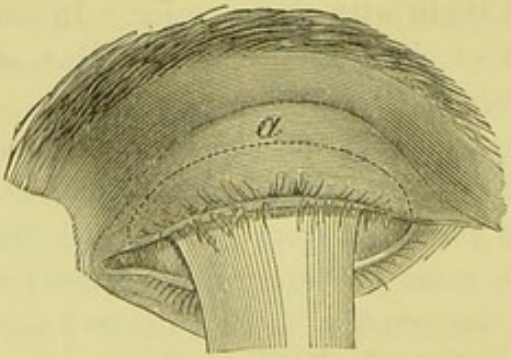


Fig. 214.

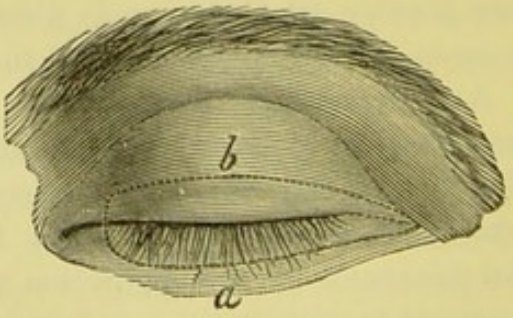


Fig. 215.

and the longitudinal band should be cut as indicated by the dotted line, *b*, Fig. 215, for the upper lid, and by the line, *a*, for the lower lid.

* *Zanerini: Dissert. Supra Trichiasis.* Paris, 1829.

The longitudinal band, which is thus marked off by the two incisions, is raised with a pair of toothed forceps and completely dissected off, the adhesions which keep it in position being divided with a bistoury or pair of scissors.

This method, although possessing the advantage of removing the deviating hairs without the shortening of the lid which takes place when the entire palpebral margin is cut off, has still its inconveniences. In the first place, it deprives the eye for ever of the natural protection afforded by the cilia; and, moreover, it may give rise to a cicatricial eversion of the lid. For these reasons, it should only be employed when the method of displacement, about to be described, cannot be used.

3. To modify the faulty direction of the cilia, various methods have been recommended, with the common object of changing the position of the palpebral margin into which the hairs are inserted, either by eversion or by transplantation.

Even in slight cases, *eversion*, in our opinion, can only be obtained after an intra-marginal incision, 3 or 4 millimetres in depth, dividing the palpebral margin into two portions. Only the outer lip of the wound into which the cilia are inserted is to be everted by the following means:—According to the effect required, we use either cauterisation of the skin beneath the cilia with the galvano-cautery, or excision of parts of the skin near the cilia and suturing the wound, or the insertion of ligatures, according to *Gaillard's** method, or according to his method modified by *Rau.*† If we deem it expedient to use several ligatures, we proceed as indicated in Fig. 216. The ligatures should be made of strong, well-waxed silk thread, and they should be inserted along the surface of the tarsal cartilage, and, according to the effect desired, should include a larger or smaller portion of the orbicularis and skin.

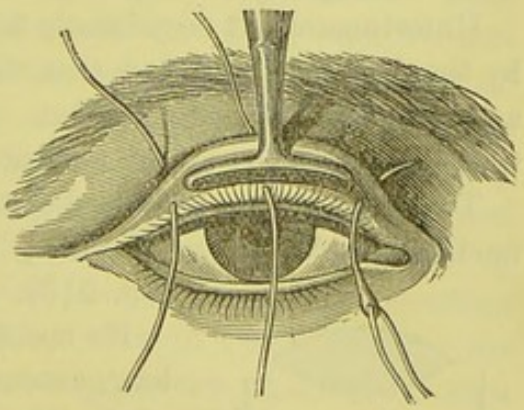


Fig. 216.—Cutaneous ligatures.

Tamamcheff performs the division of the ciliary margin as in *Flarer's* operation, and cauterises the whole wound with a finely-pointed pencil of nitrate of silver. This very simple proceeding has an excellent immediate effect upon the direction of the cilia, but this effect does not seem to be always permanent.

Direct *transplantation* of the external lip of the lid is effected by the

* *Bullet. de la Soc. de Poitiers*, 1844.

† *Archiv für Ophthalmol.*, 1855.

operation devised by *Jaesche* * and modified by *Arlt.*† It is performed in the following manner:—

We begin by dividing the lid into two portions, according to *Flarer's* method (see p. 556, Fig. 213), and then we excise a cutaneous flap by means of two incisions on the external surface of the lid (Fig. 217, dotted lines); both of these incisions should extend down to the tarsal cartilage. This flap, the vertical diameter of which should be in proportion to the amount of inward deviation of the cilia and to

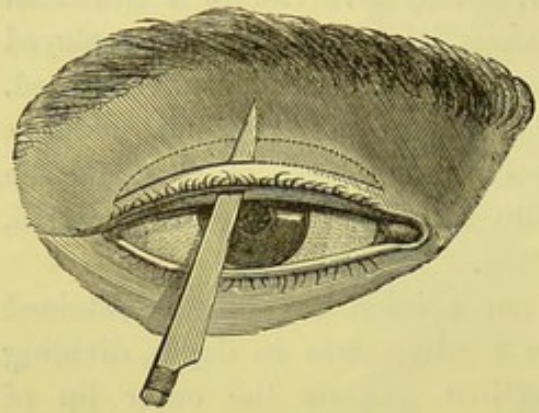


Fig. 217.—Excision of a cutaneous flap.

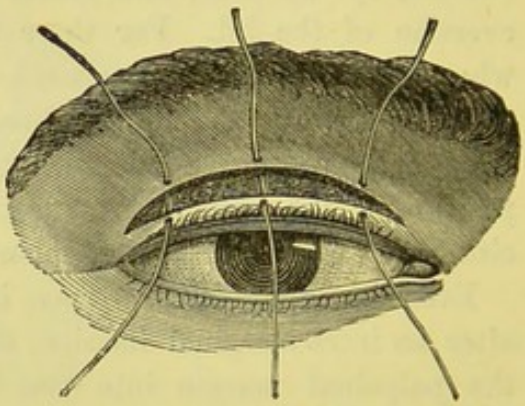


Fig. 218.—Displacement of the cilia by sutures.

the looseness of the external skin, is dissected up so as to spare the orbicular muscle as much as possible. The lips of the wound are then brought together by sutures which unite the superior margin of the strip containing the cilia to the superior lip of the cutaneous section, thus drawing the band upwards over the fibro-cartilage (Fig. 218).

Unfortunately, it occasionally happens that union does not take place by the first intention, and that the strip of skin becomes gangrenous and is destroyed by suppuration. It is also found that this transplantation has little effect on the cilia situated near the angles of the lids.

To obviate these drawbacks, *von Graefe* ‡ has introduced important modifications in this operation, which he performs as follows (see Fig. 219):—

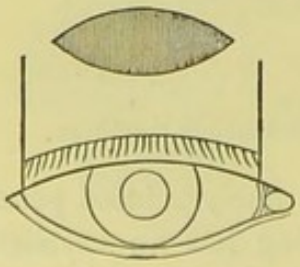


Fig. 219.—Operation for trichiasis—von Graefe's method.

He makes two vertical incisions, 9 millimetres long, extending upwards from the free margin of the lid, through the skin and orbicular muscle, and thus marks off laterally the part which is to be transplanted. He next proceeds to make the intra-marginal section, dividing the lid into two sections, according to *Flarer's* method (Fig. 213).

Having done this, it becomes easy to evert the cilia and to attach the cutaneous layer, so

* *Medic. Zeitung Russlands*, 1844, No. 9. † *Prager Medic. Vierteljahrschrift.*
‡ *Archiv für Ophthalmologie*, 1864.

that the ciliary margin be drawn up about four lines. To increase the effect, and to make sure of the direction of the cilia, an oval piece of skin may be excised, the extremities of which do not require to extend to the vertical sections (see Fig. 219); or we may content ourselves with including a similar fold of skin between two or three ligatures without previous excision.

In *von Graefe's*, as in *Arlt's* operation, we may recover the denuded intra-marginal portion with the cutaneous flap taken from the skin of the lid.

A combination of the special advantages found in the methods which we have just described gives the following method:—The operation is begun by a cantoplasty (see p. 552, Fig. 211), then the palpebral margin is divided into two by an incision in the intra-marginal space (see p. 556, Fig. 213), and ligatures are inserted as suggested by *Gaillard*, so that they include a bridge of skin and muscular tissue about 8 or 10 millimetres broad (*Bauchon, de Wecker* *). Still, ligaturing the skin should be avoided on account of the unsightly cicatrices which it leaves, and may be replaced by the use of subcutaneous ligatures inserted as follows:—

Having applied a blepharostat which holds the lid firm and prevents any hæmorrhage, which is often such a source of annoyance to the surgeon (*Snellen, Knapp, Warlomont*), a cutaneous incision is made throughout the entire length of the lid, at 2 or 3 millimetres from and parallel to the ciliary margin. The skin is dissected up to the height of the tarsal cartilage or even beyond it (*Anagnostakis*). Four or five ligatures are then inserted through the ciliary margin, and carried on beneath the orbicularis, the thread running as close as possible to the anterior surface of the cartilage, until the needle comes out at its superior margin, or even a little higher, without touching the palpebral skin (*Lebrun*). The threads are then tied tightly, and the cutaneous flap is allowed to fall forwards. A portion of this flap may be excised if it be too long. If necessary, we may combine this method with cantoplasty, and, if we wish to obtain a very great displacement of the ciliary margin, we may perform at the same time the intra-marginal incision dividing the lid in two (*Warlomont* †).

Panas makes a horizontal incision through the skin and muscle as in the operation just described; he then dissects the marginal flap from above downwards, laying the tarsal cartilage bare, and inserts the ligatures, passing the needles from above through the suspensory ligament of the lid, and through the marginal flap behind the row of cilia.

* *Annales d'Oculistique*, 1879, p. 186.
† *Annales d'Oculistique*, 1878.

The operation of *Hotz* is analogous to that just described, except that he begins by the intra-marginal incision.

The method first proposed by *Watson** and modified by *Junge* consists in a double transplantation, in which the ciliary margin with the hairs is displaced, and a cutaneous flap brought into the situation which it formerly occupied. This operation (on the superior lid) is performed in the following way (Fig 220):—The margin of the eyelid has at first to be divided by an intra-marginal incision, as in *Jaesche-Arlt's* method; then we make a horizontal incision, parallel to the margin, at a distance of 3 to 4 millimetres, extending from one angle to the other (*a b*). From the two extremities of this incision, two small incisions are then made (from *a* to *c* and from *b* to *d*) traversing the entire thickness of the margin. We have thus described a quadrilateral, which in retracting removes the lines *a c* to *a′ c′* and *b d* to *b′ d′* (see Fig. 220).

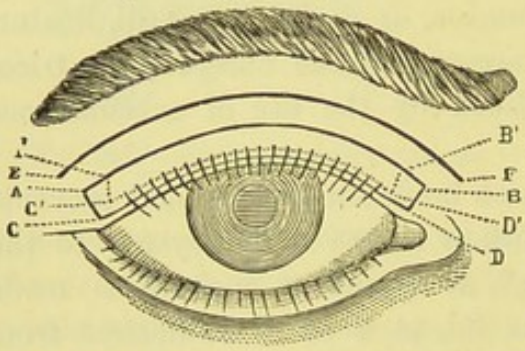


Fig. 220.—Watson-Junge's operation for Trichiasis.

Now we make, through the skin at 3 to 4 millimetres above the line, *a b*, another horizontal incision parallel to the last, thus obtaining a bridge, *a, e, f, b*, which we detach entirely from the subjacent tissue, leaving it only attached at its two extremities. This bridge is then drawn downwards and replaced by the quadrilateral containing the cilia. The edge, *a b*, is united to it by four catgut sutures, and the bridge, *a, b, e, f*, fixed in the intra-marginal incision also by means of sutures. Before performing this double transplantation, hæmorrhage must be completely arrested.

The operations of *Gayet* and *Dianoux* are based on the same principles. After the intra-marginal section, a horizontal incision extending down to the tarsus is made from one angle to the other at a distance of 4 millimetres from the ciliary margin. A third incision 3 millimetres above and parallel to the last, but 2 millimetres longer at each extremity, is then made, and the bridge thus formed, detached from its base and drawn under the ciliary border by means of forceps, is then fixed by means of 3 sutures in the intra-marginal space. The ciliary flap is drawn upwards and held in place by 3 sutures passed through the tarsus. Antiseptic dressing is applied. Similar operations have been proposed by *Nicati*, † *Schoeler*, ‡ and *Burchard*. § The

* *Opht. Hosp. Reports*, 1873, and *Med. Times and Gazette*, 1874.
† *Marseille Medical*, 1879. ‡ *Klinischer Bericht*. Berlin, 1880.
§ *Charité-Annales*, p. 663. Berlin, 1882.

chief danger to be apprehended in these very rational and well-conceived operations is partial or total sloughing of the transplanted flaps. Nevertheless, in our hands this operation has been attended with good results.

In partial trichiasis or distichiasis, a good result may be obtained by excising the corresponding parts of the lid. For this purpose we may, as in Fig. 221, insert a triangular knife in the intra-marginal space, behind the deviating cilia along the tarsal cartilage, to the depth of 5

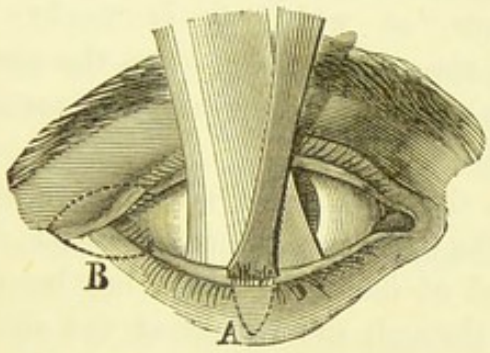


Fig. 221.—Operation for partial trichiasis.

millimetres. Having done so, we excise, by means of two incisions extending down to the cartilage, a V-shaped flap (Fig. 221, A) from the external surface of the lid. This flap should include the follicles of the deviating hairs; and the margins of the wound may be brought together by one or two sutures. When the misplaced hairs are situated at the external or internal commissure, the incisions are made as figured at B (Fig. 221).

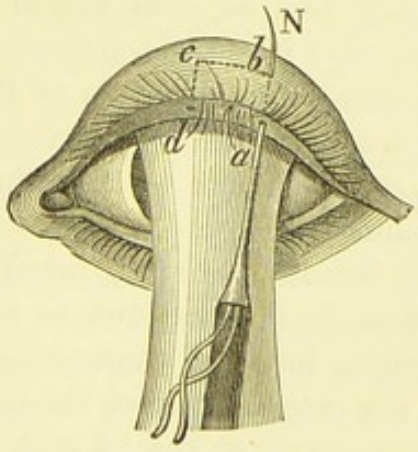


Fig. 222.—Herzenstein's operation for Trichiasis.

Another method of curing partial trichiasis or distichiasis is that proposed by *Herzenstein;* it consists in the introduction of a seton, which sets up an inflammatory suppuration leading to the destruction of

the follicles. His plan is as follows:—A needle, N (Fig. 222), furnished with a silk thread, is introduced at the point, *a*, in the intra-marginal space, pushed on beneath the skin parallel to the cartilage, and brought out at the point, *b*, at 4 or 5 millimetres above the palpebral margin. It is again inserted at the point, *b*, and made to slide under the skin, parallel to the ciliary margin of the lid, till it is brought out at the point, *c*, the distance, *b c*, being equal to the length of the portion of the ciliary margin which has misplaced hairs. The needle is again inserted at the point, *c*, and made to descend to the point, *d*, in the intra-marginal space, at which it is finally brought out. The extremities of the thread are fastened to the cheek, and the eye is covered with a compress and bandage. This method does not always give a certain result.

In cases where a single cilium or several isolated cilia are misplaced, which we would like to preserve but in a better direction, we can try the ancient method of *illequation* which has been revived by *Snellen*. He runs a thread through the tissues at the side of the cilium, and carries it round the cilium so as to enclose it in a noose. As the noose is withdrawn it takes with it the included hair.

ART. XIV.—Entropion.

By entropion is meant the inversion of the palpebral margin. A part of the eyelid only may be thus turned towards the eyeball (partial entropion); but, most frequently, the entropion is total; it may effect one or both eyelids. Considered as to its **ætiology** we can distinguish two varieties of entropion—1, entropion due to spasm of the orbicularis muscle; 2, entropion due to retraction of the conjunctiva and deformity of the tarsal cartilage.

1. The first variety is most commonly found to affect the inferior eyelid, which is rolled on itself, sometimes to such a degree that the ciliary margin is brought into the conjunctival cul-de-sac. If the finger be applied to the external part of the lid and the skin drawn slightly downwards, the margin of the lid with the cilia returns to its normal position, and is only again displaced when the eyelids are closed. The slackening of the integuments of the eyelid which takes place in advanced life (senile entropion) promotes the development of this anomaly and renders it permanent.

Its real cause is a contraction of the circular portion of the orbicularis

muscle, such as takes place in those attacks of ophthalmia which are accompanied with œdema of the lids, or when a compress and bandage have been kept on for a length of time.

2. The second form is often the result of granular conjunctivitis or of chronic blepharitis, producing atrophy of the conjunctiva with thickening and incurvation of the cartilage. This condition may also be due to cicatrices of the conjunctiva, the result of injuries or burns. The superior eyelid is as liable to this alteration as the inferior, whilst not uncommonly both eyes are affected at the same time.

Entropion gives rise to considerable irritation of the eyeball, with photophobia, lachrymation and blepharospasm. As a consequence, the cornea becomes inflamed, and a pannus is formed which seriously compromises the vision.

The **treatment** of entropion necessarily varies with the nature and the degree of this deformity.

When we have to deal with a simple inversion of the margin of the lid, due to some passing cause, such as the prolonged application of a bandage on the firmly contracted lids or some analogous circumstance, it suffices to draw the lid outwards with a strip of adhesive plaster. In such cases, benefit is to be derived by placing a small ball of lint between the orbital margin and the lid, keeping it in position with strips of plaster.

*Arlt** recommends the following dressing:—He takes a narrow band of linen, an inch and a half long and half an inch broad, and fixes one extremity with a layer of collodion beneath the internal angle, between the orbital margin and the adherent margin of the tarsal cartilage. Having done so, he stretches the band tightly, drawing horizontally from within outwards towards the skin of the external angle, which is pushed as much as possible beneath the linen before its external extremity is also fastened down with collodion. When the band is firmly attached by both its extremities, we may insure and increase its effect by covering it with a layer of collodion, for it then contracts on itself and the lid is re-adjusted.

The same result may be obtained by enclosing a fold of skin near the free margin of the lid in a ligature or in a pair of catch ptosis forceps (see Fig. 223). But the pressure exercised by such instruments on the skin is very ill supported by the patient, at least if it is of long duration; so that the surgeon is sometimes obliged to divide the external palpebral ligament, as *Wardrop* advises, especially when the spasm of the orbicularis is kept up by the irritation of the

* See *Archiv für Ophthal.*, 1863.

conjunctiva or of the cornea. *Stellwag* performs in these cases an oblique section through the entire thickness of the lid near the external angle.

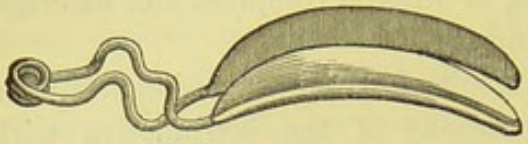


Fig. 223.—Ptosis forceps.

In slight and recent cases of spasmodic or senile entropion (especially of the inferior lid), we may attempt to evert the eyelid by the cicatricial contraction which follows cauterisation, ligature or excision of the skin, near the margin of the lid (Fig. 224). If, as frequently happens in cases of chronic entropion, the palpebral fissure be contracted and the external commissure displaced, we must, to remedy the entropion, begin by enlarging the palpebral fissure by a cantoplastic operation (p. 552). Often this operation by itself suffices to replace the palpebral border in its normal position; if not, it may be beneficially combined with *Gaillard's* ligatures, as has been recommended by *Pagenstecher*, or with excision of portions of the cutaneous surface of the inverted lid.

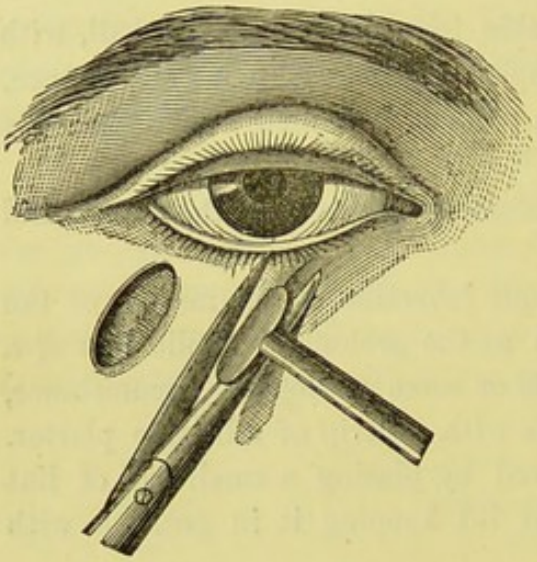


Fig. 224.—Entropion operation by excision of cutaneous flaps.

Von Graefe has indicated for the various forms of spasmodic stricture a method of operation which we have often employed with good results

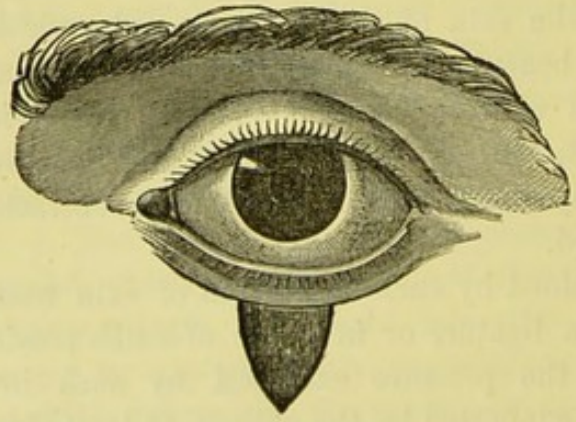


Fig. 225.—Entropion operation (*von Graefe's* method).

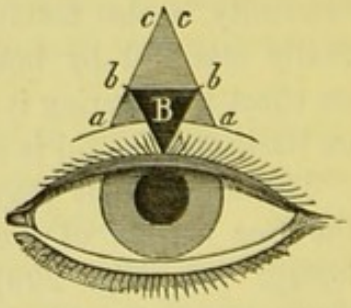


Fig. 226.—Operation for entropion; partial incision of the cartilage.

(Fig. 225). At 3 millimetres from the palpebral margin and parallel with it, a cutaneous section is made which extends on both sides to

within 3 or 4 millimetres of the commissure; a triangular flap is then excised, and the margins of the wound are slightly freed and brought together by two or three sutures. The horizontal wound is left to itself.

As to the size and height of the flap which should be excised, they vary with the relaxation of the cutaneous structures. Its height is, however, of little importance; its base should be from 6 to 10 millimetres.

If, in elderly persons, the relaxation of the orbital portions of the orbicular muscle be greatly at fault, *von Graefe* makes his flap in the shape of a cupola. When the palpebral fissure is contracted, this method may be combined with the operation for blepharophimosis (p. 552).

In cases of spasmodic entropion of the upper lid, in which the corresponding tarsal cartilage is perceptibly altered, *von Graefe*, in addition to his ordinary operation, partially excises the tarsal cartilage in the following manner (see Fig. 226):—The cutaneous flap having been excised in the way described, the lips of the wound are separated by retractors; the orbicular muscle is incised horizontally, close to the free margin of the lid, and the fibres are pushed upwards so as to lay bare the tarsal cartilage. A triangular portion, B, is excised from the tarsal cartilage in the opposite direction to the cutaneous flap; its base should measure 5 or 6 millimetres, and should coincide with the orbital margin of the cartilage, whilst its summit should extend to the palpebral margin. The cartilage should be excised in its entire thickness, leaving only the conjunctiva. The sutures should be so arranged that the middle one (*b* in Fig. 225) includes both the skin and the superficial layers of the cartilage.

As a rule, this operation should be combined with that of blepharophimosis.

Frequently entropion is accompanied with incurvation of the tarsal cartilage, and can then only be cured by one of the following operations directed towards this complication.

Streatfield's Method.*—The lid being held in Snellen's clamp, so that the flat blade is in contact with the mucous membrane, and the ring with the skin, a cutaneous incision is made with a scalpel, at 2 millimetres from the palpebral margin and parallel to it, laying bare the roots of the hairs, without incising them.

Then, freeing the skin, this incision is carried down to the cartilage, and the extremities of the section are made to incline towards the palpebral margin. This having been done, a second incision is made at 3 or 4 millimetres above the first and parallel to it, at once dividing

* *Ophthalmic Hospital Reports*, vol. i., p. 121; and *Annales d'Oculistique*, xi., p. 212.

the integuments down to the cartilage; this second incision should be continued till it meets the extremities of the first. We then excise an oval portion of the fibrocartilage, taking hold of it with a pair of forceps and liberating it from all adhesions with a scalpel or pair of scissors (grooving the cartilage). At the same time we remove the corresponding portion of the integument, and allow the wound to cicatrise without using sutures.

The cicatricial process causes a contraction in the portion of the cartilage which is contiguous to the free margin.

Sœlberg Wells* has succeeded in curing difficult cases of entropion with contraction and incurvation of the cartilage, by the following very ingenious combination of the methods of *Arlt* and *Streatfield*. He begins his operation in the same way as *Arlt* (see p. 558), and, having excised the cutaneous flap, makes a longitudinal incision through the fibres of the orbicular muscle down to the cartilage. This latter being laid bare, he marks out a triangular portion, the base of the triangle being towards the external integuments and the apex towards the conjunctiva. He then excises the cartilaginous flap by means of a bistoury. The size of the portion removed must depend on the incurvation and contraction of the cartilage. The lips of the cutaneous incision are united by sutures, which should be passed sufficiently deep to take hold of the fibres of the orbicular muscles, but need not be passed through the cartilage itself.

Snellen has proposed the following excellent method, which has been generally adopted :—Having put on a lid clamp, he makes an incision at 3 millimetres from the free margin of the lid and parallel with it; the incision is made only through the skin, and extends right across the lid. The skin is then dissected so as to uncover the orbicularis, from which a band 2 millimetres broad is excised. The tarsal cartilage being thus uncovered, a wedge-shaped portion is removed from its entire length, the apex of the wedge being directed towards the conjunctiva. The removal of this piece being effected, three sutures are applied in the following manner:—The thread, provided with a needle at each extremity, is passed through the tarsal cartilage above the excised portion; both of the needles are then passed through the skin near the palpebral margin, so as to bring them out a little above the line of the cilia at about 8 millimetres from each other. Two other sutures are inserted in a like manner, so that all the points of exit are about 8 millimetres apart. A small guard is then put on each thread so as to prevent the skin being cut, and they are then drawn tight and tied in a firm knot. Lastly, the two threads are turned up over the brow where they are held in position by strips of plaster.

* *Treatise on the Diseases of the Eye.* London 1869. p. 203.

Berlin's method is much more simple :—He makes an incision at 3 millimetres from the palpebral margin of the lid through its entire thickness—skin, muscle, cartilage and conjunctiva. Having freed the muscular tissue and uncovered the cartilage, he removes 2 or 3 millimetres of it at the place of its greatest incurvation. The wound is left without sutures and dressed with cold compresses.

Burow makes a transverse incision through the conjunctiva and tarsis in the entire breadth of the lid. He excises a cutaneous flap as in *Sælberg Wells'* method, and unites the external wound with sutures.

The methods described in the chapter on trichiasis are also of great service in dealing with entropion, and may be combined with excision of a piece of the cartilage.

ART. XV.—Ectropion.

Ectropion is characterised by the more or less pronounced eversion of the palpebral margins towards the cheek, or towards the superciliary ridge. This eversion of the lids removes the ciliary margin from contact with the eyeball, and at the same time the conjunctival surface of the eyelid is turned outwards. Ectropion may be variable in amount, and depends upon very different causes.

It occurs as a consequence of excoriation and cicatricial contraction of the skin of the lid, followed by thickening of the conjunctiva. This condition, which is most frequently found in the inferior eyelid, is due to chronic inflammations of the conjunctiva, or of the palpebral margin. When we observe it in elderly persons, in whom the orbicular muscle has already lost a portion of its normal power, we find that the lid is at a slightly greater distance from the eye, so that the lachrymal punctum has lost its normal position, and has ceased to perform its functions. The tears then accumulate in the retro-tarsal fold, and escape over the cheek, still further increasing the irritation of the integument.

Ectropion also occurs in the more serious forms of conjunctivitis, which are accompanied with considerable chemosis, directly everting the lid, by increasing the volume of the conjunctiva. This eversion produces spasmodic contractions in the ciliary part of the orbicular muscle, which, so to speak, strangles the subjacent structures and prevents the palpebral margin from returning to its proper situation. In children this condition is still further aggravated by their struggles and cries.

In the chronic forms of ophthalmia, the cartilage sometimes participates in the inflammation. It becomes soft and loses its consistence, thus contributing, by its lack of resistance, to the formation of ectropion; at the same time the palpebral margin is separated from the eyeball.

Ectropion may also be due to tumours of the orbit, protrusion of the eyeball, and paralysis of the orbicularis; and, therefore, may depend on the various causes of these affections.

Again, one of the chief causes of ectropion is cicatricial contraction in the neighbourhood of the lid, as happens after wounds and burns, and it is especially a feature of the adherent cicatrices which are formed in caries of the orbital margin.

The first effect of ectropion, especially when it attacks the inferior lid, is lachrymation. Following this, there are alterations of the conjunctiva, which are due to the continued exposure of that membrane to the air; its epithelium becomes thickened and encrusted. As to the cornea, it especially suffers from the want of protection when the superior eyelid participates in the ectropion; for, if the lower lid alone be affected, the eyeball is carried upwards, and is thus protected from the irritation which would otherwise endanger it. When this is not the case, the cornea becomes the seat of deep ulceration, which may bring about its destruction.

The **treatment** to which recourse is had in dealing with ectropion, is as varied as the causes which may occasion this deformity.

In acute cases of sarcomatous ectropion, it sometimes suffices to replace the lid in its normal position, and to retain it there by a compress and bandage. When we find some difficulty in replacing the lid, either from the congested state of the mucous membrane, or from spasmodic contractions of the orbital portion of the orbicular muscle, it is well, before applying the bandage, either to make numerous scarifications of the conjunctiva, or, if necessary, to divide the external commissure. If there be considerable hypertrophy of the conjunctiva, we may cauterise the mucous membrane with solid sulphate of copper, and then repeat the scarifications.

These manipulations generally diminish the extent and thickness of the conjunctival swelling. If, notwithstanding this treatment, the conjunctival exuberance is still such as to prevent the reduction of the deviated lid, it is then beneficial to excise a band of the thickened conjunctiva, parallel to the free margin of the lid.

We can also treat ectropion with Snellen's sutures, which are applied in the following manner:—A silk thread is provided with two strong needles, one at each of its extremities. One of these needles is made to enter the conjunctiva at its most prominent part, and is carried as near the skin as possible, being brought out on the face 2 centimetres

below the lid. A similar manœuvre is made with the other needle, the point at which it enters the conjunctiva being 1 centimetre from that where the first needle entered, so that the noose formed by the thread is perpendicular to the palpebral margin. The point of exit of the second needle should be on the cheek at 3 centimetres below the lid. This being done, the extremity of the inferior thread is drawn so as to bring the loop into close and firm contact with the conjunctiva, the lid being thus caused to rotate from below upwards, and from before backwards. The threads are then tied over a piece of glove leather to prevent their cutting the skin of the lid. It is often necessary to make a second suture of the same kind.

Still, in a certain number of these cases, such attempts have only a transitory effect, the lid (we are dealing here, especially with the inferior lid) soon falling again into its abnormal position. This is especially to be feared when the margin of the lid seems to be considerably elongated. It then becomes necessary to reduce its volume by surgical interference.

The method which is most efficient, and which is applicable to almost any case, is tarsoraphia combined with excision of a triangular cutaneous flap. This method, first suggested by *Dieffenbach* and modified by *von Graefe*, is the following (see Fig. 227):—An incision

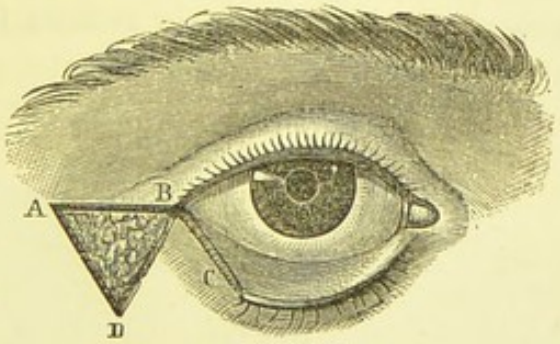


Fig. 227.—Graefe's operation for ectropion.

is made as in ordinary tarsoraphia in the external commissure, and the palpebral margins are made raw; but, in this case, we must make raw a larger portion of the everted lid than of the other (4 to 6 millimetres). This being done, we next excise a triangular flap (A, B, D), having for its base the extremity of the commissure, and being about 4 or 6 millimetres broad. Before uniting the lips of the wound we must free the skin surrounding the triangular wound from the subjacent tissue. The sutures are first applied to the lips of the triangular wound, then to the lips of the external commissure as in ordinary tarsoraphia.

When the ectropion affects the external portions of both lids, so

that the entire external commissure is everted, we shall find most applicable the method of tarsoraphia proposed by *Walther*,* combined with *Adams'*† operation. The free margins of both lids are excised to the extent of the eversion, as are also the commissure and a triangular flap of the surrounding skin. The base of the triangle

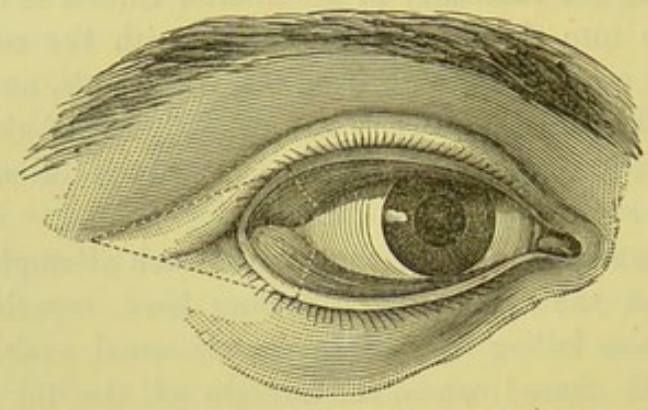


Fig. 228.—Operation for ectropion by the combination of *Walther's* and *Adams'* operations.

thus marked off is turned towards the eye, the summit towards the temple. The inventor of this method immediately unites the lips of the incision by two twisted sutures.

Walther's method, which we have just described, is, as it were, only an application to both lids of the older method of *Adams*, modified by *Ammon*, such as was proposed by these authors for evertion of a single lid.

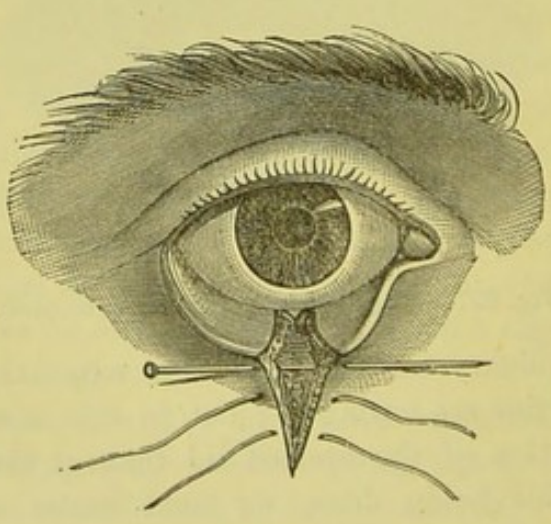


Fig. 229.—Operation for ectropion (*Adams'* method).

Adams,‡ to bring the lid into its normal position, excised a triangular portion from its entire thickness, as shown in Fig. 229.

* *Journal de Graefe et de Walther*, 1826, x.

† *System der Chirurgie*, 1828, vi., p. 160.

‡ *Practical Observations on Ectropion or Eversion of the Eyelids*. London, 1812.

After the flap has been excised, the lid is held in its normal position, and the edges of the wound are brought together by a twisted suture. In this method there is danger of a coloboma of the lid, if the union

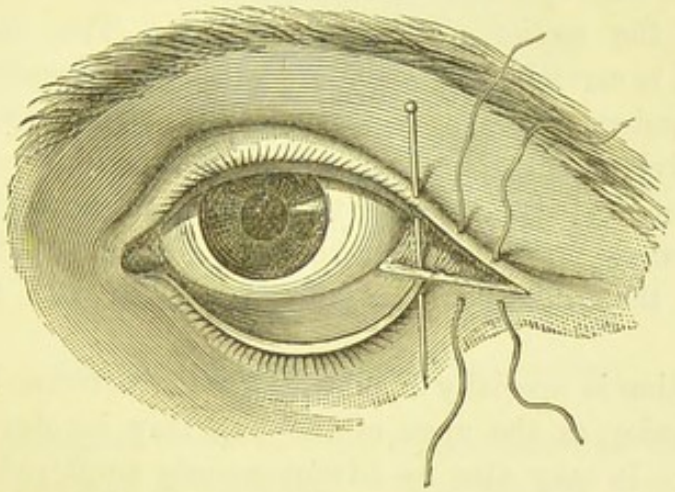
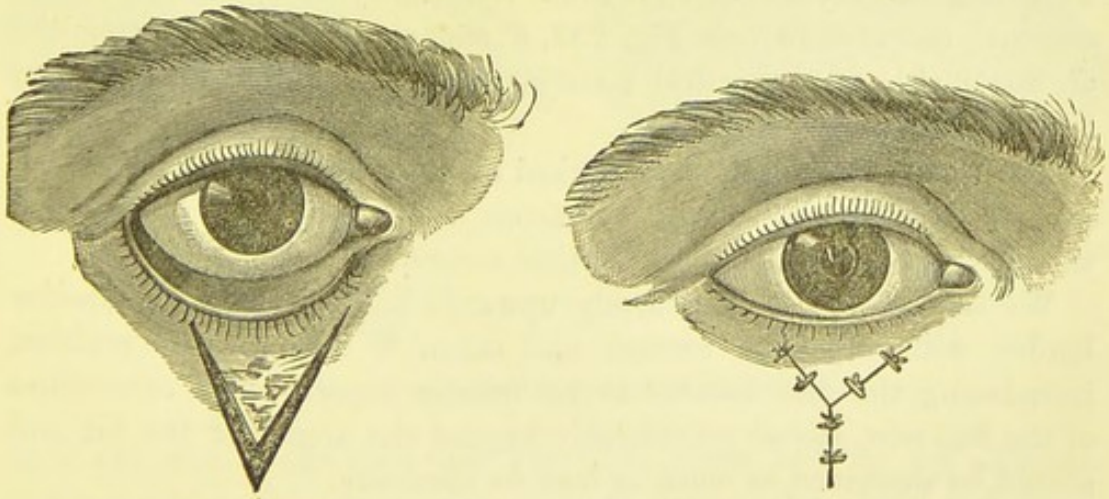


Fig. 230.—Operation for ectropion (*von Ammon's* method).

of the wound does not take place in the manner hoped for, or there is at least the inconvenience of the deformity caused by the cicatrix. To obviate this as much as possible, *von Ammon** placed the triangular flap so that its external side is the prolongation of the external commissure (see Fig. 229).

All these methods of operation are wholly insufficient for those varieties of ectropion in which the everted lid is retained in that position by a retraction of the integuments, or by a cicatricial band.



Figs. 231 and 232.—*Wharton Jones'* operation for ectropion.

The operations which we are about to describe are applicable to this form of ectropion, and may be regarded as types which can be modified to suit the necessities of the case.

* *Zeitschrift für Augenheilkunde*, I., p. 529.

Wharton Jones' Method.*—When a cicatrix has shortened the palpebral skin and has everted the lid, *Wharton Jones* sets it free, as shown in Fig. 231, by two convergent incisions, which begin near the angles of the eye, and meet on the cheek or forehead beyond the cicatrix; the section is thus V-shaped. The cutaneous flap circumscribed is carefully dissected off, from the summit towards the base, all adhesions which would prevent the free movement of the flap being divided. Lastly, the palpebral margin is restored to its normal position, and the skin near the margin of the incision is freed to a certain extent, in order to promote coaptation. When the parts are sutured, the edges of the wound are in the form of the letter Y.

This operation is specially applicable to the inferior lid; it is less so to the superior, as the apex of the flap may involve the hairs of the eyebrow. It may also be advantageously employed in cicatricial displacements of the external commissure. Still it does not remedy any abnormal elongation of the palpebral margin, and cannot be used either to raise or to lower the level of the external commissure; hence, it becomes necessary to combine it with tarsoraphia (*Stellwag*).

Von Graefe's Method.†—*Von Graefe*, in cases of pronounced ectropion of the inferior eyelid, accompanied by alteration of the palpebral margin, recommends the following method:—

Having carefully cleansed the everted lid, we endeavour to find the point at which the cilia are implanted, and make a horizontal incision behind them—that is to say, in the intra-marginal space. This incision should extend from the lachrymal punctum to the external commissure (see Fig. 233, *d* and *e*). From the extremities of this incision two vertical incisions (*d*, *b*, and *e*, *f*) are made, about $1\frac{1}{2}$ or 2 centimetres long.

The quadrilateral flap thus marked off is freed in its entire extent, and, if necessary, when the cutaneous contraction is great, beyond the inferior extremities of the vertical sections.

We then draw the flap firmly upwards, holding it by its superior border with a pair of forceps, and stitch it into its new position, introducing the first sutures at its inferior aspect. The extremities of the flap now extend considerably beyond the angles of the lid, and should be shortened as much as may be necessary.

Von Graefe advises that the shortening should be effected by two incisions, *b*, *b*, which meet at the angle, *c;* he also fixes the angle, *c*, to the point previously occupied by the internal angle of the flap. The

* *Treatise on Ophthalmic Medicine and Surgery*, p. 627.

† *Archiv für Ophthalmol.*, 1864, x.

nearer the point, *c*, is to the palpebral margin, the more does the section shorten the margin and the less does it elevate the flap.

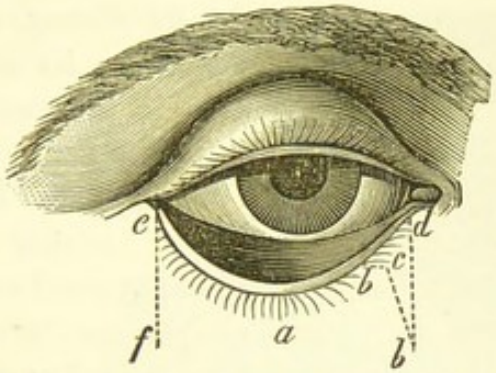


Fig. 233.—Ectropion (*von Graefe's* method).

When the ectropion is due to a cicatrix adherent to the bone, there are different methods of operating. It sometimes suffices to detach the cicatrix from the bone by the subcutaneous method, and thus to render the entire lid mobile; when the latter is restored to its normal situation, it may easily be maintained in it by occlusion (see *Mirault's* Method).

When the cicatrix is extensive, **von Ammon's Method** may be employed with advantage. It is performed in the following manner:— He makes an incision in the skin round the cicatrix and leaves the

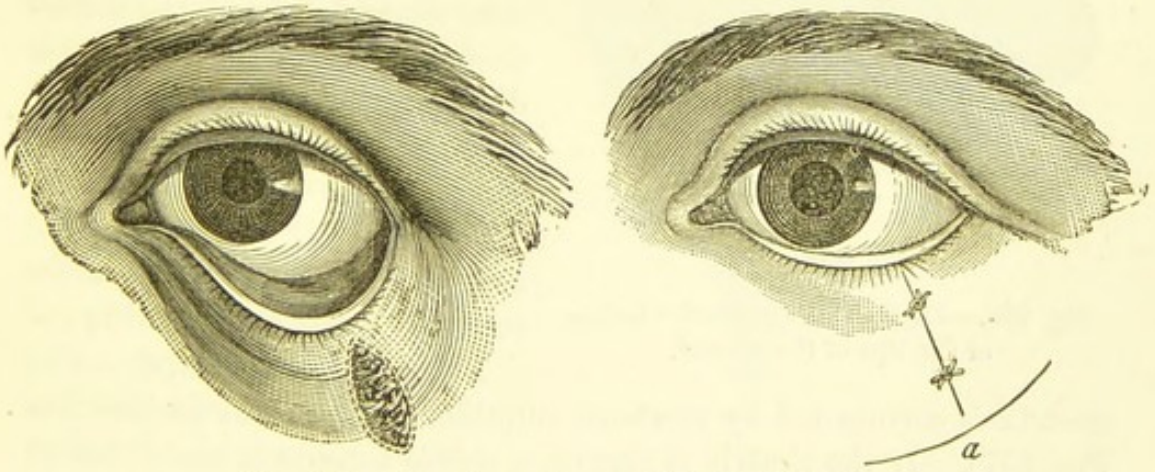


Fig. 234.—*Von Ammon's* operation for ectropion.

skin adherent to the bone (see Fig. 234); then he frees the adjacent integuments round the incision, so as to liberate the eyelid and allow the patient to shut the eye. He then makes raw the old cicatrix, and draws the lips of the wound together over it.

Dieffenbach * makes a triangular section round cicatrices of this kind, the base of the triangle being directed towards the palpebral margin;

* See Zeis, *Handbuch der Plastischen Chirurgie.* Berlin, 1838.

he then entirely removes the cicatrix (see Fig. 235), and prolongs the horizontal section in both directions. He next frees the skin all round the incision so as to allow of the lid sliding, and having placed the lid in its normal position, he fixes it with sutures as indicated in Fig. 236.

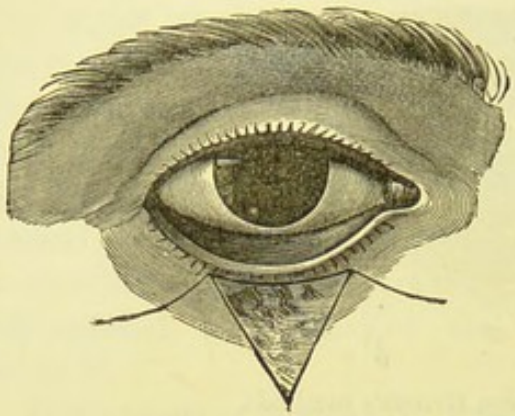


Fig. 235.—Cicatricial ectropion (*Dieffenbach's* method).

Guérin's Method.—A V-shaped incision is made, with the opening turned away from the everted margin, and two incisions, starting from the inferior extremities of the first, are made towards the edge of the lid. The two triangular flaps which result from the incisions are dissected off, which may be done in such a way as to make their margins fit into the primary incisions of the inverted V. The flaps are then united to each other by interrupted sutures, so that their lowest point is below the summit of the triangle, which occupies the same position as it did before the operation.

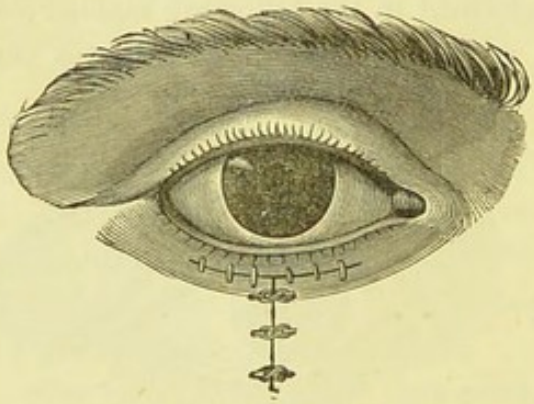


Fig. 236.—*Dieffenbach's* method—Union of the lips of the wound.

When the external integuments of the everted eyelid are changed in their entire thickness into cicatricial tissue, the retraction is very great and it is difficult to get the surrounding skin to move with sufficient freedom. In such cases the foregoing methods are insufficient, and we must, therefore, have recourse to one of the following :—

Fricke's* Method.—The cicatrix is surrounded by two semi-elliptical incisions and excised (see Fig. 237). If the cicatrix is narrow, a simple incision is made parallel with the free margin of the lid; after which all cicatricial bands are cut and the skin very carefully dissected up to the ciliary margin of the lid, thereby being rendered perfectly mobile. The lid is then put in its normal position, by continuous traction being made in the direction of the palpebral fissure, and by the careful division of all adhesions which seem to prevent the complete reduction of the lid.

* *Die Bildung neuer Augenlieder* (*Blepharoplastik*), by J. C. G. Fricke. Hamburg, 1829.

There is thus established a considerable opening in the external integuments, of a variable size, which we try to cover by a cutaneous flap taken from the neighbourhood. For the superior lid, we generally try to take it from the temple, and from the cheek for the inferior lid. As shown in Fig. 237, we mark off a flap having the same form as the opening which it is intended to fill up, only we make it 2 millimetres longer and broader, in order to allow for the ultimate retraction. This flap, previously measured and marked off, is dissected from the subjacent structures with as much cellular tissue as possible, and in such a way as to leave it attached to its original position by a very large pedicle. It is then adapted to the palpebral wound, and fixed in position by ordinary sutures. To avoid repetition we will here state that, in our experience, *transplantation of non-pediculated skin flaps from the arm* replaces in a most satisfactory manner those flaps taken from the adjacent parts. Details will be given in the chapter on Blepharoplasty.

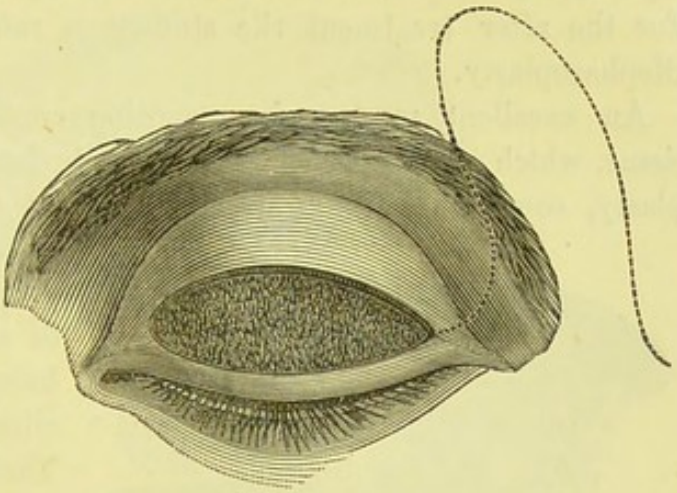


Fig. 237.—*Fricke's* method.

Dieffenbach's Method.—For the inferior lid *Dieffenbach*, in dissecting off a cutaneous contraction or a cicatrix, made a triangular incision, the base of the triangle being turned upwards (see Fig. 238, *a*, *b*, *c*). This triangular space be then filled by a flap formed by two incisions, one being the direct prolongation of the horizontal base of the triangle, and the other parallel with its external border (see Fig. 239, *b d*, *d e*). The length of the line, *b d*, should be a few millimetres greater than that of the base of the triangle. Any hæmorrhage

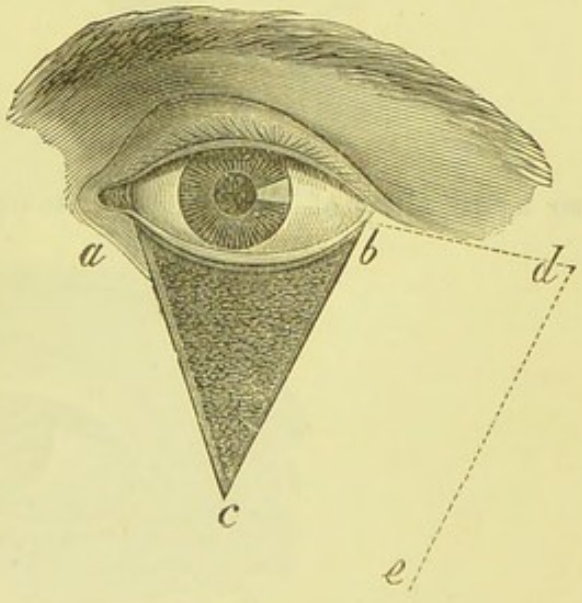


Fig. 238.—Blepharoplasty (*Dieffenbach's* method).

being arrested, the detached flap is made to slide into the opening which it is intended to fill, and carefully adapted to its new situation by simple sutures (see Fig. 239). The lips of the wound on the cheek where the flap has been taken, may, as far as is possible, be brought together by sutures, and the remainder should be allowed to cicatrise. For the after treatment the student is referred to the chapter on Blepharoplasty.

An excellent means of preventing contraction of the cicatricial tissue, which may often spoil the best devised operations for blepharoplasty, consists in the *temporary occlusion* of the lids according to *Mirault's* plan. For this purpose the internal margin of each lid is removed, care being taken not to injure the cilia and lachrymal punctum. Then the raw surfaces are united by four or five suture points, which should pierce the entire thickness of the lid. This blepharoraphia is necessary after nearly all operations for ectropion.

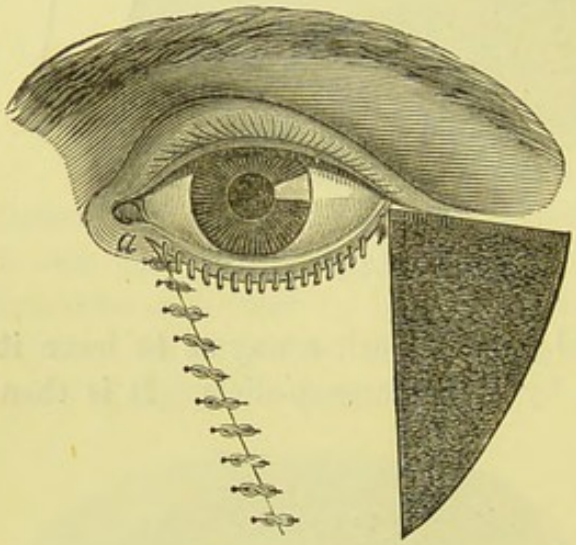


Fig. 239.

Denonvillier's Method.* —It is begun by a dissection of all cicatrices and adhesions, so as to allow of the palpebral margin being restored to its normal

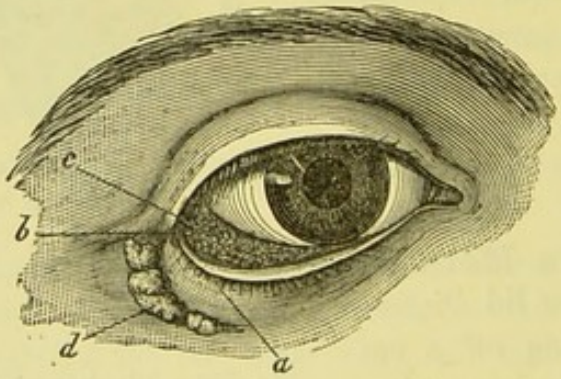


Fig. 240.—Before the operation.—This figure represents ectropion of the inferior lid with granulations sprouting from the bone of the orbital margin.

a, The everted inferior lid, kept everted by cicatricial contraction; *b*, the external commissure drawn outwards and downwards so that it is ½ centimetre below the level of the internal; *c*, everted conjunctival cul-de-sac; *d*, granulations arising from the bone. There exists a deep depression, at the bottom of which we find bare bone; all round it the integuments are thinned and excoriated by ulceration.

* *De l'Ectropion*, thèse de concours, par Cruveilhier. Paris, 1866.

position. Then the palpebral margins are made raw and sutured. The exact amount of tissue which has to be made up being thus ascertained, the surgeon marks off a flap from the malar region and dissects it from the point to the base. When the base is reached, the

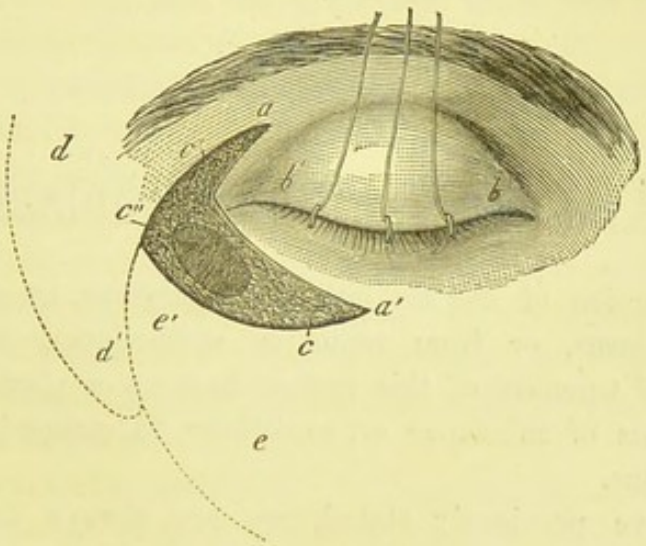


Fig. 241.—*a a''*, Double incision freeing the inferior lid, the external commissure, and, consequently, the superior lid from all adhesions with the bone; *b b''*, the two lids are sutured together, their free margins having been made raw; *c c''*, the space left bare after dissection of the commissure; *d d''*, the superior flap marked off but not yet dissected; *e e''*, the inferior flap.

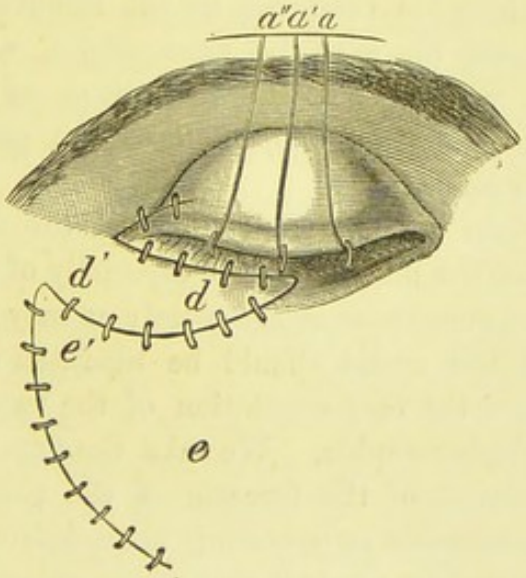


Fig. 242.—After the operation.—The lettering of the flaps is similar to that in the last figure; *a a'a''*, the ends of the threads suturing the lids turned back over the forehead, to which they may be fastened by adhesive plaster.

incisions are separated, so that, if possible, the border of the wound is brought in contact with the adjacent border of the flap. The first suture is inserted at the summit of the flap; next, the most distant point is sutured, and finally the nearest (method by *pivoting*).

Richet's Method.—*Richet* begins by freeing the lid so as to restore it to its normal position, after which he performs occlusion. Lastly, he marks off flaps; the one he uses to fix and maintain the lid, the other he shapes inversely to the former so that its contraction may neutralise that of the other.

ART. XVI.—Blepharoplasty.

The destruction of the lid either by gangrene, as after malignant pustule or burns, or from lupus or epithelioma, or, lastly, from extirpation of tumours of this region, requires a plastic operation to fill up the loss of substance or, sometimes, to completely replace the destroyed tissue.

As we have previously stated, we are always in the habit of performing transplantation of a non-pediculated flap taken from the arm, and have succeeded in that way with flaps of more than 10 centimetres in extent.* This method has the advantage of being applicable in those cases where the skin surrounding the lids is so much damaged that no flap can be taken from it. Again, we avoid those cicatrices which are produced by the removal of flaps from the face. Finally, should the graft be unsuccessful, we may repeat the operation; whilst unsuccessful transplantation of a flap from the adjacent skin aggravates the condition of the patient, and seldom admits of a second attempt.

In order to obtain a good result, it is of the first importance to preserve as much of the lid as possible, especially of its free border, and to save the mucous membrane as completely as may be. Secondly, the preserved skin of the eyelid should be liberated from the subjacent tissue, so as to allow the easy coaptation of the two borders which are to be united by blepharoraphia. We take the flap from the fine skin on the internal aspect of the forearm of the patient, or of another person, which is preferable in operating upon infants. The extent of the flap should exceed by one-half that of the defect in the lid. When detached, the flap is laid on a warm plate, and every particle of fat and cellular tissue carefully removed. Then we apply it to the defect, and retain it in its position by a sufficient number of sutures. It is much better that the flap should be too loose or even in folds than have any tension. The dressing consists of lint covered on the side of the flap with a thick layer of boracic acid, vaseline ointment and pheni-

* *Bulletin de la Société de Chirurgie de Paris*, 27th July, 1881.

cated cotton, kept in place by a flannel band which should exercise a moderate compression. *The first dressing is left unchanged for four or five days.* In removing it, we insert a large spatula between the lint and the flap, in order to retain the latter in its place. Half of the sutures are then cut, and the other half upon the removal of the second dressing at the end of about three days. The epidermis of the flap is generally puffed up and has to be cut. The entire flap shrinks considerably in the course of time, hence, as we have already stated, the necessity for making it much larger in the first place than the loss of substance seems to require.

In view of the results we have thus obtained, it seems to us likely that this so-called Indian method, which was first applied to the eyelids by *Lefort* (1870 and 1872), and afterwards by *Wolfe* (1874), will become more extensively appreciated, and entirely replace the blepharoplasty hitherto employed.

Blepharoplasty consists in the transplantation of a flap taken from some adjacent part, to which it remains attached by its base. Here also the size of the flap to be transplanted should always exceed that of the opening into which it is to be placed: for cicatricial contraction is prevented from disturbing the result, and the part transplanted can be more easily adapted to the margins of the wound, without giving rise to tension.

We must also take care that the neighbouring skin, after the coaptation, be not too tense; if necessary, we must relieve the tension by superficial incisions near the base of the flap, removing early any sutures which seem to cause the tension.

The base of the flap should always be large enough to assure the vitality of the transplanted skin. The vitality is moreover influenced by the good adaptation of the raw surface of the flap to the subjacent structures. In this respect the dressing of the parts after the operation is of the greatest importance. The bandage should be so applied as to ensure the close contact of all the structures, but, at the same time, the flap should not be pressed too tightly against the subjacent bone. The chances of success are all the greater the nearer the transplanted flap is to a cutaneous surface in all respects healthy and free from any inflammatory or cicatricial alteration.

Amongst the operations which may be employed, we have already, in speaking of ectropion, mentioned those of *Fricke* and *Dieffenbach* (p. 575). The method of the latter, which consists of the immediate transplantation of a triangular flap taken from the neighbourhood of the part to be covered, is inconvenient, in so far as it leaves near the lid a wound which must be left to cicatrise by granulation. This cicatrisation almost invariably drags on the surrounding structures, and

we can easily understand that the new lid will be readily disturbed by such traction.

This inconvenience may be in great part avoided by the ingenious method devised by *Burow*,* which is performed in the following manner :—

We begin, as in *Dieffenbach's* operation, by giving the palpebral wound a triangular form (Fig. 243, *a b c*). Then the horizontal incision

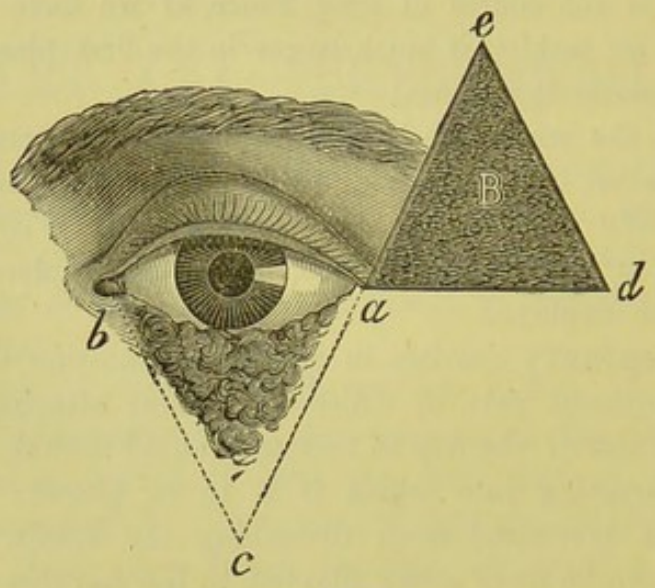


Fig. 243.

is prolonged in a straight line towards the temple, and is made to form the base of another triangle (*a d e*), the apex of which is directed upwards. The length of the incision which serves as a base to the triangle marked out in the temporal region should be equal to the base of the triangular flap of the lid; the vertical incisions may be

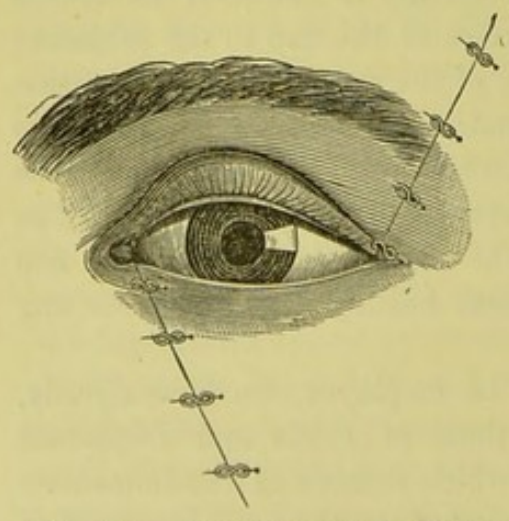


Fig. 244.—*Burow's* method—Union of the lips of the wound.

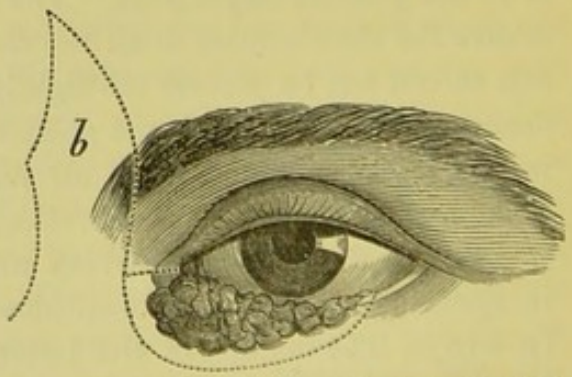


Fig. 245.—Blepharoplasty (method of *Blasius*). The flap is taken from the forehead above the nose.

* *Beschreibung einer neuen Transplantationsmethode.* Berlin, 1856.

shorter. In dealing with the superior lid, the apex of the lateral triangle should be made downwards.

The temporal flap, B, being excised, we take hold of the skin near the point, *a*, and dissect it sufficiently to make the cutaneous flap, *a c d*, completely mobile. Then we draw it inwards, so that its angle, *a*, is placed at *b*, and the border, *a d*, forms the free margin of the inferior lid. In the same way we free the skin near the incision, *e d*, and by sutures unite *e a* with *c b*, and *d e* with *a e*, so as to skilfully mask the two losses of substance.

The methods of *Fricke*, *Dieffenbach*, and *Burow* may be used to make good a loss of substance in the middle of the lid, and even to replace an entire lid. For this latter purpose, *Blasius** and *Hasner d'Artha*† have also devised methods which restore the lid by flaps taken from the skin of the forehead or nose. Figures 245, 246, 247, 248, 249, and 250 sufficiently indicate the nature of these operations, and render further detail unnecessary.

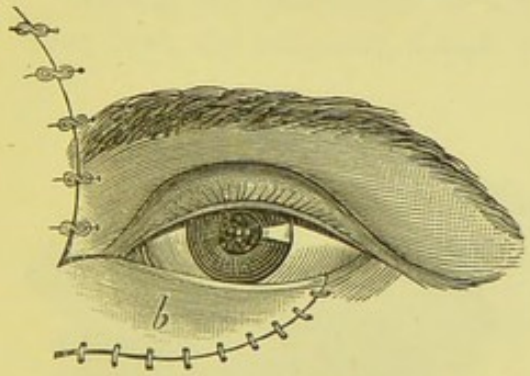


Fig. 246.

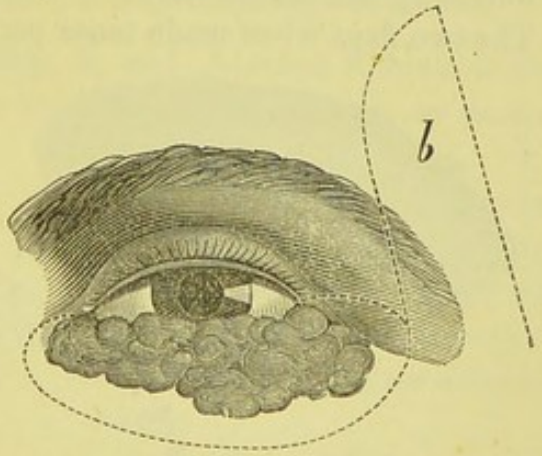


Fig. 247.—Blepharoplasty (*Blasius'* method). The flap is taken from the temple and forehead.

Knapp‡ uses a very ingenious method which was suggested to him by one of his pupils, *Dr. F. Pagenstecher* of Heidelberg, for the restoration of a lid which had been partially removed for cancer (see Fig. 251). Having given to the margins of the wound the rectangular form depicted in the figure, he prolonged the horizontal incisions towards the nose, and in this region dissected out a quadrangular flap. He then made two incisions, one starting from the external commissure, and dividing the skin on the temple; the other a continuation of the primary inferior horizontal incision on to the cheek; the extremities of these two incisions slightly diverging from each other.

* *Berliner Medic. Zeitschrift*, March, 1842.

† *Entwurf einer Anatomischen Begruendung der Augenheilkunde.* Prague, 1847, p. 182.

‡ *Archiv für Ophtalmologie*, 1867, xiii., p. 182.

He thus formed an elongated flap, which widened considerably towards its base; this flap was detached from the subjacent tissue and

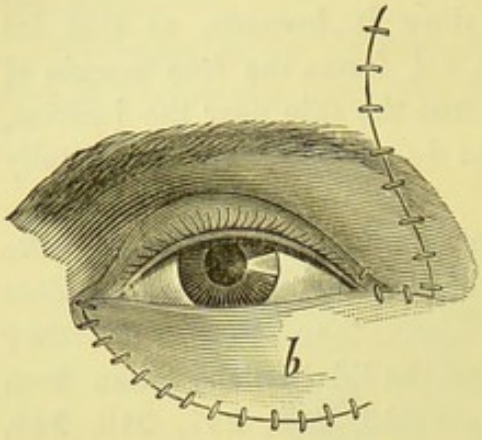


Fig. 248.—Application of the sutures.

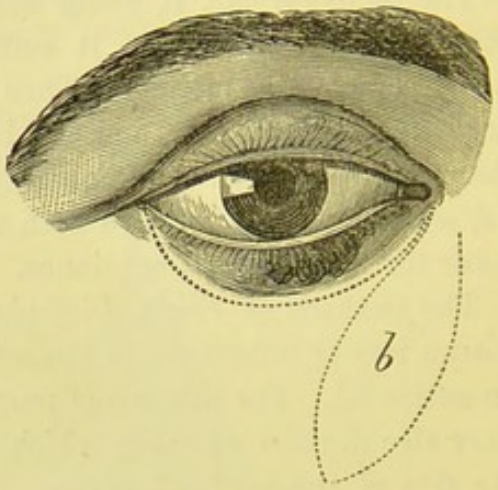


Fig. 249.

united by its vertical border to the vertical border of the internal flap. The two flaps when made tense perfectly covered the loss of substance.

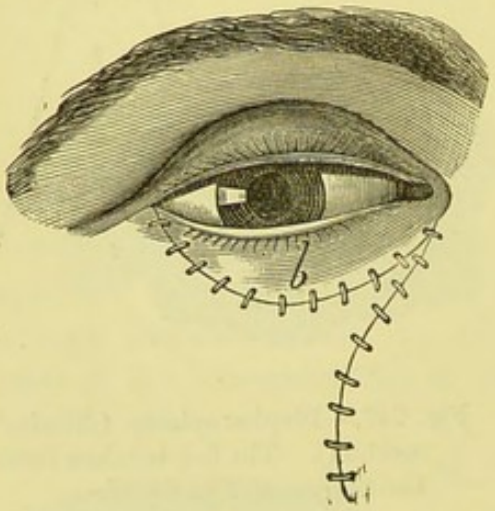


Fig. 250.—Displacement of the flap, *b*.

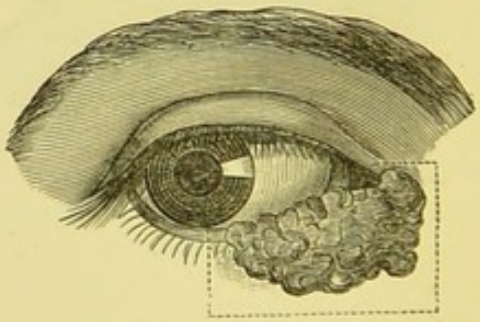


Fig. 251.—Removal of tumour from inferior lid.

They were carefully united by several sutures, as indicated in Fig. 252.

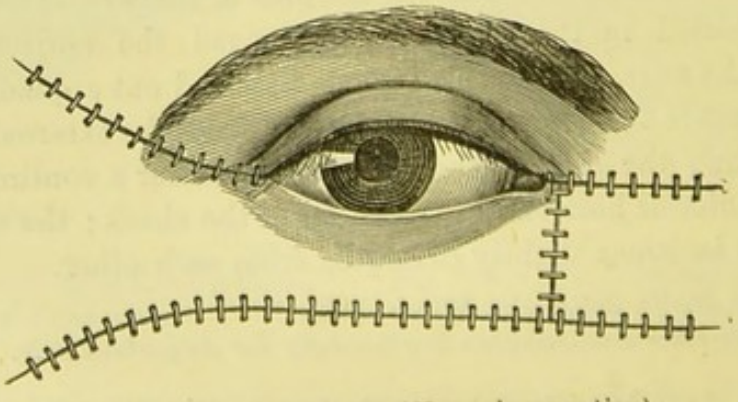


Fig. 252.—Blepharoplasty (*Knapp's* operation).

When we require to restore a loss of substance, involving the commissures of the palpebral fissure, we may use the following methods of operation suggested by *Hasner d'Artha:*—In the usual manner we make two elliptical incisions round the diseased part, as indicated in Fig. 253, *a*. We then take from the integument of the nose a flap whose base should be about 6 millimetres from the internal extremity of the wound. This flap ends in a bifurcation similar to the angle itself.

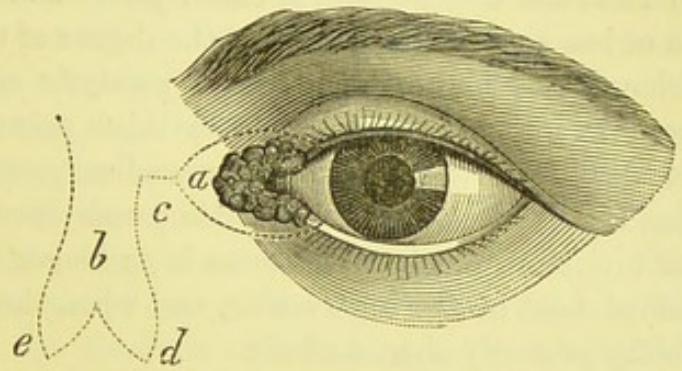


Fig. 253.—Blepharoplasty.—Restoration of the internal angle of the lids.

Having cut the bridge of the flap, *b*, and detached it down to its base from the subjacent tissue, we fix it in its new position by means of sutures (Fig. 254). In order to cover as completely as possible the wound left by the dissection of the flap, we draw downwards and inwards the flap formed by the divided bridge.

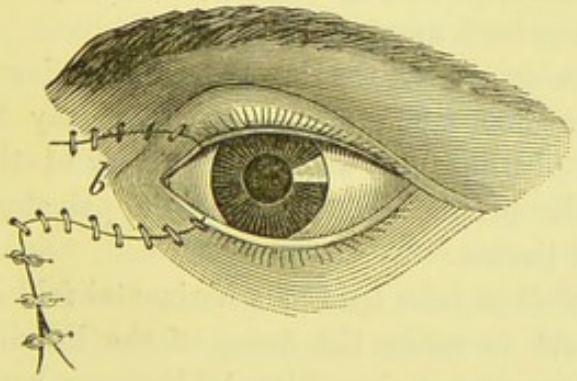


Fig. 254.—Insertion of the sutures.

In dealing with the external commissure, we proceed in a perfectly similar manner, only we take the flap from the temporal region (see Figs. 255 and 256).

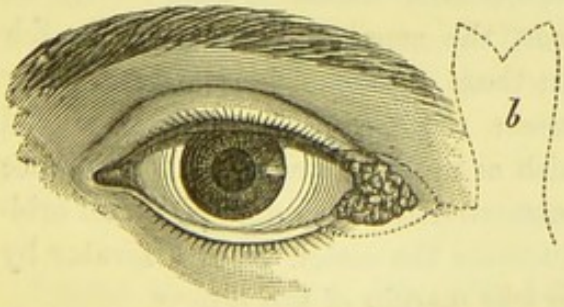


Fig. 255.—Blepharoplasty.—Repair of the external angle of the lids.

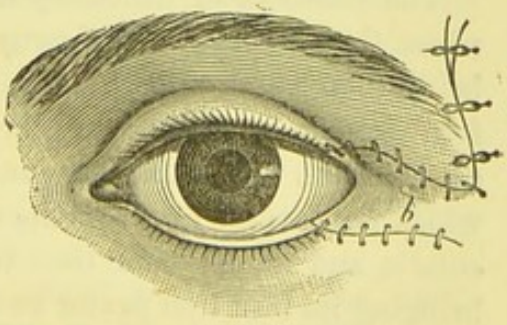


Fig. 256.—Insertion of the sutures.

ART. XVII.—Drooping of the Superior Eyelid, Ptosis.

Inability to raise the upper eyelid is called *ptosis*, and this want of power is more or less complete according to the degree of the affection.

This condition may be a consequence of paralysis of the levator palpebræ superioris muscle (paralysis of the third pair; p. 469); in which case it should be treated by the remedies generally used in paralysis, especially by electricity. Paralytic ptosis becomes the subject of surgical interference only when there is no longer room to hope for the re-establishment of the innervation, and when the disease is in a state of stability perfectly characteristic.

Again, ptosis results when the eyelid becomes too heavy, from superabundance of skin, chronic inflammation or granulations, or when the levator palpebræ have been implicated by wounds and suppuration. Finally, it exists *congenitally* when the levator muscle is defective or absent; this condition is often accompanied by defect of the superior rectus and other muscles of one or both eyes.

When there exists simply an excess of the integument forming a fold, we may remedy it by excision. The same operation may be applied to cases of relaxation of the skin with hypertrophy of the cellular tissue, as occurs in old people, or after chronic palpebral affections with congestion of the tissues.

With von Graefe's forceps we then take hold of a horizontal fold of the integuments sufficiently great to make the droop of the lid disappear when the patient looks straight before him, taking care, however, not to make it of such a size as will interfere with the shutting of the eyelids. This fold is excised and the wound is united by a few points of suture.

The existence of deficiency of the levator muscle is best recognised when the patient looks downwards, the separation between the lids being then equal on both sides. In those cases excision of a cutaneous fold would be injurious; for them *von Graefe* has recommended an operation which tends to diminish as much as possible the resistance which the levator meets in the contractions of its antagonist, the orbicularis, and at the same time to increase the action of the levator by bringing its insertion nearer to the free margin of the lid.

This operation is performed in the following manner:—We make a horizontal incision in the skin of the superior eyelid, at 5 millimetres

from its free margin, from one commissure to the other. We then separate the edges of the wound by drawing the one firmly upwards, the other downwards, and lightly dissect the adjacent subcutaneous tissue.

The orbicular muscle is thus laid bare, and of it we lift up with toothed forceps a piece 8 or 10 millimetres broad, which we excise with curved scissors, taking care not to injure the subjacent aponeurosis. Immediately after the excision of the orbicularis, we unite the edges of the wound by two or three sutures, which should include the margins of the muscular wound as well as those of the cutaneous.

These sutures may be inserted as follows:—The needle is first introduced into the lower lip of the cutaneous wound, and then the inferior lip of the muscular wound is lifted with a pair of forceps, and the needle is run deeply into it.

Next, the superior lip of the muscular wound is taken with the forceps, and the needle is run through it from within outwards, and then through the superior lip of the cutaneous wound. Finally, the suture is made fast. Three such sutures are generally found to be sufficient, but, if necessary, the cutaneous wound may be closed by a few additional ones.

When the action of the levator muscle is entirely wanting, it may be replaced by that of the frontal muscle, by a cicatricial union between it and the eyelid—a procedure originated by *Dransart** and *Pagenstecher*.† To do this by means of a simple ligature, including also the palpebral skin, should be avoided, on account of the deformity caused by the scar. It is better to make subcutaneous ligature by means of a silk thread furnished with needles at each extremity. One of them is introduced near the ciliary margin, following the tarsus, and emerging 1 centimetre above the eyebrow; the other is inserted in the same way, parallel to the first, and at a distance of about 5 millimetres. By making traction upon the two extremities of the thread, the eyelid may be raised as required—somewhat higher than the lid of the opposite eye, and the ligature closed over a roll of kid. Two or three of these ligatures may be inserted according to the size of the lid. Before inserting the ligatures, *de Wecker*‡ makes a horizontal incision, or even an oval excision of the skin, and removes part of the orbicularis muscle, as in the operation of *von Graefe*, which we have just described.

In some very severe cases, we have obtained excellent results § by

* *Bullet. Med. du Nord.*, Juin, 1880. *Ann. d'Ocul.*, Juillet, 1880; Oct., 1882.
† *Transactions of the International Med. Congr.*, p. 180. London, 1881.
‡ *Ann. d'Ocul.*, Août, 1882.
§ *Rev. Gén. d'Ophtalm.*, p. 39, 1883; and p. 248, 1885.

dissecting the palpebral skin up to the superciliary muscle, after having made a horizontal incision across the lid at a distance of 1 centimetre from its margin, and two vertical ones extending from the extremities of the first upwards to the extremities of the eyebrow. This cutaneous flap being turned up to the forehead, three cat-gut ligatures are successively introduced from above downwards, at a distance of 1 centimetre apart, under the superciliary and orbicular muscles, the needle being guided over the cartilage, and brought out near the ciliary margin. In closing these ligatures, they may be tightened so as to raise the lid as required, and the ends cut off close to the knots. The cutaneous flap is then put in place, and united to the ciliary margin by several points of suture. The dressing is the same as for plastic operation.

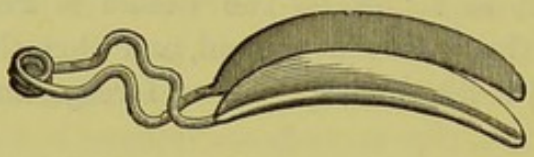


Fig. 257.—Ptosis forceps.

Should no operation be admissible, the lid may be lifted and maintained in place by small ptosis forceps (Fig. 257).

ART. XVIII.—Traumatic Lesions of the Lids.

Incised and lacerated wounds of the eyebrows and lids vary in their gravity according to their situation and extent. A horizontal incised wound, which does not extend down to the conjunctiva, usually heals very rapidly without disfiguring the patient, unless, indeed, the levator muscle has been divided, in which case there will be extreme ptosis.

Superficial wounds in the vertical direction, when they do not involve the palpebral margin, are free from danger. When the injury extends through the entire thickness of the lid, there is reason to fear simultaneous injury of the eyeball, or the ulterior formation of a symblepharon.

Ruptures of the lid may, moreover, end in suppuration, and thereby cause deformity from the irregular cicatrisation. When the lesion has involved the supraorbital nerve, blindness of the corresponding eye has been known to occur.

The **treatment** of all such injuries requires often the greatest care. A simple wound produced by a sharp instrument may be united by a

suture. In dealing with a torn lid, the wound must be carefully cleansed, all lacerated tissue removed, and the edges drawn as carefully together as possible by one or several sutures. In all these cases the best dressing is a compress and bandage.

In *stings* inflicted by wasps, bees, and other insects, we sometimes have considerable swelling and irritation. If the sting of the insect remain in the wound, we must try to extract it, after which the lid may be anointed with olive oil, and protected with a compress steeped in a solution of chloride of ammonium.

We have already spoken of malignant pustule (p. 532).

Deep *burns* of the lids are often dangerous from the cicatricial contraction, which may become the origin of severe ectropion.

The best method of preventing such a result is to close the eyelids at once by suture, and to use a skin graft, in order to obtain a favourable cicatrisation.

ART. XIX.—Congenital Anomalies of the Lids. Coloboma and Epicanthus.

1. By **coloboma** is meant a fissure of the lids, which is sometimes found to be confined to one lid, but sometimes involves both. This fissure is often combined with other anomalies of a similar nature, such as harelip and cleft palate, &c. In treating coloboma of the lids, we make raw the margins and very carefully draw them together by sutures, one of which at least should pierce the cartilage.

2. **Epicanthus**, a congenital anomaly caused by the presence of a fold of skin covering the internal angles of the palpebral fissures, is often complicated with a flattening of the bones of the nose, and an enlargement of the space which separates the internal angles of the eyes. Along with epicanthus we often have microphthalmos (sometimes only apparent and caused by the contraction of the palpebral fissure), drooping of the superior lid, strabismus, and affections of the lachrymal passages.

The operation for epicanthus has for its object the contraction of the skin which separates the two internal angles. It is not necessary to perform this operation in the first years of life, for the contraction often takes place spontaneously, and the fold of skin disappears as the nose becomes more prominent. Still, if this does not take place, and the deformity is so very obvious as to be a source of annoyance to the

patient, we must operate, removing an oval and vertical piece of skin from the back of the nose. This operation is applicable when the epicanthus affects both eyes, and is performed as follows:—

To determine the amount of skin which must be removed, we pinch up, either with the fingers or with a pair of ectropion forceps, a fold of skin sufficiently great to make the epicanthus disappear, and then draw an ink mark round the base of the fold. Having done so, we may immediately insert the sutures which will be required to unite the lips of the wound after the excision of the cutaneous flap. In this excision, which is best made with a sharp bistoury, we must carefully dissect the angles of the wound, so that its margins may be brought together without difficulty.

When epicanthus is present only on one side, we make the excision on the corresponding side of the nose.

DISEASES OF THE LACHRYMAL PASSAGES.

ART. I.—Anomalies of the Puncta Lachrymalia and Canaliculi.

The anomalies of the puncta and canaliculi are chiefly displacement, contraction, and obliteration. Such anomalies prevent these organs from performing their proper functions, and occasion a more or less pronounced degree of lachrymation, or irritation and even inflammation of the conjunctiva, produced by the contact of the tears.

The lachrymal punctum may be displaced in a twofold direction. We may find it displaced outwards, as in cases of eversion of the palpebral margin, or we may find it separated to a greater or less distance from the eyeball. The causes of eversion are the same as those of ectropion; the causes of separation are swelling of the caruncle or thickening of the lid and of the palpebral conjunctiva.

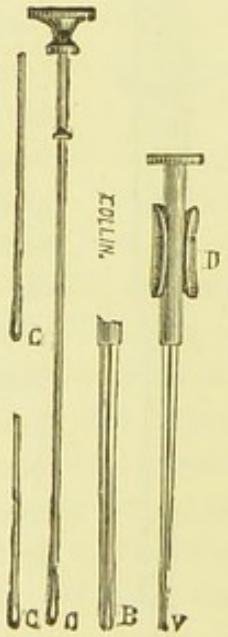


Fig. 258.

Obliteration of the lachrymal puncta may be due to their deviation, to burns, ulcers, or injuries involving the puncta or the surrounding tissue. It may also be due to various forms of conjunctivitis or blepharitis.

Contraction or obliteration of the canaliculi may also be attributed to the extension of some inflammatory condition of the conjunctiva, to burns or wounds in their neighbourhood, or again to the presence of foreign bodies (cilia, calcareous concretions, filiform fungi).

Treatment.—When the anomalies just described are the source of inconvenience to the patient, it becomes necessary above all to establish the natural drainage of the tears. A simple stricture of the canaliculi can always be overcome by the use of a fine conical style. But the greatest precaution should be taken to avoid any rupture of the mucous lining, which, in cicatrising, would add to the contraction of the passage. Further dilatation may be attained by means of probes successively increasing in diameter, or by a small instrument with movable branches (dilator of Bowman or Desmarres, Fig. 258) constructed for this purpose. Should complete and lasting per-

meability not be obtained by these means, the puncta and duct must be divided as first taught by *Bowman*.*

This operation is very simple. *Bowman* performed it with a narrow-pointed bistoury and a small grooved director. The following is the manner in which he used these instruments:—Applying one finger of the left hand to the external angle of the eye, the inferior lid is drawn towards the temple; the palpebral margin is thus made to assume a perfectly horizontal position. Another finger of the same hand is placed in the internal angle beneath the canaliculus so as slightly to evert it. The grooved director can then be easily introduced with the right hand into the passage and pushed forwards till it reaches the sac. This having been done, the sound is kept by the thumb and index of the left hand in the horizontal position, so that the canal may be straightened and made tense. The bistoury is then pushed along the groove and the canal is divided.

Fig. 259.

The operation thus performed is, however, much too long, and presents some difficulties, especially if we have to deal with a timid patient who contracts the orbicularis muscle, or if we are short of assistance. It may happen that, just at the moment at which we pass the sound from one hand into the other, some movement on the part of the patient may cause the sound to slip out of the canal, and the whole operation has to be begun again. On this account it is better to use a small dacryotome (Fig. 259), in which both the sound and bistoury are combined. It is introduced into the inferior canal in the same manner as the sound just mentioned; then, by pressing the extremity of the instrument, the small knife which it contains (*b*) glides forwards. This little instrument, so easily managed, is still used by us in operating on such patients as are frightened by the appearance of any cutting instrument.

We may also perform this small operation with a pair of very sharp scissors, the points of which have been rounded off to prevent their piercing the mucous membrane while being used. One of the branches, purposely made thinner than the other, should be introduced into the canal in the same way as the probe, and then, whilst the lid is stretched by the fingers of the left hand, the two branches are brought rapidly together and the canal is incised at a single stroke. The best way is to use the small probe-pointed knife devised by *Weber* (Fig. 260). The rounded extremity is made to slide into the canal,

* *Medico-Chirurgical Transactions*, 1851, v. xxxiv., p. 337.

which is divided by raising the handle of the knife. To obtain a satisfactory result, slight downward traction should be made on the canal—that is to say, it should be drawn in the direction opposite to the movement of the knife.

Fig. 260.

In cases where the eversion of the punctum is inconsiderable, the canal need not be divided in its entire length; a small incision of about 2 millimetres often suffices to cure the lachrymation.

If some difficulty be experienced in introducing the blunt point of the scissors, of the knife, or of the director, into the opening of the duct, which is sometimes very much contracted, the orifice should be previously dilated by the introduction of a small conical style, which should be pushed into the canal for a certain length and then rotated several times between the thumb and index finger.

Whatever be the method which we employ to divide the lachrymal passage, we must be careful to divide the mucous membrane only to the same extent as we divide the entire thickness of the canaliculus.

If this precaution be not observed, we may produce a cicatricial contraction which will for ever obliterate the passage. We must also divide the canal so as to leave the artificial opening as far as possible turned inwards—that is to say, towards the eyeball. This is easily accomplished by everting the eyelid in the manner we have just described, and by turning the edge of the knife towards the eye.

If, notwithstanding this precaution, the thickening of the lid and the swelling of the mucous membrane are so great as to keep the parts at such a distance from the eye, that, even after careful probing, the canal remains everted, and the tears which cannot flow through it still escape over the cheek, we must adopt *Critchett's* method.* This surgeon recommended that, in these cases, a piece of the posterior wall be taken hold of and cut off with a pair of scissors. By so doing we obtain a triple benefit: the canal is drawn more towards the caruncle, the passage of the tears into the sac is rendered easier, and the reunion of the various structures is prevented.

When the lachrymal punctum is closed the treatment is more complicated. In such circumstances it is sometimes a matter of difficulty to discover the orifice, which, however, should be carefully looked for, if necessary with the aid of a magnifying lens. If it be found, we can, as a rule, introduce a very fine probe. If we do not succeed, we should, following *Juengken*, remove with scissors the portion of the conjunctiva which covers the canaliculus, and search in the

* *Leçons sur les Maladies de l'Appareil Lacrymal* (*Ann. d'Ocul.*, t. li., p. 79).

wound for the opening by which to introduce the probe. According to *Bowman*, there is less risk of the opening again closing if the incision be made obliquely.

When the canaliculus has been converted into a permanent groove, if the tears still escape over the cheek, we must look for some obstruction at a more remote point of the lachrymal passage. This obstruction is sometimes situated near the internal extremity of the canaliculus at the point where it opens into the sac. In that case, as soon as the probe arrives at the contraction, there is the sensation of an elastic resistance, and, on pushing it still farther, we see the external integuments in the neighbourhood moving with the probe. Then we introduce a small hollow probe, enclosing a trochar (Fig. 261) into the lachrymal canal. As soon as the constriction is reached, we push forward the point of the trochar, at the same time making the skin tense with the fingers of the left hand, and thus enter the sac. Having removed the obstacle, we withdraw the trochar, and prevent the occlusion of the opening by introducing a fine probe.

Fig. 261.

If the careful and persistent introduction of the probe is a matter of too great difficulty, or does not have the desired effect, we divide the canaliculus and enlarge its opening into the sac, thus securing a permanent communication between the conjunctiva and the lachrymal sac.

After each exploration or operation of the lachrymal passage, we make a careful injection of tepid water, or a weak solution of borax, by means of a very small syringe (modification of *Anel's*). It is necessary to insert the nozzle as far as the lachrymal sac, and to make very slight pressure while injecting the liquid, which, if the head of the patient be depressed forward, flows out through the corresponding nostril, thus proving the permeability of the entire lachrymal apparatus.

For ourselves we desire to see the *indiscriminate habit of dividing* the canaliculus in all cases of epiphora abandoned, inasmuch as we consider it useless and injurious. Whenever we can introduce a fine probe into the lachrymal sac, and an injected liquid flows freely through the nostril, it is sufficient to renew these proceedings several times to obtain a cure. Even, when the exploration of the nasal canal (*vide infra*) requires the introduction of a probe, the division of the canaliculus may be avoided; and in those cases where the division of the canaliculus

seems indispensable, the probes and the syringe ought to be introduced near the sac, in order to allow the punctum and the adjacent part of the canaliculus to cicatrise and so recover their normal functions.

ART. II.—Catarrh of the Lachrymal Sac and of the Nasal Canal. Blennorrhœa.

In the large majority of cases this disease developes very slowly and in a very insidious manner. The patients at first notice a more or less pronounced degree of lachrymation, which increases when they are exposed to cold or moisture, or to the action of any irritant. Soon the region of the lachrymal sac becomes slightly swollen, and if it be gently pressed a mucous or serous liquid resembling the white of an egg emerges from the puncta. In other cases, the liquid on pressure passes down into the nose. In the first case, the liquid lodging in the cul-de-sac of the conjunctiva is a frequent cause of conjunctivitis or blepharitis.

The quantity of the abnormal secretion due to the catarrhal swelling of the inflamed mucous membrane of the lachrymal sac is proportionate to the amount and extent of the irritation.

The products of secretion lead by slow degrees to a distention of the sac, which may be sufficiently great to form a tumour large enough to be a great source of annoyance to the patient (hernia of the lachrymal sac). As long as the distention of the sac is not considerable, the disease may pass off spontaneously. Should this distention have supervened, spontaneous cure is still possible after acute phlegmon (*vide infra*).

Ætiology.—Catarrh of the lachrymal sac is often caused by an inflammation, either of the mucous membrane of the nose, or of the palpebral conjunctiva; sometimes it is due to constriction of the nasal duct or canaliculus. Lastly, in many cases in which it seems to be idiopathic, it may be attributed to a natural narrowness of the lachrymal passages, which sometimes coincides with pronounced flattening of the back of the nose, sometimes with an abrupt projection of the nasal bones.

Treatment.—The first indication for treatment is to overcome the catarrhal state of the mucous membrane of the nose, or of the lids, when it is the cause of the disease.

In many cases, it is sufficient to inject water into the nostrils, or, for a certain length of time, to use nasal douches of salted or chlorated water, at the same time adopting such general treatment as will overcome any tendency of the patient to catarrh of the mucous membranes.

Still, it must not be forgotten that the lachrymation may have caused some irritation of the conjunctiva, which irritation in turn will hinder the cure of the lachrymation. Hence, our next indication, not less important than the first, is to re-establish the permeability of the lachrymal passages, and thereby prevent the stagnation of the liquids.

For this purpose, after dilating the lachrymal duct, we make use of injections as described in the preceding article. If the injected liquid flows freely through the nostril, the treatment should be continued with weak solutions of sulphate of zinc or copper, or nitrate of silver, and the patient advised to press upon the sac with his finger from time to time. If the liquid does not pass, or passes with difficulty drop by drop, we introduce an olivary sound, not too fine (Bowman's No. 2), into the duct, without previously dividing it, and thence through the sac and into the nasal canal. This, with the addition of injections, will succeed when there is only a moderate degree of general swelling, or slight isolated strictures. But should the first introduction of the probe demonstrate the presence of a considerable contraction, which is likely to require its prolonged use or other treatment, we pass immediately to a method which *Bowman* has described in the *Ophthalmic Hospital Reports* for October, 1857.

The method is as follows:—We begin by opening the inferior lachrymal passage, as has been described in p. 589. The communication once established, we can easily empty the sac by external pressure, and thus prevent the accumulation of matter.

To penetrate the nasal canal, we select one of the finer numbers of Bowman's series of probes. There are six sizes in the series. These probes, made of malleable silver, are of different diameters, No. 1 being about the thickness of a strong horse hair, whilst No. 6 is nearly a millimetre in diameter. We prefer to use probes with an olivary point, for they seem to enter more easily, and are less liable to tear the mucous membrane or to make a false passage. The probe which we are about to use may be bent into a curve, as it then follows the course of the passages more easily. The introduction of the probe by the inferior canaliculus may be effected in the following manner:—

With the left hand the inferior palpebral margin is drawn outwards, then the probe is introduced into the opened canaliculus, along which it is made to glide gently towards the lachrymal sac, its extremity being

directed inwards and slightly upwards. In this way the probe is advanced, without interruption, till its progress is arrested by a firm structure. Having arrived at this point, its direction must be completely changed. Keeping the extremity in the sac, we give to the probe a circular movement, only stopping when it is in a straight line with the nasal canal. At the same time, we always keep close to the posterior wall of the sac, along which it should be made to glide into the canal.

In the majority of cases, if the rules just described have been carefully observed, there is no difficulty in entering it. Still, if the membrane be greatly swollen, the probe may be caught in the orifice. The exercise of any force should be carefully avoided in these manipulations. Whenever the probe meets an obstacle, it must be slightly withdrawn, and again pushed gently forwards in a fresh direction, until we feel it sliding gently into the opening.

If these precautions are not attended to, we run the risk of irritating the mucous membrane, or even of perforating it and of making a false passage. If, notwithstanding all our care and patience in these delicate manipulations, we do not succeed in finding the opening of the canal, it is better to give up all attempts for the time being, and to repeat them next day.

When we have once entered the duct, we require only to push the instrument from above downwards, gradually increasing the pressure if we experience any resistance, but avoiding any deviation to one side or the other. Most frequently the obstacle is overcome without difficulty when it consists only of a moderate swelling of the mucous membrane, or even of a slight cicatricial contraction.

When we are stopped by a constriction, it is well to withdraw the probe for a short distance and to push it in again, endeavouring to remove the obstacle by continuous and steady pressure. The probe first introduced is of moderate size (No. 2 or 3 of Bowman); but when the contraction is great we are obliged to have recourse to No. 1.

When we wish to catheterise the nasal canal by *Weber's** method, that is, by introducing the probe by the superior canaliculus, we use Weber's knife (Fig. 260) to open it. The small rounded point of the knife is introduced into the superior lachrymal punctum, whilst we draw the internal angle with the left hand upwards, and turn the palpebral margin slightly outwards. The small knife is then made to enter the sac, and the canaliculus is divided by lowering the handle.

If we wish at the same time to divide the internal palpebral ligament, a proceeding which will greatly facilitate the introduction of probes, we make the blunt point of Weber's knife slide along the posterior wall of

* See *Archiv für Ophthal.* 1861.

the sac behind the ligament, then, turning the edge of the knife forwards and pressing it against the ligament, we divide it by a single sweep of the knife from behind forwards.

Weber also uses special probes; these are elastic bougies, and the

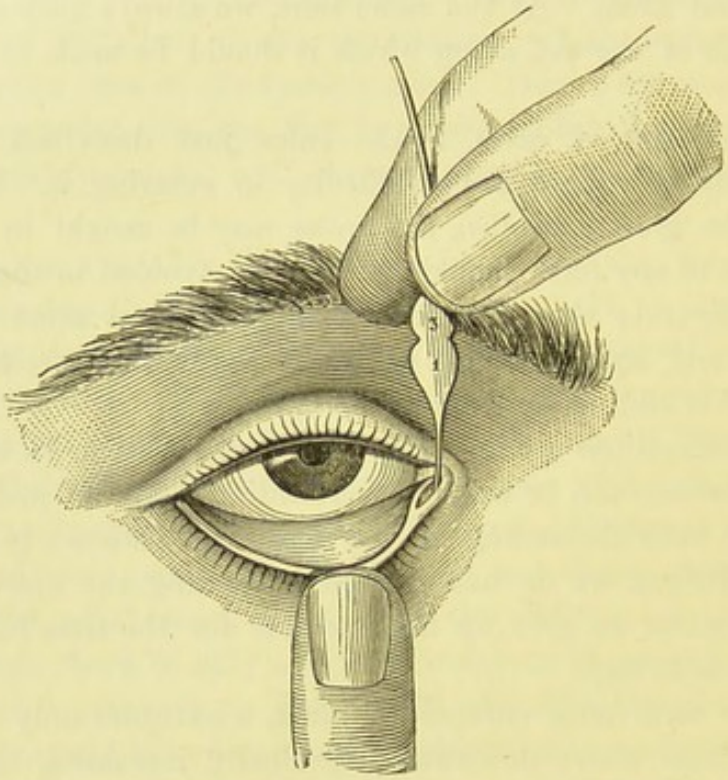


Fig. 262.—Probing the nasal duct (Bowman's method).

smallest corresponds with Bowman's No. 5. If he does not succeed in introducing the finest at the first attempt, he uses a narrower conical probe to break up the constriction (Fig. 263).

Fig. 263.—Weber's Sound.

Otto Becker has shown that we can introduce probes without previous division, even using those of considerable size with conical extremities.

Whatever procedure be employed, it is well to inject afterwards cold water into the sac and canal. In case the injected fluid does not pass through the nose it is necessary to use hollow sounds, to which we can adapt a caoutchouc bag or a small syringe filled with

water. Having introduced the sound into the canal, we apply the small bag, and make the water pass through the sound, which is gradually withdrawn from the canal and sac. We may also use injections of tepid water or antiseptic solution to cleanse the nasal canal and diminish the congestion of the mucous membrane. In the same way we may also inject astringent lotions, such as solutions of the sulphate of zinc or of copper. During the injection the patient should be directed to bend the head a little forwards, so that the liquid which comes into the nasal cavity may escape by the nostrils.

The sounding of the nasal duct should be continued till its permeability is re-established. Although the inflammation is arrested, and the tears resume their regular course, and the patient experiences great relief, we should not all at once discontinue the treatment, but increase the length of time between the successive introductions of the probes, and thus overcome any tendency to relapse, which is only too frequent in such cases. Usually we do not employ any larger probes than Bowman's No. 3 or 4.

For patients who cannot come sufficiently often to consultation, and with whom the insertion of a probe for a few minutes does not seem to be sufficient, we, as a rule, leave the probes in position for several days. In such cases, we use small probes with olivary ends, with the other extremity curved at a right angle and made very thin, so that it can rest in the inferior canaliculus. If its contact irritates the conjunctiva, we bend its extremity at an acute angle over the skin of the commissure. *Bowman*, *Critchett* and *Schweigger* have used similar sounds, and have been satisfied with this permanent dilatation. Still, if we seem to be long in accomplishing our purpose, we try for a few days the introduction of Bowman's or Weber's largest sounds, and continue their use according to the effect produced.

Sometimes a continuation of the lachrymation is due to an increase in the size of the caruncle, which may easily be reduced by a partial excision. At other times we treat the condition of the mucous membrane by injecting astringents into the nasal duct, and by injecting nitrate of silver into the lachrymal sac. In a certain number of cases, it is true, we can easily pass sounds into the canal, but neither the tears nor any liquids injected by the hollow sound escape into the nasal cavities. We must then look for an obstruction at the inferior opening of the duct. To remove it we introduce a grooved sound as deeply into the canal as possible, and by means of this sound we guide a very narrow-pointed knife down to the obstacle, which we divide. We then at regular intervals during the first few days wash out the duct by injections.

Special attention must also be given to any change in the dimensions of the sac.

When, for example, the sac has been much dilated and the walls thinned and distended by the long retention of accumulated fluids, it often happens that, after the obstruction of the canal has been overcome, the sac, from the relaxed and dilated condition of the walls, does not regain its normal dimensions; such dilatation may seriously impede the recovery of the patient.

In such cases, the patient should be directed to empty the sac frequently by pressing on it with the finger, compressing it as often and as long as possible so as to prevent its filling again. To prevent its repletion during the night, we may have recourse to pressure kept up by means of compresses kept in position either by adhesive plaster or a bandage. We never follow *Bowman's* advice, viz., to remove by dissection a portion of the anterior wall of the sac, nor *Critchett's*, who makes a large opening into the sac, and applies potash to its interior, thereby destroying it considerably, without damaging the skin.

Weber, with the intention of preventing the tears from entering the sac for some time, causes a temporary eversion of the inferior lachrymal canal by means of a small ligature, in which he encloses the lachrymal punctum and a small fold of the external skin. The faradic current applied to the orbicular muscle also hastens the return of the sac to its former dimensions.

In the large majority of cases, a combination of these different expedients overcomes the disease. Still it must be admitted that we find cases in which, although the lachrymal passages have returned to their normal condition, there remains a certain amount of lachrymation. It must also be remarked that, in a certain number of cases, the probing of the nasal duct should be continued for a length of time, and that a course of treatment of several weeks' or even months' duration is not possible in all cases, and is not always followed out by the patients.

In these cases benefit is derived from the use of *Stilling's* procedure, which consists of the internal division of the constrictions of the nasal canal, and is performed in the following manner:—The canaliculus is first incised, and an exploratory sound introduced to ascertain the exact seat of the stricture. Having withdrawn the sound, we introduce Stilling's small knife (Fig. 264), with its edge forwards, and push it on

Fig. 264.—Stilling's knife.

till it encounters the obstruction. If the obstruction is distinctly felt, we plunge the instrument in up to the handle; then we withdraw it a little, and make incisions in three or four different directions, so that

the instrument, which was at first tightly grasped, can be turned on itself in every direction. This finishes the operation, and the knife is withdrawn. According to *Stilling* we should beware of introducing sounds after the operation.

Other surgeons prefer to catheterise the nasal duct with Weber's sounds immediately after the division of the stricture. We use *Stilling's* method in cases in which there is a single contraction difficult to dilate; and in these cases it has always given good results. We never use it when the passage is stopped up by a swollen mucous membrane, which yields more easily and with less risk of future complications to astringent injections. To incise a single constriction we introduce a grooved sound, and along the groove run a small narrow convex probe-pointed knife. Having withdrawn the sound, we make our incisions, and immediately thereafter pass a thick sound, and finish the operation by injecting cold water.

When there is no contraction we must look for the cause of lachrymation also in a faulty position of the palpebral margins, accompanied with an insufficient occlusion of the lids and a defective action of the orbicular muscle. This source of lachrymation has been specially mentioned by *Ad. Weber*,* who has also suggested some very ingenious methods of remedying it.

In certain cases we find a shortening of the palpebral fissure due to cicatricial contraction of the free margin of the lids (after blepharitis). The inferior lid is then stretched between the external and internal palpebral ligaments, and does not, when the lids are shut, become displaced inwards so as to compress the lachrymal sac.

The skin seems wrinkled at the internal angle, as in epicanthus. When the patient tries to shut his eye, the lachrymal puncta project forwards. To remedy this state of affairs, we may divide the external palpebral ligament in the following manner:—An elongated vertical oval, comprising the skin and the muscular layer, is excised, in a zone intermediate between the external palpebral commissure and the insertion of the external palpebral ligament to the orbital margin. Having freed the margins of the wound above and below, we take hold of the external palpebral ligament on a sharp hook and detach it with a pair of scissors. This being done, if the palpebral occlusion is still imperfect, we incise, on both sides of the external palpebral ligament, the tarso-orbital aponeurosis in a direction parallel with the palpebral margin; then we unite the wound horizontally by two or three sutures. If there be at the same time a tendency to ectropion, we make the incision in the skin alone, and separate it, especially

* *Annales d'Oculist.*, 1875.

towards the inferior lid, as far as the palpebral margin, so as to give it perfect mobility.

In another set of cases, the lids are relaxed; they seem to be too large and are much wrinkled. If the relaxation is confined to the margin, we excise from the neighbourhood of the external commissure a semi-lunar piece, the concavity of which faces inwards, and which embraces the skin, the aponeurosis and the tendon. The size and shape of the piece excised should vary with the amount of lid tension which we wish to procure. The margins of the wound are united in the primary direction by sutures which pierce the skin and the muscle. If we wish to increase the tension throughout the entire breadth of the lid, we remove in the same way and from the same situation a flap in the form of an open V directed upwards.

In a third set of cases the lids are so relaxed as to allow the external palpebral commissure to fall downwards, the superior lid covers a large segment of the cornea, and the inferior lid leaves here a greater portion of the sclerotic beneath the cornea, especially towards the external angle. To rectify this condition, we excise, opposite to the external commissure, a rectangle including the skin, the muscle and the aponeurosis. The ligament should be entirely left alone, and the position of the rectangle should be such that its inferior border corresponds with the inferior margin of the palpebral ligament. According to the effect which we desire to obtain we must vary the diagonal length of the rectangle which begins at the commissure and extends upwards and outwards. The union of the margins of the wound is so arranged that the angle of the rectangle nearest to the commissure fits into the angle immediately opposite.

These operations of *Weber* only indicate general principles, which the physician may modify and combine according to the nature of the case.

ART. III.—Phlegmon of the Lachrymal Sac, Acute Dacryocystitis.

This disease manifests itself by redness of the skin near the internal angle of the eye, and by a swelling in the region of the lachrymal sac. The redness and the swelling extend along the lids, and even the bulbar conjunctiva becomes hyperæmic and chemosed. This condition is accompanied by intense pain on pressing the lachrymal sac.

At this period, plegmon of the sac is apt to be confounded with

diffuse abscess of the cellular tissue which surrounds it. The diagnosis, however, is cleared up if there be a previous history of lachrymation and catarrh of the sac.

Moreover, after some time, we find in the middle of the general swelling a well-defined tumour, of the shape and in the position of the lachrymal sac. The swelling increases, as does also a throbbing pain; the skin becomes of a deeper red and softens, and fluctuation sets in; before long the tumour bursts, and gives issue to the purulent matter contained in the sac. The evacuation of the abscess greatly relieves the patient; and, in fortunate cases, the inflammation disappears, the opening in the sac contracts and becomes closed, and the tears resume their normal course.

In other cases, the pus passes beyond the wall of the sac, and makes its way to a point at a considerable distance from the morbid focus; hence there is a fistulous opening which allows the morbid products and, at a later stage, the tears to escape (fistula of the sac). This condition, and the persistence of the catarrh of the mucous membrane, predispose to repeated attacks of phlegmon.

Ætiology.—Phlegmon of the lachrymal sac is frequently caused by the constriction of the nasal canal, due to catarrh of the lachrymal passages. Inflammation of the periosteum and caries of the bones of the nose, in syphilitic or scrofulous subjects, also lead to acute dacryocystitis. This disease is sometimes also idiopathic, being occasionally accompanied with erysipelas of the lids and face after a chill.

Treatment.—In the very beginning of the disease, we may apply hot fomentations to the diseased part; we keep the patient at rest and administer a laxative. As soon as we feel fluctuation, it is necessary to empty the sac of its purulent contents in some way. Formerly, for this purpose, an incision was made through the external integuments, the sac was emptied, and advantage was taken of the opening thus made to apply the necessary remedies to the mucous membrane. In actual practice, we now preserve the external integuments of the sac as much as possible, and empty it of its morbid contents by opening one of the canaliculi and dividing the internal ligament, which allows the pus to escape freely by the conjunctival opening. Hot compresses promote the separation of the pus, and, if necessary, we afterwards inject and catheterise the canal (*v.* the preceding chapter).

Snellen suggests the following treatment:—When, in cases of phlegmon of the sac, we are threatened with perforation, or it has already taken place, a large incision should be made through the anterior wall of the sac, into which as large a piece as possible of prepared sponge should be inserted, and allowed to stay for twelve or twenty-four hours. The wound is then sufficiently enlarged to admit

of the entire surface of the membrane being painted with nitrate of silver after the removal of the sponge.

Recovery takes place rapidly, and we begin, when necessary, the catheterisation of the nasal duct in the usual way.

In treating a *fistula* of the lachrymal sac, we must, in the first place, by catheterising, ensure the escape of the tears by the usual passages. This of itself, in a number of cases, suffices to close up the fistula.

If, however, it remains open, notwithstanding that the normal conditions as to the excretion of tears have been restored, we must have recourse to some operation adapted to close the fistulous passage and its external opening. Thus, we may incise the fistula, excise the membrane which lines it, and unite the edges of the wound by one or two sutures.

In these cases, we have found the application of the galvano-cautery of great benefit. It is applied by means of a loop of platinum thread introduced into the fistula, and heated after introduction; the external integuments being carefully protected from contact with the thread. We have sometimes been obliged to apply the cautery several times, but even then we prefer it to any other method, for patients do not experience any pain, and can return immediately after this small operation to their ordinary occupations.

Obliteration of the lachrymal sac is only employed in the most serious cases, in which the integrity of the structures is so compromised that we cannot hope to restore, even incompletely, the freedom of the nasal duct. Such cases are those in which the bone and the periosteum are affected, in which the sac has been the seat of repeated inflammations, with prolonged suppuration in the fistula, the skin being discoloured and altered, or in which we can no longer find any trace of the nasal duct.

The methods by which the sac may be destroyed are many, but to be of any service they must fulfil the same ends—viz., (1) the obliteration of the canaliculi, in order to prevent the tears reaching the sac; (2) the destruction of the mucous membrane of the sac, so as to allow of the obliteration of the sac by granulations.

To destroy the passages, we use the galvano-cautery with good results. The loop of platinum thread is introduced into the passages and heated to a white heat; the thread being pressed against the internal wall of the passage until it is destroyed. Occlusion takes place rapidly, but, when necessary, the cautery may be re-applied.

For the obliteration of the sac, we may use the galvano- or thermo-cautery, or solid caustics, such as nitrate of silver. We must first, however, make a large opening in the wall of the sac, that through the opening thus made we may be able to apply the caustic to the entire

mucous membrane, and especially near the internal orifices of the lachrymal passages. This cauterisation occasions no reaction which cannot easily be held in check by cold compresses and a bandage.

When we wish to destroy the sac by solid caustics, we may advantageously use Delgado's* caustic holder (Fig. 265).

The movable valves of this instrument separate the lips of the wound considerably, and allow the caustic to be directly applied to the openings of the canaliculi. After forty-eight hours the thick eschar which covers the mucous membrane should be removed, and a bandage applied sufficiently tight to bring the surfaces of the sac together.

An unsuccessful result is sometimes due to the alterations of the thickened mucous membrane, on which the caustic has hardly any effect. It may then be necessary to excise the membrane lining the sac before applying the caustic.

Berlin, of Stuttgart, has published a certain number of cases in which

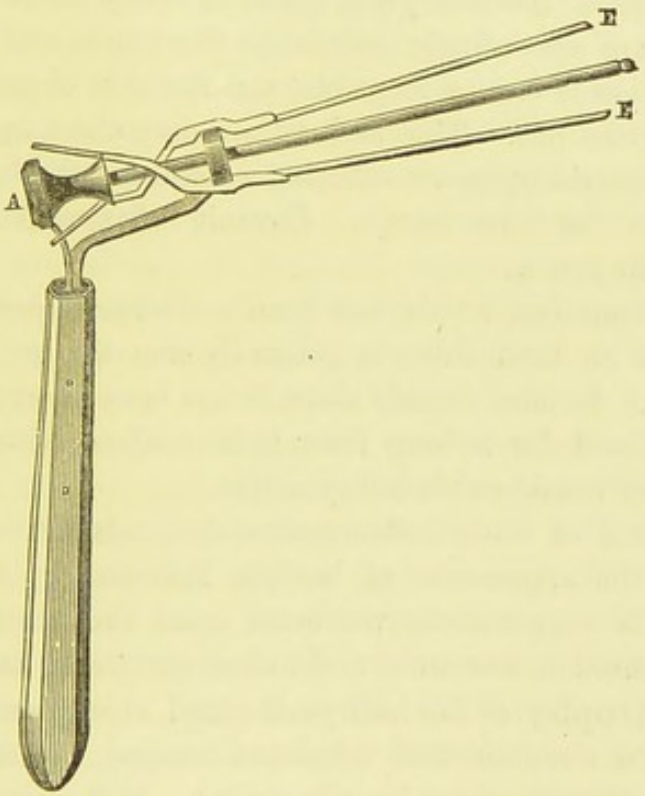


Fig. 265.

he has obtained obliteration of the sac by simple excision of the mucous membrane, which he has removed either at once or by small flaps at different times.†

* See *Annales d'Oculistique*, t. lv., p. 236.

† See *Compte Rendu des Séances de la Société Ophthal. de Heidleberg* (Session 1868), reported in the *Annales d'Oculistique* for January and February, 1869, p. 63.

ART. IV.—Inflammation of the Lachrymal Gland (Dacryoadenitis). Hypertrophy and Tumours of the Lachrymal Gland.

1. **Inflammation** of the lachrymal gland, an exceedingly rare affection, produces a considerable swelling at the superior and external margin at the orbit. The superior lid is swollen and hyperæmic, the conjunctiva is injected and chemosed. If the swelling is great, the eyeball may be displaced downwards and inwards, and its movements upwards and outwards restricted.

Inflammation of the lachrymal gland is rarely acute. Should it be so, the parts are exceedingly painful to the touch, and the swelling is great; fluctuation is soon perceptible, and the skin is perforated, giving outlet to a little pus. The perforation may close again in a short time, or may remain open, constituting a fistula of the lachrymal gland, through which the tears escape. Chronic inflammations of the gland may also end in fistula.

Acute inflammation, which has been sometimes observed occurring simultaneously on both sides, is generally due to the effects of cold, or to injuries. In the chronic state, it has been observed in persons who have suffered for a long time from conjunctivitis and corneitis accompanied by considerable lachrymation.

The treatment of acute inflammation demands active antiphlogistic measures, as the application of leeches, followed by hot cataplasms. When there is suppuration, we must open the abscess freely. In chronic inflammation, mercurial and iodine ointments have been used.

2. **Hypertrophy** of the lachrymal gland, slowly and without pain, gives rise to a circumscribed lobulated tumour, sometimes tolerably hard, which attains considerable dimensions. It then comes to interfere with the movements of the eyeball and of the superior lid.

This hypertrophy appears without any known cause, and has been observed to occur in children and even newly-born infants. We may try to procure its absorption by rubbing with mercurial and iodine ointments; but the excision of the tumour always becomes necessary when, from its bulk, it becomes a source of great annoyance to the patient.

3. Fibroid and sarcomatous tumours of the lachrymal gland have

been recorded, as also adenomas, hydatid cysts, and, more rarely, cancers. They require extirpation of the gland (*vide infra*).

Dacryops has already been described with the tumours of the lids.

ART. V.—Operations Performed on the Lachrymal Gland.

The operation for *fistula of the lachrymal gland* does not present any other difficulty than that of obtaining a permanent obliteration of the fistula. For this purpose, we may introduce into it probes covered with melted nitrate of silver, or needles at a white heat.

There have also been tried galvano-cautery, the injection of irritants into the fistula, and the union of the fistulous opening after its margins have been made raw or excised. *Bowman* * has been completely successful by establishing an artificial opening on the conjunctival surface of the superior lid. He operated in the following manner:—A silken thread was provided, with a needle at each of its extremities; one of these needles was introduced by the fistulous opening on the external surface of the lid, and directed somewhat upwards; then it was made to pierce the lid and the conjunctiva so as to come out on the internal surface of the lid, drawing the thread with it. The other needle was introduced in a similar way through the conjunctiva, at about half a centimetre from the first, and more towards the superior aspect of the lid. The ends of the threads were brought out at the external commissure and fastened to the temple.

Ten days after, a larger thread was introduced, which caused more irritation than the first. Lastly, the external opening of the fistula was closed by excising the portion of skin which contained it, and bringing the edges of the wound closely together. Four days later, the thread was withdrawn, the wound being perfectly cicatrised.

The *extirpation of the lachrymal gland* is rendered necessary by the development of tumours in the gland itself, or in its neighbourhood, and by its hypertrophy and induration.

* See *London Ophthalmic Hosp. Reports*, vol. i., p. 288.

It has been recommended and practised to overcome lachrymation which has not yielded to any other form of treatment (*Z. Laurence*).*

When there is a hypertrophy or a tumour, the operation is begun by a cutaneous incision above the tumour, parallel with the orbital margin, and sufficiently long to lay bare the anterior portion of the tumour which forms the altered gland.

We may also, before the incision, draw the lid firmly downwards, and carry the knife into the skin of the closely shaven eyebrow. If the size of the tumour requires it, we may, following *Velpeau's* advice, divide the external commissure towards the temple, thus uncovering the external two-thirds of the orbital circumference.

The gland thus laid bare should be seized with a hook or toothed forceps, drawn forwards and separated from all adhesions with a knife or scissors. When there is induration of the gland, it is better to free the tumour with the finger nails and the handle of the scalpel. After the removal of the tumour we must carefully examine the cavity with the finger, in order to make sure that no indurated tissue remains. When the hæmorrhage has stopped, we clear the wound from all clots and bring the margins together with sutures. A compress and bandage keep the eyeball in position, and maintain the walls of the cavity which contained the tumour in close apposition.

Laurence's method of removing the healthy lachrymal gland is the following:—After the patient has been completely anæsthetised, the skin is divided with a long and narrow scalpel, immediately above the orbital margin, in its external third. The fascia is then incised, and we enter the orbit at the lachrymal gland. This last is easily felt, as a smooth round body, by running the finger along the orbital wall.

If any difficulty is found in getting the gland, *Laurence* advises that the external commissure be divided by a horizontal incision which is prolonged till it meets the first; thus a flap is formed with the apex turned outwards, and the gland can be much more easily felt. It is then seized with a double hook, drawn forwards, and detached with the extremity of the scalpel. The hæmorrhage which follows this operation should be arrested by cold water irrigation, and, after it has completely stopped, the lips of the wound may be drawn together by a few sutures.

In one case of congenital epiphora of both eyes where all treatment had been of no avail, the patient being a young girl of sixteen who considered her condition as insupportable, we extirpated both lachrymal glands with complete success.† In order to avoid the cicatricial retraction of the upper eyelid in case of suppuration, the incision was

* *Compte Rendu du Congrès Opthalmol. de Paris*, 1867, p. 35.

† *Bulletin de la Soc. de Chirurgie*, Mai, 1881.

made above the eyebrow after drawing it firmly downwards, following the superior border of the orbit from its external third to its union with the inferior border. The soft parts being detached from the periosteum, and the gland being laid bare, it was drawn out and separated from its adhesions. After the hæmorrhage was arrested, the wound was closed with some sutures and a borated dressing rather tightly applied. The wound united by first intention, leaving only a linear scar, scarcely visible. The epiphora completely disappeared, and the eyes did not appear drier than in their normal condition.

DISEASES OF THE ORBIT.

ART. I.—Inflammation of the Cellular Tissue of the Orbit and of Tenon's Capsule. Periostitis, Caries and Necrosis of the Orbital Walls.

1. **Inflammation of the cellular tissue** is manifested in its early stages by an erysipelatous swelling of the lids and a serous chemosis of the conjunctiva. The patient complains of localised pain in the depth of the orbit and of supra- and sub-orbital neuralgia. Contemporaneously there supervenes a gradual protrusion of the ball and a restriction of its movements in all directions. When the disease attains its height, the eye becomes immobile, and the chemosis is sometimes so considerable as to prevent the lids being shut. The sensibility is very great, the patient is feverish and sometimes delirious.

The development of this disease is generally very rapid, rarely it is very slow; in the latter case all the symptoms are less pronounced. Exceptionally, the inflammation of the orbital tissue terminates in resolution; as a rule it ends in suppuration. The skin of the lids then becomes of a dusky red, and the swelling becomes localised to one spot, at which we can feel a more or less pronounced fluctuation. Lastly, the abscess bursts on the eyelids or into the conjunctival sinus. The vision may remain intact; occasionally there supervenes an optic neuritis with secondary atrophy of the nerve. Separation of the retina and suppurative choroiditis have also been observed; complications which can be explained by the communication of the lymphatic channels, of the sub-choroidal space and of Tenon's capsule (*Schwalbe*).

A more benign form of this disease, in which the inflammation is entirely confined to the fibrous envelope of the eye, has been described under the name of *capsulitis*, or *inflammation of Tenon's capsule*. The symptoms, less pronounced than in phlegmon of the orbit, consist of a slight swelling of the lids (this however may be entirely absent), and of a subconjunctival injection with chemosis, accompanied by slight exophthalmos and diminished mobility of the eye, which, when the visual acuteness is perfect, may give rise to diplopia. This form of

capsulitis has been observed after injuries to the capsule, after strabotomies, in cases of panophthalmitis, in erysipelas of the face, and idiopathically after chills.

2. **Periostitis of the orbit** in its acute form has many points of resemblance to phlegmon of the orbital tissue. As distinctive symptoms of periostitis we would mention the acute pain which follows pressure on the orbital margin; the lids in the early stages are less swollen, and do not present the intense redness of inflammation of the cellular tissue; lastly, the inflammation is often more circumscribed, so that the eyeball is displaced only to one side, and its mobility is more restricted in one direction than in another. The pain is very great, and is accompanied with great prostration of the physical strength of the patient.

Suppuration sometimes takes place very rapidly, and the pus, escaping along the periosteum, produces necrosis of the osseous walls and perforation into the adjacent cavities.

Chronic periostitis is much slower in its course. The disease is accompanied with periorbital pain and slight swelling of the superior lid. It may terminate in intraorbital abscess with caries or necrosis of the bony wall, or in resolution, leaving a thickening of the periosteum or an exostosis.

3. **Caries and Necrosis of the Orbit.**—These affections, as we have just said, may supervene as a consequence of periostitis. Still, the disease often begins in the bone itself, and may be situated either in the depth of the orbit or at its margin, and in the latter case it by preference attacks the inferior and external or superior and external part.

When the affection occupies the bottom of the orbit, it generally causes pain, exophthalmos and a general febrile reaction. Caries of the orbital margin manifests itself at first by œdema and swelling of the affected lid, accompanied at a later stage with inflammation of the conjunctiva. After a considerable length of time, the purulent collection gives rise to fluctuation, and finally pierces the integument of the lid, or opens into the conjunctival cul-de-sac. The pus from such an abscess has the characteristic fœtid odour of osseous caries.

After the abscess has burst, the inflammatory symptoms of the skin and conjunctiva do not completely disappear, and the suppuration continues.

A fistulous opening is thus formed, which leads to the rough surface of the denuded bone, or to a movable osseous sequestrum. The external orifice of the fistula is covered with fleshy granulations; its margins become inverted, and, when the swelling of the lid has abated, contract adhesions with the bone. Again, the tarso-orbital

fascia is also often drawn towards the diseased portion of the osseous wall, and its shortening is frequently the source of ectropion of the lid.

The fistula may temporarily close up, in which case the escape of the pus is prevented, and the inflammatory phenomena (exophthalmos, pain, fever) reappear. The disease may thus be continued for years before the secretion ceases. Should, however, a sequestrum be eliminated at an early period, the course of the disease is much more rapid.

Ætiology.—Orbital phlegmon may supervene after severe illness. Thus it may be secondary to typhoid, scarlet, or puerperal fever, or to purulent meningitis, glanders, &c.; it may also follow the penetration of a foreign body into the orbital tissue, or any operation performed on the lachrymal gland or sac. It sometimes accompanies erysipelas of the face and lids. Lastly, it is common in orbital periostitis.

Periostitis may set in after a contusion or a wound in the neighbourhood of the orbit, or it may be an extension of inflammation from the periosteum of the adjacent cavities—the frontal and maxillary sinuses, the cranial cavity. It occurs more frequently in early life than in the adult.

Caries of the orbital walls is often observed in scrofulous children, as a consequence of some exciting cause—*e.g.*, a contusion or a blow. Sometimes the caries of the nasal bone, so frequent in the syphilitic diathesis, extends to the orbital cavity. In the same way, other changes in the adjacent cavities may cause suppuration and perforation of the orbital walls.

Lastly, caries or necrosis affecting the superior orbital wall sometimes occurs in advanced life without any well ascertained cause.

The **prognosis** of orbital phlegmon is not of itself serious when uncomplicated with periostitis, for the disease rapidly subsides after the evacuation of the purulent material. It, however, is rendered serious by the possibility of the extension of the inflammation to the cranial cavity, and by the effect it may have on the eye, the vision of which may, as already described, be destroyed.

In periostitis, the gravity varies with the seat and phase of the disease. When it has been detected in the early stages, when it is situated near the orbital margin, and when the abscess has been opened at once, the affection may subside without extending to the neighbouring structures. But, on the other hand, when the periostitis is localised in the depth of the orbit, there is then a danger of its extending to the cranial cavity, and of its producing a thickening of the periosteum or an exostosis with permanent exophthalmos, more or less complete blindness, or paralysis of the ocular muscles.

The prognosis of caries and necrosis of the orbital walls is always

serious. When the disease affects the orbital margin it may give rise to ectropion; in the depth of the cavity it may extend through the optic foramen, the sphenoidal and spheno-maxillary fissures; or the pus, after perforating the orbital plate, may enter the cranial cavity. Again, in sickly children, prolonged suppuration may lead to exhaustion and thus prove fatal.

Treatment.—Except in cases of injury to the orbit, we must abstain from all antiphlogistic treatment. Locally we may use hot poultices, aromatic fomentations, mercurial and belladonna ointment as an inunction. Our general treatment must take into account the indication furnished by the state of the patient's health, and by the presence of any diathesis (syphilitic or scrofulous).

As soon as we have reason to suspect the presence of pus, it must at once be evacuated by an incision. When we are in doubt as to the presence of pus, we should make an exploratory puncture with a narrow bistoury in the oculo-palpebral furrow at the level of the orbital margin. If the fluctuation is distinct, the abscess should, if possible, be opened through the mucous surface; but, if this be not possible, it should be opened through the lid. We may sometimes be compelled to penetrate deeply into the orbital cavity, which has in the adult a total depth of about $4\frac{1}{2}$ centimetres (equal to about $1\frac{3}{4}$ inches). In these cases, a sharp bistoury is inserted between the eyeball and the wall of the orbit, at the point at which the phlegmonous swelling seems to have most widely separated the ball from the orbit.

In puncturing the abscess, we must keep in mind the direction taken by the orbital wall, along which the knife must be made to advance.

Thus, for example, on the internal side of the eye, the bistoury should be directed obliquely backwards and outwards; on the external side, obliquely inwards and backwards, following the horizontal direction. The knife should always be pushed very gently forwards, as otherwise it may pierce the bony plate.

As a general rule, it is better to make the puncture too soon than too late.

If the puncture is made too soon, it may give issue only to a very small quantity of pus, or perhaps only a little blood may escape, but by this puncture the intensity of the affection is diminished, partly by the freeing of the inflamed tissue, partly by the escape of blood, and by the opening of a few small cavities which are filled with pus. Besides, these small abscesses will open more easily in the canal of the wound than at the surface of the integuments, and we may expect to see the pus escaping through the incision, even although it may not do so at the time of puncture.

When the abscess is emptied, we should abstain from injecting the

cavity with tepid water, for the water may find its way into the cellular tissue, and increase the inflammation and suppuration. We should, however, carefully explore the cavity with a probe, and thus ascertain the condition of the periosteum and of the bone which it covers. If we find that the periosteum is thickened, or even separated by the pus, it is of the first importance to incise it deeply, in order to relieve the painful tension of the periosteum, and to prevent a more extensive separation.

When the probe reveals the presence of a bony sequestrum, it should be extracted, the wound being enlarged if necessary. In all these cases it is necessary to insert a small drainage tube of perforated rubber.

If the suppuration gives rise to an unhealthy and scanty pus, we may inject antiseptic solutions. At a later period we may use weak astringents, or a slightly irritating ointment spread on a piece of lint, which should be inserted instead of the drainage tube.

When the surface of caries bone ceases to be rough, and when we feel that the abscess is filled with granulations, we may cease the drainage and allow the external wound to close.

The prominence of the eyeball, which sometimes remains after the abscess is cured, should be checked by a compress and bandage. Any cicatricial contraction of the integuments can be removed only by an operation at a later period. We may also attempt to prevent it by temporary occlusion of the lids.

ART. II.—Wounds of and Foreign Bodies in the Orbit. Emphysema. Hæmorrhage.

1. **Wounds** of the orbit may become serious either from the secondary inflammation of the orbital tissue and from periostitis to which they may give rise, or by the direct penetration of the wounding instrument into the optic nerve or the cranial cavity. The same holds true for foreign bodies which are lodged in the orbit. Sometimes foreign bodies of considerable size remain for a long time in the orbit before they give rise to symptoms of irritation.

When the injury has fractured the orbital walls, the seriousness of the case depends especially on the situation and extent of the fracture.

A simple lesion of the orbital margin may heal up without any complication; fracture of the ethmoidal or frontal cells is generally accompanied with emphysema of the orbit and eyelids. If the vault of the orbit has been injured, the proximity of the brain and its membranes renders the case serious, for these structures may become inflamed even a few days after the injury.

The **treatment** of injuries of the orbit is, in the first place, antiphlogistic (leeches, cold compresses), and, if we cannot avoid suppuration, any pus should be evacuated at once. Any foreign body should be removed as soon as its presence is detected. When we have ascertained its position and nature, we should, if necessary, enlarge the wound by which it has entered; or, if the wound has been closed for some length of time, we must open a passage for it by an incision in the conjunctival sinus, carefully avoiding any injury to the eyeball.

2. **Emphysema** is caused by the entrance of air into the cellular tissue of the orbit. It gives rise to a certain amount of exophthalmos, and a peculiar sensation of crepitation to the touch. It is often accompanied with emphysema of the lids, and with ecchymosis when of traumatic origin.

This affection may depend on general emphysema, on rupture of the lachrymal sac, or on fracture of the frontal sinus or the ethmoidal cells.

The **prognosis** of emphysema is *per se* perfectly good; it may, however, betoken a lesion of a very serious nature.

The **treatment** is limited to the application of a compress and bandage.

3. **Effusion** of blood into the orbit causes exophthalmos and a restriction of the movements of the eye when the effusion is considerable. It is frequently accompanied with ecchymotic spots on the eyelids and conjunctiva.

In a few cases such hæmorrhages are spontaneous, and without any well defined cause (heart disease). More frequently they are due to injury, such as contusion of the orbit, a fall on the head, with fracture of the bones of the cranium.

The **treatment** consists in the application of cold compresses at the time of the hæmorrhage; at a later period the compresses may be replaced by a compress and bandage. Incisions made for the purpose of allowing the blood to escape are of no use, except in cases where the prolonged compression of the eyeball is a serious danger. Such cases are, however, rare, for the eyeball readily yields without danger to itself, and, moreover, retrobulbar collections of blood are very rapidly absorbed.

ART. III.—Exophthalmic Goitre, Graves' or Basedow's Disease.

The symptoms of this disease, of which the nature and origin are but imperfectly understood, consist in cardiac disturbance, swelling of the thyroid gland and exophthalmos.

The palpitations are often very distressing, for the number of cardiac contractions may be as many as 200 per minute. At first there is no lesion of the heart; but later we find hypertrophy with dilatation, chiefly affecting the left ventricle. We can also detect a murmur which extends along the aorta and carotids.

The increase in the size of the thyroid gland, which, however, is not present in every case, is primarily produced by a turgescence of the vessels of the gland, in which we may sometimes detect murmurs and diastolic pulsations. At a more advanced period, there is developed a true goitre, with gelatinous or cystoid degeneration and fibroid induration of the gland.

The exophthalmos is due to a hyperæmia of the cellular tissue of the orbit, which ultimately ends in hypertrophy. It generally exists to the same degree on both sides, but may be found only in one eye, or in one to a less degree than in the other. The protrusion of the eye is sometimes very slight, but at other times it is so great as to keep the eyelids from closing.

A very characteristic symptom of this affection, which is of all the greater importance from the fact that it is present from the beginning of the disease, even before the exophthalmos, is a deficiency of the innervation of the superior lid (*von Graefe*). This lid does not come down as far as usual, especially when the patient looks downwards, so that, when the eye is in this position, a portion of the sclerotic above the cornea becomes visible.

In addition to the symptoms enumerated, there is also nervous agitation and a great predisposition to perspirations, trembling of the hands, disturbance of the digestion, especially in the early stages of the disease, and to frequent vomiting. The patient suffers from a feeling of langour and from all the signs of anæmia. When the exophthalmos is so great that the lids no longer cover the cornea during sleep, we find various forms of conjunctivitis and ulceration of the cornea as in neuroparalytic corneitis. Finally, the eye may be destroyed. In

general, vision remains normal. The ophthalmoscope reveals extensive pulsation of the retinal vessels (*O. Becker*).

Ætiology.—The disease is much more frequent in women, especially when chlorotic, than in men. It occurs in men at a more advanced period of life, and is then of a much more dangerous character.

Prognosis.—The disease may at the outset be completely cured, or may be arrested, leaving only a slight degree of exophthalmos or of swelling of the thyroid. As long as there is the abormal frequency of the cardiac beat, we may expect to have a relapse. The prognosis is more serious in men, for in them corneal complications and a fatal termination of the disease are more frequently observed.

Treatment.—We must avoid all reducing treatment. Iodine preparations are rarely of use, bromides and digitalis serve to modify the excessive action of the heart. Good results have followed the administration of the tincture of veratria viride, of iron preparations, as also from hydrotherapeutics, milk and whey diet, and change of air. The constant current seems in some cases to diminish the protrusion of the eyeball. *Dujardin-Beaumetz* advocates hypodermic injections of $\frac{1}{4}$ to $\frac{1}{2}$ gr. of duboisine.

The exophthalmos may become the object of special treatment, either from its persisting after the disease is cured, or as a means of preventing corneal complications. *Von Graefe* advises, with a view of meeting the special conditions, tarsoraphia, or partial tenotomy of the levator palpebræ superioris. The following is his method of operating:—An incision is at first made parallel with the superior palpebral margin, at about half a line from the superior border of the tarsal cartilage. A few fibres of the orbicularis having been excised, the tarso-orbital fascia is laid bare, and in it we see the expansion of the levator. This layer is divided with a narrow and very sharp knife, care being taken not to wound the subjacent conjunctiva. The section should extend on both sides to the limits of the tendon, leaving at the middle a bridge about a line broad. We thus bring about a kind of semi-ptosis which recedes during the first fortnight, leaving ultimately the desired effect.*

As to the treatment of corneal complications, the reader is referred to the special chapter on that subject.

* *Compte Rendu du Congrès Ophthalmologique International*, 1867.

ART. IV.—Tumours of the Orbit.

Tumours which are developed in the orbit push the eyeball forwards, and at the same time often displace it laterally, according to the size and situation of the neoplasm. The movements of the eye are almost always restricted, either because the tumour directly prevents them mechanically, or because it has involved the muscles and nerves, which may only be compressed, but are often destroyed, by the growth of the tumour. Moreover, the neoplasm, as it enlarges, often becomes more adherent to the eyeball, or after piercing its envelope may even extend into its interior. More frequently, however, we find intra-ocular tumours perforating the sclerotic and extending to the orbital tissue.

As the exophthalmos produced by the tumour increases slowly, the visual functions of the eye are not exposed to immediate danger; on the one hand, because the optic nerve stands a certain degree of extension very well, and, on the other, because the superior lid, in such cases, elongates considerably, and thus continues to protect the cornea. Thus, the vision is preserved till the irritation, the compression, or the distension of the optic nerve leads to neuritis or atrophic degeneration. If the optic nerve itself be involved in the tumour, atrophy of the disc and blindness occurs at the very outset.

Direct examination of tumours of the orbit is not possible so long as they are very deeply situated. The best means of detecting them is to insert the little finger between the superior lid and the eyeball, and thus explore the orbit through the conjunctival sac. In other cases we may even require to puncture with an exploring needle before we can make certain as to the nature of the neoplasm.

The tumours which are developed in the anterior portions of the orbit are naturally more easily diagnosed. When they at the same time extend behind the eyeball, and become the source of exophthalmos, it is not always easy to say how far they extend.

In all such cases it is important to take into consideration the ætiology, the mode of development of the tumour, and such conclusions as may be drawn from the patient's general condition.

1. **Cysts and Hydatids.**—Follicular cysts may occur in any part of the orbit ; but they are most common in connection with the skin of the eyelid, from which they may extend into the depth of the orbital cavity. Sometimes we find dermoid cysts which are due to the congenital invagination of a piece of skin. Viewed externally, the cyst forms a round and elastic projection between the eyeball and the

orbital margin. It is more or less fluctuating, and on pressure recedes into the orbit.

Cysts generally take a considerable time to develop, and during their growth the patient does not suffer much, nor is the sight perceptibly diminished.

More rarely, the cyst increases rapidly, attaining a considerable size in a short time, in which case it may disturb the functions of the eye. Cysts are of more frequent occurrence in young subjects than in adults, and seem sometimes to be due to a contusion in the neighbourhood of the orbit.

The wall of the cyst is in some cases thin and serous, but in others thick and fibrous, containing cartilaginous or even bony deposits. The contents may be serous, fatty, atheromatous, or like honey. Hairs, and even rudimentary teeth, are found in such tumours of the orbit, as often happens in the case of dermoid cysts.

The two forms of hydatids observed in the orbit are the cysticercus and the echinococcus. The diagnostic characters are those of encysted orbital tumours generally. The cysticercus seldom attains a greater size than that of a large bean. The echinococcus may be isolated, or there may be several of them together.

2. Orbital **lipoma** is due to a hypertrophy of the adipose tissue, and may occur either in the intra-muscular space or external to the muscles. It is of very slow growth, and to palpation seems puffy, and gives the sensation of false fluctuation.

In case of doubt, an exploratory puncture will indicate the nature of the tumour.

Lipomata are generally found in young persons, and have even been observed as congenital malformations.

3. **Fibromata**, of somewhat rare occurrence in the orbit, originate in the periosteum, and are most frequently pediculated, although sometimes they have a broad base. They grow very slowly from the side of the orbital cavity, pushing the eyeball aside, and are very frequently surrounded with a layer of condensed cellular tissue. The fibroma sometimes contains nuclei of bone, and gives to the finger, if it can be reached, the sensation of a small, circumscribed, firm, and mobile tumour. Very rarely its contents become soft, and give rise to a sense of fluctuation.

When the fibroma is of large size, it may hollow out, or even destroy the orbital wall.

4. **Exostosis** is of frequent occurrence in the orbit, and may be due to periostitis or ostitis. Tumours of this class are sometimes composed of a bony envelope enclosing a soft substance, sometimes of a bony nucleus surrounded by a cartilaginous tissue; again, they

may be composed of a true, perfectly-developed, and excessively-hard bony tissue throughout the entire thickness of the tumour. The last-named variety is the commonest in the orbit.

These eburnated tumours are of slow growth, and may remain stationary; but often their progress, although slow, is continuous, so that they come to invade the surrounding cavities. They almost always originate in the frontal or ethmoid bones. Their surface is irregular and nodular, and they are as hard as ivory.

5. **Sarcoma and Carcinoma of the Orbit.**—Tumours presenting the characteristics of carcinoma and of medullary cancer occur in the orbit. Some of these tumours are melanotic, being largely provided with pigment. The orbital sarcomata are sometimes benign, sometimes malignant. In the first case they are of slow growth; they affect the eyeball only by mechanical pressure, and do not recur after extirpation.

Carcinomatous tumours of the orbit originate in the cavities surrounding the orbit, in the orbital walls, in the retrobulbar adipose tissue, and, most frequently, in the eyeball, from which they extend to the orbit, either perforating the sclerotic, or else growing along the optic nerve. Only occasionally do we find the cancer beginning in the orbit and extending to the eyeball.

When the tumour affects the ball, it pushes it before it, and destroys it by compression. Again, when the lids no longer cover the cornea, that membrane becomes ulcerated, and the eye gradually atrophies. The surrounding cavities also become affected after the cancer has destroyed the bony walls, but the disease does not seem to spread through the natural fissures of the orbit.

Sometimes the growth of such tumours is slow, but at other times it is rapid and accompanied with more or less pain. Cancerous tumours of the orbit are of more frequent occurrence in early life.

Hard scirrhous cancer is not common in the orbit. The orbital tumour is generally soft, and may communicate to the finger a deceptive sensation of fluctuation.

6. **Vascular tumours** of the orbit may exist either as nævi or cavernous tumours, or as aneurisms.

The nævi and cavernous tumours almost always begin in the lids, from which they extend to the orbit. Still, cavernous tumours have also been known to begin in the orbit itself. In such cases they are, as it were, surrounded by a layer of condensed cellular tissue.

The characteristic symptom of vascular tumours is that they become enlarged whenever there is anything to cause mechanical hyperæmia or general disturbance of the circulation, as when the patient cries, or makes strong muscular efforts, or bends his head.

True aneurism has been observed in the orbit in a few rare cases, as aneurism of the ophthalmic artery, and of the central artery of the retina. Such aneurisms are always very small and do not greatly disturb the vision or displace the eye.

False or diffuse is much more frequent than the last-mentioned variety. It is always caused by some lesion of an orbital artery. Thus the artery may previously have been the seat of an aneurism which has burst, or its walls may be atheromatous (secondary aneurism), or the lesion may directly affect a previously healthy artery (diffuse aneurism).

Intraorbital aneurisms, especially frequent in England, have only been observed amongst adults, usually as the result of a blow or a fall, and amongst women sometimes without these causes. In traumatic cases, symptoms of fracture of the base of the skull are observed at the outset. In spontaneous cases, patients suddenly perceive in the orbit or in the head a noise like the crack of a whip or the click of a gun lock. The conjunctiva becomes injected, the lids become œdematous and open with difficulty. The patient experiences a sensation of tension and of pain, together with pulsations in the orbit and the head.

In all cases exophthalmia supervenes. Sometimes a nodulated, soft elastic tumour makes its appearance. The tumour is highly pulsatile, but the pulsations cease when the carotid of the same side is compressed. When the patient bends his head the pulsations become still more marked, and the colour of the tumour becomes darker. By applying a stethescope to the eye, we can distinctly hear a souffle which varies in intensity, or detect the peculiar hissing or beating sound which is such an annoyance to the patient himself, and sometimes so loud as to be audible at some little distance.

All these symptoms may follow the injury immediately or after the lapse of some time, gradually and slowly increasing.

Compression of the carotid on the affected side causes a diminution in the intensity of the symptoms, or may even make them disappear altogether.

Treatment of Orbital Tumours.—When we have to deal with ordinary exostoses it is advisable to make use of prolonged treatment with the iodide of potassium administered in progressive doses as high as 8 or 10 grammes daily. We have seen large ones made to disappear in this way. We should operate on an orbital tumour when it is of a malignant nature, and on any other one whenever it begins to disturb the eye, when its rapid increase in volume threatens the destruction of the organ, or when we can foresee that operation would be more difficult at a later period.

The method of operating is, in general, determined by the nature and position of the neoplasm. We usually prefer to remove the tumour through the lid, for the operation through the conjunctiva is more difficult, and may end in a faulty cicatrix. Sometimes it is sufficient to enlarge the external commissure of the lids. It may also be necessary to separate the superior lid by two vertical incisions extending from the extremity of the commissure to the superciliary ridge, and thus to turn the lid back on the frontal bone. As a rule, at the most prominent part of the tumour, we make an incision parallel with the orbital margin, which should extend down to and lay bare the surface of the tumour.

When the tumour is of great size, it may be necessary to make a T-shaped incision. In any case the tumour must be freed from the surrounding structures, and drawn out with forceps, all adhesions being divided with a bistoury or scissors.

The tumour should be removed as completely as possible, so as to prevent a recurrence. When it is closely adherent to the periosteum, that membrane should be thoroughly scraped. This precaution is all the more necessary when we have reason to suspect that we are dealing with a carcinoma.

When we are dealing with *cysts* it is important to remove them in their capsules, for cases have been seen in which, after the incomplete removal of a dermoid cyst, the suppuration has lasted for years, until another operation has removed the last remnants of the cyst wall.

The operative treatment of orbital cysts depends entirely on the consistency of their contents, which may be liquid, semi-liquid, or somewhat dense. In many cases we can make certain of the diagnosis only by an exploration puncture; but, before introducing the exploring trochar, we should make sure, by palpation, auscultation, and a study of the previous history of the case, that we are not dealing with an aneurism. The puncture can only give absolute certainty when a more or less fluid liquid escapes by the canula. In such cases, simple puncture, followed if necessary by the injection of irritants, or by a more extensive incision, often suffices to bring about a cure by setting up an adhesive inflammation.

When the fluid contents are very considerable, and extend deeply into the orbit, it is dangerous to provoke suppuration, for the cyst may be in contact with the membranes of the brain. In such cases, the introduction of irritants or of lint into the cyst should not be resorted to, the more prudent course being to repeat the incision or puncture, and to apply a pressure bandage. When the cyst is not large, and when its contents are dense, the tumour should be dissected out, care being taken, when dissecting near the capsule, to use the

finger or the handle of the scalpel rather than the blade; for, if the capsule is wounded, the complete enucleation of the cyst is rendered more difficult, if not impossible. In all these operations, we must carefully protect the eye from any dragging or needless manipulation. It is only when the complete extirpation of the neoplasm is impossible without the enucleation of the eye, and when the eye has undergone considerable alterations, that the removal of the ball is indicated (see further on). When the tumour is external to the muscles of the eye, the ball should be preserved intact, even when we are obliged to lay it bare to a considerable extent. Experience has shown that, in such circumstances, the eyeball may be preserved in a fit condition for its ordinary functions.

Vascular tumours have been submitted to various modes of treatment. In a few cases of cavernous tumour, excision has been practised with success. Aneurismal tumours have been treated by compression, by ligature, and by direct coagulation of the contained blood. Amongst the means employed to obtain the coagulation, we may mention the injection of the perchloride of iron (*Motteggia, Désormeaux, Bourguet*),* or of the lactate of iron (*Brainard*),† acupuncture, and electropuncture.

Compression has been made either directly on the aneurism or on the carotid artery.

Ligature of the artery seems, however, to have been the most successful method of treatment, for in thirty-two cases reported by *Demarquay*,‡ *Zander* and *Geissler*,§ there were twenty-two successful cases, eight cases of partial cure, and two cases of death.

We should therefore have recourse to surgical interference only in such cases as are unsuited for any other mode of treatment.

Special mention should be made of *bony* tumours, which are sometimes exceedingly difficult to remove, because their hardness makes it almost impossible to attack them with surgical instruments. Their extirpation is only possible when we can succeed in removing the entire mass;‖ for the hardness of these tumours renders any attempt at partial extirpation futile. It is scarcely necessary to say that when the tumour is fixed to the orbital wall by a broad base, we must give up the idea of operating, as there would be a great risk of opening the cranial cavity. Death has followed operative attempts in such cases.

* *Demarquay, Traité des Tumeurs de l'Orbite*, p. 348. 1860.

† The *Lancet*, 1853; *Union Médicale*, No. 104.

‡ *Loc. cit.*, p. 574.

§ *Die Verletzungen des Auges.* Leipzig, 1864.

‖ *Maisonneuve, Gaz. des Hôpit*, No. 95, 1853; *Heynes-Walton, Operative Ophthalm. Surgery*, p. 345. London, 1853. *Textor, Würzburger Medic. Zeitschrift*, t. vii., p. 5.

After the orbital tumour has been removed and all hæmorrhage stopped, the wound of the integuments is closed by suture, the corner of the wound being left open and a drainage tube inserted. The cavity previously occupied by the tumour soon becomes filled with granulations, not unfrequently there remains a fistulous opening which requires to be treated with irritants or caustics before it is permanently closed.

ART. V.—Extirpation of the Eyeball and Orbital Tissue.

The **enucleation** of the eyeball has already been described at p. 139. *Tillaux** has proposed the following modification of *Bonnet's* method:—Having divided the external rectus, the surgeon draws the eye firmly inwards and introduces his scissors behind the eyeball; he then divides the nerve near its point of entrance. He next takes hold of the posterior segment and rotates it forward through the conjunctival wound, so as to bring the posterior part to the front. The recti muscles, as well as the obliques and capsule, are thus made tense on the sclerotic, and are very easily divided close to its surface.

The extirpation of the ball and the orbital tissue is required in malignant disease of these structures. This operation is exceedingly painful, and always requires the administration of chloroform. One assistant should administer the anæsthetic, another should fix the head and keep the lids separate, and another should be exclusively employed with a sponge in keeping the parts free from blood.

To facilitate the necessary manipulations in the interior of the orbit, the external palpebral angle may be lengthened by an incision. Then we dissect up the lids, carefully separating their internal surfaces from the eye, in order to evert them upwards and downwards, and hold them in position by blunt hooks or forceps. Drawing the eye upwards and forwards with a sharp hook or Museux's tentaculum, the surgeon inserts a narrow bistoury, held like a pen, into the internal orbital angle, along the surface of the ethmoid till he comes into the neighbourhood of the optic foramen. He then divides from within outwards all the structures in the inferior semi-circumference of the orbit, detaching all the soft structures till he comes to the external angle. Then, lowering the hook, he draws the eyeball

* *Bulletin de Thérapeutique*, p. 24, 15 Juillet, 1872.

forwards and downwards. The bistoury is then brought from the internal angle along the superior semi-circumference, the two incisions being united at the external angle. The eye is now held in position only by the muscles and optic nerve, forming a pedicle at the back of the orbit, which should be divided as far back as possible by a single cut with curved scissors.

If the lachrymal gland is involved in the disease for which it is found necessary to remove the ball, it also should be extirpated, which may be done either by including it in the original incision, or by detaching it after the removal of the ball.

The tumour being removed, the orbital cavity should be most carefully examined with the finger, and wherever diseased tissue is discovered, it should be removed down to the bone. If necessary, the periosteum should be scraped, and in a few cases we shall feel ourselves compelled to take away a portion of the bony wall. When the neoplasm has penetrated the orbital wall, we sometimes succeed in removing it with a scraper, and thus extirpate it very completely.

When the lids are involved in the disease, two semi-lunar incisions are made round them, following the line of the orbital margin and including all the diseased structures.

The hæmorrhage which occurs after the extirpation of the eyeball is often considerable, and may best be held in check by the injection of iced water and plugging of the cavity. These means are almost always successful, so that we rarely require to have recourse to the ligaturing of the ophthalmic artery and its branches, or the application of perchloride of iron, or of the actual cautery.

There is always a certain degree of danger in using the perchloride of iron in such cases, because of the proximity of the brain. The perchloride especially is apt to impede the circulation, and to cause chemical changes in the blood contained in the vessels to some distance from the part to which it has been applied. Still, we are sometimes compelled to have recourse to it.

Plugging is best effected by pledgets of lint soaked in antiseptic solution, over which the lids are shut and kept shut by a borated lint compress or phenicated cotton and a bandage. Should we succeed in arresting the hæmorrhage before applying the compress, we may at once suture the external commissure.

The bandage should not be changed for the first twenty-four hours, and the wound must be kept bandaged till the cavity is filled with a layer of granulations. After the operation, and until the wound has healed, the patient requires to be as carefully nursed as after any serious lesion. Any local inflammation or general feverishness demands the remedies usually employed in these conditions.

When all danger of secondary hæmorrhage is past, and the cavity is filled with granulations, the bandage is no longer required. We have then to bathe the orbit several times daily with solution of boracic acid, till cicatrisation is complete.

If the granulations take some time to form, or if they be pale and flabby, benefit will be derived from the application of some irritant ointment.

ART. VI.—The Artificial Eye.

The object of wearing an artificial eye is to diminish, as far as possible, the deformity caused by a greatly altered eye, or by the absence of the eyeball in the orbit. In cases in which the ball has been lost or considerably diminished in size, it prevents also any secondary contraction of the orbit, any retraction and atrophy of the lids, as also the inversion of the margins of the lids, so often a cause of irritation to the conjunctival sac.

Again, the wearing of an artificial eye keeps the lids in their normal position, promoting the regular escape of tears, and thus enables the patient to escape epiphora and its annoying consequences.

In order that an artificial eye should serve these ends, it must fulfil certain conditions. Thus, it should not only be fixed in front by the eyelids, but the posterior concave surface of the enamel should rest on the bulbar conjunctiva by as many points as possible without irritating it.

From what has just been said, it will be inferred that the cases least favourable for an artificial eye, are those in which the orbital tissue has also been removed, the tissue left by the reparative process not having any mobility. The conditions are more favourable after simple enucleation; for the preservation of the muscles gives a certain mobility to the conjunctival sac to which the artificial eye is applied, and thus, to some extent, it moves in a manner similar to the natural eye.

The best results are obtained when the eyeball is only diminished in size. Almost every part of the artificial part is supported on the stump, and the amplitude of its movements is nearly as great as in the normal condition.

When an eyeball, altered to such an extent as to make the use of an artificial eye desirable, is larger than or even the same size as the

normal eye, it is impossible to fit it with an artificial eye, no matter how thin the latter may be made. It then becomes necessary to diminish the volume of the eye to a proper extent, which may be done either by one of the methods described for the removal of anterior staphyloma (p. 136), by setting up a slight atrophy in the eye, as is advised by *von Graefe* (p. 139), or by performing evisceration (p. 140).

Again, in symblepharon it is sometimes necessary to separate the lids from the stump, and even to transplant a conjunctival flap before fitting the artificial eye.

The artificial eye should only be worn when there is no longer any inflammation or sensibility of the conjunctiva or stump. We always begin with a small eye, and gradually increase its size till it as nearly as possible resembles the natural eye.

To apply the eye, we take hold of it by its external margin and slip it in under the superior lid, which is held up; then, lowering the inferior lid, we introduce the lower border between it and the stump. To remove it, it suffices to draw down the inferior lid and to introduce the head of a large pin behind the inferior border of the artificial eye.

THE END.

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