OCULAR THERAPEUTICS.

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TRANSLATOR'S PREFACE.

This work was originally delivered in the form of clinical lectures during the years 1877–8 to the students and practitioners, both French and foreign, who attended Professor de Wecker's well-known clinique in the *Rue du Cherche Midi*. The lectures were at the time reported *verbatim* by Dr. Masselon, the *Chef de Clinique*, and afterwards revised and amplified by the Professor himself, and published as a whole. They will, it is hoped, be followed by the translation of a similar volume recently published and dealing exclusively with Ocular Surgery. The reception which these lectures have met with in France has been most satisfactory; they have been translated into Italian and Spanish, and will shortly appear in German.

In spite of the many able treatises which exist on Ophthalmology in the English language, it is believed that there is ample room for a work like the present. While intended primarily and chiefly for practitioners of general medicine, it will also, it is hoped, in many respects be found not unworthy the attention of specialists. If on the one hand these lectures avoid the prolixity and profundity of the great German works, on the other they steer clear of the meagreness and paucity of detail of many English and French manuals on the same subject, especially in the matter of therapeutics. The chief purpose kept in view throughout the work has been to describe clearly and with sufficient fulness all the more important affections of the eye, with special reference to medical treatment. The subjects of Ocular *Surgery* and *Refraction* have been mentioned only incidentally, or when absolutely necessary to supplement or complete some given plan of treatment.

While preserving as far as possible the spirit and style of the original, the translator has not considered it necessary to adhere slavishly to the text. With the author's consent certain slight omissions have been made, with a view of somewhat reducing the size of the work, but nothing of importance, it is believed, has been either omitted or altered. In order to render the work more useful to English and American readers, whenever a French formula is referred to in the original, the same is given in full in a foot-note, and translated, if there is any equivalent for it in the British Pharmacopœia. The French formulæ in the notes have been taken from the 21st edition of the "*Nouveau Formulaire magistral*" by A. Buchardat, Paris, 1878, an excellent work of its kind. Appendices have also been added on the "Metric System in Ophthalmology;" "The Metric Equivalents of British Weights," and "The Metric Notation of the Thermometer."

THE TRANSLATOR.

LONDON, 1879.

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OCULAR THERAPEUTICS.

DISEASES OF THE EYELIDS.

LECTURE I.

AFFECTIONS OF THE SKIN.

Before speaking of the various cutaneous affections to which the eyelids are liable, it will be well to consider the points of difference anatomically, between the dermoid covering of the eye-lids, and that of the face and body. The skin of the lids extends superiorly as high as the bony arch of the brow, while inferiorly it descends to the palpebro-malar fold, that is somewhat lower than the edge of the orbit. The skin of the lids, though directly continuous with that of the face, is distinguished from it by the presence of numerous folds. These owe their origin to the functions the lids have to fulfil, and are correlated with the length of time these functions have been active. This system of folds, together with the peculiar looseness of the subcutaneous cellular tissue, permits the skin to be easily raised up, conferring thereby great elasticity and freedom of movement.

One distinctive feature of the skin of the lids is the absence of all fat in the subcutaneous tissue. Moreover, between the conjunctiva, which is the direct continuation of the integument, and the delicate skin of the lids, there is not only a muscular layer interposed, but also a plate of dense felt-like cellular tissue, to which, incorrectly, the name of cartilage has been given.

Briefly then, the skin which covers the eyelids is extremely delicate, is wrinkled, possesses a cellular tissue free from fat, is highly elastic, and reposes on a frame of condensed and tough cellular tissue.

The cutaneous affections of which I shall treat on this occasion are, (1) *œdema*, (2) *hyperæmia*, (3) *inflammation*, *hypertrophy*, and *tumours*, and lastly, (4) *abnormal secretions*, will form the matter of another Lecture.

Œdematous effusions of the eyelids are either serous, hæmorrhagic, or gaseous.

The lids are a favourite locality for subcutaneous serous effusions. This is so true that very often the mere inspection of this region will indicate to a practitioner that he should direct his attention rather to the general circulation, and the eliminative functions. But apart from this form of symptomatic œdema, or that which so often accompanies the development of a sty or pimple, and which requires no particular treatment, we meet in very young and lymphatic subjects, or again in the old and anæmic, another variety. This, by its persistency and the dilatation of the lymphatic vessels which accompanies it, simulates a form of œdema, of which I shall speak further on, namely *lymphangioma*. It is very refractory as regards treatment, which should consist in continuous but light pressure, by means of a flannel compress bandage applied nightly. With nervous subjects this may be supplemented by the use of aromatic wadding. In order to hasten the absorption of the serous infiltrations, a layer of collodionised castor oil may be applied at intervals, together with lotions composed either of eau-de-Cologne simply, or of spirits of lavender, rosemary, and alcohol at 90°, in equal parts.

It is only in cases where these means have proved of no avail that scarification should be resorted to. If the swollen lids cover the eyes like a veil, we may be compelled to even excise some of the vertical folds, which, as they cicatrise, will contract and draw the lid upwards.

Extravasations of blood are most commonly the result of a bruise. They may attain considerable proportions, but, as a rule, however large, call for no interference. They are, in fact, very quickly re-absorbed, and exhibit no tendency to form unhealthy abscesses. Hæmorrhagic effusions have, as you are aware, a considerable diagnostic importance in fractures of the skull. Their significance as a symptom of a general morbid condition is much less.

Emphysema of the eyelids may be caused by rupture of the lachrymal ducts, or by a fracture of the bony walls of the nasal fossa, or may be consequent on the establishment of a communication between the frontal and sphenoidal sinuses. It seldom calls for any direct treatment. Benign in the two first cases, it requires merely the application during some days of regular pressure. It can never be necessary to resort to drawing off the air, no matter how great the degree of distension may be. Emphatically malignant, when the result of fracture of the skull, which has opened up the sphenoidal sinuses, it calls for no particular notice from the point of view of treatment.

Hyperæmia of the lids may invade them as a whole, or be limited to the margins. I will speak here only of the first form, reserving the second for consideration along with blepharitis, to which it is often only the prelude.

Congestion and redness of the eyelids may be merely symptomatic of some inflammation of adjacent parts, and particularly the orbital periosteum. They will then depend on obstruction of the facial or superior ophthalmic veins. The erythema, at other times, appears alone as a premonitory symptom of a diffuse inflammation of the skin. In none of the above cases need this affection become a subject of direct treatment. Not so, however, when the erythema constitutes a pathological entity. It is then, as a rule, hopelessly obstinate, and very distressing to patients, especially women, on account of the disfiguration it causes. The outlines of the orbital cavities become as distinct as though painted. This disagreeable appearance of the eyelids becomes all the more marked in consequence of the persistence of slight tumefaction and redness, in the congested parts, together with relaxation of the muscular fibres of the orbicularis. A leaden pigmentation is then developed, while the venous plexuses stand out in a manner not a little unsightly.

The disfiguration is what chiefly calls for medical interference, the slight sensation of smarting, and the actual rise of temperature scarcely occasioning the patient any discomfort. The chronic nature of this affection renders inquiry into the state of the patient's general health very necessary, in order to rectify, as far as possible, any disturbances depending directly on the circulatory or respiratory organs.

Direct treatment is of but little avail. It should consist in accelerating by transient irritation the circulation of the congested parts. This indication may be fulfilled by brushing them over quickly with a light application of nitrate of silver (1 in 30), even though the leaden hue may be thereby intensified for the moment; or, in place of this, compresses soaked in a solution of subacetate of lead (4 parts to 300), or of sulphate of zinc, of the same strength, may be laid upon the eyelids at short intervals, during five or ten minutes at a time. Vascular contraction can also be secured by frequent applications of lotions of rectified spirits (eau-de-Cologne), or by applying with a camel-hair brush, a thin layer of a mixture composed of oil of cade and spirits of wine, in equal parts, good care being taken to keep at a distance from the commissures, and to use a dry brush. A film of collodion, or pressure carried out nightly by means of a compress bandage, rarely achieve success. Metallotherapy might perhaps be of some use in these obstinate cases. In practice painting, or blackening the edges of the lids with charcoal, so as to obtain the effects of contrast will, especially with women, attain the desired object better than therapeutic agents.

I now pass to the subject of *Inflammation*, that is inflammation which has invaded the whole lid, and not settled exclusively on the margin as blepharitis. The morbid states of which I shall first speak are erysipelas, and diffuse inflammation of the eyelids. I shall then consider the circumscribed inflammations, such as sties, anthrax, &c.

Erysipelas, which anatomically consists of widely disseminated microscopic abscesses, together with general serous infiltration of the skin, is, as a rule, nothing more than the sign of a similar inflammation of the integuments of the face, and may always be traced to some lesion, such as an abrasion, a pimple, &c. To the surgeon, erysipelas of the eyelids has a peculiar importance, in that, though remaining confined to the palpebral tissues, the confluence of the numerous minute abscesses may generate a large abscess, or a diffuse cellulitis. Nor must the danger to which the eye, or rather the optic nerve is exposed, be forgotten, should the inflammation extend to the tissue of the orbit, and especially to the capsule of Tenon. Note also that in certain cases the brunt of the inflammation may fall upon the veins, and spreading to the venous sinuses, may quickly bring about a fatal result.

These considerations will show how necessary careful treatment will be. This, however, need not differ essentially from the treatment of erysipelas in other parts of the body. Having removed by means of saline purgatives, any tendency to constipation, recourse should be had, if the temperature is high, to cold or even frozen compresses. These often give great relief, nor need there be any dread of their causing a so called metastasis. The employment of cold should not, however, be carried to the point of causing cutaneous anæsthesia. If the erysipelas exhibits any tendency to spread, the affected parts should be strapped with Vigo plaster, changed daily.*

Careful palpation with the finger will show whether any general aggregation of the leucocythes, and consequently the tendency to abscess, and diffuse cellulitis is present. If so, soothing applications should be resorted to without delay, in order to limit suppuration as far as possible. The pus should be afforded a free and early exit by puncture, more especially if any indications of phlebitis be present.

Diffuse inflammation of the eyelids may occasion great distension from the accumulation of pus. This as a rule forms circumscribed collections in the loose cellular tissue of the skin within the edge of the orbit. In most cases these diffuse inflammations arise from violent contusions, though they may also depend on inflammation of the lachrymal sac, or periosteum, facts which must of course be inquired into previously. As a rule, abscesses of the eyelids should be opened early, and unless there be a distinct indication that the abscess will point towards the conjunctiva, the incision should be made along the ciliary edge. It is especially important to follow this rule with the upper eyelid, so as to prevent the pus accumulating, as it were, in a pocket. In cases where the pus has extensively undermined the skin we should be chary neither of the size, nor the number of our incisions. Immediately after the evacuation of the pus, a bandage should be applied, and frequently changed, care being taken on each occasion to wash the wounds with carbolised water (1 part in 100), and to keep them as clean as possible. The cure of simple cellular inflammation is in this way rapidly obtained. Thanks to the numerous folds existing in the eyelid, there is no danger of a permanent cicatrix, even where the skin has been very freely incised.

Furunculus, sty (*hordeolum*), *anthrax*, *Aleppo boil*, *malignant pustule*, *variolous pustule*. It has already been remarked that for the diffuse inflammations of the skin no special indications of treatment were to be deduced from the anatomical or microscopical characters of the affected part. The same holds true for those localised and circumscribed inflammations of the integument

* Vigo plaster is a mercurial preparation made from the *emplâtre Vigo*, the formula for which is as follows: emplâtre simple, 2000; cire jaune, 100; poix résine purifiée, 100; gomme-résine ammoniaque, 30; bdellium, 30; oliban, 30; myrrhe, 20; poudre de safran, 20; mercure, 600; térébenthine, 100; styrax liquide purifié, 300; huile volatile de la vande, 10. Bouchardat, Nouveau Formulaire magistral, p. 490.—Tr.

which I have just enumerated. A pimple developed in the vicinity of a hair follicle, on the border of the lid, and which is commonly known as a sty, insignificant though it be, may be capable of wrecking the fair fame of the practitioner. Owing to the extreme elasticity of the subcutaneous tissue, and the readiness with which it becomes infiltrated with serum, the eyelid, especially the upper one, becomes enormously swollen, and of a violet hue. This eyelid concealing a conjunctivitis, and bulged out by the chemosis, which presses forward towards the external angle, and between the lids, while at the same moment a mucopurulent secretion gums them together, imparts to the eye an aspect very similar to that which marks the commencement of severe purulent ophthalmia. Among the upper classes we may sometimes, in such cases, find the family doctor alarmed, and anxious for a consultation. If, however, he had examined the lid with a *tactus eruditus*, he would have found that when he pressed upon the ciliary margin, the patient experienced a sharp pain at the affected spot. Furthermore the absence of a true purulent secretion, of epiphora, and of swelling of the palpebral conjunctiva, should have amply sufficed to reassure him. Poulticing, or, with strong minded persons, a small incision into the indurated part, would have quickly dissipated all cause for alarm.

However trivial and harmless the appearance of a pimple on the eyelid may seem to be, constantly recurring attacks of it, known as "furuncular rash," may cause serious perplexity to the most experienced surgeon. The irritation which gives rise to these inflammations, localised as they are round the hair and sebaceous follicles, may arise from an eyelash which has remained in its sheath after this should have been occupied by a new tenant. Epilation, therefore, should be recommended every two or three days, and it must be effected by the aid of gentle traction applied to the row of lashes. Similar irritation arises in certain cases from the products of the sebaceous glands, either of the integument or of the tarsal portion, becoming abnormally condensed. In order to combat this troublesome symptom, it has been recommended to apply, before retiring to rest, some fatty substance, as little irritant as possible, to the edges of the eyelids. For this purpose, the best preparation is undoubtedly the oxide of zinc ointment, prescribed as follows :

Oxide of Zinc	1 part.
Cold Cream, unscented	20 parts.

Together with the above treatment, every direct cause of irritation to the skin of the eyelids must be avoided. In the morning, bathing with very warm water should be ordered so as to ensure thorough cleansing of the parts. All rubbing of the eyes on awakening must be eschewed. Attention should be paid to the mounting of spectacles, and other instruments, such as reading-lenses, microscopes, &c., in order that the lids may not be subject to friction. During the whole course of treatment, nutrition should be improved by ferruginous or arsenical preparations; and the cutaneous excretions made aromatic, *sit venia verbo*, by an unsparing use of tar water.

Under the influence of peculiar conditions of climate, and nutrition, a furunculus may become an anthrax, and in the East assume the characters of the "Aleppo," or "Biskara," or "Bagdad" pimple; "for each country," as *Godard* has remarked, "has a variety of its own." The essential point for the surgeon in these cases is to open the parts, freely and early, by ample incisions, in order that the compression and strangulation of the vessels may not result in a characteristic gangrene. Extreme cleanliness is absolutely necessary in these cases, and can be insured by means of pulverised jets of carbolised water, or of salicylic acid in solution, thus:

Salicylic acid	5 parts.
Bi-borate of soda	1 „
Distilled water	500 „

In cases where independently of the local lesion, there is reason to suspect a disposition to virulent infection, we should direct inquiries as to the channels through which the virus has been conveyed, which has caused such terrible affections as *malignant pustule*, or *œdème charbonneux*. The social position and occupation of the patient may give valuable hints, especially when it be considered how frequently eyelids are rubbed with soiled hands. I could have shown you a few months back, a butcher who had not scrupled to supply his customers with meat infected with *charbon*. This man in a careless moment passed his hand over his right eye; the *charbon* deprived it completely of its lids.

Whenever we have reason to suspect a malignant infection of this kind, we should endeavour to localise the evil by some method of cauterisation, which is strictly under our control. The galvano- or thermo-cauteries are the sovereign remedies. This cauterisation is a safeguard, both to the patient himself, and, by checking absorption of the poison, to those about him. When we have thus by cauterisation enlarged the area of destroyed skin, we should not neglect to repair it by a skin-graft as soon as the wound begins to granulate. But to this subject I will return when considering burns in general. The eruption of small-pox on the lids demands particular care, if we wish to prevent the line of pustules, which in many cases spreads along the ciliary border, causing great destruction of the skin, glandular apparatus, and hair follicles, and at the same time inducing baldness and redness of the edges of the lids, known as *madarosis.* From the beginning of the development of the pustules, the eyelids should be covered with strips of Vigo plaster, overlapping one another, exactly along the ciliary margin. Absolute rest, which is very difficult to obtain in the case of children, should be enjoined. As during this period an excessive conjunctival secretion is always present, the lids should be opened from time to time, and the eyes washed with carbolised water, of the strength of one per cent. When they have been wiped thoroughly dry, they should be carefully dusted over with a mixture of violet powder and oxide of zinc. If called to a case in which a pustular eruption has occurred (and this will occur at times in spite of the overlapping plaster) the granulations must as far as possible be checked by nitrate of silver, the effects of which are to be modified by a solution of salt and water. The moment the skin begins to retract, it will be necessary to look carefully after the position of the lower lachrymal puncta, so that an epiphora may not become established, as this would keep up indefinitely the conjunctival irritation.

Of *Eczema* of the eyelids I shall treat more at length under Blepharitis. At present, I shall say a few words about the affection such as it appears when it occupies the whole lid, becoming developed there without apparent cause as it does in delicate-skinned, light-complexioned children. In such subjects eczema localises itself by preference where the skin is thin and often moistened. It is true that the treatment of these cases requires no special modifications as regards that employed for this disease generally. It is well, however, to bear in mind that compresses imbued with nitrate of silver, or sulphate of zinc (1 in 300), act marvellously in cases of eczema rubrum, with abundant discharge. The constant moisture of the parts must be met by dusting them over with oxide of zinc and starch in equal proportions. As a rule, fatty substances are not well borne by children with delicate skins, they should therefore be used as sparingly as possible. When, after the exhibition of astringent compresses, the epidermis has become more healthy, we may have recourse to tarry preparations, *e.g.*, oil of cade and alcohol in equal parts.

Herpes of the lids.—Two varieties of herpes must be noticed here. One, perfectly benign, analogous to the hydroa of fever, is ushered in by a slight sensation of heat, without actual pain. It is often developed in the form of patches, arranged more or less symmetrically on both eyelids. It requires no other treatment than the use of some drying powder, such as starch. The other variety, ophthalmic herpes, or zona, is a severe affection developing itself under the influence of some morbid changes in the branches of the fifth pair of nerves, and being, as a rule, complicated with inflammation in the vicinity of the globe. The pain which accompanies it may call for injections of morphia, or liniments containing chloroform, or continuous currents, especially if the circum-orbital neuralgia is very persistent. The herpetic eruption itself does not require local treatment, unless perhaps the employment of some desiccating powder.

I now pass on to consider the inflammatory affections of the edges of the lids.

Hyperæmia of the palpebral margins, and blepharitis.—The edges of the lids may become the seat of chronic congestion, due to the tardy shedding of the lashes, which in its turn depends on sluggish action of the tarsal and cutaneous excretory glands. This state of congestion is readily induced by slight irritation of the conjunctiva, such as that which follows any irregular or excessive flow of tears, due, perhaps, to some long-sustained effort of the eyes, as, when persons with abnormal refraction, use their vision continuously for any great length of time. This hyperæmia of the ciliary margin, apart from the fact that there is always danger of its passing into a true inflammation or blepharitis, has, further, the serious inconvenience of making the eyes, as it is commonly called, "tender," or "weak." It prevents those who are thus affected from working continuously at night. It incapacitates them from remaining in a close atmosphere, one contaminated with tobacco-smoke, etc., and exposes them, should they endeavour to conquer the unpleasant sensations of smarting and difficulty in keeping the eyes open, to frequent attacks of conjunctival catarrh. The treatment of this very common affection will be considered under that of blepharitis. I will only say here that if sundry pomades, into the composition of which red precipitate enters as the active ingredient, have, like the pommade de la Poste, de la Veuve Farnier, de Montebello, etc., succeeded in acquiring a popular reputation, it is because they have been used diligently and methodically. Not a few persons have derived real benefit, because they have made use of such remedies with far more patience and perseverance than they ever would have done, had they received them in an orthodox prescription.

Blepharitis often arises from the same causes as simple hyperæmia. In the majority of cases it is nothing more than a variety of *Eczema*. This, if due to causes emanating directly from the eye, may be said to be *traumatic*. On the other hand, where the general state of the patient's constitution, or his diathesis, plays the chief part, it may be called *idiopathic*. Let me say at the outset that unilateral blepharitis is always traumatic, and is brought about by prolonged and excessive moisture, the result of a stagnation in the movements of the tears.

Among the various forms of eczema to which the edges of the lids are liable, I distinguish *simple blepharitis* (E. furfuraceum, eczema rubrum), *hypertrophic eczema* (chronic eczema, with induration of the epidermis), and *ulcerative blepharitis* (the various forms of E. sycomatosum). Just as the different varieties of pityriasis and eczema may elsewhere in the body (the scalp for example) leave indelible traces, so also we may here have unsightly baldness of the ciliary margins, suppuration and destruction of numerous glands, tarsal or cutaneous, and an unequally distributed thickening of the skin, leaving traces that never become quite obliterated.

The chronic nature of eczema may thus lead to permanent lesions, which are a source of misery to those subject to them. This is the more true, inasmuch as the distortion of the ciliary margins, the want of exact coaptation of the eyelids, the vitiated direction of the lashes, which follows cicatricial contraction in the neighbouring parts, or in follicles that have suppurated, give rise to a vicious circle of symptoms, to epiphora and conjunctival irritation, which are most difficult to cure.

Let me remark in passing that parasitical diseases, and the production of fungi in the follicules, are, in these western countries, very rare.

The ætiology in each case should be thoroughly made out (no easy matter in old-standing blepharitis,) in order that a rational method of treatment may be pursued. Further, we should clearly grasp the fact that complete recovery is only possible in slight cases ; in the hypertrophic and ulcerative forms, we are generally forced to palliate rather than to cure. The treatment of the varieties of eczema is a very important matter, and the region where the eczema has localised itself, or the lesions it may have caused, will furnish important indications. In every form of blepharitis, cleanliness of the lids is essential. Therefore, warm lotions, either of water, or water with the addition of some minims of liquor plumbi, if the skin is easily excoriated, may be prescribed. Patients who are really anxious about themselves will use a pair of small tweezers with curette points (fig. 1), and with these will remove all pellicles and scabs from the edges of the lids.

Epilation of the eyebrows is only called for in the sycomatous form of eczema, when small abscesses are formed around the thickened roots of the lashes, or when misshapen cilia are in contact with the globe. All other varieties of eczema can be treated without recourse to epilation, which is always painful and unsightly.

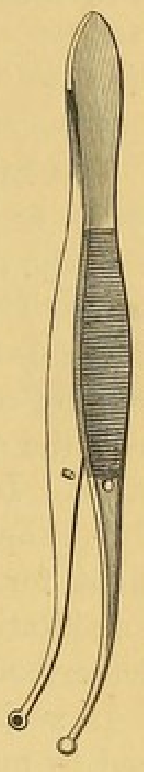
Fig. 1.

In every case of blepharitis depending on eczema furfuraceum or rubrum without excoriations or the formation of crusts, it is better to rely solely on the oil of cade, applied daily or every second day by means of a camel-hair brush, care being taken not to approach too near to the commissures. When the skin has been thoroughly braced up by means of preparations of tar, recourse may be had to the red precipitate ointment. This should be laid on with a small brush by the patient himself at bedtime, along the row of lashes, a very thin layer only being applied. The formula which I generally use is the following :—

Red precipitate, obtained by precipitation	1 part.
Liquor Plumbi subacetatis	15 parts.
Cold cream, not scented, and very fresh	100 ,,

The use of this ointment over a long period of time, should be recommended for all persons disposed to acne and seborrhœa.

In cases of blepharitis allied to eczema impetiginodes, where thick scabs are more or less abundantly formed, and where the palpebral margin has become thickened, external remedies, such as poultices, play an important part. Recourse may be also had to a lead ointment which I have named "*pommade antibléph-aritique*," and which in composition is somewhat similar to that used by Hebra in cases of eczema impetiginodes. The following is its formula:—

Litharge plaster	aa. 20 parts.
Linseed oil	
Balsam of Peru	1 part.

The litharge plaster should be as fresh as possible, and perfectly free from glycerine. It is to be melted in a water-bath with the oil, the balsam being added, and the mixture stirred till cold. This pomade cannot be properly prepared except in considerable quantities. It should also be often renewed. Small discs of calico, the shape of spectacle glasses, are to be smeared with the ointment, and the eyes covered up with them during the night. In the morning any pomade remaining on the lashes should be removed with hot water. A steady use of this medicament for some time, to which, when there is no question of cohabitation, patients soon get accustomed, should always be prescribed in hypertrophic blepharitis.

In such circumstances, recourse may also with advantage be had to an ancient recipe known under the name of "balm of Saint Yves." It is composed as follows:—

Butter, thoroughly fresh	360 part.
White wax	60 parts.
Red oxide of mercury	40 "
Prepared tuthie *	16 "
Triturated camphor	9 "
Yolk of egg	8 "

This should be applied every evening to the eyelids, care being taken to prevent its reaching the conjunctival cul-de-sac.

In cases where the hypertrophy is very marked, benefit may be derived from a method which has recently come into vogue, and which is as follows:—Seize the lid with Desmarres' or Snellen's forceps, to prevent hæmorrhage, and with a tattooing needle make deep punctures close together in the hypertrophied parts. Then by means of a camel-hair brush, apply over the punctures a concentrated solution of nitrate of silver, which must be immediately neutralised with common salt. The little wounds thus cauterised will become, in the absence of hæmorrhage, centres of contraction

* *Tuthie* is a refuse substance found in the flues of zinc furnaces; in composition, it is a mixture of oxide of zinc and cadmium, with traces of arsenic, and other impurities.—Tr.

which, as the number of punctures is so great, will act on the whole eyelid.

The sovereign remedy for all forms of ulcerative blepharitis (acne mentagra) is cauterisation, either by means of compressors, imbued with one part of nitrate of silver, of sulphate of zinc or copper respectively, to 300 of water. If the minute ulcers are confined to the hair follicles, direct cauterization with a pencil of mitigated nitrate of silver, followed by neutralisation with common salt, may be practised. Removal of the diseased cilia should precede the application of the caustic, which ought not to be repeated until the eschars of the previous cauterisations have become detached. In the intervals of cauterisation, a solution of nitrate of silver (1 in 20) may be applied with a camel-hair brush. It should be immediately neutralized to prevent its reaching the conjunctival cul-de-sac.

I need scarcely say that every attention must be given both to lachrymal and conjunctival secretions; and that the functions of the skin should be regulated by frequent sponging, either with salt and water, or sea water.

The general health will require looking after. Arsenical and ferruginous preparations should be prescribed in the case of weak or lymphatic subjects, and the functions of the eyes duly attended to, all ametropia, etc. being corrected. Prolonged tension of the accommodation must be avoided, especially by artificial light, as also whatever can cause congestion of the face, such as hearty meals, and alcoholic drinks.

This account of inflammatory affections of the skin of the lids may be closed with a few words on the syphilitic affections, of which they may be the seat. Primary and secondary ulcerations, pustular and papular eruptions, and finally gummata, are all found in this situation. There is nothing surprising in the fact of primary sores appearing in this region, when it is remembered how common the custom of kissing the eyes is. The existence of gummy tumours is more frequent than is generally supposed. We know that in cases where a gummy eruption attacks the face, it has its point of predilection in the eyelids. Further, the palpebral border is readily invaded by a series of small gummata, which ulcerate, and constitute an obstinate blepharitis known as the *gummy*. This affection calls for specific treatment, which will consist in the use of compresses imbued with a solution of corrosive sublimate (1 in 500), and the application at night of strips of Vigo plaster laid on one over the other.

It must be clearly understood that all syphilitic affections of the eyelids which threaten serious mischief, require to be combated by mercury. It will not, without extreme peril, be possible in such cases to yield to the infatuation and absurd prejudices of the anti-mercurialists. Inunction should form the basis of treatment, while locally, in conjunction with compresses of corrosive sublimate, recourse may be had, if large ulcerating gummata require to be cleared away, to the application in spray of weak solutions of corrosive sublimate, one part in 2000. Calomel sublimed, and applied with a brush in very thin layers, may also be used with advantage.

In long-standing secondary ulcerations, which are often remarkably obstinate around the destroyed eyelids, enemata of iodide of potassium may be exhibited, conjointly with the inunction treatment. Two enematas daily of 1* part iodide of potassium to 30 of water may be employed. Together with this, continuous perspiration may be secured, either by sudorific mixtures or by subcutaneous injections of pilocarpine, *e.g.* 5 minims of a ten-per-cent. aqueous solution of hydrochlorate of pilocarpine, may be prescribed. When the sores begin to heal and become covered with granulations, skin-grafting may be resorted to, and that without any misgivings on the score of a specific diathesis, which indeed is no bar to such transplantations.

* *e.g.*, 2 grammes of the salt to 60 of water. *Vide* Appendix.

LECTURE II.

HYPERTROPHIES AND TUMOURS OF THE SKIN OF THE EYELIDS—ABNORMAL SECRETIONS.

Hypertrophy of the skin of the eyelids brings me to the subject of the tumours of this region. *Warty growths* comprise *warts*, properly so called, *papillomata* or *follicular nævi*, and *vascular maternal nævi* or *erectile tumours*. So far as the treatment of the two first varieties are concerned it is unnecessary to say much. They should be removed if they cause any annoyance. They not unfrequently in advanced life take on an epitheliomatous character.

Erectile tumours should be operated on, more especially in young subjects, whenever they are a source of trouble or deformity, and when there might be greater difficulties later on in removing them. Three methods of doing so are at our disposal: the galvanic cautery, injections with perchloride of iron, and ligature. Of these three methods the last is to be preferred. Injections should only be employed when, owing to the small bulk of the tumour, the lid can be grasped in a Desmarres' or Snellen's forceps, and all danger of a clot passing into the general circulation thereby avoided. In England cases of sudden death have been recorded, occurring simultaneously with the injection of a few drops of perchloride of iron.

For these small telangiectases I prefer a plan of ligature which I often resort to, and which consists in passing beneath the tumour two fine harelip pins, crossed, taking care to confine them to the healthy skin. Behind these pins I twist a strong silk thread, with which the subjacent issues are ligatured, and strangulated.

This little operation is within the competence of every practitioner. It is far superior to the use of ligatures, which, passing through the tumour, are liable both to the risk of hæmorrhage and of a portion of tumour escaping the ligature and becoming the starting-point of a fresh growth. This you may have observed in the case of a little boy four years of age, who had a tumour on the anterior portion of his lachrymal sac the size of a bean. A ligature, consisting only of a single thread, had been passed through the tumour, and this thread having come away, the child was seized in the middle of the night with an alarming hæmorrhage. A ligature applied behind two pins, in the same case, came away three days after, and the cure obtained subsequently within a fortnight may now be looked on as permanent. Compression of these tumours with special apparatus should only be had recourse to when the great extent of surface involved may possibly necessitate a capital operation, such as ligature of the carotid. I need only mention in passing those forms of hypertrophy of the epidermis known as "horns." They may readily be destroyed by depriving them at the same moment of their papillary and dermal attachments. The same treatment, namely removal, applies also to the various forms of *fibromas,* and of *elephantiasis.*

I pause for a moment to consider a condition preliminary to elephantiasis, namely, a rare form of *angioma,* sometimes met with in young subjects. This affection constitutes a serious deformity, and in certain cases is a source of great annoyance, as it transforms the lids into swollen doughy masses and prevents their being opened. Three varieties of treatment have been suggested. Coagulating injections, similar to those recommended for vascular tumours have been tried, with the object of obliterating the dilated lymphatics, and must be condemned as highly dangerous, inasmuch as the parts to be injected cannot be cut off from the general circulation by compression with rings. The second method is to make frequently repeated punctures in conjunction with regular pressure; while the third method is as follows:—Small trocar canulæ covered with a pressure bandage so as to establish continuous drainage are to be introduced under the skin. The dressing should be changed frequently. This is the method to which I give the preference, inasmuch as simple puncture has been shown to be useless in some cases; while the same remark applies to pressure made directly, or over layers of collodion, and to all substances employed internally with the object of hastening absorption of the serum effused into the subcutaneous tissue. These forms of idiopathic angiomata, so rebellious to treatment, are fortunately rare. You are much more likely to be called upon to treat a thickening of the skin depending on dilatation of the lymphatics, and arising from oft-recurring attacks of erysipelas, or chronic eczema. In these cases also the same treatment may be tried.

I now pass on to consider a peculiar form of hypertrophy, followed by fatty degeneration of the cellular elements, and of the sheaths of the vessels, known as *Xanthelasma.* The appearance of a dusky spot above the internal palpebral ligament, marks the commencement of this curious affection. It generally attacks women over forty, about fifty per cent. of whom have had, at one time or another, an attack of jaundice. The deformity occasioned by this yellow, dirty-looking frame around the eyes, is quite sufficient to justify excision of the altered portions. This may be easily done by raising the patches up with a forceps, and then snipping them off with curved scissors. I am inclined to think that the early removal of patches as soon as noticed, checks the further progress of the disease. In many cases where I have thus operated, I have requested the patients to return immediately, should any new spots appear in the neighbourhood of those removed. I have not as yet had any cases of relapse.

I now come to the subject of tumours of the lids, but will mention only two varieties, both of which frequently come under the notice of the practitioner, namely, granuloma and epithelioma. Cystic tumours, lipoma, sarcoma, and carcinoma, demand purely surgical treatment, that is to say, removal, and need not therefore be considered here.

Granuloma of the lids is also known as *Chalazion.* It was long confounded with atheromatous cysts, which are very rare in the skin of this part, and with a cystic dilatation of the meibomian glands, which singly never constitutes a chalazion. Still, this pathological change may help to form a granuloma by invading the interior of a tarsal gland, and bringing about the obliteration of its excretory duct, or by merely forming a diverticulum to the gland, and so causing it to assume a cystic development. A granuloma appears by preference on the external surface of the tarsus, on which it always, more or less, encroaches; it may, however, primarily invade the felt-like tissue, as it increases distending this in every direction, in such a manner as to thin the tarsus chiefly in the direction of the conjunctiva; lastly, it may become localised at the orifice of a tarsal gland, in which case it forms a prominent tumour most marked on the internal edge of the lid.

In practice, chalazion may further be distinguished as *external,* *internal*, and *marginal*. All three extend down to the basemen membrane of the tarsus, and, according to some authors (*de Vicentiis*), the giant cells are generated in the epithelium itself, of the Meibomian glands. Whatever produces irritation of the tarsal glands may be a cause of granuloma; this explains the hardening of the contents of these glands met with in persons predisposed to a similar condition of their sebaceous glandular system generally: hence, the subjects of acne are also those in which chalazion appears most frequently. Hyperæmia, too, of the lids, by inducing congestion round the excretory ducts of the tarsal glands and thereby interfering with the escape of their contents, may favour the growth of these small tumours. The treatment consists in incising and turning out the chalazion by means of a curette with cutting edges (fig. 2). When a granuloma is more developed towards the inner surface of the tarsal cartilage, it is almost always complicated with retention of the fluid secretion of the gland. This imparts a semi-transparent brown tint to the thinned portion of tarsus. In incising and turning out a chalazion, the first step is to invert the lid, generally the upper one, and seize it between the thumb and index finger; in this way the flow of blood will be checked as effectually as with a ring forceps.

Fig. 2.

Where a chalazion has spread mainly in the direction of the skin, and has sensibly thinned it, it will be found best to steady the lid in a Desmarres' or Snellen's forceps, and to turn the granuloma out as thoroughly as possible, including in an oval incision, if necessary, some of the skin that has not been too much thinned. The sharp curette may also be used in order to thoroughly clean the portion of tarsus that has been occupied by the tumour. A single suture will be sufficient to bring together the edges of the cutaneous wound.

Whether the incision be made from the conjunctiva or through the skin, it is always well to avoid applying nitrate of silver, with any idea of preventing recurrence of the growth. Scraping with the curette is an ample guarantee of complete removal, and does not expose the lid to the same risk of irritation and swelling. The action of the caustic, too, is always difficult to limit exactly to the wound.

Marginal chalazions offer the greatest difficulty as regards treatment. When in this situation, the best practice is to cut them in two, by a large incision perpendicular to the palpebral border, and to the cartilage, and to scrape away carefully, entering the curette through the conjunctival incision, any spots on which the granuloma has trenched. The operation is to be terminated by smoothening with a pair of scissors the margin of the lid, which is the position such outgrowths generally occupy.

No *pommades* (such as those of iodide of potassium, iodide of lead), can have any influence, except in cases where the chalazions show some tendency to recede spontaneously. This is by no means uncommon, a fact which may be imparted to patients whom the prospect of an operation alarms.

When the lids have become transformed into irregular-shaped masses, owing to the development of numerous granulomas, thereby causing great deformity, we must be satisfied with extirpating the more bulky growths, and prescribing subsequently a thorough course of *pommade antiblépharitique* (see p. 12).

Of all the malignant growths to which the eyelids are liable, epithelioma is the most frequently met with. It may present itself under three forms: namely, the *smooth*, the *phagedenic*, and the *papilliform*.

The smooth variety, which is the commonest of all, as a rule first shows itself in the vicinity of the commissure, and the ciliary margin, under the form of a small patch of induration, composed of raised points, which are sometimes more or less transparent. The phagedenic variety which generally settles on tissues at some distance from the ciliary border, is characterised by the presence of well-marked nodulations, not unlike, except for the colour, those of lupus. The nodulations disappear, but only to leave deep funnel-like depressions, which merge one into the other. Lastly, the papilliform epithelioma, is neither more nor less than a smooth cancroidal patch, upon which fungous granulations spring up, and bleed at the slightest touch. The diagnosis can only present difficulties at the beginning, where there might conceivably arise a question as to syphilitic origin, *e.g.*, an ulcerated gumma, or a secondary sore. But the history of the case, the length of time that has intervened between the first appearance of the epithelioma as a mere wart, and its ulceration, will enable a diagnosis to be made, which will be further corroborated by the fact, that in such cases the patients are generally over fifty years of age. It is altogether the exception to have to treat young subjects, that is, persons under thirty, for cancroid of the eyelids.

Treatment must consist in the removal of the growths, when not very extensive, care being taken only to cut into absolutely healthy tissue, and to obtain reunion at any cost, either by bringing the skin together, advancing a flap, or grafting upon the raw surface. If however we have to deal with extensive and deep destruction of tissue, in which the periosteum is also apparently involved, the best treatment will be found to consist in the use of chlorate of potassium *intus et extra*, as recommended by M. *Bergeron*.

I have now a patient, who since the year 1848, has been the subject of epithelioma, which became developed consequent on a trivial wound of the left commissure. This epithelioma, which has been growing for a period of twenty-nine years, had destroyed half of the upper eyelid, and eyebrow, two thirds of the lower, and had invaded the bones of the nose, causing a loss of substance sufficiently great to allow of the first phalanx of the thumb being inserted into the cavity. The man suffered acutely, and was anxious to have an operation performed, which, considering the extent of the existing lesions, I would not undertake. He was put upon the chlorate of potassium treatment, which consisted in the daily use of two spoonfuls of a five per cent. solution of the salt. The wounds were continuously dressed with compresses soaked in a saturated solution of the same. This patient has obtained relief so great as almost to amount to a cure. The ulcerated surfaces have come closer together, their edges are more level, the cavity that existed in the nose is filled in, and finally, the severe pain has been mitigated. Fortunately he bears well the constant application to the sores of the concentrated solution of chlorate of potassium. In some cases it produces very severe pain.

Experience has taught me that it is chiefly those epitheliomata, in the development of which *acne confluens* or *rosacea* has played an important part, which derive special benefit from M. Bergeron's treatment. For such patients, I also order, with marked advantage, a prolonged course of sea-water baths.

In cases of unulcerated epitheliomata of small extent, cauterisations with acetic acid may be tried, as recommended by Dr. *Broadbent*. These cauterisations are effected by means of a glass rod, brought to a sharp point, and dipped in concentrated acetic acid. With this the nodules of cancroide are pricked in all directions. These cauterisations are to be practised two or three times a week, and are not very painful if care be taken to wipe the rod well, so that the acid shall not run over portions of healthy skin. I prefer this method to that of injections, which can only be carried out by means of clumsy glass syringes, as also to that of mopping over with acid, which is exceedingly painful, when large surfaces have to be dealt with.

These three methods of treatment, to wit, ablation, chlorate of potassium, and acetic acid, are sufficient to enable us to combat this very rebellious, but generally very slow-growing affection. Cauterisation, with pâte de Canquoin,* and Frère Côme's powder,† at one time so much lauded, I have now entirely given up, owing to the impossibility of limiting the effects: I have moreover often observed that cauterisation practised on other parts of the body with these substances, appeared to give a fresh stimulus to the disease.

Before quitting the subject of diseases of the eyelids, I have a few words to add as regards the *anomalies of secretion.* So far as the glandular apparatus is concerned, we may have excessive secretion of the sebaceous glands, known as *seborrhœa;* while as regards the sudoriparous glands we meet with *ephidrosis,* or *hyperidrosis.*

Seborrhœa may be either of the *dry* or *moist* variety. In both equally the edges of the lids are hypertrophied, and covered with small friable crusts, but in the moist variety a greasy and lustrous appearance is superadded. As a rule, those subject to this unpleasant condition suffer from a similar affection on other portions of their bodies; while there is often something irregular about the sexual organs, such as the presence of dysmenorrhœa, puberty, the change of life, etc.

Treatment must consist mainly in scrupulous cleanliness. Applications of soap and water are here especially called for; and a choice may lie either between a medicated or any mild soap.‡

* *Pâte de Canquoin*, composed as follows :—

Chloride of zinc	}	Equal parts.
Fine flour	}	

Mix the chloride of zinc in powder with the flour, and add water until the mass becomes fairly consistent.—TR.

† *Poudre du Frère Côme*, composed as follows :—

White arsenic	1 part.
Cinnabar	5 ,,
Calcined sponge	2 ,,

Triturate together; when required for use add water sufficient to form a mixture of the consistence of syrup.—TR.

‡ In the original "savon de Thridace." This is a commercial article much used in France, and here stands for any kind of mild, unirritating soap.—TR.

Ladies are often recommended to press lightly pieces of tissue paper upon their eyelids, so as to absorb the greasy discharge. In cases of dry seborrhœa, mild *pommades* of oxide of zinc may be employed 1 in 40, or simply a small quantity of cold cream. All persons subject to seborrhœa should use, after the face has been washed in very warm water, lotions of rectified spirit (Eau-de-Cologne), so as to contract the dilated orifices of the glands, and, as much as possible, the glands themselves. When the affection is of very old standing, a thin layer of a mixture of oil of cade and rectified spirits may be spread twice weekly over the lids.

The retention of secretion in the sebaceous glands themselves may be the cause of various forms of acne. *Comedos* (flesh-worms) occupy chiefly those parts where the skin is tolerably thick, whilst, on the other hand, dilatation of the sebaceous follicles, with occlusion of their external orifices, a condition known by the name of *millet,* developes itself rather in parts where the skin is extremely thin; and this sometimes so abundantly as to have obtained the name of *herpes miliaris.* In order to free the patient from the disfigurement caused by these numerous whitish bodies, some of which attain the size of a small pearl, it will be necessary to puncture the little prominences with a cataract needle, and so get rid of the thickened contents of the gland.

Another alteration undergone by the sebaceous glands, and which may also simulate a true eruption of the eyelids, is that known as *molluscum contagiosum.* The follicle, dilated by its own contents, is, by reason of a proliferation of the cellular tissue surrounding it, bulged forwards and assumes the appearance of a small rounded tumour, with a central depression. It encloses a putty-like mass, composed of epithelium, and of bodies resembling ruptured starch granules, an appearance pathognomic of molluscum. There is no doubt that these masses are endowed with infecting properties, and that the disease is very easily communicated among members of a family, while at the same time, curiously enough, it may not be possible to produce it by inoculation.

I shall from time to time have occasion to show you children, the subjects of molluscum, which in this country never grows as large as a bean or hazel-nut, while it seldom exceeds that of a small pea. It is not difficult to cure children of this affection, at once disfiguring and repulsive; it is sufficient to seize the prominent follicle with ciliary forceps, and pull it out. The glands metamorphosed and actually detached from the skin easily come away, and the affection is cured in a few days.

Excessive secretion of the sudiparous glands may be observed in the eyelids, as in other parts of the body. Here it may produce hyperæmia of the skin, or even eczema, or, by making its way into the palpebral aperture, a catarrhal condition of the conjunctiva. This latter is extremely rebellious to treatment, and may mislead those who have not recognised in it a continuous cause of irritation to the mucous membrane. Ephidrosis, as soon as it has given rise to excoriations, calls for the remedies pointed out under blepharitis, namely, the *pommade antibléph-aritique,* astringent compresses, and oil of cade diluted with alcohol. As a local treatment in ephidrosis, recourse may be had to an application, also useful in eczema arising from friction and moisture, *e.g.*, perspiration, namely, dusting over the parts with a mixture of starch and salicylic acid, 1 part of the latter to 20 of the former.

I pass over *cystic dilatations* of the sudoriparous glands, giving rise to transparent cysts, as also *hematidrosis* and *chromatidrosis.* The two last are extremely rare affections, and are in fact medical curiosities. They have, at the same time, afforded a measure of the gullibility of certain members of the profession. If we were to encounter a genuine case of chromatidrosis, etc., the treatment would not be different from that of seborrhœa generally, from which the affection is distinguished only by the presence of a certain amount of vegetable indigo.

LECTURE III.

AFFECTIONS OF THE TARSUS AND OF THE MUSCLES OF THE EYELIDS.

THE tarsus, as already stated, is nothing more than a condensed portion of the subcutaneous cellular tissue. Indeed it is so closely connected with the subconjunctival tissue, that considerable difficulty is experienced in separating one from the other. In this felt-like tissue, which contains no cartilaginous elements, are found the tarsal glands. They vary in size according to the breadth of the tarsus. The apertures of these glands form a more or less regular line near the sharp inner edge of the lid, and behind the row of cilia. Their arrangement at once becomes visible when the lid is everted, owing to the white emulsion-like matter they contain. On slight pressure their ducts allow of the escape of an appreciable quantity of this fatty emulsion, the function of which is to lubricate the margins of the lids.

The tarsal glands differ but little from the sebaceous glands of the skin generally, and are liable to analogous morbid changes. Thus we find, as it were, a true acne of the lid, which runs on to suppuration, to induration of the contents of the gland, and even to calcification (*lithiasis palpebralis*). In consequence of the distension which the gland undergoes, and the pressure it exercises on the surrounding tissue, changes both in the tarsus and in the calibre of the gland itself may be produced, which occasion very curious appearances. What is commonly called an *inflamed chalazion*, is as a rule nothing but a spot of tarsal acne, which has suppurated.

The infarct of the gland results at times in the expulsion of small, cylindrical, transparent, and very tough bodies, which, making their way into the palpebral aperture, give rise to the sensation of a foreign body under the lids. When the gland has been much distended by an infarct, in which calcareous salts have been deposited, elimination generally takes place towards the conjunctiva. It sometimes becomes necessary to remove actual calcifications, which occasionally may acquire the bulk of a small cherry-stone.

Inasmuch as any irregularity in the working of the glandular apparatus is accompanied, as a rule, by marked hyperæmia of the margins of the lids, the treatment suitable for this latter is here indicated. The tarsal surface must always be examined after the lid has been everted, so that we may be prepared to deal with any calcification which may be presenting towards the conjunctiva. All such products should at once be removed, so as to obviate the painful friction against the cornea to which they give rise.

A genuine *tarsitis*, known also, though incorrectly, as *chondritis*, is met with after old-standing eczemas, erysipelatous inflammations, and chronic catarrhs of the conjunctiva. The lids in such cases become the seat of strumous congestions, very similar to what is met with in the lips and nostrils of scrofulous subjects. A finger applied to the doughy lid will inform you that the tarsus has both increased in thickness, and that it is considerably inflamed. A steady use of poultices, and of the *pommade anti-blepharitique*, healthy surroundings, douches of salt or sea-water, preparations of arsenic or iron, days spent in a pure and mild air, may cure this troublesome and unsightly affection.

Another variety of tarsitis, which is extremely rare, is the *gummy*. This is occasionally met with as a sequela of gummy blepharitis. In this affection the eyelids may become the size of pigeon's eggs. Even when such is the case a mixed treatment, consisting of inunction and enemata of iodide of potassium may effect a cure. A well-marked atrophy of the tarsus may, however, remain, but it will not affect the shape of the lid.

I shall mention, and merely mention, a morbid alteration of the tarsus which, like the affection just spoken of, causes a considerable amount of swelling,—I mean *amyloid degeneration*. This generally encroaches more or less on the conjunctival culs-de-sac. Removal of the degenerate masses, the skin and healthy portions of conjunctiva being preserved, has been sometimes practised, and has resulted in a rapid cure when other means had previously failed.

A detailed description of the anatomy and physiology of the sphincter muscle of the orbit is by no means necessary in order to study the treatment of the diseases to which it is subject. I may remark, however, that although the orbicularis extends in an unbroken layer round the orbital cavity, it can nevertheles be divided into three portions, namely, an orbital, a palpebral, and a malar. The orbital is constituted by the portion attached to the rim of the orbit; the palpebral rests upon the eyelids themselves; while the malar belongs exclusively to the lower lid, and encloses in two V-shaped fasciculi the inferior portion of the orbicularis. It is lost eventually in the skin about the angle of the mouth.

The various portions of the orbicularis do not generally contract in unison; a phenomenon, which is seen only when the eyelids are hastily closed under the stimulus of a dazzling light. Even in such a case it is more particularly the orbital portions of the muscle which act, while the palpebral contract but feebly.

The palpebral are the only portions of the orbicularis capable of isolated action, whether both muscles act simultaneously or separately. Thus, when the eye is turned upwards, the muscle of the lower lid undergoes a slight contraction, while the reverse obtains if it is directed slightly downwards. The simultaneous contraction of the two palpebral muscles narrows the aperture in myopic and astigmatic persons, either giving the same effect as a stenopaic slit, or imparting to the countenance a threatening look. If to such an expression be joined also one of contempt, then the superior or orbital portion of the orbicularis contracts, and in unison with the frontal produces a slight knitting of the brow. When the inferior portion of the orbicularis, that is the malar muscle, and the lower portion of the orbital, contract—and their contraction is always in unison—we get, if the action has been slight, an expression of disgust, if considerable, of horror. Curiously enough, when the contraction of this muscle is confined to one part of its fibres only, namely, the external division of the orbicularis and malar, it produces the expression of good humour and laughter; on the other hand, when the corresponding internal portions of the orbicularis act, the result is an expression denoting pain. Few opportunities, however, will occur of utilising this physiological knowledge.

Let me add a few words about the non-striated muscular fibres, scattered over the eyelids, and which play a not unimportant part in affections of the sympathetic. These non-striated fibres have been subdivided into an inferior and superior palpebral muscle; which, however, owing to similar names having been given to the striated muscles, can only create confusion. The superior arises close to the levator palpebrarum muscle, preserves a straight course, and is attached near the convex superior border of the cartilage, by tendinous and elastic insertions. The few non-striated fibres, to which the imposing name of *palpebralis inferior* has been given, are found under the conjunctiva, are disposed without much regularity, and pass from the conjunctival cul-de-sac in a direction towards the inferior border of the tarsal cartilage.

The smooth fibres which depend on the sympathetic may be the seat of an excess of innervation, determining spasm, or of a deficiency entailing sympathetic paresis. Spasm gives to those subject to it a surprised and even terrified air. As they look before them, or up or down, the margins of their corneæ, and not unfrequently a small band of sclerotic, become visible, owing to the excessive action of the affected portions of the muscles, and a very unsightly gaping of the palpebral aperture results. This spasm is generally associated with other neuroses. It is observed chiefly among pregnant and hysterical women, and in connection with exophthalmic goître. It is also met with as a sequela of spinal irritation, chiefly at the commencement of locomotor ataxy, when there is present well-marked dilatation of the pupil. It often reveals the presence of amaurosis. Treatment can do little or nothing in combating what is at most a symptom; however, if deemed necessary, injections of morphia may cause the spasm to disappear for the time.

Paralysis of the sympathetic is revealed by the narrowing of the palpebral aperture, simulating a ptosis, such as might result from excessive action of the palpebral portion of the orbicularis, the effect of which would be to lower the upper, and to raise the lower lid. Together with the drowsy look that this paresis of the sympathetic gives, there is also marked contraction of the pupil, puffiness of one side of the face, blushing, and heightened temperature, recalling the symptoms noticed in the ear of a rabbit after unilateral division of the sympathetic. This affection is met with after other serious nervous symptoms have already shown themselves, and should always place the practitioner upon his guard. It seldom becomes a subject of special treatment, but were it to do so, it would be advisable to have recourse to a very weak subcutaneous injection of atropine, namely, 5 to 6 minims of a solution of one part of sulphate of atropine to 2000 of water, and to the employment of continuous currents. Six to eight cells should be used, the negative pole being placed over the apex or body of the lung, while the positive is moved over the region of the ascending branch of the inferior maxillary.

Spasm of the orbicularis is much commoner than affections of the non-striated fibres. We find two forms of spasm, the *clonic* and the *tonic*. The former, which may also be called *palpebral chorea* is observed especially in delicate children, about the time when they first go to school, and begin to use their accommodation more than they have hitherto been required to do. This mild form of chorea demands very accurate correction of any existing ametropia, together with strengthening treatment by means of ferruginous medicines, cold sponging, etc.

Tonic spasm of the orbicularis may be either *intermittent* or *continuous*. It is often intermittent in the beginning, particularly with children, and becomes continuous after a certain time. Ætiologically, three varieties of blepharospasm may be described, namely, the traumatic, the inflammatory, and that which is allied to convulsive facial tic. The first kind is observed consequent on lesion of the cornea, (a scratch, abrasion, etc.) but more especially after penetration by a foreign body. More than usual care must therefore be exercised in searching for such a body, when a tetanic spasm of the lids has followed a wound or contusion of the orbital region. Inasmuch as efforts directed to open the eyelids very readily induce epileptiform attacks in children, anæsthetics are indicated in carrying out such examinations.

The inflammatory form, especially in young subjects, coincides with the development of pustules on the conjunctiva, or of slight phlyctenulæ on the cornea. In these cases the part borne by the orbicularis, as regards the flow of tears associated with the affection, and the excoriations or true fissures of the external commissure, may be considered analogous with that played by the sphincter ani in another affection. Besides direct treatment of the inflammation, which was the cause of the spasm, we may act against the latter by forcibly dilating the palpebral aperture, with two good-sized dilators, or by incising the commissure, and permanently enlarging the aperture.

Convulsive facial tic commences sometimes in the orbicularis, and only secondarily invades the whole side of the face. This extension is more especially to be dreaded when the malar muscle (the inferior portion of the orbicularis,) begins to contract appreciably, and when the narrowing of the palpebral aperture takes place, together with an elevation of the angle of the mouth. The treatment of this variety of tic, will be attended with success in proportion as the spasm depends on a reflex neurosis of the fifth pair, that is when neuralgia, or lesions of the trigeminal, have preceded the appearance of the tic.

In such cases compression of that division of the fifth within the domain of which the original cause of the reflex neurosis lies, may furnish an indication for treatment, which is to break the vicious circle, which the spasm maintains, by section of the sensitive nerve. Along the course of the branches of the nerve, those spots are to be sought for which, when gently pressed against the bone, cause the paroxysms of pain to cease. Such spots are sometimes discovered empirically by patients themselves. They exist chiefly at the points of exit of the supra- and infra-orbital nerves, and may be discovered by pressing the subcutaneous malar branch against the malar bone, or the inferior maxillary nerve against the ascending ramus of the jaw. An attentive examination of the teeth and gums should never be omitted.

When the fact has been established that gentle pressure on a branch of the fifth pair arrests the spasm, we may proceed to divide or dissect the nerve out. Section of the supraorbital is that most frequently called for. It is performed by sliding a common tenotomy knife along the brow, having entered the skin on the temporal side, and then freely incising the periosteum, which overlies the junction of the lower and middle third of the bony edge of the orbit.

When such an operation does not succeed in effecting a cure of convulsive blepharospasm, but little more can be done. Continuous currents afford a method of treatment which may be worth trying. We may apply, following *Remak,* the negative pole over the contracted portion of orbicularis, and the positive over the transverse process of the fifth cervical vertebra, corresponding to the middle ganglion of the cervical sympathetic. Or again, the negative pole may be placed on the cervical region, and the positive on any points which, when compressed, have been found to exercise a favourable influence on the spasm. This method of treatment is essentially empiric, and should only be tried with feeble currents. In such cases very weak currents might also be tried, such as those generated by 2 or 3 cells of a Trouvè battery employed continuously during the night. Finally, in this well-nigh hopeless affection metallotherapy might be suggested. This it would seem has a palliative action in painful facial tic, as you perceive in the case of this patient, who was sent here by the Medical Society of Upsal, to be placed under M. Charcot's and my care.

The internal exhibition of eserine, in doses of 1 to 4 milligrammes (*i.e.*, $\frac{1}{60}$ to $\frac{1}{15}$ grain) daily, is a powerful remedy in blepharospasm. But as a rule the nausea it occasions prevents its being taken for any length of time. It should also be noticed that sulphate of eserine acts in such cases in almost homœopathic doses, and when dropped into the eye its absorption in infinitesimal quantities induces at times, especially on the internal portions of the orbicularis, (the palpebral muscles,) very marked clonic contractions. Nausea and even vomiting may be produced in certain individuals by frequently repeated instillations of eserine.

Morphia, like eserine, has a paralysing action upon the fibres of the sympathetic, and when used hypodermically arrests for the moment the spasmodic twitching.

Bromide of potassium in large doses does not appear to exercise any favourable action. An agent which deserves a trial in these cases of blepharospasm, is the new myotic pilocarpine. This alkaloid, when introduced under the skin near the temple, occasions the same general depression and nausea as eserine.

In no case can section of the orbicularis be recommended as a remedy for blepharospasm, even where every means has been tried and failed; in such cases it would be even preferable to have recourse to pressure of the facial nerve by instruments specially devised for the purpose.

LECTURE IV.

PARALYSIS OF THE PALPEBRAL MUSCLES. ANOMALIES OF THE PALPEBRAL APERTURE.

Paralysis of the seventh pair, usually unilateral, involves a deficient action of the orbicularis, which prevents the eye closing. This condition, known as *lagophthalmos,* at once becomes evident if the patient be asked to close both eyes. It is further shown by the fact of the brow being drawn upwards, the cheek and nostril flattened, and the mouth deviated towards the unaffected side. The symptom which causes most inconvenience to the patient is the epiphora, which results from the aspirating machinery, represented by the lacrymal sac, having been thrown out of gear, as also from displacement of the inferior punctum, the chief support of which, namely, the lower lid, no longer fits closely to the eyeball. In these cases, the duct should not be slit up with a view of removing the epiphora, as is done in other displacements of the lower punctum, inasmuch as, even if the communication was re-established, aspiration of the tears would not be restored.

It is well known that paralyses of the facial nerve, when simple, generally are due to some peripheral cause. Pressure induced by inflamed glands, by bone, or by a swollen periosteum, here play an important rôle. Partial paralysis of the orbicularis, pathognomonic of leprosy, never becomes altogether complete. Treatment must depend entirely on the cause of the paralysis. Should this arise from a rheumatic affection, diaphoresis by means of injections of pilocarpine, or by Turkish, or vapour baths, every second or third day, will be indicated. A free use of iodide of potassium must be insisted on when the absence of a specific cause cannot be clearly established. This should be followed up by mercurial inunctions, if the history of the case lead us to suspect the existence of a gumma, or a specific exostosis.

When it is evident that a certain amount of contractile power has returned to the paralyzed muscle, the result may be hastened by injections of strychnine in the vicinity of the temple. For injection the following solution may be employed, in quantities of 12 to 15 drops,—

Nitrate of strychnine	1 part.
Distilled water	100 parts.

Extreme caution must be shown in the use of these injections with children, and the amount should seldom exceed 3 to 4 drops. As a matter of fact, symptoms of poisoning are never met with except in the case of children.

Continuous currents may also be tried with the object of stimulating nutrition in any portions of the muscle which have become weak from disuse.

Surgical treatment must be resorted to in cases of old standing paralysis, which have proved rebellious to every other method. The question now arises of protecting the eye-ball from continuous contact with the air. With this object the lower lid should be permanently raised, within and without, by means of a tarsoraphia. The internal tarsoraphia should not extend beyond the lachrymal punctum, so that when later on the lids come to be separated, there may be no occasion to have to deplore permanent occlusion of the punctum and incurable epiphora. Such operations will, of course, give way to a temporary trial of the pressure bandage, whenever there is the slightest hope of the paralysis disappearing within a reasonable time.

The most common form of paralysis is that of the levator palpebrarum. It causes a dropping of the upper lid, more or less complete, known as *ptosis*. We must distinguish three varieties of ptosis. There is first a *congenital* form, probably due to an arrest of development of the muscle, and not to be confounded with ptosis the result of traumatic paralysis of the third pair induced at the moment of birth by a difficult labour.

Besides congenital ptosis there is a form dependent on *relative insufficiency;* in other words, the weight upon which the levator palpebrarum has to act is beyond its power. Ptosis from *relative muscular insufficiency* may result from the integuments of the lid having become unusually weighty or bulky, or from the antagonist muscle having become unduly powerful, the result of inflammation and irritability. This is due most commonly to conjunctivitis, which has had the twofold result both of stimulating it functionally and of eventually causing its hyper-development. Again, the resistance may be out of proportion to the normal strength of the levator, as in cases where the latter has to struggle against some obstacle such as roughness of the conjunctiva due to granulations, or cicatricial bands in the cul-de-sac.

The commonest form of ptosis is that which depends on *real insufficiency*, that is to say, on a total or partial paralysis of the branches of the third pair. It is very necessary to analyse from an ætiological stand point each particular case, before deciding on any plan of treatment, the object of which will be to make the motor power proportional to the resistance to be overcome. I shall not here enter largely into the treatment of paralytic ptosis, as I propose to speak of it under paralysis of the third pair. In order to palliate the unsightly effect of a complete droop of the eyelid, the result of paralysis, a small ptosis forceps may be worn, somewhat resembling a serrefine. Or again, the folds of the lid may be embraced in a loop of silver wire, passed under the skin, and concealed as much as possible in the supraorbital hollow in those individuals whose eyes are deeply set. We are often compelled to abandon all attempts to raise the lid temporarily, for as soon as the globe is uncovered the patient becomes liable to very troublesome diplopia.

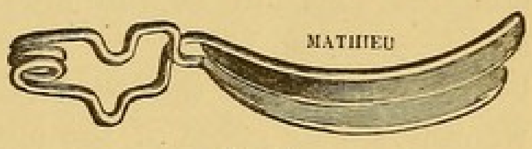

Fig. 3.

In ptosis from relative insufficiency, that is to say, when the eyelid has become too bulky, or the orbital muscle too weak for its antagonist, both or either of these conditions may be combated together or singly. The surgical treatment proper in such cases should not of course be resorted to, unless we are satisfied that the condition is one of permanent deficiency of equilibrium, and that the weight which the levator muscle has to sustain is not merely momentarily increased by transient inflammation and swelling of the skin, or irritability of the orbicularis, etc. The best treatment in these cases is to lessen the size of the membranous covering upon which the levator acts, by excising a fold of skin of an oval or olive-leaf shape. Such an excision should not be made on too large a scale, nor above all should it approach too closely the ciliary border, lest even after union by first intention, there should still remain an unsightly want of symmetry in the lid.

This disadvantage may be completely escaped if, instead of trying to increase the power of the levator muscle by diminishing the weight of the lid, we do so by weakening its antagonist.

With this intention, an incision is to be made in the skin, as *Von Graefe* directed, at a distance of 5 millimetres from the palpebral border and parallel to it. The skin is to be carefully turned back, after having been detached, so as to expose the fibres of the orbicularis. An oval, or rather olive-leaf shaped portion of muscle is then to be excised. Great care should be taken in bringing the lips of the wound together. In fact, not the skin only, but the whole edge of the muscular incision must be included in the sutures, in order that after the skin has united, the muscle may not remain with a deficiency corresponding to the loss of substance, whereby it would be too much weakened. If a very marked result is thought desirable, a still better plan is to combine excision of the muscle with that of the skin, as I am accustomed to do, but here also it is important to carefully bring together at the same time the muscular and cutaneous wounds. The effect of the operation does not become manifest until the inflammation caused in the wound has disappeared. The swelling is more considerable during the first few days, because, to make such operations easy and accurate, we are obliged to employ the hæmostatic forceps of *Desmarres, Snellen,* or *Warlomont.*

It would certainly be more rational if, instead of diminishing the power of its antagonist, we were to increase that of the weaker muscle, and to advance its insertion as in the operation for squint. But the anatomical relations of the levator, together with the danger of non-coaptation, have caused all attempts in this direction to be abandoned.

Before speaking of the anomalies of the palpebral fissure, I shall describe its normal proportions and position. In the adult the size of this opening is from 14 to 15 millimetres, for persons with large eyes. For those whose eyes do not open very widely, and in the case of the Mongolian race in particular, the extent of the opening is not more than from 10 to 12 millimetres. A fact, which at first seems curious, is that in the human male as compared with the female, the space between the lids is wider. The characteristic feature in children's eyes is that the opening is about equal in length to what it is in height. In Japanese and Chinese children this rotund appearance of the eyes is much less marked, while at a very early age the slit visibly slants towards the temporal side.

In Europeans the direction of the slit is not horizontal; on the contrary, its internal extremity is from 4 to 5 millimetres lower than the external commissure. Careful examination of the surrounding skin, and of its greater or less flaccidity, and especially of its tension over the palpebral ligaments, may afford valuable hints in cases where patients wish to dissemble their ages. The palpebral aperture may be abnormally *enlarged* or *narrowed*. Perfect symmetry does not exist between the two eyes, but for all that, we are not disagreeably impressed by a slight disproportion between the length and breadth of the aperture. It is otherwise, however, when these diameters are even slightly too long; the resulting condition then appears very unsightly. Exaggeration in the width of the aperture is caused by spasm of the non-striated muscles, known as the superior and inferior palpebral, and already described (p. 27). It is also very frequently observed in cases where the contents of the orbit have become protruded, or, again, simply as the result of enlargement of the eyeball from lengthening of its antero-posterior axis, a condition which, if confined to one side, renders the change in the shape of the aperture the more conspicuous. A case in which there often exists a disproportion in the size of the aperture is where an operation for strabismus having been performed on the eye, the capsule of Tenon has been roughly dealt with, and the conjunctiva very largely separated.

My method of treatment is of the simplest. I gently introduce the index finger of my left hand into the conjunctival sac, and with it and the thumb grasp the external commissure, enclosing thus within two fingers, the external third of the upper and lower lid. This manœuvre is executed with the double object of steadying the parts to be operated on, and more especially of restraining hæmorrhage by compression. With the aid of very fine curved scissors, I next detach the skin from the row of cilia to the inner edge, sparing as much as possible the orifices of the Meibomian glands, and carefully freshening the commissural fold. Two fine silver sutures, which pass through the whole border of the lid, bring the freshened parts accurately together, and a pressure bandage ensures union. I have lately had a patient under my care with an excessively large palpebral aperture, the result of too free an incision in an operation for squint. In this case I brought together the edges of the lids accurately, and by preserving the row of lashes concealed the line of union. Excessive reunion, which however should always be secured at first, may easily be dealt with by separating the lids with straight scissors until the two apertures are perfectly equal. Those coarse methods of tarsoraphia, in which the freshening was performed by detaching a considerable portion of the edge of the lid, together with the cilia, and which De Graefe has highly commended, should be once for all abandoned.

In certain pathological conditions of the seventh pair, should it not be considered desirable to perform external and internal tarsoraphia, with a view to allowing the closure of the lids, temporary apposition may be secured by bringing together, not the edges of the lid, but the folds of skin above and below. These may be either first slightly freshened as *Von Arlt* recommends, or they may be left intact, and two or three sutures merely passed through them as I generally do in children threatened with neuro-paralytic keratitis.

The palpebral aperture may be abnormally contracted, and give rise to a condition known as *blepharophimosis*. The contraction falls chiefly on the external portions of the aperture. This affection is not uncommon among old persons who, in consequence of prolonged catarrh of the conjunctiva and epiphora, have been long affected with fissures of the external commissure. In such cases, a band grows between the outer extremity of the edges of the lids, which is not unlike the membrana nictitans. Should union of the palpebral edges have taken place over a large extent of surface, as after a burn or a wound (the conjunctival cul-de-sac usually sharing in the process), the result is the condition known as ankyloblepharon.

The operation of *canthoplasty* must be resorted to in order to remedy this state of things, and to enlarge the fissure permanently. This is an easily performed operation, when we can dispose of sufficient conjunctival surface to cover the edges of the cutaneous incision. The incision should be made with straight scissors, and in the line of the fissure. If the skin is wanting, the operation must necessarily be abandoned, unless, indeed, we can cover the lips of the wound by detaching a flap of ocular conjunctiva, and so perform a regular plastic operation; or unless we can graft on a portion of conjunctiva, either human or animal. In order to counteract the cicatricial contraction of the edges of the cutaneous wound, we may employ the sutures of *Gaillard*. These should include the most central fibres of the orbicularis, together with the skin, so as to produce temporary ectropion.

An abnormal condition of the internal angle of each eye is sometimes met with, which consists in redundant folds of skin on the bridge of the nose. This irregularity is known as *epicanthus*, and imparts somewhat of a Mongolian look to the face. It is frequently observed in new-born children. It can very rarely call for treatment, which, however, should consist in the excision of an oval flap of skin from the bridge of the nose, the parts being subsequently carefully brought together. It is never advisable to operate on young children, seeing that this unsightly condition generally corrects itself as they grow older.

Among *anomalies of position*, I will first mention an alteration which is confined to the skin covering the ciliary margin, and to the eyelashes. This affection, known as *trichiasis* or *districhiasis*, is characterised by extreme irregularity in the arrangement of the lashes. These are disposed without any uniformity, their points being often directed inwards. The healthy condition of the tarsus is proof that this alteration in direction is due to skin changes, and not to any incurvation of the ciliary border depending on distortion of the lids.

The various forms of chronic eczema of the palpebral border readily induce shrinking of the skin in elderly persons around the hair follicles. This condition may become developed very slowly, without apparently the presence of any inflammatory condition, but merely of a more or less chronic congestion. This affection may also at times be the result of a slightly catarrhal state of the conjunctiva, which has attacked more particularly the mucous covering of the palpebral edges.

The treatment in the case of old people can often be merely palliative. A parent thus affected calls on his child, who sees the pale misplaced lashes, and pulls them out. This, unfortunately, must be repeated every two or three weeks, and at last becomes annoying. After a time, either from laziness or carelessness, removal of the hairs in this way will have been neglected, and then the crooked lashes will cause serious irritation of the cornea, and become the starting point of a further unhealthy action in the ciliary border. Under such circumstances the necessity will arise of resorting to some method of destroying the edge of the lid, or, what is much better, of displacing the portion upon which the lashes grow.

The simplest mode of effecting this latter, if a few cilia only are misplaced, is to employ a Gaillard's suture. A needle armed with a stout silk thread is to be passed close to the crooked lashes, and gliding over the tarsus should include in a noose, of about half a centimetre in extent, the skin, the subcutaneous tissue, and the muscular fibres. The thread is then firmly knotted, so as to cut its way out at the end of about a week.

One or two sutures, so as to cause cicatrices, with the object of directing the ciliary border outwards, are sufficient when the trichiasis is limited. If, however, the deviation affects to a considerable extent the row of cilia, it is advisable to have recourse to a more complicated operation. This consists in transplanting the dermoid base of the cilia by detaching and removing it. An oval flap immediately adjoining the strip of skin upon which the misplaced lashes grow should be first of all excised. This mode of grafting by displacement, according to the combined method of *Jaesche* and *Arlt*, is that which should be employed in preference to all others, for the following reasons: firstly, because we know now, as regards skin grafting, that the mortification of narrow strips of skin need not be feared, provided only that accurate apposition is secured; secondly, because with very little surgical ingenuity any man can himself modify the procedure of transplantation, limiting it according to the extent of the ciliary deviation.

I lay stress on this point, for I must here become the champion of conservative surgery, and would, once for all, make an end of those destructive proceedings which only render eyes already sufficiently disfigured worse. Moreover, all such barbarous procedures as excision, galvano- or thermo-cauterisation, or that with acids, etc., leave tough and irregular scars, which cause friction against the eyeball whenever, as is generally the case, the position of the lids is not quite normal. I should also add, that the formation of a cicatrix on the ciliary border itself, is a somewhat serious matter as regards the transplantation of the skin base of the lashes, and this the more so, if the bistoury, at the moment of separating the portion to be transplanted, has not sufficiently avoided the row of cilia; in such a case, the result may be that the cicatricial tissue at the edge will contract and drag on the transplanted skin, until the cilia upon it again come in contact with the globe. To obviate this, cicatrisation of the denuded surface which extends along the ciliary border, may be facilitated by grafting patches of epidermis on it, or even making a regular skin graft.

The amount of displacement of the lashes to be obtained by simple excision of a flap of skin from the immediate neighbourhood, the wound being allowed to heal spontaneously, is altogether trifling and temporary.

LECTURE V.

ECTROPION AND ENTROPION.

Those changes which affect at once the framework and the skin of the lids, and which are known as *Ectropion* and *Entropion*, belong more properly to the domain of surgery. I shall therefore here touch but lightly upon them. An eyelid is said to be affected with ectropion, when, no longer adapting itself accurately to the surface of the globe, it falls away from it at a greater or less angle. This displacement may depend on contraction of the skin, by which the inner border of the lid is dragged outwards. An analogous traction, or more properly constriction, is seen when the external portions of the orbicularis are too powerful for the inner, that is, for the so-called palpebral muscles. This disturbance of equilibrum in the orbital sphincter, may depend on the fact that the marginal portion has been unduly stretched; as, for instance, by protrusion of the globe, or chemosis of the conjunctiva.

Seeing that the muscular layers of the orbicularis become thinner in proportion as they pass from the edge of the orbit to the palpebral aperture, it is evident that, if the muscular system becomes affected by fatty degeneration, as in old age, a preponderant action of the orbital portions of the muscle over the palpebral may be established. In such cases the ectropion will the more readily become developed, owing to the looseness of the skin, and the infiltrations it is liable to in old persons; the increased weight of the lower lid from this cause will also facilitate its eversion.

Besides *cicatricial* and *muscular* ectropion, there is also the *paralytic* form. All these three, after a longer or shorter time, if well marked, will produce more or less lengthening of the lid, which may be complicated with hypertrophy of the conjunctiva, from constant irritation due to exposure. The condition known as *sarcomatous* ectropion, may thus be brought about.

Treatment must necessarily depend on the cause. If the case be one of cicatricial ectropion, in which contraction has resulted merely from cicatrisation of the skin consequent upon large superficial wounds, an attempt may be made to excite contraction in the opposite direction. With this object the fundus of the conjunctival cul-de-sac may be freely cauterised in the following manner. The lower lid (for this is the one generally affected), is turned outwards and carefully wiped dry. A crayon of nitrate of silver pointed, so as to cauterise a strip of mucous membrane from 2 to 3 millimetres broad, is then to be drawn over the whole length of the cul-de-sac five or six times, and then neutralised with salt and water. It is well to bear in mind that while this severe cauterisation irritates the eye intensely, it does not always succeed in bringing about the desired degree of approximation.

I prefer myself to obtain the necessary retraction by sutures, as recommended by *M. Snellen*. The object of these is to establish at the fundus of the cul-de-sac, and between it and the skin, bands of contractile tissue, which act by drawing the everted edge inwards. To effect this half a centimetre of the portion of cul-de-sac, most prominent above the affected lid is to be enclosed in a noose made with a thread and two curved needles. The needles are to be passed under the skin so as to present at two centimetres below the edge of the lid, and to be distant one centimetre from each other. The ends of the thread are to be knotted over a small pad of glove skin, and tightened so as to cause the edge of the lid to incline inwards. Generally speaking, two such nooses are required. They should be left in position, under a pressure bandage, for three or four days.

If the case be one of muscular ectropion, and the proponderance of the orbital muscles over those of the lids be, as in purulent ophthalmia, merely temporary, it will suffice to reduce the parts, and maintain them in position by a pressure bandage. If necessary, with this treatment may be combined incision of the external commissure, and scarification of the engorged and constricted mucous membrane.

But if, on the other hand, we have to do with those forms of muscular ectropion which are developed slowly, either because the muscular fibres have been impaired by old-standing cutaneous inflammation (blepharites), or have become atrophied from paresis or senile changes, recourse must be had to operative interference. The objects in view are to weaken the external portions of the orbicularis, to bring about cicatricial contraction, and by re-establishing apposition of the lid to remove the epiphora which tends to keep up the ectropion. To this end, according to *M. A. Weber,* semilunar incisions, with the concavity inwards, should be made in the skin near the external commissure, through both the fascia and tendon. The size and curve of this semilunar section will be in proportion to the amount of shortening desired.

Instead of a semilunar incision, if a considerable effect is to be obtained, two incisions may be made at an obtuse angle outwards. The angle of the internal section reaches to the external commissure, its sides incline nearly vertically to the orbicularis, and meet the lines of the second angle, which should be distant from the first in proportion as a more marked effect is to be obtained. In bringing the wounds together, both the skin and layer of muscle should be included in the sutures.

In proportion as a more marked effect is desired, the summits of the two angles should be separated, so as to give a rectangular form to the excised flap, care being taken not to include the external palpebral ligament in the section. According to *M. Weber,* it should be exposed before cutting away the skin flap.

It will be seen that these various methods are devised in order to weaken the outer portion of the orbicularis in favour of the inner, or palpebral, to shorten the skin about the lids, and by means of cicatricial contraction to make the lid approximate more closely to the globe. These operations have, however, the undoubted disadvantage of localising this traction too exclusively to the external commissure.

In cases of partial ectropion where, as after facial paralysis, the internal commissure is chiefly involved, more direct traction on the affected part will be desirable. With this object, the skin may be taken up in the way *Von Arlt* has lately recommended. With a small forceps, a fold of skin, 2 or 3 millimetres broad by 6 or 7 long, is to be seized below the inferior punctum, the blades of the forceps being held horizontally, and the skin drawn forwards. This fold having been excised, another and similar one is next removed, forming a triangle, the apex of which will be directed towards the superior punctum, the base towards the nose, while its upper border will pass close to the caruncula and conjunctiva. The operation should be commenced by detaching with scissors the apices of these triangles. This must be performed with great care, for the skin in this region adheres very intimately to the ligament. If a portion of epidermis is left behind, there is always danger of incomplete union. Accurate union will be insured by three sutures, which, once in position, will draw the internal angles towards the nose, and cause them to lie evenly against the eyeball.

This procedure may be made more effective by removing some of the fibres of the orbicularis along with the skin. In this way the peripheral or orbital portions of the muscle may be weakened in favour of the palpebral.

It is impossible to describe here the various operative procedures which have been devised to fulfil the following indications: (1.) To shorten the lid (*Adams, Dieffenbach*): (2.) To detach the cicatricial tissue which holds it back (*Samson* and *Wharton Jones*): (3.) To slide forward a flap and interpose it between the cicatrix which causes the deformity (*Richet*): (4.) To dissect out the cicatrix (*De Ammon*): and with this to combine tarsoraphia (*Richet*), or to shorten the elongated lid after the cicatrix has been previously excised (*Fred. Jaeger*).

These methods all belong to the province of major surgery, and are called for at very rare intervals, even in the largest cliniques. What more than anything else has tended to limit their employment, is the fact that, for the majority of cases of traumatic ectropion, it has come to be recognised that tarsoraphia, combined with a graft applied directly upon the raw surface, made by freeing the everted lid from its cicatricial attachments, gives much more certain results, and affords a far better guarantee against relapse, than the most skilfully devised flap advancements or displacements. Thus, a much wider field has been opened to surgical enterprise; a field to which I believe I was one of the first to invite the attention of specialists.

Conversely to ectropion, *entropion* is due to a drawing inwards of the palpebral border, owing to cicatricial contraction of the conjunctival or subconjunctival tissue, the densest and most resisting portion of which is represented by the tarsus (tarsal incurvation). It is especially by the bending of the frame of the lid that the palpebral border with its lashes are carried inwards towards the globe. Simple contraction of the conjunctiva would have the effect rather of drawing both the ocular conjunctiva and that of the cul-de-sac, towards the palpebral margin. A process here takes place analogous to that witnessed in ectropion. Here the loss of superficial portions of skin is compensated by traction on the skin in the immediate neighbourhood. On the other hand, the formation, however slight, of any cicatricial tissue near the framework of the lid (and as such I regard not only the tarsus, but the tarso-orbital aponeurosis) produces displacement. Thus, the so-called *angular* ectropion follows the healing of a fistula due to caries.

Granular conjunctivitis, an affection which so frequently changes conjunctival into cicatricial tissue, is one of the commonest causes of entropion. Nevertheless, every granular conjunctivitis which has reached its final stage, by no means necessarily becomes complicated with incurvation of the tarsus, and consequent entropion. Another factor must therefore be present in cases which terminate in entropion and trichiasis. There is a muscular form dependent on causes analogous to those described under ectropion. But then it is no longer the external portions of the orbicularis, but the internal, the palpebral muscles, which come into play. During the stage of lymphatic infiltration, which, as a rule, accompanies the development of true granulations, a stage in which the tarsus undergoes softening by infiltration of lymph, if the conjunctiva has been subjected to frequent inflammation, the portions of the orbicularis ramifying over the tarsus become the seat of irritation more or less chronic, the palpebral muscles contract, and the softened tarsus moulds itself, upon the circle of contracted fibres. The same thing also happens in frequently recurring superficial inflammations of the cornea, when intense spasm of the orbicularis becomes established.

In opposition to the ectropion of paralysis we have a spasmodic *entropion* which may develop itself rapidly in cases where, owing to over-stretching (serous imbibition), the peripheral portions of the orbicularis have become weaker than the internal. This spasmodic entropion may often be witnessed in the lower lid, when a bandage has pressed unduly upon the fibres of the orbicularis which pass over the lower edge of the orbit.

The entropion known as *senile* is also a spasmodic form. On the one hand its development is favoured by the serous infiltrations to which the skin around the orbit in old people is liable, and which drags upon and stretches the subjacent fibres of the inferior portion of the orbicularis; on the other, by the retreating of the eye in old age, which is due to the diminution of the cushion of fat in the orbit. The palpebral border, and the tarsi thereby lose their support, and consequently their normal fulness, while the fibres of the palpebral muscles which pass to this point, tend more and more to contract and to assume a preponderance over the peripheral portions of the orbicularis. It is this increased action which generates the spasmodic ectropion observed after atrophy or enucleation of the globe.

The treatment admits all the less of delay, inasmuch as the friction of the lashes and edge of the lid against the eyeball, will soon produce a state of irritability. This intensifies conditions already favourable enough to the development of spasmodic entropion; in other words, it augments the preponderance of the palpebral over the orbital muscles.

The cause of the entropion once recognized, a rational method of treatment becomes possible. In cases where distortion of the tarsus plays a chief part, mere simple excision of portions of skin can scarcely be of any avail. The same applies to excisions in the spasmodic forms of entropion; for here the retraction of the lid will quickly overcome the eversion produced by the removal of a flap of skin. It will be necessary, then, in order to combat cicatricial entropion, to attack those parts which have been most vitally altered by the cicatricial process, that is, the tarsi. In the spasmodic variety it is more especially the affected portions of the orbicularis, the palpebral muscles, which we must treat. It is only by attacking the primary cause of the disease, and not merely one symptom, that success can be ensured.

Spasmodic entropion, especially the senile, and that form developed under bandages, should be treated on the principle of weakening a portion of the palpebral muscles, which should be included in two or three Gaillard's sutures. *Von Arlt* proposes to effect this by means of threads which do not include the skin; but his mode of introducing and tightening them over small rolls of lint, renders the method not very practical.

As tarsoraphia was advocated in ectropion, so in entropion the converse operation, namely *canthoplasty*, should be performed. In this operation, the most internal fibres of the orbicularis are divided, while the space between the lids is enlarged by interposing the mucous membrane in the wound, in such a manner as to permanently weaken this portion of muscle. In conjunction with this method two others may also be practised. One is to apply two or three Gaillard's sutures, having first of all enlarged the palpebral aperture, and covered the freshened surfaces with mucous membrane. This combination was suggested by *M. Pagenstecher*, and is specially called for in the treatment of granulations, though we must bear in mind that it leaves indelible traces, and that thereby its employment becomes of use practically only in general clinics, where cosmetic considerations are of minor importance.

The second means aims at redressing the faulty position of the curved tarsus by slitting it along the whole length of its conjunctival aspect. This longitudinal *tarsotomy* of *De Ammon* may be practised in conjunction with Gaillard's ligatures, and with the excision of flaps of skin, but it requires in every case, if it is to be of any real use, that the tarsus, by means of canthoplasty, be freed on the side of the external commissure.

There is still another operation reserved by preference for bad cases of tarsal incurvation. The important feature of this operation, as recommended by *Streatfield*, is the excision of a wedge-shaped portion of tarsus, the base being directed outwards. At the same time a flap of the skin on the outside should be removed in order to make the cicatrix draw the tarsus back into position. *Snellen* advocates a complicated system of sutures, and excises merely a strip of the orbicularis.

From the preceding descriptions it will be readily gathered how important it is to go back to first causes before deciding on what method is the best to cure any given case of entropion. The severity of the case will be the best guide as to whether the sutures of Gaillard will be sufficient, or whether canthoplasty with or without tarsotomy should be superadded. The combined procedures of *Streatfield* and *Snellen* commend themselves especially in cases where it is important to remedy the deformity of the tarsus, and at the same time avoid conspicuous scars.

Foreign bodies in the eyelids are very rarely met with. Nevertheless, it is useful to bear in mind that the extreme looseness of the subcutaneous tissue, together with its remarkable elasticity, is peculiarly favourable to the long-continued sojourn of such bodies, while at the same time the swelling of the surrounding tissue, and the readiness with which such bodies elude the explorer's instrument, enable them to escape even a careful examination.

In all cases of wounds, the lid should therefore be diligently explored with the finger, in order to prevent too hasty reunion, and the sojourn of foreign bodies. As regards this, I mention in my full treatise on Ophthalmology a case where a piece of broken cane two centimetres in length and one in breadth was left in the lid during eighteen months by a distinguished surgeon. But in my turn, after having extracted this foreign body, and moreover carefully explored the wounded lid, I left behind, because perhaps I may have pushed it back into the orbit with my little finger, a second fragment of cane one centimetre long, which I did not extract till three months afterwards.

Wounds of the eyelids easily lead to permanent deformity, and require peculiar care in the manner in which they are brought together. No matter at what period we are called to treat lacerated or incised wounds of the lid, reunion must be immediately attempted. Even if several days have elapsed since the accident, we should never hesitate about freshening the edges, making them smooth by removing any dead portions, and bringing them together with metallic sutures. Fine silver sutures have this great advantage, that they can be left in position, and can hold the parts together, even where it has not been possible to obtain union by first intention.

In cases of loss of substance from burns, whereby eversion of the lid is so easily produced, it is not good practice to leave such injuries to heal spontaneously. The raw surfaces should be covered as soon as ever they commence to granulate, with skin grafts taken from the patient himself, or from some other person. The skin best suited for these grafts is that from the inner part of the forearm, whence squares of 4 millimetres in extent should be taken. The raw surface is to be covered as completely as possible with a mosaic work of these little patches, over which a portion of animal membrane should be gummed to keep them in place. *Reverdin* relates in his first monograph on skin grafting, the history of a case which I thus treated, and which, in spite of fearful burns on the face, escaped without any deformity of the lids.

If as a consequence of wounds or ulcerations the eyelids have been completely destroyed, they should be restored by the operation of *blepharoplasty*. I cannot, without trespassing on the domain of ocular surgery explain here the various procedures of blepharoplasty. I will merely remark that the greater number of them have fallen into disrepute since we have at our disposal the resource of skin grafting. It is now more than five years since I first insisted on the fact that, by combining tarsoraphia with grafting, it would be possible to abandon most of the operations of blepharoplasty, which in case of failure leave the patient still more disfigured. This idea has been taken up by *M. Verneuil*, for cicatricial ectropion. There can be no doubt that it is along this path of conservative surgery that every practitioner who, when he cannot benefit a patient, would fain not injure him, will prefer to travel.

DISEASES OF THE CONJUNCTIVA.

LECTURE VI.

HYPERÆMIA AND CATARRH OF THE CONJUNCTIVA.

Before entering on the study of the diseases affecting the mucous membrane of the eye, it will be well to give a brief outline of the anatomy of the membrane itself. The conjunctiva, then, is made up of an epithelial layer, a stratum of tissue proper, and a subjacent tissue connecting this with the parts upon which it rests.

Superficially the epithelium is of the cylindrical variety; deeper down, a layer of flattened circular cells are found, which assume moreover various forms according to the region of the conjunctiva they may be in. Upon the tarsal conjunctiva the mucous membrane forms a series of furrows and prominences over which the epithelial layer is continuous; hence on section the arrangement appears not unlike that of a sacciform gland.

The supporting membrane of the epithelium is of the tissue proper of the conjunctiva, which, on the tarsi, is attached directly to the framework of the lid, while elsewhere, a submucous tissue intervenes. The conjunctival tissue proper consists of a very fine reticulated structure, which at the points where the meshes intersect, discloses numerous nuclei. Very few elastic elements enter into this net-work, it being wholly occupied by masses of lymph-like cells, which give it an appearance not unlike that of the adenoid tissue of the intestinal mucous membrane.

The *subconjunctival tissue* which commences where the mucous membrane parts from the tarsus, consists partly of the more open meshes of the conjunctival tissue proper, with lymphoid cells in abundance, and partly of numerous elastic tissue fibres. These various fibres unite upon the ocular conjunctiva, with those of the sclerotic.

The *papillæ*, or *papillary bodies*, of the conjunctiva, are neither more nor less than the eminences and depressions presented by the mucous membrane on the tarsi. The depressions which are impressed on the epithelial layer by these folds appear in a vertical section, like cones of epithelium passing between the papilli; in reality they are pleats which run longitudinally over the tarsal conjunctiva.

A word as to the *lymphatic follicles*, for as such we must consider the general lymphoid infiltration of the conjunctiva. These follicles are better marked in some places than in others, and form agglomerations, around which the cellular tissue is more condensed. According to the best authors, as *Waldeyer*, the human conjunctiva does not contain any true follicles. Many observers, however, of not less weight, assert that the region of the cul-de-sac presents always, though in very small numbers in the healthy eye, rounded masses of lymph-like corpuscles, which differ in no respect, structurally, from closed lymph follicles.

According to *Krause*, in the region of the cul-de-sac a series of acinous glands are found. They are situated in the subconjunctival tissue, and terminate on the epithelial layer by a narrow excretory duct.

When I mention some small folds of epithelium, situated towards the corneal border, and which, enclosed within the meshes of the conjunctival tissue, have been called glands by *M. Manz;* when I mention the bulb-like ends of the nerves of the conjunctiva, the so-called spherical terminal corpuscles of *Krause*, peculiar to the neighbourhood of the cornea and the surface of the ocular conjunctiva, I have placed before you all the anatomical peculiarities of the mucous membrane, whose various pathological conditions I now propose to pass in review.

Before speaking of the mildest of all affections of the conjunctiva, namely, hyperæmia, it is advisable that I should make you acquainted with the various vascular plexuses of the conjunctiva. When an injection of the proper vascular reticulum of the mucous membrane, which ramifies over the whole conjunctiva, becomes generalised, it constitutes what is known as *injection of the conjunctiva.*

When this injection is limited to the circumference of the cornea it is called *pericorneal.* It may not extend beyond the terminal vessels of the conjunctiva itself, in which case it will be *conjunctival;* or it may depend on injection of the anterior ciliary vessels, when it will be *subconjunctival.* Usually a pericorneal injection is both conjunctival and subconjunctival. This latter, called also *episcleral,* ends in festoons which are directed towards the equatorial portion of the eyeball, and follows the track of the large ciliary vessels without ever reaching the equator of the eye. As regards the pericorneal injection of the conjunctiva, it always fades away, as may be seen with a low power, into a band of fine, closely-set, radiating vessels, which pass towards the corneal border, and overlie the less distinct and regularly arranged vessels of the episcleral injection.

Injection of the *sclerotic* appears under the form of purple-coloured, badly-defined spots, and results from the engorgement of the vessels, which chiefly ramify in its external layers. This injection may exist without the overlying conjunctiva in the least sharing in the engorgement. While injection of the conjunctiva spreads uniformly over the whole membrane, and while on the other hand a subconjunctival or episcleral injection is only immediately round the cornea, injection of the sclerotic exists both close to and at a distance from the corneal margin, in the form of isolated patches. These three forms of injection may then coexist together, but only near the edge of the cornea, as is often the case in phlyctenulæ of this region.

Hyperæmia of the conjunctiva is characterised by generalisation of the injection. This becomes especially conspicuous on the tarsi, where it conceals the tarsal glands, and imparts a yellow hue to the cul-de-sac. The injection of the ocular conjunctiva has the appearance of a coarse network of vessels, radiating up to the edge of the cornea. Not merely the transparency, but also the smoothness of the mucous surface is affected by the hyperæmia. The pleats and the furrows, in other words the papillæ, are more marked, and give the conjunctiva of the lids a velvety look. The engorgement of the papillæ with blood, the haze which conceals the tarsal glands, and a slight serous transudation, are the signs which chiefly strike an observer ; for injection of the *ocular* conjunctiva is met with only in acute cases of hyperæmia, and disappears as soon as the affection becomes chronic.

This condition would scarcely deserve so much of our attention, were it not that it causes great annoyance to persons so affected, and becomes a frequent subject of treatment. Patients cannot remain in a close or vitiated atmosphere, cannot use their eyes for any length of time, when a continuous effort of accommodation is required, and are tormented by an unpleasant sensation of weight in the lids. The symptom most commonly mentioned to the surgeon, is the great difficulty experienced in opening the eyes on awaking.

When speaking of hyperæmia of the palpebral border, I had occasion to enumerate most of the above symptoms. In fact, the two conditions are very similar to one another, inasmuch as hyperæmia of the mucous membrane is a propagation of the same condition from the skin. Thus, whatever predisposes to one, such as infarcts of the tarsal glands, or stagnation of tears, will predispose to the other.

Causes, more or less direct, and acting more or less continuously, may induce hyperæmia of the conjunctiva. Among such may be mentioned a lengthened stay in places where the temperature is very high, or the air constantly laden with dust, or surcharged with ammoniacal vapours. Finally, it must not be forgotten, that sustained and excessive efforts of accommodation in an eye of ametropic form may indirectly be the cause of a condition of permanent hyperæmia.

The above are a few of those general causes which must guide you in mapping out your treatment. This should consist mainly in regulating the amount of work done, and in looking after the hygiene of the eye. The selection of proper glasses, and fresh air, are often alone sufficient to place a patient in the way of recovery. The cure may be accelerated by the means pointed out in the treatment of hyperæmia of the margins of the lids. The use of slightly astringent solutions is here particularly indicated. With this object subacetate of lead in solution (1 part in 75), sulphate of zinc, and nitrate of silver (1 in 300), may be prescribed. The latter agent is indeed very efficacious, but has the disadvantage of darkening the skin in an unsightly manner; the subacetate of lead leaves a white deposit scarcely noticeable.

Applying certain collyria, in order to transform a chronic into an acute hyperæmia, and so produce congestion and stimulate the vessels to contract, is practically useless in simple hyperæmia. A collyrium of laudanum, composed of equal parts of laudanum and distilled water, may occasionally be of some benefit, due probably to the alcohol contained in the tincture of opium.

The attempt to stimulate the conjunctival vessels directly by cauterising them with solution of nitrate of silver (1 in 50) is not justifiable when the discharge is not increased, for in such cases the shedding of the eschar is always slow. The pain lasts so long that the patient becomes extremely dissatisfied with his medical adviser.

In all cases where, together with this affection of the conjunctiva, the edges of the lids are hyperæmic, and where at the same time there is a manifest tendency to eczematous affections of the skin, it will be best to prescribe morning and evening warm lotions. These may consist of liquor subacetatis plumbi, twenty minims to be dropped into a good-sized bowl of water and applied to the part. If this should not appear to be sufficient, the edges of the lids may be rubbed every evening at bed-time, with a very thin coating of red precipitate, or oxyde of zinc ointment, in accordance with the formulæ given when treating of hyperæmia of the lids, (pp. 7, 11). It should be borne in mind that in eczematous or rheumatic subjects the prolonged action of damp or cold is badly borne.

For hyperæmia to become inflammation, the products of inflammation must be superadded to the symptoms already mentioned. It is not wholly from the nature of these inflammatory products that we form a classification of the various forms of conjunctivitis. To suppose that in these cases the tree may always be recognised by its fruit is to make a grievous error. We must be guided rather by a consideration of the positions which such products actually occupy. Relying on this we shall be more likely to form a correct classification, though all classification must remain to the end more or less artificial. There are two great categories of inflammation: in one, the products are directed outwards, *upon* the surface of the mucous membrane; in the other they are deposited *in* the actual stroma. The first category comprises catarrhal, purulent and croupous; the second, diphtheritic, phlyctenular, follicular, and granular inflammation.

Catarrhal conjunctivitis exhibits much the same symptoms as hyperæmia of the conjunctiva. To these, is now added a discharge from the membrane, a mere hypersecretion, without any sensible alteration in physical properties. A healthy conjunctiva secretes naturally a certain quantity of mucus, mixed with detached and effete epithelial cells. When this mucus is very abundant it takes on a tenacious, stringy character, with perhaps small masses of pus in it. These float freely in the conjunctival sac, and are driven from between the lids to the margins, where they dry, and form friable, glassy-looking scabs.

In addition to the fact that the hyperæmic symptoms are all much better marked in catarrh, and that the tarsal glands may be completely concealed, the transudation of serum through the mucous membrane is increased to such an extent as to raise up the ocular conjunctiva and produce chemosis, which may even spread to the margin of the lid, causing œdema.

What distinguishes catarrhal inflammation from the severer form, known as purulent ophthalmia, is that the symptoms of congestion and serous infiltration, together with the discharge, never even in the most acute and severe attacks, assume more than moderate proportions. This question of mere difference in degree may be of much practical importance, for in catarrh of the conjunctiva, the inflammatory products, though containing the elements of pus, are never, properly speaking, truly purulent. Moreover in catarrhal inflammation destruction of the corneal epithelium from maceration is much less likely to take place in a fluid which is being continuously secreted afresh; or if it does take place, the consequent effects of cell migration through the raw corneal surfaces, are less to be dreaded.

These catarrhal affections have a tendency to localise themselves upon the conjunctiva of the lid, and to become more and more chronic in character. It is not uncommon to see them finally complicated with blepharitis, the two affections existing side by side.

The secret of treating catarrh of the conjunctiva successfully consists in recognising the causes which have occasioned it and which keep it alive. As direct causes, I may mention impure air, irritating exhalations, prolonged exposure to smoke, and the continuous contact of tears, or decomposed cutaneous excretions. As a cause depending on a general diathesis, I may mention a peculiar proneness to catarrh of the mucous membranes, existing in persons affected with exanthematous eruptions, or malarious fever.

The removal of all disposing causes will of itself be an important step towards effecting a cure. But it will further be necessary to discover any local causes which may tend to keep alive the catarrh, such as the presence of a foreign body, crooked lashes, etc. The next step is to enquire whether you have before you an acute form of the disease, and one in which the ocular mucous membrane is very hyperæmic and injected. In these cases it does not do to have any doubts as to the existence or otherwise of corneal complications, or irritation of the iris. I have often seen cases of iritis mistaken for conjunctivitis, and treated with collyria of nitrate of silver. As regards the diagnosis the absence of any episcleral and pericorneal injection should remove all doubts. The exhibition of refrigerants is the most efficacious means I know of, of promptly curing a conjunctival catarrh. Cold compresses prepared with water slightly carbolised (1 part in 200), and applied hourly for fifteen or twenty minutes at a time, give great relief, and remove the sensation of smarting and heat. Similar compresses, imbued with a solution of 1 part nitrate of silver or sulphate of zinc to 300 of distilled water, may also be used twice or thrice daily.

If thoroughly assured of the correctness of your diagnosis, and convinced that you have to do with simple catarrh (and in this case, the statements of the patient as regards the quality and quantity of the discharge, will remove any lingering uncertainty as to the possibility of iritis or keratitis without secretion), you may venture on abortive treatment. To this end you evert the lids, and pass over the surfaces a brush moistened in a solution of equal parts of liquor plumbi and water, taking care to wash the parts immediately afterwards with water. Similarly nitrate of silver solution (1 in 50) may be used, if thoroughly neutralised afterwards by salt and water. I do not approve of swabbing the mucous membrane with the caustics just mentioned, or not immediately washing them off. Such a method of cauterisation is much more painful than the one I have just recommended, and with it complications as regards the corneal epithelium are more likely to arise.

Moreover, I would earnestly impress on every surgeon before he resorts to the abortive treatment of catarrh, the necessity of carefully examining the patient with oblique illumination, so as to make sure that the cornea, especially near its conjunctival border, presents no small abrasions or facets. Where such is the case, cauterisation is badly borne, and the same may be said of refrigerants. If the cornea be intact, three or four applications of caustic, every second day, will soon cure a simple catarrh. When, however, it is not intact, this method of treatment must be abandoned. The corneal lesions will require to be dealt with by means of warm fomentations, consisting of a weak solution of carbolic acid.

In cases of catarrh coupled with very marked and old-standing flaccidity of the conjunctiva, in aged persons, warm astringent lotions, especially those of subacetate of lead, are indicated.

A collyrium, composed as follows, may be prescribed with advantage :—

Sulphate of zinc	2 parts.
Tincture of opium	3 „
Distilled water	160 „

As drops for use morning and evening.

I have also derived much benefit from an old-fashioned collyrium known as *Aqua Horstii*, and which I have christened *Yellow Collyrium*. It requires for its preparation several drugs, and therefore should be obtained ready made from a druggist. Its composition is as follows :—

Hydrochlorate of ammonia	15 parts.
Sulphate of zinc (pure)	40 „
Distilled water	3000 „
Camphor (dissolved in alcohol of S. G. 0.850).	12 „
Saffron	2 „

Mix and digest at a temperature of from 35° to 40° C. (95°—104° F.), allow it to cool, and use pure, or better, mixed with equal parts of distilled water.

There is no doubt that collyria of nitrate of silver are also very efficacious in these cases; nevertheless, I have completely banished them from routine practice, and that for the following reasons. First, when once the formula of such a collyrium has been given to a patient, it is impossible to say how it may be abused. I could show you cases where by prolonged use of nitrate of silver the whole conjunctiva has become darkened and the eyes perfectly hideous. Secondly, we can not be sure when once a patient has been removed from our immediate observation, that some complications of the cornea will not arise. If his cornea later on become ulcerated, he will silver over a greater or less portion of its tissue. A collyrium of sulphate of zinc could not have been attended with any of these bad results.

I cannot too strongly insist on the importance of your thoroughly satisfying yourselves that the catarrh you are treating is not one which is being kept alive by something irregular as regards removal of the tears. In old persons such a condition often results from displacement of the inferior puncta. If such is the case, a slight incision comprising one half of the duct is better than all the collyria that can be devised.

In many persons of a herpetic diathesis, suffering from catarrh of the conjunctiva, collyria, compresses, and astringent lotions, are badly borne, and give only temporary relief. The use of oxyde of zinc or red precipitate ointment every evening, according to the directions already given (pp. 7 and 11) under blepharitis, will soon effect a cure, if coupled with the regular removal of any lashes which would eventually fall off.

It is almost needless to remark that all work with the eyes should be governed by rule, that the hygiene requires careful attention, and that all ametropia must be accurately corrected.

LECTURE VII.

PURULENT OPHTHALMIA.

Purulent ophthalmia is an affection which the general practitioner is quite as likely to be called on to treat as the specialist. In the majority of cases it is due to infection, which breaks forth with such intensity, that the most critical period for treatment has passed away before the family doctor can obtain special advice. It is necessary, therefore, to attend carefully to the signs which tell you that you are no longer in the presence of a mild conjunctival catarrh, but rather of an inflammation of the mucous membrane, requiring extremely watchful treatment.

All the symptoms mentioned as proper to catarrh are now pushed a degree further. The most striking of all is the serous engorgement, which gives rise to puffiness of the ocular conjunctiva, and surrounds the cornea with chemosis, thereby giving it the appearance as though at the bottom of a funnel. The effusion works its way all along the palpebral margin, and transforms the upper eyelid into a violet-coloured mass, the size of a small pigeon's egg. From all this it follows that there should be no difficulty in recognising an acute purulent ophthalmia.

In the chronic forms you will see, as in catarrh, the inflammatory symptoms deserting the conjunctiva for the mucous membrane. In proportion as the serous exudation which fills the ocular conjunctiva subsides, the papillæ become elevated and form villi, such as are never met with in the catarrhal form. These villi cover the tarsi so thickly with a layer of dense tissue, that all resemblance to catarrhal conjunctivitis, which, at least, allows of the tarsal glands being always made out, is lost.

A very characteristic sign of purulent ophthalmia is the discharge, which, in the acute form becomes, at an early period after the commencement of the attack, distinctly purulent; and this to such an extent, that genuine pus courses over the cheek, and bathes the inflamed conjunctiva in every part.

Let a catarrh be never so intense, it will not give rise to true blenorrhœa, or purulence. The discharge, in order to escape from between the lids, necessitates the lids being kept constantly on the move, for owing to the presence of a certain amount of mucus, it is so tenacious that it cannot escape unaided. This condition, together with sundry chemical and physical characters, not yet perfectly understood, differentiate between pus from the conjunctiva, and the inflammatory product of a catarrh. The more I observe facts, the more convinced I am, that those alarming complications of the cornea, which constitute the great danger in purulent ophthalmia, and mark it off so clearly from catarrh, are due to the action of the discharge upon the corneal epithelium, and upon the property which the purulent matter has of migrating through tissues denuded of their protecting epithelium.

Furthermore, we often meet with cases where the apparition of ulcers on the cornea, can not be explained by the blocking up of the channels of nutrition, for the inflammatory symptoms have not been pushed far enough to admit of such an explanation. Nor, on the other hand, do complications of the cornea correspond to the precise moment when the engorgement of the vessels of the mucous membrane is at its height, a period when the discharge is relatively scanty, and when dacryorrhœa rather than blenorrhœa is present. Speaking generally, these complications correspond better to the period when the symptoms of hyperæmia and congestion are on the decline, and this is precisely the period at which the flow of pus commences.

It should also be borne in mind, that complications of the cornea assume characters which belong to the rodent ulcer. It is true, that at the beginning, the spots of infiltration are seemingly covered by an unbroken layer of epithelium; but then it must be allowed that with patients in this condition, it is very difficult to make any examination sufficiently thoroughly to enable us to say up to what point the white corpuscles may, or may not, have made their way into the epithelial layer. The ulcer once formed, presents from the very first the characters of a rodent ulcer, having raised edges, and being of a dull yellow colour.

From an anatomical point of view the true distinguishing feature of purulent ophthalmia is its discharge. No great changes take place in the stroma of the conjunctiva. It merely becomes infiltrated with serum, and with the proliferation of the cell and lymphoid elements. The blood vessels of the papillæ are widely dilated, and the subepithelial capillaries appear markedly increased in number.

The epithelial layer is in no wise thinned. We might have imagined it would have been destroyed, atrophied, in consequence of the active part it had taken in the formation of pus. Such is not the case; on the contrary it becomes, if anything, thicker. It has after all only absorbed serum, and afforded a passage to the leucocytes which escape in great numbers from the inflamed vessels. This point is important as a guide to treatment.

A purulent ophthalmia which passes through stages of amelioration and aggravation, must be distinguished from other and graver ophthalmias more allied to catarrhal affections. It is marked off from these by the fact that though it may have been severe, it will leave an organ absolutely unharmed, and a mucous membrane perfectly sound.

Purulent ophthalmia is very rarely idiopathic. Even in cases where the starting point has been chronic catarrh, it is only a complication, and its origin must be looked for in that most potent of causes, contagion. The fact should be recognised that an altered, fermented, or decomposed catarrhal discharge may exercise a fatal influence over a mucous membrane which is already diseased. Every one is aware that sudden changes of temperature, particularly those which the habit of sleeping in the open air exposes to, are favourable to the production of catarrh of the conjunctiva, known vulgarly in France as "cocotte." Now in warm countries, in the East for example, one of the most deplorable of prejudices is that inflamed eyes should never be washed. What is there astonishing in the fact, that the continued presence of a decomposed discharge, the impurity of which is still further added to by all sorts of filth (and in the East it is not uncommon to see flies settling on the affected lids of poor children), should inoculate a mucous membrane already the subject of catarrh, and impart to the disease a virulent character?

A purulent ophthalmia in our latitudes does not break out spontaneously, and if you find it appearing among children under circumstances where infection seems scarcely probable, examine the sponges with which they have wiped their eyes. You will often be satisfied that these so-called articles of cleanliness have not infrequently been turned to uses which have rendered them the reverse of clean.

Before proceeding to consider the treatment, a few words have yet to be said on two forms of purulent ophthalmia, which on account of their peculiar origin have received special names, to wit, *ophthalmia neonatorum,* and *gonorrhœal ophthalmia.*

The ophthalmia of newly-born children when it assumes the true purulent character, requires no separate description. It is unfortunately but too well known how many victims this terrible malady claims, owing to the ignorance of those who wait on these little patients. There is one point which I must here lay stress upon, and that is, that in the production of ophthalmia neonatorum there can be no doubt that inoculation plays the sole part. The infant may be inoculated in the vagina, or at the moment of the first washing. If more infants are not attacked with purulent ophthalmia—for their mothers one and all expose them to the risk of it—it is because the infant instinctively curls its eyelids inwards. It is only in cases where an infant's eyes are prematurely opened that they contract contagion. The probability of inoculation is further increased by the fact that many of these infants live amid surroundings where infectious matter abounds. I do not speak only of cases where children are the victims of overcrowding, as in asylums and nursing institutions.

Gonorrhœal ophthalmia is always the result of inoculation; for I need scarcely waste time refuting the theory of metastasis. It is astonishing that among the poorer classes the affection is not met with even oftener than it is. Perhaps the instinct which bids the eyes to close whenever the hands approach them may explain this relative immunity. It is found that men are more often attacked, and that in the right eye, than women. There is an exception to this, however, in the midwife class who have often occasion to place their fingers in contact with infected organs.

An essential point to note is that virus from the genital organs gives rise to not only the most intense purulent ophthalmias, but may also produce something even worse, namely diphtheritic conjunctivitis. This is especially to be dreaded when a person already constitutionally predisposed inoculates himself with gonorrhœal pus, or when this inoculation takes place under epidemic conditions favourable to an outbreak of diphtheria. Without even examining a patient, we may assert that the affection he suffered from was not purulent ophthalmia, if we learn that he lost his eye-sight within from twenty-four to forty-eight hours after the commencement of the attack.

A comparison of statistics comprising cases of simple purulent ophthalmia and of gonorrhœal inoculation, would amply prove that into the latter affection, a new factor enters, which renders the prognosis considerably less favourable. One half of all eyes attacked by gonorrhœal ophthalmia are lost, scarcely one third of those attacked by purulent. This proportion would be made yet more striking if a table of carefully treated cases were drawn up.

It is in fact within our power to treat purulent ophthalmia successfully; while in the diphtheritic form intervention is often of little use, and may even be prejudicial if any attempt be made to push it vigorously. It is therefore important that this peculiar property possessed by an ophthalmia, resulting from inoculation with urethral or vaginal pus, should be borne in mind, so that we may be on our guard, and reserved, so long as the character of the disease is undeclared.

Without anticipating what I shall have to say about diphtheritic conjunctivitis, I may remark that if, with an extreme degree of swelling of the mucous membrane the purulent discharge is scanty, and the conjunctiva and eyelids hard and pale, owing to plastic infiltration of the mucous membrane, it should be interpreted as a warning that the inoculation from gonorrhœa has produced something worse than purulent ophthalmia.

I have said that, except where purulent ophthalmia is merely an extraordinary stage of other morbid states, such, for example, as granulations, contagion must always be considered as its starting point. This doctrine will be the guide to treatment, the essential object of which is to combat the pernicious action of an infecting principle, which is being constantly reproduced by the affected mucous membrane. Nor should we forget that here the purulent discharge, as regards the cornea, produces all the bad effects which the contact of infecting matter generally does in such a situation. Herein, indeed, resides the chief danger. The most effectual means of combating purulent conjunctivitis will therefore be to ensure cleanliness as perfect as possible, by the use of such disinfectants as we have at command.

At the commencement of the attack, while as yet there are no corneal complications, it will be well in every case to apply cold, which, better than any other agent, contracts the vessels, and checks in a great degree the tendency to diapedesis.

An excellent combination is that of cold with disinfectants. The solutions, therefore, recommended at page 53, should be prescribed. A basin is to be filled with one of these solutions, and pieces of ice allowed to float in it, so as to maintain the liquid at freezing point. There are two details to which the practitioner should direct his attention. The first is, that there be no lack in the quantity of disinfectant employed, for too often one sees compresses moistened in a small cup, so that within a very short time, the disinfectant becomes an infectant. The second is, that there should be some person constantly in attendance to change at each moment the compresses, so that the cold may really exercise its influence.

If you will merely insist on the solution used for the compresses being frequently changed, your patient will thereby be placed in a fair way of recovery. The use of cold applied by means of bags of membrane or indiarubber, held in position, has the great disadvantage of exercising pressure on the eye, and causing a cutaneous loss of sensation, which becomes intolerable. On the other hand, compresses, frequently renewed, relieve the distressing feeling of heat, and aid in cleansing the eye. There is no need to be timid in making use of this excellent agent, which will alone be sufficient in cases of average severity, where the presence of some corneal complications do not contraindicate a prolonged extraction of heat.

Another important point is the careful cleansing of the eye. This cleansing may be effected by slightly opening the lids, and with a sponge allowing a small stream of tepid carbolised water to flow between them, or with patients of the better class by spray and pulverisation. The cleansing of the eye must be continued through the night, and the greatest care taken, by means of lotions with warm carbolised water, to prevent the lids sticking together.

So soon as the diagnosis has been thoroughly cleared up as regards the case being one of true purulent ophthalmia, uncomplicated with diphtheria, cauterisation with a solution of nitrate of silver of a strength of 2 per cent. should be resorted to. I use these weak solutions in preference to the application of the nitrate itself, either pure, or mitigated with nitrate of potash. The consideration which has led me to alter my earlier practice, which was in conformity with the precepts of *Von Graefe* and *Desmarres,* is that caustics which cause an eschar of a certain thickness, give rise more readily by friction to excoriations, and corneal complications, than solutions do, for these merely deposit on the mucous membrane a light coating of nitrate of silver.

With the aid of certain precautions, the reproach levelled against the use of fluid caustic, namely, that the cornea cannot be sufficiently guarded from contact with it, may be escaped. It is in practice quite sufficient to carefully invert and cauterise each lid separately, while the cornea is covered with the other, and to subsequently neutralise with salt and water.

As regards the action of the caustic, I hold that it is directly efficacious by irritation of the vascular walls; and indirectly, by the contraction which follows any considerable discharge of serum such as accompanies the shedding of an eschar. I do not believe that the caustic must necessarily transmit its effects to any given depth, or determine the destruction of the epithelium, which is the source of the purulent matter. In other words, I have no wish to substitute a traumatic inflammation for a purulent ophthalmia. These various reasons have induced me to prefer superficial cauterisation, sufficiently energetic, however, to act strongly on the vasomotors.

The cauterisations may be repeated twice a day, if the discharge shows any tendency to increase some three or four hours after the application. Generally speaking, a single cauterisation in the twenty-four hours will be found sufficient.

One of the most effectual means of unloading the mucous membrane consists in making numerous scarifications. These, which must be limited to the most superficial vessels, are effected by means of a scarifier made *ad hoc*. The incisions are to extend over a considerable length, and should be close to one another. This treatment is the more indicated if free hæmorrhage follows it, for this shows that we have to do with a true purulent conjunctivitis, uncomplicated with any fibrinous infiltration of the mucous membrane.

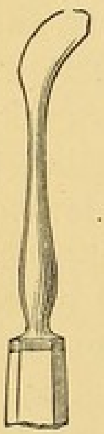

Fig. 4.

Scarification should succeed cauterisation, and be repeated every twenty-four hours. The flow of blood should be encouraged by kneading the lids, and wiping them with a sponge and warm water. It may be discontinued as soon as the conjunctiva has more or less emptied itself, as will be shown by subsidence of the chemosis.

We possess also a means of unloading to a very considerable extent the vessels of the conjunctiva in *Arteriotomy*, which is best performed by incising the external commissure.

The wound should be allowed to bleed more or less freely, according to the condition of the patient. Arteriotomy offers the following great advantages: it is united with incision of the external commissure, it relieves the cornea from pressure, and it facilitates cleansing of the eye. But on the other hand, it should be noted that this snip of the scissors is justifiable only if we are certain of not having to do with a diphtheria, and, therefore, have no reason to fear that the wound will become infected.

Excision of the hypertrophied portions of the papillæ, and of chemosed folds of conjunctiva, has always appeared to me bad practice. It may give rise to an exuberant growth of subconjunctival tissue in the ocular mucous membrane, which after the cure of the ophthalmia, may be very difficult to repress.

Ought the above treatment to be persisted in when complications of the cornea show themselves? The answer is "Yes," with this reservation, however, that the use of cold be not too much pressed, that extra precautions be taken to prevent the caustic from coming in contact with the cornea, and that every application be followed by abundant washing.

From the moment that the cornea exhibits the faintest tendency to share in the disease, and that the presence of any, even the least, excoriation of the epithelium has been detected, (and to settle this, in the case of children, the eyes should be examined with elevators,) a drop of collyrium of sulphate of eserine (1 part in 200), should be instilled into the eye, two or three times at intervals. I cannot sufficiently insist upon the advantages that the alcaloid of Calabar bean possesses in these cases over atropine, which, till now, has generally been recommended by all ophthalmologists. Its action is truly marvellous in extensive ulcerations, with or without perforation. In such cases I succeed in healing, with flat and slightly marked cicatrices, ulcers which doubtless would have occasioned staphylomatous bulgings, had they been treated without eserine, or *à fortiori*, with atropine.

I shall return to the curative properties of eserine when treating of corneal affections. For the present it will be enough to say that it acts essentially by contracting the vessels, and thus opposing an obstacle to diapedesis. By diminishing the excretion of serum into the interior of the globe, it lessens intraocular pressure. The ulcers then heal under less pressure, and with less proneness to cell migration.

In cases where a very large ulcer threatens to perforate, when its floor has become thin, and when in spite of eserine, it commences to bulge, we must as it were anticipate, and by means of sclerotomy diminish pressure, and check as far as possible, the migration of leucocytes. I shall have occasion further on to lay down more precise instructions as regards the employment of this remedy. Let me only say here that according to the extent of the ulcer, a sclerotomy of from 2 to 3 millemetres in length should be made. The cornea should be transfixed in its whole extent, near the upper or lower border, according to the position of the ulcer. Care must be taken to ensure the sclerotome entering and leaving slightly without the corneal border, a difficult matter enough when the chemosis is very considerable.

When called to treat an eye in which large perforations, together with prolapse of the iris already exist, removal of the prolapsed portion by means of the scissor forceps, may be attempted. In such a case eserine, division of the external commissure, and absolute rest must be particularly insisted on. Here the medical attendant must show some dexterity in the manner in which he everts the lid, so as to avoid all pressure on the globe.

For patients with acute purulent ophthalmia whose general health is good, active saline purgatives for some days, are indicated in order to secure an active drain from the intestines. It will be more especially desirable to transfer the patient to fresh air; he should change his apartment if it is deficient in any hygienic requirements, while constant residence in small chambers, which, as a rule, are badly ventilated, must be strictly prohibited. Ophthalmia neonatorum is to be treated in exact accordance with the principles enunciated above. In the subjects of such an affection all excessive cauterisation must be avoided at the outset of the attack, seeing that at this period the mucous membrane readily takes on a cyanotic condition, which, in its destructive action on the cornea, resembles very closely diphtheritic infiltration. Cold, disinfectants, and cauterisation with a solution of nitrate of silver (1 in 50) ought to cure every ophthalmia in new-born infants, without danger to the cornea.

As regards the treatment of gonorrhœal ophthalmia, it differs in nothing from that of purulent, when such is the character the disease actually assumes. On the other hand, the treatment proper for diphtheria should be resorted to the moment this terrible malady threatens to show itself.

LECTURE VIII.

CROUPAL CONJUNCTIVITIS; DIPHTHERITIC OPHTHALMIA; PHLYCTENULAR CONJUNCTIVITIS.

In 1861 I defended, before *Trousseau*, a thesis upon diphtheritic conjunctivitis. In it I declined to consider croupal conjunctivitis as forming one of the group of diphtheritic affections; a view which met with complete disapproval from that great physician. In my earlier publications I did not even think it necessary to describe croupal conjunctivitis as a distinct affection. I simply classed it along with those purulent ophthalmias secreting a discharge, which quickly coagulates on exposure to air. If now I speak of "conjunctival croup" it is only to establish once more that this form of conjunctivitis, which pours its discharge on the external surface of the mucous membrane, has absolutely nothing in common with the fibrinous infiltration of diphtheria, the seat of which is in the stroma of the conjunctiva.

Besides the fact that more or less thick membranes may be thrown off, in the form of a cast of the sac, in conjunctival croup, the affection differs further from purulent ophthalmia, in that both the swelling and injection are much less. The culs-de-sac are the portions which more especially become covered over with a yellowish-green membrane which hangs, as it were, above the eyeball. The mucous membrane, lining the tarsi and globe, is comparatively little thickened. These are points which at once distinguish croupal conjunctivitis from diphtheritic. The folds of the cul-de-sac, within which the croupal membranes lurk, are more or less bulged forward and rise above the ocular conjunctiva. This is but slightly injected, and never covered with fibrinous exudations.

This disease is always acute, and gives rise to membranes very similar, as regards their microscopical structure, to those of tracheal croup. In England buccal croup has actually been seen simultaneously with conjunctival. True conjunctival croup is peculiar in this, that the formation of a fibrinous layer is the essential feature of the disease. This is cast off, with a slight purulent discharge, after which a cure rapidly ensues.

To call an ophthalmia, in which the discharge shows a certain readiness to coagulate on exposure to the air, and which discharge if removed is succeeded by another layer of pus, exhibiting the same property—to call I say such "croup of the conjunctiva" is to interpret facts amiss, and to frame an artificial distinction.

The true conjunctival croup shows itself chiefly among children in spring and autumn; and especially at times when diphtheria of the air passages is epidemic. It is absolutely necessary for the practitioner to be able to recognize this disease so as not to treat it as he would simple purulent ophthalmia, *i.e.*, with caustics. Cauterisation at a moment when the conjunctiva is covered with the products of croup, and particularly if under the influence of a diphtheritic tendency, may easily provoke an attack of true conjunctival diphtheria.

Treatment will consist in the use of cold and disinfectants, as at the commencement of purulent ophthalmia. Instead of cauterising with nitrate of silver it will be better to evert the lids, and pass over them a brush dipped in a two per cent. solution of carbolic acid and water. Solution of nitrate of silver (1 part in 50) should only be used when the false membranes having been cast off, a true purulent condition is left behind. The employment of disinfectants is here strongly indicated as the affection is essentially contagious, and consequently a source of danger to those in its immediate vicinity.

In France an opportunity, happily, but seldom occurs of witnessing the dreadful spectacle of an attack of diphtheritic conjunctivitis. The lids, all livid and swollen, are lined with a thick lardaceous conjunctiva, flecked here and there with greyish masses. You are struck at once by the dryness of the eyes which is in remarkable contrast to the copious discharge characteristic of purulent ophthalmia. A grey sanious fluid with difficulty escapes from the palpebral fissure distended as it is by fibrinous masses to the very edges of the lids. Instead of injection you have marble-like streaks furrowing the conjunctiva. These result from small hæmorrhages due to strangulation of the vessels by the infiltration.

The acute pain suffered by the patient is also remarkable. His complaints are unceasing, while in purulent ophthalmia, even when the lids are enormously swollen, there is never much distress.

The suffering in diphtheritic cases is due to the strangulation of nerve and blood-vessel by the infiltration, which occupies more or less completely the whole thickness of the conjunctiva, renders all diapedesis impossible, checks the flow of blood from scarifications, and imparts to the eye that fearful look, as though some fatal blast had passed over it.

Essentially contagious, the scanty discharge of diphtheria is remarkable for its great proneness to undergo fermentation and decomposition, and produce a greater or less quantity of bacteria. The secretion thus altered quickly exercises a corroding action on the borders of the lids, while the neighbouring parts, once robbed of their epithelium, are transformed into masses of specific infiltration.

In true diphtheria of the conjunctiva the cornea is cut off from most of its sources of nutrition, and is attacked early by necrosis. A perfect cast of the whole palpebral cavity will be thrown off, and unless a purulent discharge supervenes and lasts for some time, the cicatricial stage will set in, bringing with it wasting of the eye, and contraction of the cul-de-sac, which may proceed to actual symblepharon.

These desperate cases are, it is true, seen only in countries where there is a predisposition to diphtheria. In France the most common form is that in which the affection penetrates the stroma of the conjunctiva to only a slight depth, and in which, after the fibrinous masses have been thrown off, a period of suppuration more or less well marked and lengthy supervenes.

The differential points between this bastard diphtheria and simple purulent inflammation are as follows: in the former the danger of corneal complications is very much greater than in the latter; the changes which take place in the cornea easily escape observation, as they give rise to facettes, which exhaust its vitality; and, lastly, once the infiltration has penetrated to a certain depth, a cure is never effected without loss of conjunctival substance—that is, without cicatrices. It must be recollected too that in diphtheria the disappearance of the masses of infiltration is affected less by absorption than by elimination, in which the epithelial layer shares; the result is that certain portions are deprived of their epithelium, and being in contact may easily grow together.

Diphtheria of the conjunctiva, like all other forms of the same affection, is the expression of a constitutional state; besides this, however, it assumes a locally infectious character. Under the influence of a general morbid state, and usually as the result of direct inoculation, a locally infectious malady is developed, which in turn may poison the whole organisation. The surgeon called on to treat an eye attacked with diphtheria may find himself in a somewhat trying dilemma; on the one hand there is a distinct indication to destroy the focus of general infection; on the other there is the imperative duty of abstaining from all violent measures; for it is of the first importance to preserve as far as possible parts which are essential to the due performance of the functions of the eye.

In managing a case of true diphtheria the first step should be to protect the sound eye by suitable dressings. The plan recommended by *Snellen*, which consists in covering the eye with a watch-glass secured by means of sticking-plaster (or, better, animal membrane) may be practised with advantage where the patient can be kept in the horizontal position. But the fact is, that no bandage or protective dressing can at all times prevent the healthy eye sharing in a process which depends more or less on a general condition. Nevertheless, as a matter of conscience, such precautions should be adopted, and every care taken, by washing the hands in carbolised water, not to become oneself a vehicle of infection.

Cauterisation and scarification should be avoided, for they only increase the tendency to specific infiltration. Even cold must be employed but sparingly in severe cases. Alone of all the others, antiseptic treatment can be resorted to without misgiving, from the very outset. When the diphtheritic infiltration has penetrated deeply,—and in such cases the cornea, as a rule, becomes dull within a few hours, with symptoms of loss of substance,—it will be better to abandon the use of cold altogether, and use instead warm aromatic fomentations, or compresses moistened with carbolised water, or a half per cent. solution of salicylic acid.

The chief indication in deciding whether to employ heat or cold will be not so much the degree of infiltration, which it is difficult to gauge accurately, but rather the amount of the purulent discharge. This discharge will be in inverse proportion to the degree and tenacity of the infiltration. The more marked the diphtheritic state, the less the discharge; the nearer the period of fibrinous infiltration is to its close, and the more freely its products are being cast off, the more will the characters of purulent ophthalmia be reproduced, especially the purulence. There is, therefore, nothing inconsistent in the conduct of any man who in this terrible affection recommends at first warm compresses, but subsequently perceiving that the conjunctiva is becoming vascular, and the eye discharging, gradually lowers their temperature even to freezing point. If a case is really, and from the commencement, one of purulent ophthalmia, with a certain brawniness of the lids, and stasis in the circulation due to slight infiltration, if in fact, it is one, which hovers on the borderland of diphtheria, croup, and purulent ophthalmia, the best treatment will be not warmth, an agent difficult to control, and even dangerous, seeing it may provoke excessive purulent discharge, but iced compresses from the very first. The absence of corneal complications does not, as a rule, contraindicate the active employment of cold.

You cannot, in the treatment of true diphtheria, too carefully avoid caustics, which only interfere with the circulation in the conjunctiva, and may precipitate some accident to the cornea.

The only agent that can be directly applied to the mucous membrane in these cases is a strong solution of salicylic acid. I prescribe 1 part of salicylic acid to 10 of distilled water, adding a sufficiency of biborate of soda to the warm solution to dissolve the acid. A preliminary application of the caustic should be carefully tried, and followed immediately by ablution in order to mitigate the pain. If these attempts have clearly increased the vascularity of the conjunctiva, they should be persisted in.

The great aim of treatment is to terminate as quickly as possible the stage of specific infiltration, which is fraught with such danger to the cornea, and to guarantee the patient against relapse. If this first stage has been satisfactorily tided over, then, with a true purulent ophthalmia to deal with, we shall be in a much better position to guard against corneal mischief. From what has preceded, it may be gathered that in cases where the diphtheritic infiltration has been intense enough to at once invade the totality of the conjunctiva, and to determine the shedding of this and the diphtheritic products at the same moment, no method of treatment will be of any avail. The purulent stage will then have been forcibly suppressed, and we no longer possess any adequate means of preventing necrosis of the cornea. The block in all the chief channels of nutrition of this membrane is, under the circumstances, so complete that the shedding of the superficial layers will follow almost instantaneously, directly exposing the tissues to the action of the septic matter, which very soon alters and destroys them. Even though you may make diligent use of eserine and sclerotomy, or by means of keratomy open up the ulcers at their first appearance, you will not succeed in relieving the tension. The wounds will quickly be invaded by infiltration, and will become choked up and closed, as it were instantaneously. I have already said that blood cannot be induced to flow from a conjunctiva affected with diphtheria. Arteriotomy even fails, except in mild cases, or when the infiltration stage has already been passed. In robust patients you may, in order to diminish stasis, establish a derivative current by successive applications of leeches to the bridge of the nose, near the inner canthus. Having myself but little faith in the action of such derivatives, I prescribe them only in the case of weakly children, who unfortunately are also those most generally attacked by this malady.

An efficacious means of cutting short the period of infectious infiltration, is to bring the patient under the influence of mercury, provided the weak state of his health does not offer an insuperable barrier. Inunction, morning and evening, should be made by preference on the arms and front or back of the neck, with 2 to 4 grammes (31 to 62 grains) of mercurial ointment; while for internal use, doses of from 5 to 10 centigrammes ($\frac{3}{4}$—$1\frac{1}{2}$ grain) of calomel, should be prescribed every two hours. In addition to this, friction on the forehead with an ointment of mercury and belladonna (*e. g.*, extract of belladonna 1 part, mercurial ointment 2) should be made every two hours. By frequent gargling with chlorate of potassium (1 in 30), and the use of lozenges of the same, salivation should be checked as much as possible. With children the above treatment should be used very moderately, and abandoned whenever signs of vascularisation show themselves.

The diet of the patient requires careful attention, for any imprudence in this respect may be followed by aggravation of the diphtheritic deposits, or by a relapse. A patient affected with purulent ophthalmia may possibly be treated without keeping his bed, but in diphtheria, at any rate, absolute rest is essential.

Phlyctenular or *pustular* conjunctivitis is a very common affection, and a special appanage of children. It differs from all the inflammations hitherto described in being confined to a limited territory, localised, in fact, exclusively on the pericorneal region and on the globe. It consists of slight subepithelial exudations, composed of transparent fluid, holding a small quantity of leucocytes, which form the phlyctenulæ; or, again, the exudations may consist of a number of white corpuscles and a small amount of serum, in fact, of true pustules; lastly, there may be no appreciable amount of serum, but only of lymphoid cells, which thus form minute abscesses.

According to the nature of this limited inflammation and its situation, three forms of it are described, namely, the *true phlyctenular*, the *miliary*, and the *pustular*.

The first, and also the commonest form, is that characterised by the presence of phlyctenulæ of the conjunctiva. These may be spread in various proportions over the margin of the cornea, or at some distance from it over the ocular conjunctiva. They form semitransparent vesicles, occupying the apex of a triangle of conjunctival or subconjunctival, or even of scleral injection, (this latter, when the vesicle encroaches on the corneal border). They are situated superficially, and are readily cast off, and leave a greyish-yellow cavity filled with a pultaceous material.

When the phlycten is directly on the ocular conjunctiva, it soon clears away, becomes clothed with epithelium, and heals up, while meanwhile a fresh crop appears in other places. Should the eruption be situated upon the margin of the cornea, it will assume the characters of a small vascular ulcer, healing without trouble. In a certain number of cases, however, successive crops of phlyctenulæ will appear on the same spot. These elevate tbe epithelium gradually more and more towards the centre of the cornea, giving rise to a form of keratitis known as *fascicular*, (*keratite en bandelette*). It may at times give rise to an opacity in the form of a horse-shoe.

The second variety is marked by the simultaneous appearance of innumerable minute phlyctenulæ, like microscopical abscesses on the border of the conjunctiva. While in simple phlyctenular conjunctivitis the number of phlyctenulæ does not at any one time exceed five or six, in the *miliary* the entire circumference of the conjunctiva is found studded over with innumerable elevations, like pin points, which form a narrow border of œdema round the cornea, and are accompanied by marked pericorneal injection, photophobia, and often an abundant flow of tears. The train of symptoms is much better marked in this than the preceding variety. Both alike are however, characterised essentially by the absence of all conjunctival discharge, as also by the fact that the palpebral conjunctiva never shares in the inflammatory symptoms, unless repeated attacks may have somewhat modified the type.

The third and most dangerous variety is the pustular. In it four or five large pustules, bearing no resemblance whatever to vesicles, but rather to yellow pimples, are seen upon the corneal margin. These pimples soon become excoriated, and surrounded towards the cornea by a greyish zone. They then become ulcers, which burrow perpendicularly into the tissue of the cornea, often giving rise to perforation at points symmetrically opposed to one another. (Thus in the lower portion, externally or internally; in the external superiorly or inferiorly.)

These three forms of eruptive conjunctivitis may be *complicated* with true phlyctenulæ of the cornea. These appear as spots near the centre of that membrane, and are due to the epithelium having been forced up from below by leucocytes. Their elimination is followed by a superficial ulceration, which soon heals. This phlyctenular keratitis by attacking various points in succession finally gives rise to a more or less general vascularisation of the cornea, to which the name of *pannus scrofulosum* has been given.

In addition to this complication, the true pustular or malignant form just described may be accompanied by a general inflammation of the conjunctiva, having all the attributes of purulency, and thus modifying the distinct character of phlyctenular conjunctivitis.

A condition may be superadded to the three preceding forms of this common affection, viz., an eruption of eczema on the edges or over the surface generally of the lids. This latter complication is met with so frequently in children with delicate skins, that it may fairly be a question whether either there has not here been a continuation of the eczematous eruption from the skin to the globe of the eye, or a crop of pustules of ecthyma. Hence the name *Herpes of the Cornea*, which an attempt has been made to introduce, but unsuccessfully.

Without doubt an eruption of phlyctenulæ on the conjunctiva indicates in the eye the same feeble power of resistance as eczema does in the skin generally. But although symptoms of scrofula and phlyctenular conjunctivitis are often met with simultaneously, I do not think they stand in the relation of cause and effect. I see in the simultaneous appearance of phlyctenulæ and of eczema, merely the sign of a feeble power of cuticular resistance in general. It is useful to bear this in mind in treating children so affected. I hold too, that a vitiated atmosphere, a general want of cleanliness as regards the eyes, and defective nutrition, are causes which give a much better explanation of the presence of the affection than a scrofulous diathesis does.

Starting from these premises it will be conceded that in such cases more if possible than elsewhere, the medical attendant must vigilantly look after the general hygiene. Living in pure air, sponging the body with salt water on rising, to be followed by rubbing with flannel and good shampooing, together with nourishing food and preparations of arsenic or iron, should be strongly insisted on.

As regards the direct treatment, except where, as in malignant form of pustular conjunctivitis, some grave corneal mischief exists, three canons may be laid down; namely, 1. to employ irritants; 2. never to use derivatives; 3. to continue the treatment after an apparent cure has been effected.

LECTURE IX.

PHLYCTENULAR CONJUNCTIVITIS (*continued*); VERNAL, AND FOLLICULAR CONJUNCTIVITIS; GRANULATIONS.

Among the irritants most commonly employed in the treatment of phlyctenular conjunctivitis are sublimed calomel, and binoxyde of mercury, obtained by precipitation. In every case where you have to deal with phlyctenulæ, either upon the ocular conjunctiva or corneal margin, or if they are of the miliary form, you can prescribe one or other of these agents. For instance, 10 grammes (2 drs. 35 grs.) of sublimed calomel, which is much more minutely divided than ordinary calomel, may be kept ready for use in a wide-necked bottle. A camel's-hair brush of medium size is dipped into this powder, and any coarse particles having been removed, a light coating of the calomel is, by a sudden jerk, to be projected on the conjunctiva of the globe and lower lid. This treatment must be repeated every twenty-four hours during some weeks, even after all irritation has apparently disappeared.

There is not the least doubt as to the fact that calomel in powder, forming minute rolls which remain some twenty-four hours in the cul-de-sac of the conjunctiva, is partly changed into corrosive sublimate. The major portion, indeed, is washed away by the tears and conjunctival secretion. In patients under this treatment, chemical analysis has shown the presence of traces of mercury in the urine. In some cases an almost immediate change of the whole of the calomel insufflated has been noticed when the patients were, at the time, under the influence of iodide of potassium. When this reaction has taken place, and the calomel been changed into biniodide of mercury, it acts as a powerful caustic on the conjunctiva, causing a copious flow of tears, and considerable pain. It is not to be supposed, however, that this reaction can be demonstrated at will on every patient; it is well, however, to bear in mind that the use of calomel in a dry state to the eye is incompatible with the internal exhibition of iodide of potassium. The calomel, as it undergoes a slow transformation into corrosive sublimate, acts by reducing the calibre of the vessels and obliterating a certain number of the finer vascular twigs. (*Donders*). At the same time it also renders the conjunctiva less impressionable to those fugitive irritations which induce fresh attacks of phlyctenulæ. The employment of insufflations may be continued over a long time, without any inconvenience resulting, except to disabuse the practitioner who may have, perhaps, placed too much confidence in their efficacy.

More easily employed and more efficacious is the ointment of M. Pagenstecher. Here is its formula:

Binoxide of mercury, obtained by precipitation	1 part.
Cold cream	8 parts.

This yellow binoxide of mercury offers the great advantage of being minutely divided, and therefore not requiring prolonged trituration in order to produce a homogeneous mixture. By means of a probe (all brushes should be banished from every clinique, as potential vehicles of infection) a portion of ointment the size of a pin's head is passed into the conjunctival sac, by wiping the instrument, as it were, between the lids. By rubbing the lids, the medicament is further spread over the whole conjunctiva of the globe; any excess should be removed by washing, and care taken to thoroughly cleanse the everted lower lid with a piece of linen. Without such precaution there might be a risk of cauterising the cul-de-sac, as was pointed out above, when a biniodide of mercury was formed from the insufflated calomel. The result of such a reaction would be acutely painful to the patient.

The advisability of not allowing this active preparation to remain too long in contact with the conjunctiva, is a reason why every medical man should himself apply it. If, however, it be thought well to entrust it to laymen, prudence would suggest that a preparation half of the above strength (1 part in 15 or 20) should be prescribed, while at the same time strict injunctions be given to wash the eye immediately with warm water, as a preparation even of this strength is very active.

The above pommade is peculiarly efficacious in cases of phlyctenular conjunctivitis that have passed into keratitis *en bandelette*. It does away with the necessity of scarification in such cases, cuts short the period of the attack, and helps in no slight degree to remove the corneal nebulæ which this keratitis always leaves. Its action is also very beneficial in cases of so-called scrofulous pannus. Nevertheless, what was said of calomel applies here also, and a lengthened use of it affords no guarantee against relapses. In many cases in children, the too continuous use of so powerful an irritant induces follicular conjunctivitis. In such cases it will be necessary to fall back on insufflations of calomel, which are always harmless.

Irritants are quite inadmissible as a mode of treatment, in cases of serious corneal complications arising from ulceration of a vesicle, or from the presence of a true pustule on the margin. Irritant treatment is likewise badly borne when there is a small non-vascular phlycten on the centre of the cornea. I will go farther and say that no phlyctenulæ which, after loss of their epithelium, show a tendency to form large pultaceous ulcers, can, as a rule, be treated satisfactorily by such active remedies, and this, even if they are at a certain distance from, or if their edges are only just in contact with the cornea. In such cases, should the cornea share in the ulceration, I prefer compresses of warm carbolised water (1 part in 200). The chlorinated water recommended by *Von Graefe* should be definitely abandoned, for it is difficult to keep, and gives off an unpleasant odour.

When you have to treat any complication of the cornea following on pustular conjunctivitis, I should advise you to have recourse without delay to a collyrium of eserine (1 part in 200). If there be present simultaneously a certain amount of purulent discharge from the conjunctiva, warm carbolised water is indicated. Particular stress should be laid on the regular use of eserine with children who are actually suffering from perforation of the cornea.

In cases of pustular keratitis the use of white precipitate ointment, rubbed into the forehead, has been much extolled; its formula is as follows:

Ammonio-chloride of mercury . . .	āā. 2 parts.
Extract of belladonna	
Cold cream or lard	8 „

Rub a portion, the size of a pea, night and morning, over the brow.

The inconvenience which I have seen result from a long course of this ointment, is that of inducing obstinate eczema in children with delicate skins. Hence, on the first appearance of small vesicles, it should be discontinued.

The fact that the slightest corneal complication can precipitate a violent attack of blepharospasm, which by the pressure it exerts on the cornea, creates a vicious circle of symptoms difficult to break through, increases very considerably the difficulty of treating phlyctenular conjunctivitis in children. Be cautious, therefore, how you have recourse to derivatives, especially to tincture of iodine applied round the orbit; the only effect of which is to irritate the skin intensely. Bromide of potassium is, as a rule, powerless. The Scotch plan of plunging the head of the little patient in cold water, so as to half suffocate it, has a merely temporary effect, and moreover is very much objected to by parents.

The sovereign remedy in such cases is section of the external palpebral ligament. To this, as *Agnew* has pointed out, an incision through the tarso-orbital fascia, extending from the edge of the orbit towards the tarsus, may be advantageously joined. Having slit up the external commissure for a length of from 10 to 15 millimetres, with straight scissors, held horizontally, you should stretch the upper lid forcibly upwards and outwards, and pass one blade of your scissors between the skin and the tarso-orbital fascia, while the other passes into the superior cul-de-sac. With one snip of the scissors 4 or 5 millimetres of the fascia, which must be kept tense by traction on the lid, are divided. The cornea is thus freed from the pressure of the palpebral muscles, and upper lid, and irritation of the denuded nerve-fibres from constant friction and compression rendered impossible.

Before quitting the treatment of a disease so common, I must call your attention to a form of phlyctenular conjunctivitis, the so-called "vernal catarrh," which it would be more correct to term "conjunctivitis." Like all forms of true phlyctenular inflammation, this is not accompanied by any conjunctival discharge, so that catarrh is clearly a misnomer. The difference between this vernal inflammation and the miliary variety of phlyctenular conjunctivitis, to which it undoubtedly belongs, is that in the former the eruption spreads sensibly in area, forming small abscesses, which undergo fatty degeneration. The affection does not invade the whole of the circumference of the conjunctiva at once, but portions only, which extend and eventually involve the cornea.

This form of conjunctivitis appears generally in children, from the age of eight years up to puberty, returns each year with distressing regularity, and gives rise to successive crops of light yellow pimples. These continue in spite of treatment, during all the summer, but in winter depart leaving scarcely any traces of themselves, or at most a few yellowish stains, upon some portions of the conjunctiva, which have an extended and bluish appearance.

This affection has not been recognised or described up to the present time owing to various reasons. First of all, it is relatively rare; secondly, parents, seeing that their children derive so little benefit from treatment, soon change their medical adviser, who should have taken the precaution of telling them the course the affection would run; finally, another reason is, that parents, perceiving that after each attack sight is re-established, and has suffered no impairment, end by treating it according to their own views, or by not treating it at all.

It should be recollected that this affection is a great bar to children pursuing their studies, and for a period of five or six months in every year will render them incapable of any continuous application. It is the duty of the surgeon then to recognise it at the very commencement, and endeavour as far as possible to prevent its distressing and periodical return by careful attention to hygiene, by the use of tonics, and a sojourn in elevated situations. By attending to the age of the patient, and the unusual extension of a portion of the limbus of the conjunctiva under the influence of the inflammation, it may readily be diagnosed.

It is all the more necessary that the practitioner should recognise it, inasmuch as irritant treatment is not tolerated. Even a few slight insufflations of calomel can scarcely be ventured on. To children, lozenges containing arseniate of soda in the proportion of 1 milligramme (about $\frac{1}{75}$ grain) may be given during two or three months. When the attack has lost its primitive character, catarrh of the conjunctiva may supervene; and this may readily occur if the treatment has been unsuitable. In such cases cauterisation at long intervals with acetate of lead, mixed with water in equal proportions, may be tried, together with the use of warm lotions of carbolised water. Should follicular conjunctivitis predominate, it must be treated in accordance with principles to be laid down hereafter.

A third form of conjunctival inflammation, and one which induces deposits in the mucous membrane, is the *follicular* variety. This in typical cases is unaccompanied by any discharge. The same is true of diphtheritic conjunctivitis, and of pure phlyctenular and granular inflammations. When a discharge does appear in the course of affections belonging to the second group of inflammations—that is, to those which cause deposits in the substance of the mucous membrane—it is justifiable to conclude that the morbid entity has undergone some change. Another element—viz., some one of the varieties of the first group—has in fact been superadded, and a catarrhal or purulent complication having shown itself, treatment will necessarily require to be modified. Hence the great importance of making inquiries in every case as to the amount of discharge from the conjunctiva.

It is very necessary as regards the diagnosis of follicular conjunctivitis to note this point, which also bears upon the treatment. The affection is characterised by hypertrophy of the follicles, but without any great irritability, or any "running" from the eye, as it is vulgarly termed. The affection comes on slowly, and produces without much disturbance to the mucous membrane a crop of rounded, semitransparent elevations, arranged in lines, and generally occupying the conjunctival culs-de-sac. On the tarsi these assume the appearance of small marks or white patches slightly raised. They are analogous to those which Waldeyer had discovered in healthy conjunctiva.

You must learn to distinguish this follicular condition of the conjunctiva which comes on insensibly, from granulations. Never pronounce definitely that such and such appearances are due to granulations unless you are satisfied beyond all doubt that they are, and unless they occupy situations which granulations always occupy—namely, the lower edge of the tarsus of the upper lid. A conjunctiva may be studded over with semitransparent elevations, the tarsi covered with spots or little whitish eminences, but nevertheless, if the lower border of the upper lid be free, and its extremities towards the commissures not more affected than the rest of its surface, then hesitate to pronounce a name which may destroy at once your patient's peace of mind and your own reputation in matters medical.

Follicular conjunctivitis may continue for years without causing much annoyance, unless it changes its type and becomes a *catarrhal follicular conjunctivitis*. In these cases irritation of a catarrhal nature will have been superadded, and the mucous membrane will consequently commence to discharge more or less freely. Follicular catarrh is then a combination of two distinct maladies which may be present together from the very commencement, and constitute the affection known as *acute* follicular conjunctivitis. It appears to me probable in these cases that it is the catarrh which has led to the discovery of the follicular affection. The latter was probably present all along in a more or less chronic form, but had passed unnoticed until the mucous membrane happened to be attacked with catarrh. It is important therapeutically to be aware of the fact that repeated attacks of acute inflammation, so far from aiding the development of the follicles, is rather favourable to the cure of follicular conjunctivitis. If this latter has supervened rapidly and more or less acutely, it will have spread to the ocular conjunctiva, and the whole edge of the conjunctiva will present an appearance of general infiltration with lymph, will be thickened, and gelatinous or simply œdematous.

The same appearance may often be seen when the conjunctiva has been saturated with collyria of atropine or eserine. With certain persons a short use of either of these, especially eserine, is enough to excite an attack of follicular conjunctivitis. To this the name *toxic* has been given; and it has been but too often mistaken for granulations. The toxic is distinguished from the idiopathic form by the fact that the lymph-like masses often assume, even upon the tarsi, a spheroidal or vesicular appearance. Moreover, the follicular eruption which spreads over all the conjunctiva save the circumference of the ocular portion, advances very near to the margin of the lid. The skin also of the lid is always the seat of erythema, or even eczema, which should be sufficient to at once attract attention.

Follicular conjunctivitis, properly so called, may be induced by a vitiated and confined atmosphere. Just as this disease breaks out among domestic animals penned up in narrow sties, so likewise it makes its appearance among persons collected together in schools, boarding-houses, barracks, etc. Even a short stay in air that has not been renovated is enough to generate this affection in those whose skin and conjunctivæ are delicate. Thus I often find follicular conjunctivitis among young children who have recently landed from a fortnight's voyage between France and America, during which time they have slept in confined cabins.

The affection will cure itself with fresh air, change of scene, and climate, and proper conditions of hygiene. In spite of the slight inconvenience, however, which its presence causes, it wil always be advisable in practice to treat it, for we must bear in mind that persons whose conjunctivæ exhibit hypertrophy of the follicular system, are peculiarly liable to any endemic affections. They feel the slightest irritation, and fall ready victims to acute catarrhal inflammations, which quickly become complicated with corneal troubles. This is true more especially for military practice.

If called to a case of follicular conjunctivitis complicated with acute catarrh, you may try mild cauterisation with subacetate of lead, in solution with equal proportions of water; but carefully abstain from all violent irritants, such as sulphate of copper, mitigated nitrate of silver, and so forth. As a general rule the follicular condition of the conjunctiva will bear only very mild caustics. When there is no secretion, but when the follicular conjunctivitis properly so called is well marked, be satisfied with applying two or three times daily compresses moistened with solution of acetate of lead (6 parts to 500). If there be any tendency to an acute catarrhal condition, replace the lead by carbolised water (1 in 200 parts), in which a piece of ice may be placed.

It is also very important to see that the general functions of the eye are satisfactorily performed. Emmetropes should from time to time leave off work; ametropes should be provided with the glasses proper to their ametropia, while all patients should be protected against dust or excessive light by using out of doors smoked or blue-coloured spectacles.

The study of granulations of the conjunctiva is much complicated, and their treatment rendered more difficult, by the fact that they are by no means easily diagnosed. This is because they seldom exist by themselves, but are generally met with as complications of other conjunctival affections.

Another element of difficulty in the study of granulations arises from the fact that the anatomical constituents of the true granulation are very similar to those of an hypertrophied follicle or congested papilla. Nevertheless, the two are essentially different, not only from a pathological but also a clinical point of view. For granulation tissue, in appearance so similar to that of the follicle or congested lymphatic, comports itself very differently. It lives and dies feeding on the parent that gave it life—it consumes the conjunctiva. A granulation is therefore a malignant product, while the ultimate elements of a follicular or purulent conjunctivitis are essentially benign.

To this apparent anatomical resemblance between two affections so very different, we have an analogy in pulmonary tuberculosis. There the primitive element closely resembles the inflammatory products of bronchopneumonia; yet these latter in their subsequent history show that they have absolutely nothing in common with a neoplasm.

It therefore becomes necessary for diagnosis and treatment, to firmly grasp certain characteristic signs, which will enable us to distinguish a neoplasm of the conjunctiva, from circumscribed and benign hypertrophy. These signs at the same time will demonstrate the malignant nature of granulations, and the difficulties attending their treatment. A granulation consists of a mass of lymph-like cells, mingled with conjunctival connective tissue in increased proportions as we proceed from the external surface towards the base. The connective tissue does not here surround the mass of lymphoid cells, as in the case of the follicle, nor does it uniformly infiltrate the structure as in hypertrophy of the papilla. It might be imagined that a stream of leucocytes had rather displaced and elevated the epithelium, beneath which scarcely any elements are encountered other than those belonging to the vessels going to the granulation. A section of what is called a hypertrophied papilla never conveys any idea of injection, but rather of infiltration, in which the cells occupy a more or less distinct and defined tract of connective tissue.

It is true that this character becomes less marked just in proportion as the granulation tends to disappear, as the cells massed together so as to conceal entirely the connective stroma become absorbed, and as lines of cicatrices take their place. These when isolated and scattered throughout the granular mass, can easily be mistaken for fibres of the stroma. However slight the microscopical differences may be, the course of a granulation, whatever disguise it may assume, has something *sui generis*, which never escapes a practised eye.

A *granulation* differs from a follicle in its shape, which is oval rather than round, in the fact that it is not higher than it is broad, and that it never exhibits the semitransparent or grey yellow tint, peculiar to the follicle. On the contrary, it remains of an opal tint, being more or less pink according to the degrees of injection.

In contradistinction to follicles, granulations grow as a rule, not in the culs-de-sac, but upon the tarsi, especially the upper. They are not evenly spread over these, but appear like little islands along the free border, and especially towards the commissures. Furthermore, the surrounding mucous membrane does not show the perfect integrity observed in pure follicular conjunctivitis, but there is always a greater or less amount of injection and infiltration present.

A *granulation* differs from a papilla, which has become hypertrophied and infiltrated with lymphoid cells, by its shape. It may resemble an elevation, or pimple, but never a papilla, which is always more or less elongated and pedunculated. The vascularity of the papilla is much more marked, imparting a bright red tint to it, which a granulation never has. Finally, papillæ can only appear on those parts of the conjunctiva to which they are distributed; while the new growths known as granulations can develope themselves over the whole mucous membrane, even to the conjunctiva covering the cornea.

LECTURE X.

GRANULATIONS (*continued*); AMYLOID DEGENERATION OF THE CONJUNCTIVA; XEROPHTHALMIA; SYMBLEPHARON.

Without entering into too minute a description of granulations, I may insist once more on the fact that, even when largely developed in the conjunctiva, they pass through various stages without depositing any product of inflammation externally, in other words, without causing any purulent discharge. A typical case, and one not disturbed throughout its whole course by any complications arising from purulent ophthalmia, is essentially chronic. Acute granulations have no existence in fact, and the descriptions that are given of them arise from granulations and follicular conjunctivitis complicated with catarrh, having been confused together.

What renders both the diagnosis and treatment of granulations especially difficult is, that they have no regular natural history, but are nearly always complicated with some analogous conjunctival affection. Generally speaking, granulations which at first may be called *simple*, become secondarily complicated with purulent ophthalmia, and give rise to hypertrophy of the papillæ. They become thereby changed into *mixed*. These in turn, having become associated with hypertrophy of the follicles, and more or less general infiltration of lymph, become *diffuse*.

The seat of the disease will be the best guide to diagnosis. Granulations choose especially for their habitat the upper portions of the conjunctiva. This is their favourite haunt, here they exhibit their maximum development, and here the tough, unyielding nature of their products can best be seen. Continuous friction of the upper lid against the upper half of the cornea, is here continually taking place. This leaves traces of itself in the form of a pannus, not found in other and apparently similar conjunctival inflammations.

In the treatment of granulations, it should be steadily kept in view, that their course will imply of necessity a disappearance by cicatrisation, which must result in deformity. The deeper the granulations have penetrated into the mucous membrane, the greater will the resulting deformity be to the framework of the lids. The inference is, that to such essentially mechanical results a mechanical method of treatment must be opposed.

As compared with other conjunctival affections, the treatment of granulations is influenced by the fact, that apart from any changes which may occur subsequently, the disorganisation of the conjunctiva caused by these neoplasms interferes from the very first with the proper movements of the lids.

The characteristic ptosis of the upper lid never allows the cornea a moment's freedom from contact with a mucous membrane studded all over with hard rough points. Hence, a friction arises far more to be dreaded than any caused by the pulpy swollen papillæ of purulent conjunctivitis. This, again, becomes an indication for mechanical treatment. Recollect, too, that the mucous membrane which is continued into the lacrymal canals, may readily sympathise with the conjunctiva, that lacrymal obstructions may finally complicate the situation still more, and that these in turn will require to be treated by mechanical methods.

Such are some of the considerations which should not be lost sight of in laying down a plan of rational therapeutics, that is to say, one modelled on the methods which Nature herself adopts, in the spontaneous cures she effects. When eyes thus attacked are left to themselves, or merely placed in good hygienic conditions, the masses deposited in the mucous tissues, in a word, the granulations, will be observed to disappear slowly, leaving distinct cicatrices behind. This disappearance will take place with greater or less rapidity, in proportion as the mucous membrane exhibits from time to time a tendency to vascularity, with swelling of the papillæ, and slight purulence. Founding treatment on such facts, we should endeavour to provoke artificially a transient state of congestion, and with this object employ certain caustics.

Any idea of directly attacking the neoplasm so as to destroy it, and thereby hasten its elimination, must be abandoned. In the first place the granulation is so firmly rooted in the mucous structures as to be beyond reach, unless the sound tissues are also at the same moment attacked. In the second, nothing would be gained by the destruction of the granulation save that result to which it would, if left to itself, lead, namely, the production of a cicatrix.

The objects to be attained by mild cauterisation are the following: the production of considerable vascularity of the mucous membrane lasting a short time; hastening re-absorption without excessive formation of cicatricial tissue, as this might be endowed with powers of contraction very dangerous to the neighbouring structures; finally, the prevention of the development of fresh crops by contagion in these portions of the conjunctiva which are still intact.

In the treatment it must always be borne in mind that granulations are contagious, not only as between individuals, but as between one portion of the mucous membrane and another. Isolation, then, of persons affected with granulations is imperiously demanded in the interests of every one in the immediate neighbourhood. Moreover, change of air is always of great benefit to the sufferers themselves.

From what I have just said, it will be gathered that mild means and gentle cauterisation should form the basis of treatment; but these alone will not suffice in a disease whose phases are so various. To begin with, violent attacks of inflammation may compel the discontinuance of mild caustics, and the substitution of more energetic measures. Again, complications may appear on the cornea, and oblige all caustics to be for the time laid aside.

The method of cauterisation to be employed in various cases of granulations will depend on the degree of irritability of the surrounding and healthy conjunctiva. In many cases of simple dry granulations, there does not exist sufficient conjunctival irritability to cause absorption of the new tissue, or stop the growth of fresh granulations. In such cases moderate excitants are required, and I give the palm to daily applications of a solution of equal parts of subacetate of lead and distilled water.

Cauterisations with a smooth crystal of sulphate of copper are justly held in favour: nevertheless they are less manageable than the acetate of lead, for they readily cause an irritation of very uncertain duration. Hence, in the use of this caustic, skill and attention are needed, so as not to stimulate the mucous membrane unduly, and thus favour the appearance of corneal affections, as these lengthen out treatment and will interfere, in a very unpleasant way, with the progress of the case.

You will, from time to time, meet with patients who have been treated by means of daily cauterisations of sulphate of copper, and who complain that their eyes are painful, and that they can scarcely venture to open them even for a few moments. The cornea, in such cases, will be found to be covered with pannus, and will exhibit here and there small excoriations of the epithelium, giving rise to intense blepharospasm. In such cases, rest, and the absence of all irritants will suffice to soothe the eyes, and will allow them to derive real benefit from the artificial irritation which had been previously pushed to excess. Sulphate of copper can be of no service except to those who will consent not to use it continuously. Instead of resorting to this caustic every day, they should do so only when the irritation caused by a former application has more or less completely disappeared.

In stimulating a conjunctiva studded over with dry granulations, whatever caustic we select, we must bear in mind that in many individuals the sensibility of the conjunctiva to any one irritant, very soon becomes blunted. Hence the caustic must be *changed* at intervals. Besides subacetate of lead and sulphate of copper, a solution of tannin (1 in 20), or of salicylate of soda, may be prescribed.

The moment the granulations change in appearance, and any symptom of purulent ophthalmia supervenes, cauterisation with a solution of nitrate of silver (1 in 50) should be had recourse to, together with scarification, antiseptics, and ice.

The great difficulty in the treatment of granulations is the constant presence of corneal complications, such as ulcers, or abscesses of greater or less extent. The existence of simple pannus does not call for any particular treatment, inasmuch as it arises entirely from the friction of a rough conjunctiva. It will disappear as soon as the continuous rubbing to which the surface of the cornea is exposed ceases. I shall speak further on of that granular pannus, properly so called, which is the result of granulations upon the cornea itself.

Ulcers or abscesses making their appearance on a cornea affected with pannus put a stop to all cauterisation, unless, indeed, a condition of very marked purulency absolutely necessitates its use. Immediate recourse in such a case should be had to instillations of eserine, and warm compresses, which should be gradually left off in proportion as the amount of discharge they cause increases. Here, too, such measures as paracentesis, as enlarging the aperture of the lids, as scarifying the conjunctiva, find their proper application by removing pressure from such portions of the conjunctiva as are deprived of their epithelium. Large ulcerations should be dealt with in accordance with the directions given in the case of purulent ophthalmia.

In treating patients who have already fairly entered on the cicatrisation period, and in whom on eversion of the upper lid a line of cicatrices parallel to its edge, and distant 2 or 3 millimetres from it, is discovered, no good can be done to the irritation and old-standing pannus, except by means of some mechanical treatment, directed against the cicatricial contraction and the chronic stagnation of the tears. Here the methods of *Pagenstecher* (p. 45), and the combined method of Streatfield and Snellen (p. 45), find fitting scope. Not only do these operations relieve the cornea from dangerous pressure, but they further enable us to dispense altogether with cauterisations, which at this period are useless as regards stimulating a mucous membrane, whose nutrition has been profoundly affected by cicatricial contraction.

True granular pannus may be the object of special methods of treatment, consisting in abrasion of the conjunctiva, in iridectomy, and in sclerotomy. I shall not stop to consider these at present, but shall only say a few words as regards an heroic plan of treatment, devised with the object of clearing the cornea, and causing the disappearance of the neoplasms in the conjunctiva. Not content with the stimulus which cauterisation is capable of affording, an attempt has been made, by *Piringer* and *Jaeger*, to set up a copious purulent discharge by inoculation with the pus of purulent ophthalmia. I must confess that, though not generally deficient in boldness, I have never as yet ventured on this proceeding, the results of which are difficult to control or forecast. Of the two I should much prefer a purulent discharge produced by abrasion of the conjunctiva, followed by a diligent use of warm compresses. Inoculation is beyond all question inadvisable in all countries and at all times when diphtheritic affections are abroad. It is quite possible to inoculate unintentionally a diphtheria sufficient to destroy the cornea. Furthermore, inoculation should not be attempted in any case where an eye is but slightly affected, and where as regards it there might be some danger in inducing blenorrhœa.

I will say also that appropriate cases for such inoculations are absolutely wanting in my own practice, where I have relatively but very few patients affected with granulations. By the frequency or otherwise of that affection you may form a very good notion of the social standing of your patients. Thus, in my clinique, statistics do not show more than two or three per cent. of granulation cases, while in Paris itself there are dispensaries where the figure mounts up to 15 or 16 per cent. Hence it would appear that much might be effected by merely relieving the misery and poverty in which the greater number of such patients are plunged.

Some twenty years ago I used to hear my master, *Von Arlt*, declare, with a view of showing how very slightly infectious he considered dry granulations to be, that he would not hesitate to engage a servant so affected for his own children. Nevertheless this ripe surgeon, I imagine, would not have failed to carefully watch the nursery, lest the results might later on have made him regret his experiment. I myself think that, excluding direct infection from toilette articles used in common, one of the greatest risks is to be incurred by sleeping with persons affected with granulations. Such we know is the case in phthisis.

A very rare disease, and one which, moreover, has been confounded with granulation, is "*Amyloid degeneration.*" It determines an hypertrophy of the mucous membrane in excess of that met with under any other circumstances whatever. It is more especially the conjunctiva of the upper half of the cul-de-sac and semilunar fold, which assumes a thickness so great as to cause the membrane to protrude between the lids. Yellow gelatinous-looking masses also stand prominently out, in the substance of which semitransparent granules may be seen, not unlike granulations, but, as a rule, larger and more transparent.

When the lid is everted, the tarsus is apparently covered with a thick layer of wax, for the new growth is very slightly vascular. This doughy mass rests on a tarsus itself thickened and metamorphosed. So far as can be inferred from the few cases observed, this affection differs from granulations by being confined to one portion of the conjunctiva, while the neighbouring parts are unaffected. It would appear that, as a result of the amyloid degeneration of the capillary walls, extensive effusions of blood are not unusual, but this is hardly ever the case in even the most aggravated forms of granulations. In discussing the treatment of granulations I have purposely abstained from all mention of excision. It is an eminently irrational procedure, because it precipitates exactly the result we wish to avoid. But in the case of amyloid degeneration the infiltration of the conjunctiva is so uniform, and gives rise to such marked changes, that any treatment except one which proposes to free the eye from the degenerate mass is absolutely useless. Fortunately, owing to the disease being limited to the tarsus, cul-de-sac, and semilunar fold, these portions can be removed without undue interference with the movements of the eyes.

I now turn to an atrophic condition of the conjunctiva, which is in many cases the result of inflammation, namely, *xerosis,* or *xerophthalmia.* According to the degree of atrophy there may be *parenchymatous xerosis,* where the affection occupies the whole stroma of the conjunctiva, or *partial* or *epithelial xerosis,* in which the atrophy is superficial and confined to the upper layers of the conjunctiva, to which it gives an aspect of dryness.

If we exclude cases of atrophy of the conjunctiva consequent on inflammations, which leave cicatrices, such as diphtheria, granulations, and burns, an idiopathic form of parenchymatous xerosis is extremely rare. It is met with exclusively as a sequela of certain desquamative skin diseases, especially psoriasis and pemphigus. There is no doubt that psoriasis and pemphigus may attack the conjunctiva; in such cases the latter affection will be found to have established itself in the mouth and behind the ears.

Partial or *epithelial xerosis* is much more common. It is a sequela of the variety of phlyctenular conjunctivitis, already described as "vernal catarrh." It may be idiopathic, and occupy the limbus of the conjunctiva, which becomes considerably extended. In Brazil it would appear that badly-nourished negro children are liable to an affection of the conjunctiva, known as *ophthalmia Braziliana,* characterised by a dryness of the conjunctiva, almost unknown here. This gives a look to the eyes as though a greasy stain lay on them.

As you are aware, great attention has been bestowed upon an epithelial patch noticeable in hemeralopes upon the portion of their conjunctiva which is most liable to become dry. This condition is an infallible sign of a certain weakness of constitution, and may in some cases lead to the formation of a superficial ulcer. This patch is seen in malignant typhoid fevers, and in the collapse stage of cholera, and results from poverty and deficient fluidity of the blood.

Xerosis, when the result of a skin affection, should be treated not only constitutionally, and also locally by substances capable of lubricating the mucous membrane, namely, milk or glycerine, and warm compresses. In addition to these palliative measures, eye-cups might be so constructed as to maintain a layer of alcaline liquid in constant contact with the eye, so as to dissolve away the epithelium. It is often melancholy to consider how slight the obstacle is which hinders perfect vision in these cases. The cornea is as though covered with a thin film of oiled silk, and the lids are glued down to the corneal margin, not a trace of the culs-de-sac remaining. I do not recommend you to yield to the temptation of freeing the lids, even though you were to graft on the conjunctiva of a rabbit, as *Dr. Wolf* has done. In cases of xerosis from psoriasis, or pemphigus, these affections will recur so long as a fragment of conjunctiva remains capable of being attacked; grafting therefore will here give no satisfactory results.

In dealing with an epithelial xerosis of some size which is cicatricial, and not partial, and which ought to disappear with the improvement of the general health, the best treatment is to lubricate the conjunctiva itself, as *M. Ollier* has recommended, by means of a more or less complete tarsorrhaphy, the eyelids being left closed for a period of two years. In some cases I have tried closing the palpebral aperture on each side, so as to leave a central window of a few millimetres in extent in order to allow the patient to see sufficiently to guide himself.

When, as the result of destruction of the mucous membrane, two opposed portions of conjunctiva grow together, a condition ensues known as *symblepharon*. This union may extend over a variable space, and may be complete or incomplete. It may comprise the fundus of the cul-de-sac (*symblepharon posterior*), or only the portion bordering on the margin of the lid (*symblepharon anterior*). In proportion as the destruction of the mucous membrane, which has caused the symblepharon, and subsequent atrophy has been more or less complete, the adherent portions will vary in thickness. Thus the result may be a *sarcomatous*, a *membranous*, or a *fibrinous* symblepharon.

The most important fact to remember as regards these different varieties, is that the parts which have grown together represent a tract over which the mucous membrane is destroyed, to an extent such that by no treatment or operative procedures, however ingenious, can it be restored to its former conditions. All mere separation of the two surfaces will have the inevitable effect, not only of causing fresh union, but of further increasing cicatricial contraction. To combat this disastrous result, two methods are available; namely, either to separate the affected portions of conjunctiva and lay flaps brought from the immediate neighbourhood, or from opposite sides of the cornea between them, according to Teale's method; or failing this, to transplant a graft from another person.

Formerly symblepharon was considered, and not without good reason, as a *noli me tangere*. In the present day the above operation offers a fair chance of success, especially in cases of anterior symblepharon, that is to say, where the fundus of the sac is not involved in the union. Generally speaking, after having detached the adherent portion of lid, the wound in the conjunctiva near the cornea should be covered over by flaps, which are to be brought into apposition and secured. The conjunctiva and subconjunctiva of the globe should be detached to a very considerable distance all round, in order to render the conjunctiva freely moveable. With the view of combating still more effectually the tendency of the lid to form fresh adhesions, a temporary ectropion may be induced by the aid of a few Gaillard's sutures.

When you have to treat a very extensive symblepharon, the plan of bringing forward a flap must be abandoned, and an attempt made instead to cover the detached parts with flaps of conjunctiva, either from a rabbit or, better, from a human being. Such flaps may be obtained in cases of removal of portions of conjunctiva for corneal affections. Without entering here into operative details, I will only remark that the portions grafted on must be retained in position by a sufficiency of sutures at the sides and by a loop to hold the flap down at the bottom of the cul-de-sac. This loop should pass out through the skin of the cheek. To facilitate the application of such sutures, the first few of which are more especially difficult to insert, a needle-holder without much spring (fig. 5) may be employed. I have found it myself extremely useful in such operations. It may be asked, how far these delicate and difficult operations will afford a guarantee against relapse? The question can only be answered by a series of observations on patients extending over a number of years.

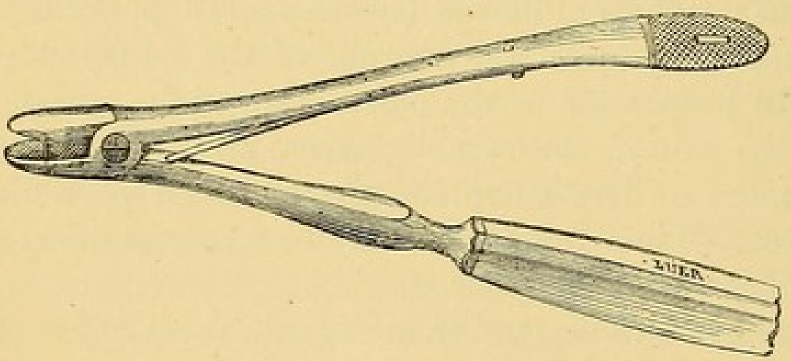

Fig. 5.

LECTURE XI.

PTERYGIUM; SUB-CONJUNCTIVAL EFFUSIONS; SYPHILITIC AFFECTIONS OF THE CONJUNCTIVA; TUMOURS.

WHILE on the subject of cicatrices of the conjunctiva, I may include an affection known as *pterygium*. In it we have a mass of conjunctiva, folded triangularly, the apex resting on the edge of the cornea, beyond the centre of which it never extends. The pterygium (*onglet*) has, as it were, a head and neck and triangular body. It may be either moveable or adherent to the globe, and be spread out more or less widely.

The appearance of a pterygium will vary considerably, according to the amount of irritation present in the conjunctiva. A pterygium is *thin* or *membranous* when all inflammation is absent, *thick* or *sarcomatous* where more or less conjunctival catarrh is present. The pterygium grows, as a rule, in the direction of one of the recti muscles, generally between the semilunar fold and the margin of the cornea. The portion of ocular conjunctiva which is exposed to the air during the time the eyes are open is its favourite seat. When situated superiorly or inferiorly on portions generally covered by the lid, it is allied pathologically to symblepharon, but in practice is distinguished from it, and is known as "false pterygium" or *pterygoid*. Pterygium only shows itself in adults or in persons of advanced age, who by their avocations are exposed to the constant contact of dust, to sea air, or to elevated temperatures.

It appears, beyond question, that the cicatrisation of small folds of conjunctiva, from which the epithelium has been removed by the friction of minute foreign bodies, and which produces a conjunctival thickening known as *pinguicula*, is one of the precursory stages of pterygium. There is formed, according to *M. Horner*, between this elevated portion of conjunctiva and the margin of the cornea, a cavity, in which secretions, and small bodies that have got into the eye, easily find a resting-place. The ulceration of the adjacent portion of the cornea and of the conjunctival limbus eventually cicatrises, drawing the pinguicula on to the cornea itself.

A pinguicula is clearly often a cause of pterygium, but even without the preliminary thickening of the conjunctiva, the mucous membrane may be drawn directly towards a marginal ulcer. Artificially, a similar condition may be produced, in the operation of advancement of the rectus muscle, if the conjunctiva has been drawn too much over the cornea, and its epithelium, perhaps, rather too roughly dealt with. To apply the name *pterygoid* to all such cases only because the development has taken place under different influences, and because the inner extremity of the growth is generally larger than that of a pterygium which has been preceded by a pinguicula, is to give undue extension to the term.

Pterygium requires no treatment, except in cases where it is manifestly advancing towards the centre of the cornea. When such is the case, it threatens to cause considerable visual trouble, and great deformity. In all pterygia which are stationary, and on the limbus of the conjunctiva, surgical interference is better avoided, seeing that with the best operation there is always more or less risk of recurrence. As a general rule, any method which consists in only excising a portion of the pterygium is useless. The only valuable methods are those of displacement.

The simplest operation is as follows: the pterygium is to be carefully separated from the cornea with a cataract knife; then marked off by two incisions along its edges, and turned back towards the caruncle, for, as a rule, it is situated internally. Two points of suture should be applied to the wound. In order to draw the edges accurately together, the sutures must be of very fine silk, and be tightened so as to cut their way out. The conjunctiva must be very freely divided, below and above the pterygium, with curved scissors passed over the surface of the globe. Another point is to fasten first the suture nearest the caruncle, so as not to make traction too strongly on the displaced conjunctiva.

M. Desmarres, senior, does not displace the detached pterygium backwards towards the caruncle, but secures it between the lips of a section from six to eight millimetres long, below the inferior border of the cornea. The disadvantage of this method is that the wound is not completely closed at the point where the pterygium is turned down, and that this portion, as it heals again, forcibly draws the neighbouring conjunctiva towards it. It is not of much advantage to divide the pterygium into a superior and inferior half (*Knapp*), if the wounds made in the conjunctiva cannot be completely closed in by drawing on that membrane. The notion of covering each denuded portion with a flap of conjunctiva grafted on (*Klein*) is logical enough, but the performance of such an operation might be found somewhat difficult.

All methods by cauterisation and suture are now more or less abandoned. The former of these is clearly illogical, since it would produce cicatrices in a disease which itself is the result of slow cicatrisation, depending on slight and imperceptible losses of epithelium.

Subconjunctival effusions, like the cicatrices of the conjunctiva just spoken of, often result from some one of the inflammatory conditions we have already studied. They may, however, also be met with in cases where the conjunctiva is not the seat of any inflammation. The ocular conjunctiva may become chemosed from some deep-seated inflammation of the eye, as purulent choroiditis, if the return of a portion of the conjunctival venous blood is checked. The same phenomenon may be noticed when the return of the blood from the conjunctiva has been interfered with in the lids by inflammation. As bearing on this, I may remind you of the chemosis, so commonly seen associated with a sty. Even without any inflammation, the ocular conjunctiva may be the seat of an effusion of serum, from the anterior chamber, which has filtered as it were through some cicatrix or fistula of the conjunctiva.

Besides the above varieties, there is another indolent form of infiltration of the ocular conjunctiva met with in old men with very loose skins, and in weak and anæmic women. Strengthening regimen, compression at night, and scarification will be the basis of treatment. Excision of folds of the conjunctiva must be abstained from, as the only effect would be to produce cicatrices, more troublesome than the symptoms they were intended to cure.

Effusions of *blood*, apart from any inflammation of the conjunctiva, are most generally the results of a blow or some very violent expiratory efforts. The ecchymoses observed in children with hooping-cough have no bad consequences other than to disfigure the little patients for the moment, and alarm their parents. If these effusions make their appearance without evident cause in persons of a certain age, they point to fatty (atheromatous) degeneration of the vessels, not confined, as a rule, to those of the organs of vision. This, therefore, is a symptom to be carefully noted; and such patients should be advised to avoid all that might conduce to congestion of the head, or nervous centres. No direct treatment is called for, unless it be with a view of relieving the patient's anxiety, when cold compresses of arnica and pressure at night may be ordered. Flying blisters are not necessary unless traumatic thickening has taken place, and is very slow in disappearing. *Conjunctival emphysema* caused by the passage of air through a communication established with the frontal sinuses, nasal fossæ, or ethmoid cells, has a certain importance if appearing after falls on the head, as a diagnostic sign of fracture. It is never necessary to make it the subject of any special treatment.

Purulent effusions or *abscesses* of the conjunctiva are very rarely met with, apart from some inflammation of the mucous membrane. They occur most frequently on the caruncle, and have their origin in spots of acnè induced by the retained secretion of one of the glands of the part. In the case of non-traumatic circumscribed suppuration, the abscess soon disappears, and but seldom stands in need of evacuation by puncture.

I now turn to the syphilitic affections of the conjunctiva. As a rule chancres of the conjunctiva are propagated from the edge of the lid to the mucous membrane, though they may also be found both on the globe and in the conjunctival culs-de-sac. They are there not to be distinguished from large ulcerated pustules, with pultaceous bases, save by the livid hue of their edges, and by their resting apparently on a patch of indurated and resisting tissue. *M. Fournier* relates an interesting case where a colleague, while applying caustic to the throat of a patient, received in the eye some coughed-up pus, from which an infecting chancre resulted. The cases hitherto noticed have been chiefly in women.

Treatment consists in the use of compresses moistened with corrosive sublimate (1 part in 600), or in the insufflation of sublimed calomel. An internal course of mercury (consisting of a spoonful of syrup of Gibert * morning and evening, with one or two Plummer's pills at bed time) should be commenced without delay, for, generally speaking, as in all chancres which occupy

* Syrup of Gibert, composed as follows:

Biniodide of mercury	1 part.
Iodide of potassium	50 parts.
Water	,,

Dissolve, filter through paper and add syrup of white sugar 2,400 parts. The dose of this is one tablespoonful, or 25 gram.; that is, in each dose there is contained ·01 gram. ($\frac{1}{6}$ grain) of biniodide of mercury, and ·5 gram. (8 grains) of iodide of potassium.—Tr.

unusual positions, those on the conjunctiva become rapidly infecting.

In cases where the face is the seat of papular or tubercular eruptions, a corresponding condition may at times, though rarely, be observed upon the lining membrane of the lids. There should, therefore, be no difficulty as regards diagnosis or treatment. An important fact to remember, is, that an isolated gumma may appear on the subconjunctival tissue while no other portion of the body presents the least sign of a similar tertiary lesion. The presence of a doughy tumour, semi-transparent, of a mixed grey and violet colour, and growing rapidly, should excite suspicion, and this the more, as from the youth of the patient, there can be little ground for believing the appearances to be malignant.

The treatment most suitable here is a mixed one, such as the syrup of Gibert offers. But should there be any suppurative tendency on the part of the gumma, or should it have been made to ulcerate by artificial means, then a more active treatment, such as inunctions, must be had recourse to. No direct local applications are required.

I will now briefly touch on tumours of the conjunctiva. The treatment of them is purely surgical, and consists in removal. Among the most benign must be ranked polypi, which, under the form of vegetations, bear a strong resemblance to the pointed forms of similar tumours found on the prepuce. They often appear near the lachrymal puncta and semilunar folds. They are formed of hypertrophied papillæ, and though pedunculated, may attain a length of a centimetre or more; and by obscuring the cornea, may produce both deformity and impairment of vision. These tumours, after a certain lapse of time, have apparently a tendency to cause a growth of similar ones in the neighbourhood.

I have lately had occasion to remove a series of polypi from a young woman twenty years of age. She had had from childhood a small polypi near the left lachrymal punctum. After marriage this increased rapidly, and attained a length of one centimetre; while at the same time a series of small excrescences appeared on the edge of the semilunar fold. In removing these small growths I was careful to excise the portion they grew upon, and next day to cauterise the wounds with a finely-pointed stick of nitrate of silver. This precaution is not superfluous, since polypi have been noticed to have a great tendency to recurrence unless the tissues from which they grow have been destroyed.

Similar fungous excrescences may be observed, consequent on wounds or burns of the conjunctiva. The operation of strabismus furnished frequent opportunities of witnessing the growth of such excrescences, which often take a very long time to disappear. Here, too, must be noticed the great tendency of such growths to recur, unless sufficient time be allowed to elapse before they are removed, in order that the conjunctiva may be able to close in upon them, and so produce a pedicle, which can be removed by a snip of the scissors.

A form of thickening of the ocular conjunctiva which, as the lids are generally open, is the more exposed to the contact of dust and of the atmosphere, is that known as *pinguicula*. From the doubling down of the conjunctiva in the movements of the eye and the lids, small erosions may be occasioned owing to the contact of foreign substances. These erosions insensibly cause adjoining portions to grow together, and so produce a circumscribed inflammation of the conjunctiva, in the neighbourhood of the margin of the cornea, and along the horizontal diameter of the globe. The yellow appearance assumed by the conjunctiva has given rise to the notion that fatty tissue is present, but this is not really the case. You should never yield to the instances of women, who, already in the sere and yellow leaf, call loudly for the removal of these spots. For, in excising pinguicula, even though the wound be accurately closed with a suture, a small cicatrix is necessarily left, which, becoming infected on the least congestion of the eye, is far more unsightly than the affection it was meant to cure.

There is another benign congenital tumour of the conjunctiva, namely the *dermoid*,—known also by the name of "wart" of the conjunctiva. It always rests on the edge of the cornea, generally inferiorly and externally. These warts often contain all the elements of the skin, to wit, hair and glands. The removal of such tumours is necessitated by the deformity they occasion. In the case of children the operation should not be deferred, for the warts will grow with years, and after removal will leave traces more or less distinct. They should be very carefully removed; but it is not advisable to excise the tissue on which they grow, for fear of opening into the anterior chamber, and producing, as has actually been done, dangerous inflammation. Cauterisation with nitrate of silver is not only useless, but worse, for it renders the scar all the more striking. The wound in the conjunctiva should be accurately brought together, and when cicatrisation is complete, the stain remaining on the cornea may be tattooed.

There is another and very rare variety of benign tumour, which is also congenital, namely, *lipoma*. It is met with almost exclusively in the spaces between the recti muscles. Those I have myself seen were all thus situated, either outwards and upwards, or downwards and outwards, and formed flattened yellowish swellings, which became apparent only when the patient turned his eye strongly to the side opposite to the tumour, or when the lid was raised with the finger. Lipomata are apparently extensions of the fatty tissue of the orbit, which has bulged towards the anterior portion of the globe and become spread out beneath the ocular conjunctiva.

These tumours show but little tendency to disfigure or to interfere with the movements of the eye. They should, therefore, not be operated on except at the urgent request of a patient, nor should they be removed in totality, as this would necessitate the introduction of instruments very far back, and the globe of the eye being very considerably denuded, with some accident as the result, such as *M. Fano* has actually put on record. The case was one in which a young girl was operated on for a lipoma, which caused no special annoyance, and was only seen when she looked in a direction opposite to the side it was on. The result of the operation was atrophy of the globe. A fortnight afterwards ulcerative keratitis suddenly showed itself in the other eye; this was followed by perforation and total blindness. One such case is quite enough to prevent a prudent practitioner from attacking such an affection without adequate cause.

Vascular tumours of the conjunctiva are very rare. You may be occasionally consulted about little triangular-shaped elevations of the conjunctiva, like pinguicula. They are situated beyond the external margin of the cornea, and cause great deformity by their bright-coloured injection. The affection is not unlike what a small permanent centre of episcleritis might be. These small vascular tumours are observed more particularly in persons subject to other forms of vascular dilatations on the face, and in particular in cases where a "red nose" coexists. Occasionally too they are found in young persons whose complexion is all that can be desired. Thus, lately I had occasion to remove a small muscular tumour of this nature from the left eye of a young lady. I took the greatest care to detach the conjunctiva thoroughly, and to bring the wound very accurately together with two points of suture, after having removed the affected portions. The patient returned six months afterwards, to thank me for the success of the operation; but, as a rule, such operations, in persons of at all a rubicund cast of countenance, leave red cicatrices as unsightly as the malady itself.

Angiomata springing not from the lids, but from the caruncula or culs-de-sac, are very seldom large enough to call for treatment. This I hold should never consist in injection of coagulating fluids, which are always dangerous, but rather in the application of sutures by means of curved needles, passed underneath the parts occupied by the dilated vessels.

Cysts of the conjunctiva constitute a variety of benign tumour very rarely seen. They are situated generally upon the border of the cornea, and may attain the size of small beans. A form of dilatation of the lymphatics of the conjunctiva is also met with, and is either vermiform in shape, or not unlike a string of small transparent beads, moveable beneath the ocular conjunctiva. Sometimes cysts are found in the cul-de-sac of the conjunctiva. Thus, a short time ago I removed from a young girl one of these cysts, which occupied the inferior cul-de-sac, and was about equal in size to a large bean. The transparency of its walls imparted to it a pale blue tint, which for the moment made me suppose it might contain a cysticercus. Incision showed it to be a cyst, the walls of which were destitute of epithelium. As regarded its origin nothing definite could be learned. I have also recently removed from an old man of seventy-two a cyst similar in appearance, which occupied the lower cul-de-sac of the left eye, and on which sixty years ago operation had been declined.

In removing a cyst, on the cornea, it will be well not to insist too strongly on detaching its base, should this be firmly adherent. There is apparently no danger of a recurrence, if the portion upon the globe be carefully removed, and the wound closed in with conjunctiva.

Contenting myself with merely naming some altogether exceptional tumours, such as *fibromata* and *osteomata* of the conjunctiva, I pass on to the malignant growths, common among which are *epitheliomata*. As a rule, these are developed on the ocular conjunctiva, near its circumference, and at first pass for phlyctenulæ, although the persistence of the affection and the age of the patient should at once place the surgeon on his guard. Sometimes the small pimple which occupies the conjunctival edge or its vicinity, ulcerates rapidly over an extent greater than the broadest ulcerated pustule, and remains stationary without deepening much, as the sclerotic opposes a stubborn resistance to its progress. Nevertheless, although the malignant nature of the affection may have been early diagnosed, there cannot be much hope of curing it *in situ* after it has penetrated a certain depth into the sclerotic tissue.

Two precautions must never be neglected in the removal of such growths. The first is to operate on sound tissue, and remove with a cataract-knife, the layer of sclerotic, upon which the pedicle of the little tumour rests. The second is to make use of instruments absolutely clean, in the removal of the neighbouring conjunctiva, which it is intended should supply the loss of substance in the mucous membrane.

Knowing, on the one hand, how often the progress of conjunctival cancroids is slow, and on the other, what difficulties are encountered in dealing with such growths without enucleating the eye, I now, before undertaking any operation, give the treatment of *M. Bergeron* a trial (p. 31), and prescribe simultaneously lotions and compresses of chlorate of potassium, in a proportion determined by the tolerance shown by the eye. I commence with a solution of 1 part in 40. If an operation has once been performed, and a recurrence of the disease has taken place, enucleation must be accepted, hard though such an alternative may seem to be, when the sight is still in great part unaffected.

What I have just said applies with equal force to another malignant tumour, *melano-sarcoma,* which also grows, generally, close to the conjunctival border, or more rarely on the tarsal conjunctiva, or the culs-de-sac. Be especially cautious here about hastening to operate, unless the rapid growth of the tumour absolutely demands it. Cases have been observed in which this terrible affection remained absolutely stationary during twelve or even twenty years; while if operated on, it sometimes recurs with fearful rapidity, or what is perhaps worse, undergoes metastasis. If such a tumour in the vicinity of the cornea is rapidly progressing, the blood should be examined in order to learn whether or not the melano-sarcoma tends to become general. As soon as you are convinced that general infection is not immediately imminent, proceed forthwith to enucleate the eye; but no such operation should be ventured on if previous attempts have already produced a return of the disease *in situ,* or if the blood is contaminated. In that case metastasis will happen almost to a certainty.

True *carcinoma* of the conjunctiva is extremely rare, its treatment is purely surgical, and consists in prompt removal.

Before concluding the subject of diseases of the conjunctiva I have a few remarks to make relative to some affections which this membrane may occasionally become the seat of, such as leprosy, lupus, tubercles, and certain cutaneous eruptions. *Leprosy* may appear on the eye in the form of a pimple, close to the cornea, and though exposing the organ to the very gravest danger, should never be made the subject of local treatment.

Such is not the case with *lupus*, which spreads from other parts to the conjunctiva, and only appears exceptionally at the outset in that membrane. As the lupus is generally situated on the lid it may be seized with a Desmarres' or Snellen's forceps. It appears generally under the form of fungous granulations, broken by cicatrices if it has lasted some time. With a cutting curette (fig. 2) you should scrape away as thoroughly as possible the soft doughy masses. This scraping process is to be followed up by active cauterisation with a solution of nitrate of silver, 1 part in 10, any excess of which should be neutralised. If the nodules show a certain toughness and resist the scraping, they may be transfixed with a tattooing needle in all directions, and finally cauterised with a concentrated solution of nitrate of silver. According to the amount of irritation thus caused, the application may be made more or less frequently, for example every three or four days.

Tubercles may at a very advanced stage occasionally be developed under the ocular conjunctiva. They will not in this situation require any special treatment. It is well, however, to be aware of the possibility of such localisation, so as not to attempt to repress the nodulation in a mucous membrane affected with tubercles, and thereby cause useless suffering to your patient.

When speaking of xerophthalmia I stated that psoriasis and pemphigus might invade the conjunctiva, and there cause considerable mischief. It is much less rare to see pityriasis become localised in that situation and give rise to an excessively obstinate form of inflammation. This pityriasis of the conjunctiva (*Blazy*) is characterised, in the absence of any pityriasis of the lids, by a very active desquamation of the mucous membrane. Here scales of epithelium in great numbers become heaped up, and are displaced to the front of the cornea, giving rise to scotomata, which move synchronously with the pulsation in the lids. This affection is generally complicated with pityriasis of the lids, and causes mild blepharitis, the anatomical characters and causes of which are the same as those of pityriasis.

These conjunctivites bear irritant treatment, either by collyria or cauterisations, badly. Besides a general arsenical treatment, arsenical collyria and compresses may be tried, namely, 10 to 25 centigrammes of arseniate of soda to 200 grammes of water.* The oxide of zinc and red precipitate ointments already described for blepharitis, may be also used here.

It is very rare to find an *entozoon* under the conjunctiva (cysticercus). The only treatment in such cases is removal, which, as the animalcula is encysted, presents no difficulty.

I will end this lecture by remarking that the caruncle and semilunar fold may become very exceptionally the seats of a circumscribed inflammation known as *encanthis*. In these cases there has been inflammation of one of the follicular glands, the contents of which have become hardened and calcified, a condition known as *encanthis calculosa*. The evacuation of the purulent or calcareous contents of these glands, causes the inflammation, which, as a rule, is confined to a very limited portion of the conjunctiva, to subside rapidly.

* Or one part to $2\frac{1}{2}$ parts, in every 2000 of water.

DISEASES OF THE CORNEA.

LECTURE XII.

ANATOMY; VARIOUS TYPES OF INFLAMMATION OF THE CORNEA; PHLYCTENULAR KERATITIS.

It is scarcely possible to treat rationally diseases of the cornea, or to understand the important revolution which the study of keratitis has caused in general pathology, and more especially in the treatment of corneal affections, without some acquaintance with the anatomical peculiarities of a membrane, which has taxed the skill of innumerable investigators, and whose complex structure is still the subject of much controversy.

The tissue proper, or parenchyma of the cornea is made up of extremely fine *fibrillæ* united into fasciculi, of a cement which binds the fibres and fasciculi together, of a system of canals which represent a continuation of the lymphatic vessels and spaces, and of cells, which line these lacunæ or lymphatic canals, and ramify throughout the whole cornea. The cornea upon its two surfaces is furnished with a layer of epithelium. Its sides are continuous with the sclerotic, forming at the points of contact in common with the other enveloping membranes, a cavernous tissue, which contains large lymphatic spaces, communicating with the anterior chamber, and connecting it indirectly with the corneal system of lymphatic canals.

The *fibrillæ* and *fasciculi of fibres* can only be shown with the aid of chemical reagents, and high powers. What is most interesting to us, is to know that the fasciculi are disposed in layers one above the other, and that in the plane of these layers they are much more closely adherent than they are vertically. Hence results a structure made up of lamellæ, better marked in proportion as we approach the internal surface of the cornea.

The *cement* of the cornea is a homogeneous substance, binding the fibres and fibrillæ so intimately together, that in the direction of the fasciculi the layers are always arranged one over the other and parallel. This peculiar and essential substance contributes in no small degree to the lamellated structure of the cornea. The cement is accumulated chiefly on the surfaces, where it forms a structureless membrane.

The corneal *system of canals* is hollowed out of the compact tissue formed by the cement and the fasciculi arranged in lamellæ. The system is composed of numerous lenticular-shaped shallow spaces, communicating together by a large number of offsets from the canals which, like the lenticular lacunæ, follow the lamellated layers of the interfascicular cement. Nevertheless, many of the canaliculi communicate also with the lacunæ, and their canal-like prolongations. Hence it follows that many of these prolongations take a course more or less at a right angle, and that the cornea is traversed in all directions by lymph canals.

The cement, where it borders the lacunæ and their branches, is somewhat more resisting than it is at a distance from them, but without in any sense providing them with true walls. Thus it may be said that the lymph circulates freely through the substance of the cornea in self-made channels.

This system of lacunæ and canals formed in the corneal cement, contains lymph, or the nutritive fluid, which is always maintained at a constant pressure, thus ensuring the absolute homogeneousness and transparency of the tissue. But besides the nutritive fluid, the lymphatic spaces enclose cells. These are in part fixed, constituting the cellular elements proper of the cornea, and in part free, representing the migratory elements.

The *proper cells* of the cornea are formed by scales lining the interspaces and lymphatic canaliculi, and which, like the scales of *Ranvier*, are composed of a nucleus enveloped in a minute portion of finely granular protoplasm, which is surrounded by a homogeneous limiting zone. This transparent zone must be considered as a metamorphosis of the protoplasm, which after having attacked the cell consumes it and becomes merged in the primitive substance of the cornea. This squamous epithelium lines the lymphatic lacunæ, and is furnished with prolongations. These pass into the lymphatic canaliculi, and like filiform appendices, or wings, as in the case with the canaliculi into which they pass, strike off from the corneal cell at right angles. These processes and appendices are formed similarly to the zone which surrounds the cell protoplasm, by a homogeneous and transparent material which gives very curious shapes to these delicate cells, as is well shown in the drawings of *M. Waldeyer.*

The *migratory corpuscles* are distinguished from the fixed cells by their large and variable size, as also by their brilliancy, and the power of motion they possess. They correspond to the migratory cells of other tissues, and are allied to leucocytes.

What relation do the fixed cells of the cornea bear to the parenchyma, and the migratory corpuscles? The views of *M. Waldeyer* on these points appear to me to be the most satisfactory. According to this excellent observer, the epithelium provided with numerous wing-like membranous processes, forms an endothelial lining to the lacunæ and canaliculi. The flattening out of the cells into transparent discs would be the first step in the formation of the proper corneal tissue, whilst the granular protoplasm surrounding the nucleus, would represent by its contractility its descent from the migratory cells. These, as they become stationary and undergo metamorphosis, change into fixed endothelial cells, and form eventually the substance proper of the cornea. In this way provision is made for a constant renewal of corneal tissue.

The migratory corpuscles would then be the type of the formative elements, while the fixed cells derived from them, would be undergoing atrophy, and would, while in this semi-atrophic condition, constitute the endothelial cells. It will be considered later on whether or not it is admissible, that these cells, having entered on a retrogressive stage, in which the minute quantity of protoplasma which surrounds their nuclei is all that shows any power of contractility, should be regarded as capable of commencing once again a life of activity, and bearing their part, under the stimulus of innervation in inflammatory processes. Such a resuscitation seems to me, even from a histological point of view, rather doubtful.

The cornea is bounded by a layer of epithelium, thin in man, formed of a superficial squamous stratum, reposing on a middle layer of dentated cells. These latter on their side overlie a final layer of cylindrical club-shaped epithelial cells. Immediately behind this threefold line of epithelial cells, comes an anhistic membrane, the anterior basement membrane of *Bowman.* This portion of the cornea cannot be separated from the subjacent tissue, and consequently the name membrane, which *Bowman* applied to it, is incorrect. It is simply a layer of corneal cement, containing fibrillæ and fasciculi, but possessing neither lacunæ nor lymph canals, and therefore neither fixed cells nor moveable corpuscles. This homogeneous layer of the cornea is somewhat more refrangent than the rest of the cornea, in which it is merged without any abrupt transition.

Towards the anterior chamber also, the cornea is bounded by a structureless thinner layer, which, like a bright streak refracting light strongly, presents a contrast to the other portions. It has the characters of an elastic lamina, rolling up on itself when removed in pieces. This membrane of Descemet, though exhibiting the above property, can be separated from the cornea only with difficulty. It really forms a portion of it in which the cement has been very much condensed.

Upon this internal anhistic membrane, rests a simple line of flat epithelial cells with very distinct nuclei. The layer which thus lines the anterior chamber, may be regarded as its endothelium.

I shall close this short sketch of the anatomy of the cornea by saying that the blood-vessels are only found on the outskirts of the cornea, namely, its margin and the neighbouring parts, and that at no epoch of life do they penetrate its substance proper. On the other hand, nerves, to the number of from 40 to 45 (*Sœmisch*), penetrate its tissue. Here they rapidly lose their neurilemma, and divide dichotomously, to form chiefly under the epithelium large plexuses and numerous reticulæ, the extremities of which are in connection with corneal and epithelial cells. These cells, according to some authors, may each have its proper nerve ending (*Kühne*). It is, however, quite sufficient for us to know that the substance of the cornea and its external epithelial layer are both very richly supplied with the minutest nerve tissue.

Everyone knows that the cornea has always been a field for the most violent and obstinate contests as to the general pathology of "inflammation." At the time when cellular pathology held sway, I was one of the first to endeavour to place the clinical facts of ophthalmology in harmony with the theoretic principles of that pathology. The difficulties were great; for now that science has advanced so quickly, it can be shown, at least as regards the cornea, that we must no longer, as I once held, look for the essential character of inflammation in some alteration of the nutritive functions of the cellular elements constituting the corneal tissue. We must rather, guided by the anatomy, hold that an absolutely passive part is to be attributed to the corneal tissue in the process of inflammation.

It is the migratory elements which, under the influence of the stimulus of inflammation, invading this membrane in more or less considerable numbers, afford a proof that it possesses vitality. The endothelial cells undergoing atrophy have, in consequence of the inflammation, a shorter retrogressive period, and we see, in the breaking down of these cells, traces of such, rather than of a resurrection, which would make them enter a new phase of life.

In this I am in complete agreement with *Cohnheim*, and I hold that all the teachings of clinical opthalmology perfectly accord with the notion that within the borders of the cornea, inflammation must be considered only as nutrition in excess; that is to say, acceleration of all cell migration, and of the stages of retrogressive metamorphosis of the fixed elements.

Inflammation may give rise to phenomena of variable duration, exciting changes in the cornea more or less *transitory* or *definite*. The *transitory* modifications consist in the separation of cement and fasciculi, between which are developed interstices filled with fluid. This imbibition may disappear by resorption, and the cornea recover transparency, after this had been more or less lost owing to the difference in refractive power, between the infiltrated liquid and the stroma.

These alterations in transparency may be due not only to absorption of fluid by the tissue, but also to the presence of cells, the result of intensified diapedesis. This invasion may block up all the corneal spaces which are permeable by nutritive fluids with an accumulation of cells imported from without. This form of infiltration may likewise disappear without leaving any traces.

Permanent changes are due to the fact that the severance of the fibrillar elements and the endothelial cells has been pushed far enough to produce destruction followed by elimination. There may here be a reconstruction of tissue as a result of the organisation of the cellular elements that had migrated; but such a reconstruction, effected in haste, never permits of the cells arriving at a degree of development equal to that presented by the fixed cells, whereby perfect transparency would be insured. Here again, clinical observation backs up the dictum of science, and teaches that a loss of substance of the cornea (an ulcer) heals with scars which will be slight in proportion as the healing process has been slow, and carried on under a diminished intraocular pressure, whereby the cells have not been massed together or their nutrition and development interfered with.

In order to make clear the nature of the diseases, against which treatment will be required, I must rapidly pass in review the *three types of inflammation* (*Sœmisch*) of which the cornea may become the seat. They are, 1, *infiltration;* 2, *abscess;* 3, *corneal ulcer.*

1. Infiltration of the cornea consists in the immigration of leucocytes derived from diapedesis, and the invasion by these elements of the lymphatic spaces, together with more or less dissociation of the parenchyma. The characteristic sign of this invasion of cells is an ill-defined haziness. In proportion as the infiltration is well marked and remains limited to certain layers of the cornea, so will the dissociation of the tissue be less. The leucocytes remaining intact within the lacunæ and canaliculi, will give to the infiltrated portion the appearance of an injected preparation, with crossed lines and striæ. The wider the fibrillæ and cement have been parted asunder, the more uniform will the colouring be, and the more will all appreciable design have vanished.

In order that the type of continuous inflammation should be persistent, the tissue which borders on the lymphatic spaces, and which is more or less engorged with leucocytes, should be the seat of an aggregation of cells and of dissociation, without destruction. The infiltration may thus pass through the various regions of the cornea and disappear without having left any traces. If, however, it have lasted a considerable time and separated the tissues widely, it may leave permanent traces, a result due to the severed tissues not having recovered complete transparency.

Infiltration may also terminate in another way. The cells which have filtered into the lymphatic spaces may be retained there, and undergo a certain amount of organisation, without ever becoming as highly developed as the migratory corpuscles would have under ordinary circumstances. The cells which are incompletely organised determine sclerosis of the infiltrated portion of the cornea, which eventually often becomes a centre of growth for fresh vessels, becoming itself more or less vascular.

Infiltrations may vary in position and extent. They may be *superficial* or *deep*, *circumscribed* or *diffuse*, and lastly, may invade almost the entire cornea, and assume thus the characters of a *generalised parenchymatous infiltration*. According to their position and extent these infiltrations exhibit phenomena of varying irritability. As a general rule infiltrations into the superficial layers of the cornea (subepithelial), the most richly endowed with nerves, are generally the most painful, seeing that the leucocytes easily follow the course of the nerves, and exercise a more or less direct pressure on them.

Infiltration is a remarkably benign process, but neither the locality nor amount will enable any one to say how far it will disappear without leaving traces. For infiltration, even when superficial and limited, may easily give rise to sclerosis; or the epithelium may have been slightly raised up, and may be cast off and ulceration ensue. On the other hand, it may happen that large parenchymatous infiltrations will pass like slow currents across the corneal tissue, which later on recovers its integrity and perfect transparency.

The general rules which should govern the treatment of all corneal infiltrations are the following: everything that can hasten the ulcerative process, in other words, the elimination of the epithelial layer must be kept from the eye; proper means must be employed to arrest, so far as is possible, the diapedesis which furnishes the elements of infiltration, so as to hinder the infiltrated elements becoming organised, and to prevent infiltration leading to sclerosis. How to fulfil these indications is what I shall treat of by and by; for the present I will only insist on this capital fact, that "*infiltration is a formal indication against any irritating agent.*"

2. An abscess is produced when, in consequence of very copious and rapid infiltration, the agglomeration of leucocytes which has taken place, has separated the corneal tissues to an extent sufficient to cause their destruction. This peculiar characteristic explains why an abscess is in general much more limited than an infiltration. It is because, in the process of growth, it does not, as the infiltration does, confine itself to the natural channels existing in the stroma of the cornea, but tends to perforate it from before backwards, at the same time preserving a distinct and more or less circular outline. The worst result of infiltration was sclerosis and vascularity; of abscess, it is destruction and ulceration. Infiltration may disappear without leaving the slightest trace, but not so with an abscess, which even if it ends by absorbing pus, and effete corneal tissue, necessitates, nevertheless, a new growth of tissue which will always be imperfect. In other words, there will always be a cicatrix more or less apparent.

The activity of the diapedesis, which eventuates in the formation of an abscess, becomes at times so intense, that the leucocytes pass through the trabeculæ of the circumferential tissue, and pour into the anterior chamber. The *hypopion*, which so readily accompanies an abscess, is uncommon in infiltration.

From the point of view of symptomatology, note that, as in infiltration, superficial and circumscribed abscesses are far more painful than those large collections of pus, for the most part indolent, which occupy the posterior portions of the cornea. Generally speaking, the abscess ends by being transformed into an ulcer, and this phenomenon may sometimes take place so rapidly that the stage of infiltration passes by unnoticed.

3. The *ulcer*, the third type of inflammation, is characterised from the very commencement by loss of substance. An infiltration may become an abscess, an abscess an ulcer, but an ulcer may appear on the cornea at once. There exists an innumerable variety of ulcers, but what is of more especial interest to us just now, studying as we are the types of inflammation, is to review (*a*) the evolution and progress of an ulcer, (*b*) the stationary condition it may assume, and (*c*) the phases of repair it will pass through, in order to become healed.

(*a*) The ulcer *commences*, on the epithelial layer, by loss of an irregularly dentated portion of substance, which exposes, and is itself often covered with the *débris* of corneal tissue, the cement in the form of the membrane of Bowman, being rapidly destroyed and cast off. The grey zone which surrounds the ulcer is formed by an infiltration of lymphoid cells, and bears no proportion to the extent of loss of substance, which the ulcer represents.

(*b*) When the ulcer enters on its *second stage*, that is when it becomes stationary, it will be observed to be getting cleaner. This cleansing affects its fundus, which becomes freed from all effete tissue, as well as the surrounding zone, which, by the disappearance of infiltration, gains in transparency. The edges of the ulcer become rounded off, and lose, near the healthy parts, their jagged outline. Many ulcers, situated near the corneal margin, become vascular at this period.

(*c*) The *third stage*, or that of *repair*, is nothing more than the preceding stage more fully developed. The ulcer becomes shallower, its edges rounder and smoother, the epithelial layer descends towards its floor, which once more assumes a bright look. In proportion as the layer of epithelium becomes more perfect, the loss of substance in the corneal tissue is repaired.

According to the extent and depth of the substance lost, will the ulcer in healing leave behind it a mere haze (nubecula), an opacity (macula), or a patch of cicatricial tissue (leucoma).

The three stages may exhibit sensible variations and modifications. Thus, the stage of ulceration may run directly on to complete destruction of the cornea, the second stage being suppressed, and the third very much modified. It may happen also, that the second stage may become chronic, and delay indefinitely the period of repair. Finally, this latter may be interrupted by a return, more or less well marked, to one of the foregoing stages.

My object has been, in the above account, to give an outline of the various types of inflammation, so as to enable you to grasp more readily the clinical varieties of keratitis, and especially to render clear those facts, which form the foundation of treatment.

Inflammations of the cornea (*keratitis*), are divided into superficial and deep. In the superficial we distinguish two varieties, namely: (A) vascular, and (B) non-vascular. As regards the deep varieties, we shall have to study, 1, deep infiltrations; 2, deep abscesses; 3, deep ulcers. The various states which result from these forms of keratitis and their treatment, will conclude the account of diseases of the cornea.

I. Superficial Inflammations.

(A.) *Superficial vascular keratitis* belongs to the inflammatory type of infiltration. As its name imports, it is localised on the surface of the cornea, and is followed by rapid organisation of the products that have filtered through, and by a development of vessels. This keratitis, when limited to a small portion of the cornea, is called, (*a*) *phlyctenular keratitis*, while if more generalised, (*b*) *pannus of the cornea*. It will be remembered that phlyctenular keratites, which, by their constant recurrence had finally come to occupy the whole cornea, were called scrofulous pannus.

(*a*) Phlyctenular keratitis commences by one or more small opacities, situated either on the centre or the periphery of the cornea. The epithelium, once it has been raised up by a small collection of leucocytes, is rapidly shed, and the part so excoriated in no long time becomes vascular. A pericorneal injection, uniform if there is a crop, but very partial if there is only a solitary phlycten, near the corneal margin, accompanies the small mass of leucocytes from the outset. These seldom disappear without having first passed through a stage of ulceration and vascularisation.

A phlycten similar to the above easily gives rise to a keratitis *en bandelette,* a form in which the vessels take the most direct route to the infiltration, and themselves repose upon a grey, slightly prominent, infiltration. Here the vascularity remains always limited in great part to the grey band, just as the pericorneal injection is limited to the spot near which the vessels pass on to the cornea.

Phlyctenular keratitis, not dangerous in itself when it holds true to its type, and does not give rise to large abscesses or wide-spreading ulcers, has, nevertheless, this grave feature, that it very readily recurs, and by successive attacks of inflammation, induces true *phlyctenular pannus* (scrofulous). Another serious consequence is the constant creation of centres of infiltration on one spot on the cornea. Here a permanent sclerosis may result, as is observed constantly in keratitis *en bandelette.*

It must be carefully borne in mind that very often the untoward course which a keratitis runs, is the consequence of injudicious treatment. Its remarkable tendency to relapse, must often be laid to the account of the deficient hygiene in the midst of which children, more especially the subjects of it, live. On these it leaves its imprints during their whole lives.

As to treatment, so important to every practitioner whose duties lie among large numbers of children, I must lay fresh stress on the precepts already given in the case of phlyctenular conjunctivitis. Be careful not to violate either of the three following conditions, namely, rest of the affected eye, scrupulous cleanliness, and abstention from all revulsive and weakening treatment. Treatment should vary according to the period of the attack. All irritation should be avoided when the phlyctenulæ are not vascularised, or when, if vascularisation has commenced, the epithelium is injured or excoriated. The treatment by irritation should not be put in practice, unless to cause the remains of this disease to disappear, that is, pannus and scleromatous infiltrations.

At the onset, for children, warm fomentations of camomile may be prescribed, or belladonna, or jasmine, while in the case of small phlyctenulæ, no collyria whatever are required. At the same time sponging with salt water every morning, and a tea-spoonful night and morning of syrup of quinine or iodide of iron, may be ordered. For children somewhat older, a powder composed of 1 gramme of quinine to 10 of sugar, divided into ten parts, may be prescribed, and one part ($1\frac{1}{2}$ grain quinine) given morning and evening.

If careful inspection has shown the presence of one or more phlyctens of some size, or slightly ulcerated, the compresses should be persevered with, and a solution of eserine prescribed of a strength of 1 part in 200, a drop to be placed in the eye morning and evening. The use of eserine should not be continued after the epithelium has become vascular and repaired, because in children, it easily provokes follicular conjunctivitis. As soon as ever vascularity and repair of the epithelium has been accomplished, the treatment suitable to phlyctenular conjunctivitis (p. 75), becomes in all respects applicable. I will remark, however, that the advent of this period can be hastened by lessening friction of the lids and blepharospasm, by means of canthoplasty and *Agnew's* operation.

LECTURE XIII.

PANNUS; VESICULAR KERATITIS; ULCER BY ABSORPTION; DEEP CIRCUMSCRIBED INFILTRATION; PARENCHYMATOUS KERATITIS.

(*b.*) *Pannus* is the type of that superficial infiltration which occupies a large extent of cornea. This infiltration may be concentrated in certain points where it produces small elevations of the epithelium, and induces more or less vascularity of the surface. The amount of infiltration and vascularity present, modifies the appearance of the pannus, which in proportion to its degree of development is called respectively, pannus *tenuis*, *crassus*, and *sarcomatous*.

The cell migration which causes infiltration in pannus, takes place between the epithelium and Bowman's layer. The latter in proportion as the accumulation of cells increases atrophies and disappears, and the pannus is then at liberty to extend more or less deeply. The vessels it contains are in direct communication with the branches of the anterior ciliary artery. As early as the period at which these vessels first become developed, the type of the inflammation has more or less altered, and the longer the disease lasts, and the more the sclerosis, due to the organisation of the infiltrated cells increases, the greater will the departure from the original type be.

Complications in pannus are to be feared chiefly in the earlier stages, or towards the close. When a general invasion of cells suddenly takes place on the surface of the cornea, the obstacles accumulated in front of the trabecular tissue, which constitutes the main channel of filtration, interfere with this important function, and cause a greater or less increase of tension. The glaucomatous phenomena which now succeed, are often wrongly interpreted, and laid to the account of the corneal affection. The tension therefore of an eye on which a pannus has spread largely and rapidly, must always be carefully taken.

When pannus has lasted a considerable time, and has lost its character of superficial keratitis, and when the deeper layers of the cornea have been attacked, it will terminate in sclerosis and contraction of the newly laid-down tissue. So considerable will this be, that flattening of the cornea and atrophy will ensue.

The length of time the inflammation has lasted, and its degree, will form the chief factors in deciding how far the cornea may be saved. The less the affection has preserved its inflammatory type, that of simple infiltration, the less hope is there of the return of complete transparency. Furthermore, examination by oblique illumination will always demonstrate that complete reparation after pannus is a vain hope. Slight traces will always remain, and will prove that the vascularity which has already borne witness to change in the type of the inflammation by the fact of new tissue having been formed, has for ever deprived the cornea of its power of complete repair. Fortunately these permanent, but slight traces are without any serious effect on vision, provided they do not extend into the area of the pupil.

The existence of pannus may, however, be a favourable circumstance from the point of view of prognosis; for although this affection exhibits a marked tendency to form organic tissue, destruction from compression of the infiltrated cells in the surrounding parts, need no longer be feared. It is therefore correct to say that the presence of a complete pannus, more or less, guarantees the preservation of the cornea. But should the pannus be incomplete, it will not prevent the formation of an ulcer or abscess, destructive of the non-vascular portion by the side of the part covered with vessels.

Besides *phlyctenular pannus*, so common in children, a *traumatic* pannus may be occasioned by the friction either of the lids, of an indurated palpebral edge, or of granulations. Properly speaking, the term *granular pannus* should be limited to that form in which the production of granular masses in the cornea has induced infiltration and vascularity of its surface.

As regards treatment, it must be remembered that the phlyctenular and traumatic forms have a great tendency to disappear so soon as the exciting cause has been removed. By opposing in phlyctenular eruptions the tendency to relapse, by removing the friction against the cornea of eyelashes or of a roughened and incurved ciliary edge, or a deformed tarsus, the essential indications of treatment will be fulfilled. Among remedies useful in clearing the cornea, and which should be employed after the cure of any conditions, such as those just mentioned, are the binoxide of mercury ointment, and insufflations of calomel (p. 75). If any affection of the conjunctiva keeps the pannus alive, it should be subjected to some suitable method of treatment as already pointed out.

To prevent sclerosis, and to hasten the absorption of a portion of the corneal cells that have become attached to its superficial layers beneath the epithelium, we have three methods at our disposal, namely, *abrasion of the conjunctiva*, *iridectomy*, and *sclerotomy*.

Abrasion of the conjunctiva, especially advocated by *Furnari*, would appear to act by obliterating some of the numerous superficial conjunctival vessels, and by the pressure which the resulting cicatricial tissue causes in the immediate neighbourhood of the cornea. By this means the tide of nutrition to the infiltrated and easily organised cells is stayed.

I have often performed the operation of abrasion of the cornea or syndectomy; but I do not strictly follow the directions given by Furnari. I take hold of the conjunctiva, with my forceps half a centimetre above the margin of the cornea, and pass one blade of my scissors quickly under the mucous membrane, cutting a strip of conjunctiva half a centimetre wide all round the cornea. This circumcision completed, I cut at one sweep, above the vertical diameter of the cornea up to its margin, the portion of conjunctiva grasped in the forceps. By snips of the scissors I detach this band very carefully from around the cornea, and separate it from the sclerotic.

I neither scrape the episcleral tissue, nor do I cauterise the raw surface with solid nitrate of silver, moistened in the saliva, as Furnari recommends; I do not do so because I have no wish to further irritate the eye or prolong an operation already sufficiently unpleasant.

During the two first days after the operation compresses of cold water should be applied to the eye. As soon as the wound has become covered with a diphtheritic-looking layer, these should be replaced by warm fomentations, which will quickly calm the pain that about this period often supervenes. Besides this, however, compresses of infusion of camomile and belladonna, if continued for any length of time, induce a certain amount of purulent discharge, which in no slight degree assists in clearing the cornea. The recipe for the compresses of belladonna is as follows :

Extract of belladonna	3 parts.
Distilled water	300 „

Filter carefully.

A tablespoonful of this solution is to be poured into a good-sized bowl of water maintained at a constant temperature of 35° (95° F.).

When we have to do with a pannus of no great thickness, or merely the remains of a pannus, no attempt should be made to excite a purulent discharge from the conjunctiva, as it is always more or less troublesome. The patient should be informed that the clearing up of his cornea can only be looked for at the cicatricial period, that is three or four months after the excision of the flap.

Syndectomy, in appearance so painful and even severe, is very easily borne, and leaves no traces behind, except that, occasionally the circumference of the cornea has a pearly blue tint, like the peculiar reflex of the enamel in artificial eyes.

When it has not been possible to obtain sufficient improvement by syndectomy, or when palpation shows an excess of intraocular tension, and makes us fear some alteration in nutrition, which might check elimination of the infiltrated cells, and favour sclerosis, the operation of sclerotomy or iridectomy is indicated.

I perform sclerotomy with a sclerotome made on purpose. It is a lance-shaped knife, three millimetres in breadth. The sclerotome traverses the eye at one millimetre from the edge of the cornea, and at three millimetres from a point corresponding to its vertical diameter, towards its superior or inferior extremity, the instrument being kept exactly parallel to the iris. The knife as soon as it has appeared on the opposite side is to be quickly withdrawn, so as not to allow of the escape of any aqueous humour, or give rise to any entanglement of the iris. A few instillations, however, of eserine before and after the operation will guarantee against this accident.

Sclerotomy, to which I will return when speaking of glaucoma, has clearly been of use in the cases I now show you, as regards clearing the cornea, and that when syndectomy had already proved insufficient. Sclerotomy has the undoubted advantage over iridectomy of not leaving any traces nor of increasing the dazzling to which diffuse opacities of the cornea are already so apt to give rise.

The grand operation against glaucoma, iridectomy, should be performed when you are satisfied that some true glaucomatous complication has arisen, and that a change in the curvature of the cornea is in process. The excision of the iris should always be made upwards. The presence of a certain amount of irritability and even purulent discharge, need not occasion any delay in performing an operation that has, under the circumstances, become urgent, more especially as the danger is in no wise increased by the presence of a simultaneous inflammation of the conjunctiva. An iridectomy should be preferred to a sclerotomy if we desire in an eye suffering from the after effects of pannus, to combine an optical effect with the clearing action of the operation; or in other words, if some other portion of the cornea is more transparent than that immediately over the pupil.

The treatment of pannus by inoculation has already been spoken of under the head of granulations (p. 88).

(B.) The *superficial nonvascular keratites* are distinguished from the preceding forms, by the fact that they exhibit no tendency either to form new tissue (vascularisation and sclerosis), or to invade the deeper layers of the cornea. The keratites included in this group are (*a*) the *vesicular*, and (*b*) the *ulcer by reabsorption*.

(*a*.) *Vesicular keratitis* or *herpes of the cornea* is generally unilateral, and appears either as one vesicle or as many, grouped together. They appear on the surface of the cornea, and are due to a circumscribed upraising of the epithelium, in which a very thin layer of cement may also take part. The contents of these vesicles is liquid and transparent; they are not composed like phlyctenulæ, of masses of lymphoid cells. This form of herpes must not be confused with a variety of keratitis, in which the cement is raised up over a considerable surface by fluid, and thereby gives rise to a large vesicle; this is what is known as *bullous keratitis*.

Corneal herpes, which appears in paroxysms, is accompanied by very severe pain. This is relieved only when shedding the vesicular envelope, and the formation of slight excoriations on the cornea take place. The affection is evidently dependent on some inflammation of the branches of the fifth pair, as shown by its being commonly coincident with ophthalmic herpes zoster, and also by the fact that neuralgic pain often precedes eruption, and sometimes continues after the corneal vesicules have healed.

The question of the innervation of the cornea being still a matter of discussion, we need here only inquire under what conditions herpes of the cornea appears. Leaving out of the question the herpes which is present in about 25 per cent. of cases of ophthalmic zona, we find a herpes of the cornea recurring simultaneously with febrile hydroa (labial and palpebral). It is in such cases, according to *M. Horner*, a catarrhal form, it being confined exclusively to persons suffering from catarrhal affections of the air passages. The true idiopathic herpes of the cornea appears suddenly, is periodic, does not lead to any serious lesion, but is very distressing to the patient owing to constant relapses, which always herald the approach of an excruciating supraorbital neuralgia.

The treatment will vary according as we have to do with one or other of the varieties of herpes. Herpes zoster calls for warm fomentations of belladonna or camomile, for atropine (solutions of 1 part in 200) in order to allay the irritability of the iris, which generally accompanies the eruption. With this, large doses of quinine, of 80 to 100 centigrammes (13 to 15 grains), may be given daily. Continuous currents, from the moment that the desquamatous stage of the herpes commences, find a fitting sphere. The catarrhal form of herpes disappears with the eruption of hydroa, and requires scarcely any treatment. A few lotions of warm carbolised water may be used if the mucous membrane shows any tendency to catarrhal inflammation, while doses of quinine may be prescribed in cases where pain continues after the drying up of the hydroa, and the elimination of the corneal vesicles. In the idiopathic form the employment of quinine is an important part of the treatment.

Seeing that it is after shedding of the vesicular envelope that pain becomes mitigated, abrasions of the vesicles may be resorted to, or they may be pulled away with very fine forceps, such as the iridectomy forceps used in *Græfe's* cataract operation. The compress bandage and atropine should be applied early. If the patient shrinks from this slight operation, for direct removal may be substituted that induced by the friction of calomel. But up to the moment of its actually fulfilling its purpose, calomel undoubtedly increases the pain.

Change of residence will be very advisable, especially where there is reason to think that malarious influences may play some part in the development of this neurosis.

b. The second variety of non-vascular keratitis, namely, the *ulcer by absorption*, represents one of the forms of the third type of inflammation, but since the attack commenced it has been in the stationary stage. It has not been possible to note any stage of evolution or of repair. This form of ulcer appears in the central portions of the cornea, under the form of a little depression, with smooth, rounded non-vascular borders. Its transparence is so perfect that its presence is often only to be discovered by the peculiar reflex from the depression, and by the disturbance of vision it causes. It is met with chiefly in children, where it is observed to appear so suddenly, and is heralded by so few of the symptoms of irritation and inflammation, that the loss of substance might seem to have been occasioned by a process of absorption, and hence the name. A mother has perhaps become aware of the existence of the affection, because she has seen a bright speck in her child's eye, or because in daylight, or with a strong artificial light, the little patient has perhaps partially closed his eye, which has readily watered.

The ulcer may remain stationary for months together. Though it should finally become partly vascular, and be apparently about to enter on the stage of repair, it will never actually do so. There will always remain a facette more or less apparent, and more or less injurious to vision, on account of the irregular astigmatism, which years after will enable the nature of the affection to be recognised.

These ulcers are most frequently met with in children, particularly in those whose skins have but feeble resisting power, and who are predisposed to attacks of phlyctenular keratitis. The two affections may often be observed together in the same patient.

The treatment of this very obstinate disease consists chiefly in warm camomile fomentations, applied half an hour at a time, three times a day; while along with these, morning and evening, a solution of eserine (1 part in 200) should be dropped into the eye. The compress bandage must be worn at night, so as to assist the effects of the warm compresses. So soon as any tendency to vascularity is noticed, recourse may be had to irritants, such as insufflation of calomel and yellow precipitate ointment. The employment of these and of eserine must be carefully watched. Eserine acts in these cases by diminishing pressure, and hastening the reorganisation of tissue, while at the same time it lessens dazzling. Such remedies should be discontinued so soon as it is perceived that they give rise to irritation and discharge; for experience has shown that the prolonged use of irritants, as also of eserine, provokes in such cases a development of chronic follicular conjunctivitis.

If patients cannot be seen sufficiently often, it will be better to prescribe as an irritant a collyrium of laudanum (equal parts of laudanum and distilled water), or a mixture of spirits of turpentine and oil, or, finally, a very weak red precipitate ointment, consisting of about 1 part in 10 or 15. Such cases in children must be carefully watched on account of the possible supervention of attacks of phlyctenular keratitis. Here an irritant treatment, similar to what has just been described, if continued without the surgeon's knowledge, might lead to serious accidents.

II. Deep Inflammations.

I now come to the subject of *deep inflammations*. Amongst these, *deep infiltration* requires to be first noticed. In this as in the superficial vascular keratitis, which also belongs to the first type of inflammation, we have (*a*) a *circumscribed* and (*b*) a *diffuse* form.

(*a*.) *Deep circumscribed infiltration* may have its seat in the central or peripheral portions of the cornea. It appears as centres which have a peculiar proneness to sclerosis. This may be so strongly marked that, should the centre fall upon the corneal margin, the appearance will be as though the sclerotic had encroached on the transparent membrane. These centres, bluish-grey in colour, are often connected together by a network of lines running superficially and at right angles to one another, an appearance not unlike that of superficial infiltration. Over the centres, the epithelium appears dotted and in places slightly raised.

The essential feature of this affection, as distinguished from what was observed in superficial infiltrations (phlyctenular keratitis), is the total absence of all disposition to run on to abscess or ulceration. With this, it is also marked by extreme indolence. All symptoms such as pain, photophobia, epiphora, are absent. It is only where some complication of the anterior portion of the uveal tract takes place that a dull pain is felt in the forehead. These deep infiltrations, when covered by the upper lid, may often for a length of time escape the patient's notice. What gives them special importance is that, after lasting often a very long time, they are susceptible of complete cure. They leave, however, indelible sclerosed patches. These are very common if the centre has been situated near the corneal margin. This affection is generally met with in persons over forty years of age, of a rheumatic diathesis. Syphilis has been alleged as a possible determining cause, and the affection might then be readily complicated with iritis and centres of episcleritis.

The treatment of these indolent infiltrations, uncomplicated by iritis, will consist in warm fomentations, and injections of hydrochlorate of pilocarpine (4 or 5 drops of a solution of 1 part in 10) daily into the arm, so as to cause active perspiration. At the same time I generally prescribe iodide of potassium (1 part to 50 of water, a tablespoonful of this morning and evening), and a lozenge of lactate of iron at each meal. If there be any complications towards the uveal tract, it will be advisable to instil atropine, and apply compresses of belladonna or jasmine.

About two weeks ago I performed an upward sclerotomy in the case of a woman, whose right cornea was the seat of a deep infiltration occupying the upper and inner quadrant. To-day I present the patient to you; she is nearly cured, and you will perceive that the infiltration has almost completely disappeared. You have at intervals seen in my practice patients affected with old-standing sclerosis of the cornea, the result of circumscribed or diffuse infiltration. In all these cases you may have noticed the great amelioration in vision which followed the clearing of the cornea effected by means of sclerotomy and eserine.

In such old-standing cases, *sclerotomy* would appear to be more efficacious than syndectomy. Besides, it has long been known that an iridectomy, by reducing intraocular pressure and modifying the nutrition of the cornea, possessed the power of clearing portions rendered opaque by sclerosis. It is not surprising, then, that sclerotomy should produce an analogous effect. At the same time it has a certain superiority over excision of a portion of iris, in that it does not leave any traces, and that it does not increase the diffusion of light from which such patients already suffer.

An iridectomy, moreover, should not be made until the affection has completely run its course, in order that the most favourable position for the pupil, from an optical point of view, may be selected. Sclerosis has at times been seen to attack the tissue bordering on the corneal section, when iridectomy has been performed at an early stage of the disease, the optical gain having been thereby completely lost. As a preventive measure, therefore, against sclerosis, iridectomy must not even be thought of. I consider that the same remark applies to keratomy, proposed by *Sœmisch* as a means of combating circumscribed and deep infiltrations. His section, made from behind forwards, and across the diseased tissues, with a narrow-bladed *Græfe's* knife, has the serious disadvantage of leaving a persistent scar.

The various agents used to clear the cornea, and which can only be employed when the disease has completely run its course, are directed, like the insufflations of calomel, the yellow precipitate ointment, and the collyria of laudanum, against permanent sclerosis. In such cases, their action is feeble, and requires to be continued for a long time.

(*b.*) *Deep diffuse infiltration* is known as *interstitial*, or *parenchymatous* keratitis. It does not differ from the form just described, save in its extending over a larger surface, while at the same time it takes so long to run its course, that a portion already affected may have recovered its transparency, while other points are being in turn attacked. Certain changes in the epithelium precede the appearance of the infiltration; the disappearance of these announces that the cornea is about to regain transparency. These alterations are characterised by a spotted and roughened appearance, a most valuable diagnostic sign whereby to distinguish a general haziness of the cornea from that of the aqueous humour, as seen in certain forms of iritis.

As a rule, clearing of the cornea is preceded by very marked vascularity; so marked, indeed, that it might be supposed the fine vessels which are crowded together were merely an extravasation of blood. The more marked this vascularity the more perfect, as a rule, will be the process of clearing. Nevertheless, on this point no illusory hopes must be entertained. The exact methods of exploration now within our reach enable us to assert that a *restitutio ad integrum* in general diffuse keratitis, which has lasted a certain time, is extremely rare, if indeed it ever actually occurs.

Diffuse keratitis is a disease peculiar to childhood and youth, and, in the great majority of cases, is a sign of inherited syphilis. Although the inquiries necessary in order to demonstrate this fact are difficult, it is nevertheless clearly made out by statistics that in the two-thirds of such cases, syphilis is the origin of the affection. Children with this inherited taint are often the subjects of affection of the internal ear (*Menière's* disease), and of an arrest of development, shown chiefly in the middle portion of the incisor teeth, known as *Hutchinson's* teeth.

The question of specific origin is important, inasmuch as iodide of potassium, and, if necessary, mercury, must form the basis of treatment. Along with tonics, such as lactate of iron and quinine, which, when young, weakly patients generally stand in need of, two tablespoonfuls of a solution of iodide of potassium (1 part in 200), or a teaspoonful, morning and evening, of syrup of Gibert,* and, if necessary, mercurial frictions, with $\frac{1}{2}$ or 1 gramme (8 to 15 grains) of the ointment, may be prescribed.

In such deep and wide-spread infiltrations, complications are not unfrequent. They result from inflammations of the anterior portion of the uveal tract, and, though often escaping observation on account of the general haziness of the cornea, are revealed by the pain, which the patient experiences, and which is extremely rare when the affection keeps true to its pathological type. Such complications call for the exhibition of atropine, three times a day, and especially for compresses of camomile or belladonna (see p. 118). Warm aromatic fomentations have the great advantage of hastening vascularity, and clearing of the cornea, while they act beneficially at the same time on the iris.

Warm fomentations, or exposing the eyes to the vapour of warm water, will form the basis of treatment, which must be persisted in a considerable time before any surgical interference be had recourse to. This affection drags slowly on for many months; nor will the most experienced surgeon be in a position to say, with any certainty, whether the means adopted will suffice, or whether surgical methods must be tried. These, it should clearly be understood, are only to be directed against the remnants of the disease. They consist in abrasion of the conjunctiva, in sclerotomy and iridectomy; the choice to be dictated in accordance with the principles I have laid down for the treatment of sclerosis, the result of deep but circumscribed infiltration.

* See note on page 96.

LECTURE XIV.

BULLOUS KERATITIS; BLENNORRHAGIC, PUSTULAR, VARIOLOUS, NEUROPARALYTIC ABSCESSES; ASTHENIC, STHENIC, INFECTANT, OR RODENT ULCERS.

There is a form of deep infiltration of the cornea, characterised by elevation of the epithelium and cement from effusion of a layer of fluid which has received the name of *bullous keratitis*. There is generally a large sacciform vesicule in front of the infiltrated portion of cornea; a point of difference between this affection and herpes of the cornea. In common, however, with herpes, its approach is always the signal for a severe attack of periorbital neuralgia. After the bullæ have disappeared, the infiltrated portion of cornea remains for some time denuded, until again covered with a fresh layer of epithelium. This in turn may be raised up by an accumulation of liquid, which is looked on by *Max Schultze* as lymph, the retention of which has determined the accompanying glaucomatous symptoms.

In practice, the apparition of this peculiar affection not only is a proof of a marked tendency to glaucoma, but is also often the last of a series of glaucomatous phenomena, due to old-standing irido-choroiditis. The paroxysms of pain may be accounted for by the stretching of the numerous nerve filaments distributed to the most superficial layer of the cement. The pain ceases, as soon as the epithelium is renewed, which is effected as a rule within a few days.

Treatment should at first be directed to alleviate pain, and will consist in the removal of the loose envelope of the vesicule. This little operation is performed in the same way as for corneal herpes (p. 120). Immediately after it, a drop of eserine should be instilled, to diminish the excessive intraocular tension which is generally present, and a compress bandage applied. Instillation of eserine (1 to 2 parts in 200) should be continued morning and evening, during several weeks, together with quinine to the amount of 40 or 50 centigrammes (6 to 7 grains) thrice a day.

If after several weeks' trial you are convinced that this treatment is evidently doing no good, there should be no hesitation about performing sclerotomy or iridectomy. Indeed, in cases where bullous keratitis, is so to say tacked on to an irido-choroiditis, medical treatment is mere waste of time. Here a large iridectomy will be the best means of cutting short the disease. Certain cases, however, will from time to time show themselves proof against this antiglaucomatous treatment *par excellence;* in such we are compelled, in order to relieve the excruciating pain, to enucleate the eye, which at any rate, has long been useless for purposes of vision. However, before resorting to this extreme measure, the iridectomy may be repeated, or several sclerotomies performed, or a temporary drainage established by means of a gold thread inserted either at the sclerocorneal junction, or through the sclerotic at the equator of the globe.

2. The second group of deep-seated affections of the cornea comprises *Abscesses.* These may be divided, according to the causes which have produced them, into three series, as follows: (*a*) deep abscesses, developed in the course of severe conjunctival affections, such as purulent ophthalmia; (*b*) abscesses arising directly from inflammation of the conjunctival covering of the cornea, consecutive on phlyctenular eruptions and corneal pustules; (*c*) abscesses directly caused by some disturbance in the innervation of the cornea, which arises from a general condition of body, or from some lesion to the branches of the fifth pair distributed to the eye.

(*a.*) A *blennorrhagic* abscess may be either marginal or central. If it make its appearance on the corneal margin, it will first be seen in the form of a greyish halo, and the epithelium covering it will be elevated and as it were dotted over. The affected portion quickly assumes a yellow tint, sheds its epithelium, and becomes an ulcer, with a strong tendency to destroy a large extent of the cornea. The commencement of a central abscess, in the course of an attack of purulent ophthalmia, is signalised by the opaline tint, which spreads over almost the whole surface, and by the peculiar raised and spotted appearance of the epithelium. The destruction of the most peripheral portion of the cornea may be somewhat slower, but once the process has commenced, the eye is very soon laid open by a huge perforation.

I need not recur to the complications of purulent ophthalmia:

I may, however, remind you that they are destructive in proportion as they appear at an early stage, or otherwise, of the disease, that is to say at the period when it is least within our power to protect ulcers, the result of these abscesses, from the immigration of conjunctival pus.

Every effort should therefore be made to preserve as far as possible, these raw surfaces from contact with pus. Incessant attention must be paid to cleanliness. By incising freely the external commissure, retention of pus within the culs-de-sac by the swollen lids, which cling closely to the globe, will be prevented. Lastly, by disinfectants, the septic action and migratory power of the purulent elements will, as far as possible, be neutralised.

Surgical intervention is quite inadmissible so long as the corneal epithelium is intact. But if ulceration supervene, recourse should be had to sclerotomy, the most potent means of repair we possess. I much prefer it to keratomy, which conduces to strangulation of the iris between the edges of the incision.

Immediately the slightest tendency towards a blennorrhagic abscess has been perceived, instillations of eserine, three times a day, should be commenced. This agent not only checks diapedesis by stimulating the nonstriated muscular fibres, and thereby causing contraction of the vessels, and thus stopping the migration of cells into the tissue of the cornea, but also by reducing the purulent discharge from the conjunctiva with the same result, when loss of epithelium or ulceration have actually taken place.

I have lately had an opportunity of satisfying myself of the salutary power of eserine, in the case of a midwife, sent to me by a fellow specialist, who considered her case as absolutely hopeless. This poor woman had been inoculated by a patient suffering from blennorrhagia, and the result had been a double purulent ophthalmia. Both corneæ presented large abscesses, which had already become ulcers, and had perforated in their lower portions. I substituted for the atropine, which up to this moment had been used, frequent applications of eserine collyria. It was from her daughter, also a midwife, that I learned how complete the transformation was which was effected in the conjunctival discharge. There is a feature in the case to which I will return further on, and which is very important, namely, that in spite of large perforations, healing took place with the formation of flat cicatrices, enabling me eventually to make artificial pupils, and restore a very satisfactory amount of vision.

In the use of eserine, a step in advance has been made in ocular therapeutics. I do not exaggerate when I say that, thanks to our now being able to substitute it for atropine, we are able to save eyes, which formerly would have recovered, if at all, only with a more or less considerable staphyloma, a condition which would have left scarcely any hope of a restoration of vision.

Furthermore, the powerful aid rendered by eserine, should encourage every careful practitioner not to resort too readily to surgical interference in abscesses of the cornea. It should always be borne in mind that, owing to the purulent condition of the conjunctiva, all wounds are only so many new routes opened to cell migration. This is why I am no advocate for making, as in keratomy, large incisions, which come together imperfectly.

(*b.*) The *pustular abscess*, already described along with phlyctenular conjunctivitis,* is observed chiefly when, together with pustules, the conjunctiva is also the seat of more or less purulent discharge. Immediately the epithelium has been shed, that is, after the pustule has ulcerated, conditions favouring the immigration of pus have actually been established. In such a case there is formed, so to say, a deep seated abscess, tacked on to an ulcerated pustule. The abscess, in its turn becoming an ulcer, rapidly leads to perforation, all the more dangerous, inasmuch as the simultaneous presence of numerous pustules threatens to stretch and bulge the cornea, by the prolapse of the iris, which takes place at the various points of perforation. The detachment of actual portions of cornea may thus occur, and result in the complete destruction of the inflamed eye.

The strictly rational treatment of multiple pustules is greatly impeded by the purulent inflammation of the conjunctiva, which generally accompanies them, and thus, removal of herniæ of the iris, and compression by bandages, is rendered almost impossible; for should the lids be kept closed, pus will be retained in contact with the eye. It will be well in such cases to confine oneself to the methodical employment of eserine, and to combat the inflammation by the frequent use of warm carbolised water, so as to keep the ulcerated surfaces always clean.

It is only when the discharge from the conjunctiva becomes actually purulent, that recourse should be had to daily cauterisation with a solution of nitrate of silver (1 in 50). An excess of caustic is to be carefully neutralised, and in children, who at

* Page 72.

the moment of cauterisation become unruly, each lid should be touched singly, in order that the cornea may be protected with the other. Care must also be taken not to exercise the slightest pressure upon the eye during the application. When the disease has been once subdued in children, it must still be carefully watched, and this for two reasons. First of all, in order by careful hygiene to prevent a relapse, which in this malady is very common. Secondly, not to allow of a glaucomatous condition coming on unperceived. This may easily be the case, in spite even of the use of eserine, when owing to symmetrical perforations, the iris has been dragged towards the cornea, and has become largely adherent in the direction of its ciliary insertion.

(*c.*) Among abscesses developed as the result of general disease, and arising from more or less local lesions of the fifth pair, I must pause for an instant over the *variolous abscess,* which before the grand discovery of *Jenner,* used to do so much to populate asylums for the blind. Under the exhausting influence of the variolous poison, a deep infiltration of the cornea is produced, which quickly changes into an abscess. As it is not generally before the period of defervescence that the corneal abscess shows itself in debilitated subjects, the older writers did not hesitate to see in its existence the effect of a metastasis. Nevertheless, it often happens that the corneal abscess appears simultaneously with the cutaneous eruption, and, consequently, in many cases the name "post variolous" is not justifiable (*Hirschberg*).

I must here remark that the most experienced clinical observers, men who have witnessed numerous epidemics of small-pox, have met with comparatively few variolous abscesses. For my part the cases I have seen, have given me the impression not of the true eruption of variola, but rather of a neuroparalytic keratitis, with marked tendency to sloughing of the cornea. At any rate this abscess only appears in bad cases of variola, and chiefly in those where the tendency to metastasis, and large purulent collections is well marked (*Adler*).

The treatment of variolous abscess will probably be satisfactory in proportion as the affection has appeared coincidently with the period of defervescence, and in proportion as scrupulous cleanliness by disinfectants has been insisted on. Frequent instillations of eserine should be made from the first, and if there be any rapid spread of the disease, large paracenteses or still better a sclerotomy, with a narrow sclerotome of two millimetres in breadth should be practised. If consulted at the stage of ulceration, warm fomentations may be ordered and the compress bandage, so far as the precautions necessary as regards cleanliness will allow. Large doses of quinine, 40 to 50 centigrammes two or three times a day, will be indicated by the patient's general condition, and with the view of checking suppuration of the cornea. No attempt should ever be made to gain this latter result, by any so-called abortive cauterisations with nitrate of silver. The only effect such can have will be to hasten ulceration, and necrosis of the cornea.

Certain indolent abscesses developed as a consequence of paralysis of the fifth pair, have received the name of *neuroparalytic*. They are usually formed with great rapidity, and quickly lead to actual exfoliation of the corneal tissue, and to dry gangrene, without any symptoms of inflammation, such as accompanies the other forms of suppurative keratitis. It appears certain that mere deficient innervation producing insensibility of the cornea, is not alone sufficient to account for neuroparalytic keratitis. This is developed rather under the influence of traumatic causes, to which the patient is exposed unknown to himself. In very many cases it is probable that the advent of the abscess could be retarded, by carefully protecting the cornea from all sources of injury. Nevertheless there are some carefully recorded cases which show that a very partial lowering of the sensibility of the cornea, may, when there is merely incomplete paralysis of the fifth pair, be the point of departure of an abscess, and in which the most scrupulous protection of the cornea will not prevent the development of neuroparalytic keratitis.

We are driven, then, to suppose that it is chiefly when some particular portion of the nerve (namely, the root of its third division, which is, according to *Merkel*, in the grey matter of the aqueduct), is the seat of some lesion, that this keratitis breaks out. If, however, the remaining portions of the nerve be the only parts attacked, these nutritive disturbances will not appear, save in cases where the cornea is exposed to direct and often-repeated mechanical irritations. Hence it must be concluded that anæsthesia of the cornea facilitates the development of keratitis, without of necessity inducing it; and that in cases of total paralysis of the nerve, the most careful protection exercised over the cornea will not be sufficient to prevent it from suppurating, because it is the portion of the nerve which presides over nutrition that is impaired.

Treatment should always be directed to protect the eye as far as possible from external irritation. The compress bandage is therefore strongly indicated. In order to stimulate nutrition, when the trophic portion of the nerve is affected, and such must always be supposed to be the case in a paralysis which extends to all the branches of the trifacial, there should be no delay in having recourse to continuous currents of six or eight cells. The positive pole to be placed on the cervical region, over the point corresponding to the superior cervical ganglion of the sympathetic, and the negative over the eyelids, or in the immediate vicinity of the affected eye. Instillations of eserine should be made in order to check diapedesis, while infection of the cornea must, as far as possible, be hindered by repeated applications of weak solutions of warm carbolic or salicylic acid, of a strength of 1 part in 1000. In order to wash the eye, the bandage must be very frequently removed, but for it there may be substituted a stenopaic eye-cup (*Snellen*), or railway spectacles coated with varnish on the sides. With children I am at times obliged to close the eyes by bringing the folds of the eyelids together with one or two silver sutures. For the matter of that, however, this encephalic keratitis appearing in infants is a septic keratitis due to the infiltration of bacteria into a cornea already insensible ; it cannot be cured, and, generally speaking, precedes by but a few hours, a fatal issue.

3. The third type of deep keratitis is the *ulcer*. Of this there are three varieties ; namely (*a*) the *asthenic*, or non-inflammatory ; (*b*) the *sthenic*, or inflammatory ; (*c*) the *infecting* or *rodent*.

(*a*.) The asthenic ulcer appears all at once, generally in the central portions of the cornea, and that so rapidly as to recal the superficial non-vascular ulcer, or ulcer by absorption. It would scarcely be correct to say that a halo surrounds its edges, which are jagged, and trench upon the healthy portions of the cornea. Their outline, though irregular, is more or less circular. The depth of these ulcers is easily concealed by the projection forwards of their thin base, which as it bulges outwards gives rise to a keratocele. The ulcer may remain for weeks or months stationary in this condition. Vascularity may then appear towards the corneal edges, the margins may become rounded off, and the loss of substance be made up ; but as in the ulcer by absorption, repair is more or less incomplete, and a facet remains to show the spot the ulcer once occupied.

This ulcer is distinguished from the ulcer by absorption, by the fact that it has a much greater tendency to perforation than this latter. Moreover, it does not, as a rule, attack children, but rather adults who bear the scars of former attacks of phlyctenular keratitis. It is also worthy of note that this deep ulcer is often found symmetrically on both eyes; so often, in fact, that it may be a question whether it is not in some way connected with deficient innervation.

The treatment pursued here must have a double object in view: to hasten repair, and to protect, during the stationary period, the eye from sudden perforation. Besides warm fomentations and the compress bandage at night, an attempt to stimulate nutrition may be made by reducing for a time the normal tension, which has now become excessive, in view of the thinning that has taken place in the floor of the ulcer. With this object, night and morning eserine should be dropped in, and paracentesis or, if necessary, sclerotomy, performed. If by such means the stage of repair has been hastened, a further attempt may be made to stimulate it by irritants, such as insufflation of calomel, yellow precipitate ointment, and collyria of laudanum, a careful watch being meanwhile kept for any sudden return to a state of activity.

(*b.*) The sthenic form of ulcer is distinguished, not by symptoms of irritation, such as pain, photophobia, and watering of the eye, but rather by the general appearance of the ulcer, of its base and edges, which tells of inflammation, and infiltration of leucocytes. The inflammation is not confined solely to the ulcer, but spreads readily to the surrounding parts, determining phenomena of irritation about the iris, with synechiæ and irruption of pus into the anterior chamber. Such a striking difference in appearance and anatomical characters, by no means hinders the sthenic ulcer from presenting, as regards the sufferings of the patient, the same indolence as the preceding variety. This will appear all the more remarkable if the ulcer is not merely in its earlier stage, but has actually seriously compromised the cornea, and is advancing towards its usual goal, namely, perforation.

This affection generally owes its existence to traumatic causes. But it also readily attacks corneæ already marked by old scars, giving rise to the form of keratitis known as *cicatricial*. This is very often the form which causes perforation in eyes attacked by incomplete granular pannus, the ulcer invading the vascular portion of the cornea. Fortunately such perforations do not take place on a large scale, because the adjoining vascular portions guarantee the cornea from any very great destruction. An adherent leucoma, generally of small size, is the final result of the affection.

The foundation of all treatments of such forms of ulceration is —rest. It may be ensured, where the conjunctival secretion is not excessive, by a compress bandage, instillation of eserine, and paracentesis. Warm fomentations can only be employed in so far as they do not increase secretion from the conjunctiva. All purulent discharge facilitates cell migration, and the empirical dictum of *M. Castorani*, uttered some fifteen years ago, to the effect that losses of corneal substance are likely to heal by formation of transparent tissue, in direct proportion as the conjunctival secretion is slight, during the period of cicatrisation, has been amply confirmed by subsequent scientific observation.

If, under the influence of eserine, we see vast ulcerations repaired by tissue which is but slightly opaque, it is because this myotic possesses a power of combating diapedesis, and of lessening the chances of cell migration, by lessening the discharge from the conjunctiva. Careful cleansing of the eye with carbolised water must be put in practice with the object of preventing, as far as possible, the contact of the discharge with the surface of the ulcer. Every means that can stimulate secretion from the conjunctiva, and heat especially possesses this power, should be carefully avoided. If necessary, cauterisations with nitrate of silver solution (1 in 50) must be had recourse to, in order to repress any undue conjunctivitis.

If a sthenic ulcer has ended in perforation, and if, owing to the bending back of portions of Decemet's membrane, fistulæ and flattening of the cornea have resulted, no time should be wasted in medical treatment. In such cases, the fistula must be attacked directly, by removing, with fine forceps, the interposed portions of Decemet's membrane, or by incising them in various directions with scissor forceps, one of the blades of which should be introduced through the fistula. Crucial incisions with the same forceps, although difficult and delicate on account of the presence of the capsule of the lens, which lies over against the fistula, appear to me to afford the most rational treatment for a very obstinate affection.

(*c.*) The third variety, namely, the *infecting* or *rodent ulcer*, is distinguished by its stubbornness and intractability. These, in the end, inevitably lead to perforation and destruction of a large portion of cornea. In the two preceding varieties, though perforation was always a potential result, it was not an inevitable one; while spontaneous repair and cicatrisation were very far from uncommon. The progressive course of the ulcer, which justly entitles it to the name of *rodent*, is by infection. This commences from the edge, and eats into the cornea, spreading in one direction. The name of *infecting* ulcer is also amply justified, because this form of ulcer is undoubtedly engendered by infection, resulting from contact with matter that is either putrid or undergoing fermentation. It may be produced experimentally in animals by introducing such substances into wounds made in their corneæ.

It is very necessary to be able to recognise at once the malignant character of this disease, which has, at its commencement, few symptoms that are calculated to raise alarms. The ulcer is often developed towards the centre of the cornea, it gives rise to slight loss of substance, it is oblong in shape, its fundus somewhat grey, while its edges, principally on the inner or outer side, are raised, and mottled or streaked with white. It is towards this raised border, which generally faces the centre of the cornea, that the ulcer gains ground in proportion as the white striæ, which give it its mottled appearance, spread to the sound tissues.

Is there any means by which the infectant character of the ulcer may be diagnosed at this period? Yes! by a careful examination of the aqueous humour, by the aid of oblique illumination. There is always present a deposit on the membrane of Decemet, coating it with a sort of mud over a considerable portion, while a small quantity of pus may often be seen collected in the most dependent part of the anterior chamber. In proportion as the ulcer spreads deeper and wider, the hypopion becomes more and more marked, and the deposit forms a patch on the posterior surface of the cornea, so as to convey an impression that the fundus of the ulcer was coloured yellow, and consisted of suppurating corneal tissue. The rapidity with which this ulcer spreads is such, that in the interval between two visits, that is, within two or three days, almost the whole cornea may have been eaten away.

LECTURE XV.

INFECTING OR RODENT ULCER (*continued*); LEUCOMA OF THE CORNEA; GLAUCOMATOUS OPACITIES; SCLEROSIS OF THE CORNEA.

The rodent ulcer, so progressive in its course, always spreads from its border which is raised and white. This finally, when the ulcer has increased to a certain size, forms as it were a frame round it. In this way the cornea is destroyed, until only a narrow strip is left bordering its sclerotic attachment. If at this moment a very large perforation takes place, permitting the escape of all the dense mass occupying the membrane of Descemet, the ulcer may enter upon a period of repair. More usually, however, many small openings become formed in the thin portion of the ulcer, and being choked up prevent any thorough removal of the septic and putrid masses. Thus the healing process is very slowly carried on, and that by the formation of a large staphyloma. The rodent ulcer, when it first commences, is generally extremely painful. Patients will often present themselves saying, they have not closed an eye for five or six days. But they will sleep well the night after artificial perforation has been performed. Spontaneous perforation is also, as a rule, the signal for more or less relief.

The rodent ulcer, being generated by infection, is found with a frequency proportionable to the want of care, which allows the sojourn of decomposed matter in the conjunctival sac. Thus the poorer classes, during the summer heats, are more than others exposed to this dangerous affection. Excoriations of the cornea, readily produced by certain sorts of labour, such as those of harvest time, open a door of entrance for any decomposed products, such as may be accumulated on the edges of the lids by a slight blepharitis.

When this disease appears among the wealthier classes, the septic matter is generally the outcome of an inflamed lachrymal sac, the secretion of which has been retained, and has decomposed. It is well known that the products of dacryocystytis are often rich in fungi. Among others, the leptothrix, which makes it possible to produce this ulcer artificially in animals.

The rodent ulcer nearly always makes its appearance in persons past forty. I cannot recall having ever treated any patient under thirty for this affection. There is another phenomenon worthy of remark; namely, that whilst in the other forms of ulcer already described, there is more or less tendency to relapses under the form of cicatricial keratitis, here the ulcer, when it attacks an eye for the second time, always respects a cicatrix, and destroys only transparent portions.

In the treatment of this affection, once so formidable, ocular therapeutics may now boast of one of its most brilliant triumphs. Formerly, treatment was limited to warm compresses and atropine, together with antiphlogistics; but in spite of all this the disease kept extending, and pus in increasing quantities occupied the anterior chamber. In despair men resorted to iridectomy, and sometimes succeeded in checking the spread of the evil, whilst in many cases the remainder of the cornea was destroyed. This operation, indeed, at times became the starting point of panophthalmitis. Paracenteses were also tried, but so dense were the deposits which filled the anterior chambers, that they could not escape in this way any more than the aqueous humour, so that no relief was obtained.

It was at this period that *M. Sæmisch* advised slitting up the ulcer boldly from behind forwards, so as to establish a large opening. This he thought might afford free exit to the pus in the anterior chamber, and keep the edges of the ulcer clean by the constant escape of the aqueous humour. Simultaneously, considerable relief to the eye would follow the incision.

The keratomy should always be performed in such a way that the swollen whitish edge of the ulcer shall be divided into two portions of equal depth. Having placed the speculum in position, a puncture with a narrow Graefe's knife is to be made near the external border of the ulcer; then the knife is to be passed gently into the anterior chamber under the thin floor of the ulcer, a counter-puncture made, and the inner border divided. It will be perceived that the keratome, having its back directed towards the capsule of the lens, must, to enter the anterior chamber, make a greater or less circuit. If, then, the ulcer be small, and less than the space the keratome must travel over to arrive in the anterior chamber, puncture and counter-puncture must necessarily fall outside the limits of the ulceration, or, in other words, be made in sound tissue. Such, in fact, is what we must often resign ourselves to, for keratomy has precisely its greatest power when directed against rodent ulcers of small extent. I have it from *M. Sœmisch* himself that it loses all its certainty of action when it has to equal, or *à fortiori* to exceed, the length of a radius of the cornea.

According to the precepts of the eminent Bonn professor, the section should be kept open for several days by passing a probe into it. By lightly pressing on the external angle of the wound, it may be readily opened and the aqueous humour allowed to flow off. This should be continued until all tendency to spread on the part of the disease has been definitely checked. Sometimes five or six days may be required for the tumid edges to sink back and become clean. These reiterated touchings of the ulcer, especially when the section has been made through tissues excessively thin, are not free from difficulties, and may lead to the base of the ulcer being torn, or the resulting cicatrix being made more marked. So soon, therefore, as I saw the very favourable action that eserine had on suppuration of the cornea, a fact to which Professor *Simi* had, as early as 1873, unknown to me, called attention, I straightway gave up reopening the ulcer after keratomy, and substituted for it very frequent instillations of eserine. This practice has the advantage of not obliging one at short intervals to meddle with an eye that has been operated on, while it also yields with greater certainty better cicatrices.

I quite allow that in the end the operation, whether section has been made across the ulceration or at a tangent to its edges, will show as a mere white line; but, inasmuch as the rodent ulcer is generally situated in front of the pupil, such a cicatrix is none the less disturbing to vision. Another and much more serious objection to keratomy is that in cases where the length of the incision approaches that of a radius of the cornea, the iris, even if it does not prolapse, will become adherent to the edges of the wound, which will hold it fast and cause traction. The result will be a condition favouring glaucomatous distension of the cicatrix, especially if we remember how freely atropine was at one time used.

I have of late had recourse, in cases of rodent ulcer, to sclerotomy. The advantage I gain thereby is that of incising the eye quite as freely without facilitating to the same extent the exit of the pus and the dense matter lying in the anterior chamber. This escape of pus does not appear to be particularly important. Many serious cases have healed just as readily as if keratomy had been resorted to, and that without the result of any adherent leucoma.

The question of the choice of an operation in rodent ulcers can only be settled by numerous trials. For my part, whilst giving to keratomy its just due as a method proper for small ulcers, I would gladly see it replaced by sclerotomy whenever the extent of the ulcer calls for an incision at all equal in length to the radius of the cornea. A similar feeling as regards the advisability of abandoning keratomy in very extensive ulcerations, has been already ventilated by *M. Horner*, who proposes to replace it by iridectomy.*

What cannot be questioned is the fact that surgical means whether paracentesis, keratomy, sclerotomy, or iridectomy, must always constitute the main treatment. But if the practitioner has not had much practice in such operations, and cannot call to his aid more special advice, he should at any rate endeavour to combat, as much as possible, the spread of infection in the corneal tissues. As such ulcerations are very often determined by affections of the lachrymal passages, every effort should be made, by opening the sac freely through the superior punctum, and incising the internal palpebral ligament, and subsequently by using hollow sounds carrying astringent injections, to hinder stagnation and decomposition of the secretions. The sac, besides being injected, should be squeezed, at intervals, and the eye washed with warm carbolised water.

The direct application to the ulcer of chlorinated water, or a solution of salicylic acid (page 7) repeated several times a day, will beyond doubt exercise a salutary effect, and hasten the stage of repair. This is more especially the case, if the conjunctival secretion be slight enough to allow of the free use of warm aromatic or carbolised compresses (1 part in 200). Instillations of eserine must be made three times a day. If the myotic acts well, it is a sign that the disease is about to enter the phase of repair. The above treatment offers a good chance of success at the commencement, and should be tried before the knife is taken in hand for either keratomy or sclerotomy.

If in the hope of escaping the necessity of using cutting instru-

* See Thèse de M. Bowkowa.

ments, you attempt to destroy the infectious principle in the ulcer itself, be it by vigorous cauterisations with nitrate of silver, or a red-hot probe (*Martinach, Gayet*), these—whereof I do not deny the efficiency—will assuredly leave more marked traces than keratomy. Let me say, too, that this latter is not more painful to the patient than cauterisations.

If consulted when perforation has already followed a widespread destruction of the cornea, it will be advisable to limit treatment to frequent cleansing with disinfectants, and to the systematic use of eserine, in the hope of eventually, when the cicatrix is sufficiently consolidated, making an artificial pupil; that is, should there be sufficient cornea left to permit of any sight whatever.

As these serpiginous or infecting ulcers readily appear in debilitated subjects, tonics, and especially quinine are as an invariable rule, required. Every drug that can have any weakening influence must be carefully eschewed.

Having passed in review the various affections of the cornea, such as we see them in clinical practice, it is now time to turn to the departures from health which follow from the various varieties of keratitis. Among such the first place must be given to spots, or *leucomata*, the greater number of which are merely cicatricial tissue in parts which have been destroyed by inflammation. But there are also opacities which depend on disturbances of nutrition, due to hyper-pressure, either affecting the tissue as a whole or in part. A distinction must therefore be drawn between (*a*), cicatrices of the cornea; (*b*), glaucomatous opacities; and (*c*), sclerosis.

(*a*.) The name spots, or *leucomata* of the cornea, is applied to all opacities the result of cicatrices following loss of substance either from abscess or ulceration. We avoid having to state the degree of opacity of any cicatrix by using the terms nubecula, macula, or albugo. To the expression *leucoma* the word *adhærens* is added whenever the iris has been included in the process of cicatrisation. It is the more reasonable to use the term *leucoma* in a broad sense, because the thickness, and even to a certain degree the extent of this spot, stand in no fixed relation to the disturbance of vision. Thus very slight central spots give rise to considerable diffusion of light, and cause much greater disturbance than large and dense, but peripheral leucomata, that is, than those which encroach but little on the field of the pupil, and especially do not alter the normal curvature of the cornea.

A cicatrix, or leucoma of the cornea, may be mistaken by an inexperienced observer for some recent inflammatory attack, more especially if the inflammatory symptoms should appear in an eye where cicatrices already exist, or where a fresh attack of phlyctenular keratitis has come on. Generally speaking, cicatrices have, as compared with infiltrations, with which they are most likely to be confused, a more uniform tint, are less diffused, and reflect light better. The cicatrix is more circumscribed, more clearly marked, and has a smooth, shining surface of epithelium. Pericorneal injection is wanting to the cicatrix, whilst even in the most indolent infiltrations by closing the eyes for only a few moments the injection can be made to appear. If, in a cornea affected with leucoma, a fresh crop of phlyctenulæ should spring up, the injection may be observed to concentrate itself near the centres of infiltration, while the cicatrices remain unchanged.

In doubtful cases a cicatrix will be seen by oblique illumination, or with a plain mirror to be surrounded by a semi-opaque zone, which merges *insensibly* in the healthy tissue. A point worth noticing is, that with this feeble translucent illumination the edge of an inflammatory infiltration is marked off from the healthy parts much more sharply than direct inspection with daylight would lead one to suppose.

Vascularity of the opaque portion is no argument in favour of the existence of a cicatrix, or of a recent centre of inflammation, for infiltrations, as well as old cicatrices, at times present considerable vascularity.

(*b.*) *Glaucomatous opacities* generally show themselves like a transverse central stripe, occupying an amount of cornea corresponding to the portion left uncovered by the eyelids. These opacities are readily developed in eyes that have been attacked by irido-choroiditis, and have become glaucomatous. But apart from such, the opacity may be but the prelude to a whole series of inflammatory symptoms in connection with the uveal tract, which end finally in glaucoma.

These opacities first show themselves on the side of the cornea, in the portion which the lids do not cover, and when, later on, a central opacity is joined to those on the corneal margins, the line becomes complete. They spread downwards to the inferior portions of the cornea, and finally occupy its entire lower half. They are never very intensely marked, but have a well-defined "ground-glass" look, together with a gray, or grayish brown, tint. The epithelium is irregular and mottled, but this irregularity may be absent on some small circular patches. Hence a singular appearance results, as though a foreign body, such as a fragment of iron, were embedded in the cornea.

This affection is rare, and is met with exclusively in patients of a certain age. It may remain confined to one eye for years, before it appears in the other, or is accompanied by symptoms of chronic irido-choroiditis. These symptoms show the affinity they have with the glaucomatous changes, and gradually pave the way for them, by uniting the periphery of the iris to the structures bordering the canal of Fontana.

(*c.*) *Sclerosis* of the cornea is the third form of opacity which I shall mention. It has been already spoken of, as one of the results of infiltration of the cornea. It is more especially the spots consequent on sclerosis, which can be diagnosed from infiltration, often only with considerable difficulty, for they may, like infiltration, have a blue or almost white tint, a very ill-defined margin, and mottled or reticulated appearance, recalling that of the injection seen in the lymphatic spaces. In such cases, I confess it is hardly possible in a case of corneal infiltration partly cured, to say what share in the production of the opacity the infiltration has, and what those more or less permanent changes recognised under the term sclerosis.

This sclerosis is produced more particularly in cases where the lymphatic channels of the cornea have been for some time blocked up. Such an obstruction may, as in the various forms of keratitis, be determined by the accumulation of migratory cells, or from closure of the eliminative lymph-canals near the angle of the iris, as is observed at times in certain inflammatory processes in this region, as episcleritis, and especially irido-choroiditis. It must be borne in mind, too, that mere disarrangement of the anatomical elements of the cornea, may be followed by loss of transparency. Therefore, any great dilatation of the canaliculi and lymphatic lacunæ, must, if continuous, result in pressure on the corneal cement, which will deprive the cornea of its transparency to an extent, such as to give it the appearance of sclerotic tissue. It is, then, by no means necessary that the lymphatic channels remain blocked with infiltrated cells, in order to occasion the sclerosis observed after certain forms of diffuse keratitis.

If the dilatation of the lymphatics is owing to some temporary cause, and if the compression exercised on the corneal canaliculi has not been unduly great, all may yet go well; and we shall then be witnesses of a *passing sclerosis*, such as is seen at times in cases of sudden and temporary exophthalmos. It is clear that the longer the obstruction to the lymphatic circulation or the dilatation of the corneal lymph spaces continues, the more likely will the sclerosis become permanent. This sclerosis more especially results in cases of episcleritis or of anterior sclero-choroiditis, obliterating the spaces which bound the trabecular tissue between the cornea and the sclerotic. In many cases it eventually becomes impossible to say where the sclerotic begins and the sclerosed cornea ends.

The treatment of corneal opacities must of course vary according to their character. Following the outline I have given of the different varieties of opacities, any treatment must have, as its main object, to re-establish that primitive disposition of the anatomical elements, from the harmony of which perfect transparency of the cornea once resulted. So far as cicatricial opacities are concerned, no such result can ever be completely realised. We may, however, render them less impervious to light, in the first place, by eliminating a certain number of cells, the overcrowding of which has produced the sclerosis of the neighbouring parts; in the second, by aiding the development of the cells, which compensate former tissue losses, so that they may be similar to those which line the lymphatic spaces of the cornea under normal circumstances.

Glaucomatous opacities may be altered and ameliorated by antiglaucomatous treatment; but only on condition that the opacity has not long existed. In a word, we shall be able to act to advantage upon the sclerosis, if either we assist in clearing the lymphatic spaces of the cells which cumber them, or if we dilate these same spaces, and so facilitate the normal circulation of nutrition in the cornea.

I would then recommend, (1) for cicatricial opacities, various mitigating agents; (2) for glaucomatous opacities, antiglaucomatous operations; (3) for sclerosis the same operations, with the special addition of abrasion of the conjunctiva. I must here remind you that no one, even after most careful examination, can pretend to tell exactly, in a given case of loss of transparency, how much of it is due to any one of the various causes just pointed out. There is therefore nothing very surprising in the fact of a method, designed more especially to combat opacities due to sclerosis, producing clearing in a cicatrix, or of a pupil made for optical purposes reducing considerably what was thought to be nothing else than a cicatricial scar. The portions of cornea rendered more clear in cases like the above were at the time the seat of a glaucomatous opacity grafted upon a cicatrix.

1. Any methods by which it may be proposed to improve the transparency of cicatricial scars should not be practised till the inflammatory process which induced the cicatrix has run its course. If this caution be neglected, an abscess or an ulcer will follow the application of the strong local irritants introduced between the lids, in order to produce a transient but very active congestion of the eye. The powers of such agents must not be overrated. They soon become reduced, especially in the cases of old and dense cicatrices, which it is generally hopeless to attempt to remove.

Among the agents which possess a clearing power, the first place should be given to a daily instillation of a drop of laudanum, either pure or diluted, with an equal amount of water, insufflation of sublimed calomel, yellow precipitate ointment (p. 75), and the various essential oils, in particular that of turpentine, either pure or mixed, in equal proportions, with olive oil. Of late, attempts have been made to introduce under the conjunctiva certain medicaments, with the object of hastening resolution of corneal cicatrices, such as solutions of chloride of sodium, injected by means of a Pravaz syringe, hydrochloric acid, largely diluted, chloroform, etc. (*Rothmund*). Such treatment can prove efficacious only if the cicatrix includes some spots of infiltration or sclerosis capable of cure. In my opinion it is not wise to push such attempts too far, nor to prolong the use of irritating and painful methods, so soon as it has become clear that they are no longer capable of producing any further changes.

Abrasions of the cornea, at one time practised with the object of producing fresh cicatrisations under more favourable conditions, are now quite abandoned. They have no logical position, except in cases where an actual deposit has taken place within the cicatrix, assuming the form of a metallic or calcareous crust. I have occasionally removed from patients who had long been treated by means of metallic collyria, actual shells, beneath which the corneal tissue was much more transparent than the aspect of the eye would at first have led one to suppose. These metallic or calcareous crusts may be raised with a narrow-bladed cataract knife, and removed with the greatest ease. When it becomes necessary, in order to detach them, to penetrate the cornea with the knife, the conditions become wholly altered, and, as a rule, the patient will receive no benefit.

When the cornea is occupied in its totality by a cicatrix—when an adherent non-staphylomatous leucoma exists,—when, after complete ulceration of the cornea, the lens has escaped from the globe, and when no glaucomatous complications have weakened the functions of the eye—then, in all such cases, if the same lesions be present in both eyes (as is frequently observed consequent on purulent ophthalmia), there can be no doubt that every effort should be made to restore to such unfortunate persons a part, however small, of the vision they have lost.

In such cases I have, following *M. Gradenigo*, endeavoured to thin the cicatricial tissue by successive trephining, until the effect of a fistulous opening had almost been produced. In this way I have been able to restore enough sight in some cases to enable fingers to be counted at the distance of one or two metres. Of late these simple trephinings have been modified by replacing the lost substance by portions of human or animal cornea (*Power, de Hippel, Dürr*). These grafts attach themselves perfectly well, and it has been actually proved that the transparency of the transplanted cornea, though impaired at the beginning, will after a time return sufficiently to allow of a certain amount of vision. The most favourable conditions for the success of these grafts are the following: 1. To use a spring trephine, similar to the one I have had made (fig. 6), which allows of a round portion of cicatrix being removed at once; 2. To thoroughly clean the edges of the opening made by the instrument, so that no portion of iris shall be interposed. This condition can only be fulfilled if the patient keep absolutely still (under anæsthetics). The vitreous humour should present directly in the wound, and the crystalline be removed, if it has not already made its escape; 3. To graft a flap of cornea removed at the same moment from an eye which has just been enucleated, on account, say, of some wound threatening sympathetic ophthalmia. We have no right in these cases to refuse any the slightest aid to sufferers who have but this one remaining chacne of recovering any little sight; neither should we be

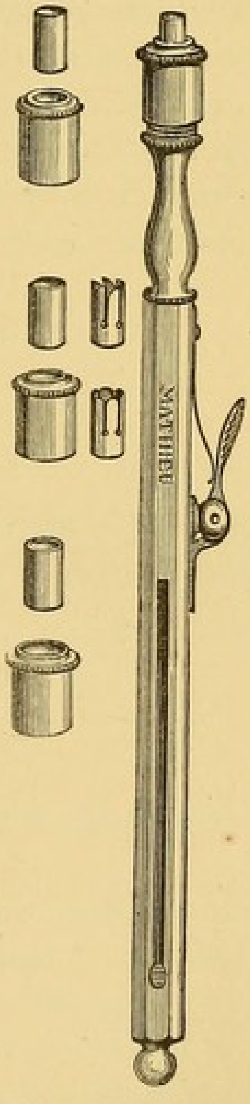

Fig. 6.

deterred by the reproach of eccentricity which will most certainly be levelled at anyone who shall attempt to graft a cornea.

If a leucoma is either diffuse and confined to one eye, or limited and opaque, recourse may be had with advantage to tattooing, which in addition to a cosmetical has also an optical and antiphlogistic action.

LECTURE XVI.

TREATMENT OF OPACITIES OF THE CORNEA (*continued*); STAPHYLOMATA; CONICAL CORNEA.

THE first attempts in the direction of altering the colour of corneal opacities were made in this clinique in the year 1869. At first I used a common cataract needle, dipped in Indian ink, and made numerous small punctures very close to one another in the cicatricial tissue. After having for some time tried a hollow tattooing needle, I finally adopted the method of *M. Tailor*. This consists in smearing the leucoma over with a thick coating of Indian ink, and pricking it very freely by means of a sheaf of needles fastened in a handle (fig. 7); with a small spatula

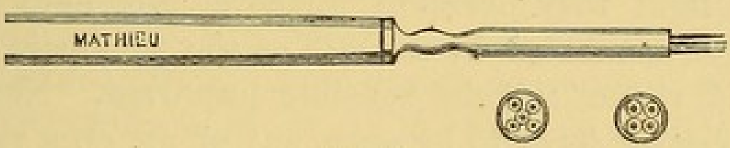

Fig. 7.

(fig. 8), friction is applied, and the colouring matter forced into the minute punctures. In order that this may not be

Fig. 8.

immediately swept clean by the eyelids, a speculum should be left in the eye for five or ten minutes.

You will have numerous opportunities, from time to time, of convincing yourselves that owing to this modification in the method of tattooing, a leucoma can now, in one or two sittings, be transformed from a pearly white into a black spot, imitating a pupil so accurately, that at a short distance, you would never imagine tattooing had been performed.

This operation known to the ancient Greeks, as *M. Anag-*

nostakis has shown, has since 1869, taken a legitimate position, and is now performed by all oculists. What has chiefly contributed to popularise it is, that, apart from the services it renders, it is almost painless and free from danger if only care be taken not to practise it on eyes disposed to glaucoma, that is in cases where an iris has been entangled in a recently formed cicatrix, and where the part has a tendency to bulging. Great care must also be enjoined in tattooing spots of sclerosis, the result of old granular pannus.

In such circumstances a wide-spread pannus, more especially if it has been improperly treated with atropine, may give rise spontaneously to an attack of glaucoma with ectasia of the cornea. If later on such a cornea be tattooed, we must expect a tendency to repetition of the same accidents. With the exception of those due to thick calcareous incrustations, no other opacities, if skilfully tattooed, will require any particular attention. To accuse tattooing of having given rise, long after it has been performed, to certain untoward changes in eyes, already at the time much disorganised, is to interpret facts amiss.*

It is well known that the great annoyance caused by semi-transparent spots on the cornea, arises from the dazzling and diffusion of light they occasion whenever the light is strong. This has been combated by the use of the stenopaic glasses of *Donders,* and vision thereby sensibly improved. Nevertheless, when such glasses have to be worn out of doors, a very serious inconvenience arises, namely, that the field of vision is reduced so much that the patient finds great difficulty in guiding himself. By means of tattooing we can as it were put the stenopaic glass in the eye itself, and so remove the above unpleasant condition.

The increase in visual acuity obtained by tattooing semitransparent central opacities is sometimes very great. An attempt has been made to utilise it in preventing dazzling, the result of the formation of an antiphlogistic artificial pupil, namely, by deeply tattooing the portion of cornea overlying it, and the portion of crystalline which is useless for vision, either from opacity or partial alteration in the index of refraction.

On more than one occasion when speaking of the various forms of keratitis, I mentioned the tendency that old cicatrices have to ulcerate. This form of the affection has at times such well-marked characters that the name of *cicatricial keratitis* has been

* Séance de la Société de Chirurgie, 30 Jan. 1878.

bestowed upon it. Since the practice of tattooing has become general, the important observation has been made, that the presence of the carbon in these wounds gives them a greater power of resistance, and is a protection against cicatricial keratitis. This remarkable and practical fact, given by *M. Vœlkers* (in the thesis of his pupil *M. Holme*), has resulted in relieving numbers of patients from those constant attacks of inflammation, which at every moment used to interfere with their work, and has besides greatly increased the popularity of the operation.

The antiphlogistic action of tattooing is accounted for by its obliterating the vessels of a cicatrix. This it may effect either by direct perforation of the vessels, and introduction of carbon, or by the carbon being carried into the current of the circulation, and subsequently penetrating their walls (*Bowicz*). The closing in this way of a large number of vessels, not only renders cicatrices more resisting, but allows them to be very deeply coloured.

I used at first to refrain from tattooing very vascular leucomata, supposing incorrectly that the relatively free hæmorrhage, which followed the puncture of such cicatrices, would wash away the carbon, and so render the colouring process difficult. I now do not hesitate to tattoo, and successfully, the conjunctiva covering the large openings made in removing corneal staphylomata. In such cases, the first few tattooings are simply with the object of obliterating the vessels. This result once obtained, a colouring can be produced as intense as in the most favourable cicatrices.

It may be said, then, that where there exists any disposition to cicatricial keratitis, artificial colouring of the leucomata, even without any cosmetic or optical intention, is the best preservative against relapse.

2. The treatment of glaucomatous opacities is reduced to iridectomy or sclerotomy. These operations exercise, however, scarcely any influence in causing the opacities, whose development is always slow, to disappear. Excision of the iris, apart from the fact that it may cause very marked improvement in vision, should always be performed in cases where the opacities are in some sort the forerunners of glaucoma, in order to ward off the attack, and the still graver symptoms that ensue from it.

Sclerosis of the cornea, especially the form which takes its origin in disturbances of the lymphatic circulation, will find an effectual remedy in operations which, like sclerotomy and iridectomy, determine a relaxation of corneal tension. I consider that sclerotomy, which leaves no traces of itself, and by not enlarging the pupil, does not cause dazzling, will in such cases be the more suitable of the two.

Incision of the trabecular tissue around the cornea, and the establishment of a fistulous cicatrix, such as sclerotomy affords, will contribute greatly to re-establish the normal conditions of corneal nutrition.

3. Among the operations specially designed to aid in clearing sclerosed corneas, abrasion of the conjunctiva figures in the first rank, and has yielded undeniably successful results. It may be performed by those who shrink from sclerotomy, which, though harmless, is nevertheless, a much more delicate operation. I have already shown how in my opinion syndectomy acts in clearing the cornea (p. 117). Although the *modus agendi* be not yet quite clear, it is at least possible that the formation of a circular cicatrix, over the trabecular tissue, which encloses the main lymph channels of the eye, may considerably modify the circulation of that fluid.

I remember to have heard *Furnari* say, that in cases of granular pannus, with glaucomatous complications, his method of scraping round the cornea had an anti-glaucomatous action as puissant as the largest iridectomy. This assertion appears to me less marvellous, now that I come to consider how much the notion has gained ground, that glaucomatous phenomena depend on a check in the flow of lymph, and that the cure of glaucoma must be based upon a re-establishment of equilibrium between lymph secretion and excretion, by means of wounds favouring filtration.

Another change, that may ensue on ulcerative processes of the cornea, is *ecstatic cicatrisation*, and *staphylomata*. Frequently losses of substances resulting from suppurative keratitis, which has not gone so far as perforation, are repaired, but with an alteration in level, that is to say, with either a hollow or a facet. On the other hand, a cure under exactly opposite conditions, as regards curvature of the cornea, is to be feared when perforation has been accompanied by strangulation of the iris, with large adhesions to the posterior surface of the ulcerated portion of cornea.

The part played by the iris in the formation of a staphyloma is most important. Let me say at once that a central loss of substance, if there be no strangulation of the iris, will not result in a bulging cicatrix ; the same may be said of the small openings like points or cracks, due to destruction of the cornea through its whole thickness, or to a wound. The iris being here but very slightly adherent to the cicatrix, the remaining portion of it becomes detached as the aqueous humour accumulates, the result being merely a cicatrix, with a small anterior synechia.

Among conditions favourable to the development of a staphyloma must be mentioned any large perforation which draws the iris extensively towards the ulcerated parts; also, perforations small in extent, but numerous and symmetrically disposed. These, by the traction they exercise on the iris, keep it tense and in contact with the cornea. The enormous perforations, which so readily cause *total staphylomata*, are met with in the course of purulent and diphtheritic ophthalmia, and of rodent ulcer. On the other hand, the narrow, symmetrical perforations, seen in children with pustular keratitis, lead readily enough to partial staphylomata.

Deficient resistance on the part of the cornea cannot certainly alone explain the formation of eccentric cicatrices, inasmuch as very large ulcerations may be met with, which having undergone perforation only in the centre, and, there being no subsequent entanglement of the iris, have cicatrised without any tendency to bulging. Clearly in such cases the iris plays a chief part; and all observers are agreed that the bulging of the cicatrix is due solely to glaucomatous symptoms. Exaggerated pressure, therefore, during the period of cicatrisation is the cause of the ectasia. We are the more justified in accepting this as proved, as the examination of eyes attacked with partial staphyloma, which has not extended to the pupil, constantly reveals the presence of glaucomatous excavation of the papilla, and generally speaking, the disturbance of vision is in excess of what the staphyloma alone would account for.

Formerly, when, with *Donders*, glaucoma was explained as an excess of secretion, it was said that the presence of the iris in the wound caused a dragging on its nerves, which was propagated to the ciliary body, and determined a neurosis of secretion. The fact was here forgotten that after very large perforations, if the iris was extensively adherent in the cicatrix, it would be so utterly destroyed that nothing save its pigment would remain.

According to the theory which I was the first to uphold, the essential cause of glaucoma is to be looked for, not in a neurosis of secretion, but in a deficiency of excretion. The cure of corneal ulcers, with subsequent staphylomata, and glaucomatous symptoms, gives great support to my views.

Whenever as a result of perforation the iris is strongly drawn within the iritic angle, and rendered adherent over a certain extent of the surface to the parts about the canal of Fontana, and is moreover attached permanently to the periphery of the anterior chamber, conditions are straightway established favourable to glaucoma, the excretory lymph channels being now blocked up to a large extent. On the other hand, in cases where all the conditions of maximum traction of the iris are present,—that is, where there exists a central perforation, if only this be small, so as not to cause the iris to adhere to the posterior surface of the cornea, a flat cicatrix will result. Nevertheless, it may be possible at a later period to prove that here the traction on the iris was sufficient to cause atrophy of it and the anterior synechia, while at the same time its peripheral attachment has also undergone traction in some cases sufficient to cause the spontaneous formation of an artificial pupil.

It is of the first importance to note well the above mechanism of formation of eccentric cicatrices of the cornea. Treatment must be directed against any lengthened contact between the iris and the periphery of the anterior chamber, and against the formation of adhesions, in the main excretory region of the eye. Ocular therapeutics made a distinct advance when it changed a treatment of acknowledged inefficacy, which had been kept up in a routine sort of way long after its worthlessness had been acknowledged.

I do not think I am guilty of exaggeration when I say that we can now save from certain loss (a staphylomatous eye must be considered a lost one) many eyes for which a cure was formerly impossible. In the first place, the pernicious use of atropine, at one time so common in all cases of perforation, must now be abandoned. This agent, by driving the iris back against the periphery of the anterior chamber, has the effect of necessarily aiding the evolution of glaucoma, to say nothing of the action it exercises on the intraocular pressure. The conditions favouring the development of a staphyloma once established, if you feel convinced that it will not do to await a favourable result without attempting something, an antiglaucomatous operation should be performed without delay.

Formerly such an operation would have been performed only when the staphylomatous process had commenced, and when the serious dangers of a glaucomatous condition had to be encountered. This rendered the iridectomy hazardous, on account of the luxation of the lens and the fluidity of the vitreous, etc. Now we ought to operate so as not to permit the loss of substance in the cornea to be repaired, while excretion is checked, and the new tissue subjected to an amount of pressure and stretching dangerous to the eye.

The means best adapted to prevent the formation of staphyloma after perforation, are given in the following precepts :—

1. Remove every portion of a prolapsed iris, even at the risk of a very large opening, and an escape of the lens, should it present in the wound. With this object, the prolapse may either be divided with a narrow-bladed knife from behind forwards, as in keratomy, or a small inferior flap be made. After the prominence of the iris has been removed, the flap (or flaps in the case of a transverse section) is seized, and cut off with the scissor forceps, which are very convenient for this purpose.

2. During the whole period of cicatrisation, make diligent use of sulphate of eserine, instilling a drop of a 1 per cent. solution three times a day; and after very large perforations, apply the compress bandage carefully. The dressings must be frequently changed, should the conjunctiva show any great degree of purulence.

3. In perforations of small extent, when in spite of the removal of the prolapse and the diligent use of eserine, it is becoming evident that the iris will become adherent about its angle, perform sclerotomy, or, better, iridectomy, if a new pupil is required. *Von Graefe's* narrow-bladed knife, which I have joined *Monoyer* in recommending so strongly for iridectomy, renders the operation feasible, even in the absence of an anterior chamber. Repeated instillations of eserine should be made subsequent to the iridectomy, so as to prevent the slightest entanglement of the iris with the wound.

The alkaloid of the Calabar bean possesses a peculiar power of checking the formation of ecstatic cicatrices after perforation. The remarkable action it exerts, and which is probably purely mechanical, consists, first of all, in so contracting the sphincter iridis as to effect the disengagement of the iris from the narrow corner, as it were, of the anterior chamber; and secondly, in causing the intraocular vessels generally to contract, whereby intraocular secretion and tension are diminished.

In treating a staphyloma already established, you will be guided according as it is partial or complete. If not of very long standing it may still be capable of improvement by iridectomy, especially if double excision of the iris, at intervals of some weeks, be practised. This should be executed in such a manner that the sections shall converge towards the corneal margin meeting at a point opposite the centre of the staphylomatous portion. By thus making two large iridectomies at an interval of two or three weeks, the iris will be completely disengaged from the angle of the anterior chamber, while any portion of it included in the wound, and perhaps adherent to the posterior surface of the cornea, will have been removed.

It must, however, be remembered that a partial staphyloma, even though very limited, is a condition which affords but slender hope of useful vision. Thus, if failure has followed a single or double iridectomy, removal of the staphyloma should be performed, either by trephining or by excising a semilunar flap, and bringing the corneal wound directly together with a very fine suture.

When a staphyloma is complete, that is when it occupies the whole extent of the cornea, it becomes a matter of importance to note whether the sclerotic has participated, and whether the boundary line between it and the cicatricial tissue has or has not been more or less abolished (intercalary staphyloma). In such cases we must admit that the intraocular pressure has become already too great to allow of either the removal of the cornea or an anterior segment of the eye, unless we be willing to brave the danger of excessive hæmorrhage, followed by inflammation, and great contraction in the stump. Under such circumstances a judicious practitioner will have recourse to enucleation.

On the other hand, in all complete ectasias limited to the cornea, ablation, with sutures passing through the conjunctiva so as to close the wound, should be performed. Four sutures should be inserted in the conjunctiva after it has first been carefully detached from the corneal margin almost as far as the equator of the eye. In order to avoid confusion at the moment of tightening the threads, the precaution should be taken of having them of different colours. The removal of the staphyloma is then performed just as though it were desired to make a large keratomy through the centre of the cornea, the two resulting portions being afterwards very carefully cut away with scissors. When we are certain that the lens has escaped from the eye, the sutures in the conjunctiva are to be tightened, and in children allowed to cut their way out. By this method I get such perfect preservation of form that by subsequently tattooing the conjunctiva, which now occupies the position of the cornea, I am able, to the great comfort of the patient, to dispense with an artificial eye.

The method of ablation by means of sutures passed through the sclerotic (*Critchett*) should be abandoned. Not only does it give rise to angular stumps very unsuitable for carrying an artificial eye, but also to the risk of sympathetic irritation in the other eye.

Although not developed, or at least not in such a way as can be followed, under the influence of inflammation, there is another form of corneal distension known as *conical cornea* or transparent staphyloma. The central portion of the cornea, and this most commonly in young subjects, bulges in the form of a truncated cone, which sinks usually somewhat abruptly into the periphery. The position of this transparent ectasia on the central portions, so that the summit of the cone often corresponds to the centre of the cornea, is a diagnostic point between it and those general ectasias, also transparent, which granular pannus may cause. True keratoconus, moreover, exhibits slight opacity only at the summit, though this may also be absent; while in general ectasia resulting from pannus, the tissues never regain absolute transparency, as oblique illumination will show.

If the transparent staphyloma be well marked it may be seen directly the eye is looked at in profile. If only commencing and but slightly developed, the corneal reflex and the changes it undergoes must be observed. Better still, a plane mirror may be used, so as to examine the cornea by transmitted light, noticing the mobile shadow that the cone on the slightest inclination of the mirror will produce on the illuminated ground of the pupil. Examination of the fundus oculi will also enable the presence of irregular astigmatism to be easily diagnosed by the distortion of the image of the papilla.

The treatment of keratoconus would be very much easier if we could gain juster notions as regards the ætiology of the affection. It often appears suddenly on both eyes, causing the very highest degrees of myopia, and reducing vision by astigmatism and polyopia to such a degree as to render those affected by it incapable of guiding themselves. It cannot yet be said for certain whether the cornea is first attacked and subsequently yields to normal intraocular pressure, or whether glaucomatous symptoms, showing themselves to the patient only by progressive impairment of vision, are not rather the determining causes.

It is this doubt which renders all efforts at treatment so unsatisfactory. Thus attempts have been made by iridectomy to reduce the ectasia, but only with the result of aggravating the polyopia and dazzling of which the patient previously complained. The treatment by a simple or double attachment of the iris, in order to improve vision by transforming the pupil into a narrow slit have also been given up, since the ultimate danger attendant on iridesis and its tendency to increase intraocular pressure have been realised.

Von Graefe's idea of establishing cicatricial contraction in the most prominent part of the cornea, was, as experience has shown, much more happy. With this object a little above the keratoconus, and not as *Von Graefe* recommended, from its thinnest part, a small flap of cornea, equal in breadth to *Von Graefe's* cataract knife, should be raised, care being taken not to open into the anterior chamber. On successive days after this removal the wound should be cauterised with a crayon of mitigated nitrate of silver, so as to induce ulceration. The ulcer should then be slit up, as I have recommended in cases of rodent ulcer. The wound should be kept open for six or eight days, while at the same time by proper dilatation of the pupil the formation of an adherent leucoma is prevented.

Another mode of treatment is to directly reduce the extent of the cone by the removal of a small elliptical flap of cornea, subsequently bringing together the wound thus formed with one or two points of suture (*Bader*). Lastly, a round portion may be removed from the conical part with Bowman's trephine or my own, and, if necessary, to this trephining may be joined an iridectomy performed by carrying through the opening in the cornea, the fine blade of the scissor forceps (*Abadie*). It cannot be denied, however, that such operations performed in front of the crystalline, are fraught with great danger, and that any opening in the cornea which abolishes during a certain time the anterior chamber, facilitates adherence of the iris. Finally, these operations often leave cicatrices more marked than would have been caused by the formation of an ulcer, with subsequent keratomy.

The influence which repeated sclerotomies, together with a protracted use of eserine, might have on the reduction of conical cornea, deserves to be further studied.

I will close this account of diseases of the cornea by calling attention to the *tumours* which may be met with on this membrane. These, such as epithelioma, sarcoma and melano-sarcoma are developed almost constantly in its epithelial covering, and commence from the edge of the conjunctiva, losing themselves finally in the proper tissue. The treatment of such tumours is limited to removal; but considering the great difficulty of isolating them, enucleation would be preferable as soon as the malignant character of the growth is beyond doubt; as also when recurrence has already sufficiently established the fact.*

* See "Tumours of the Conjunctiva," p. 97.

DISEASES OF THE SCLEROTIC.

LECTURE XVII.

SCLEROTITIS; FOREIGN BODIES AND WOUNDS OF THE CONJUNCTIVA, CORNEA, AND SCLEROTIC.

No precise line of demarcation can be drawn between the cornea and sclerotic either structurally or microscopically. Using a weak power, we see merely that in order to become corneal tissue, the fibrillæ lie more evenly, while the lymphatic spaces are more symmetrically arranged. The anterior cement ends in a thin thread-like edge where the sclerotic commences, and the fibrillæ as they break up penetrate the tissue proper of the conjunctiva, which transmits an epithelial layer, to the front of the cornea.

The study of the transformation of the inner surface of the cornea into scleral tissue, offers even greater difficulties. The area within which this is effected is the real battle-field, on which some of the most important questions in ocular physiology and pathology have to be decided. This is why I shall delay a moment to consider the subject, seeing that all scientific therapeutics are based on correct notions of anatomy and physiology.

M. Waldeyer has given the name *iritic angle*, to the point where the tissue of the iris, the cellular stroma of the ciliary body, the muscle of accommodation, and the posterior and external portions of the cornea and sclerotic intersect. These form jointly, where the anterior chamber closes in, a peculiar cavernous tissue. This tissue, as *M. Schwalbe* has shown, is composed of flattened and rounded elastic trabeculæ, which, as a continuation of the membrane of Descemet, form towards the canal of Schlemm, true fenestrated lamellæ.

Into the composition of this trabecular elastic tissue, enter from the direction of the iris, the elastic tendons and cellular tissue of the ciliary muscle. On the side of the cornea, the membrane of Descemet splits up entirely in the fenestrated lamellæ. Towards the anterior chamber this trabecular tissue is arranged crosswise, leaving in front of the more closely constituted trabecular tissue of the angle of the iris large spaces, wrongly described as the canal of *Fontana.* These are simply the large meshes of the trabecular tissue, which merge in the membrane of *Descemet,* and were formerly called the ligamentum pectinatum. These meshes, or spaces of Fontana, communicate directly with the anterior chamber.

Towards the external surface of the eye in the sclerotic itself, the cavernous tissue just described bounds a series of continuous spaces, which form what is generally a true canal or fissure, the canal of Schlemm, or the fissure of Schwalbe. The spaces of Fontana and the canal of Schlemm are nothing more than a series of contiguous lacunæ in the trabecular tissue. Some of these are placed more towards the anterior chamber, others more towards the surface of the sclerotic, but all alike, in a greater or less degree, communicate together.

The endothelium (or epithelium of the membrane of Descemet) is continued in a tesselated form, into the smallest spaces of the trabecular tissue of the iritic angle. Consequently, it lines the spaces wrongly called canals of Fontana, and of Schlemm. In proportion, as the spaces in the trabecular tissue become narrower, to form corneal canaliculi and lacunæ, or sclerotic lymph spaces, the tesselated epithelium takes the character of corneal or sclerotic cells. It may therefore be said that the anterior chamber, itself lined with endothelium, is directly continuous not only with the spaces of Fontana and the canal of Schlemm, but that, also, it is gradually merged in the lymphatic channels of the cornea and sclerotic. The circulation of red blood is never, in health, seen in the canal of Schlemm, which, with the spaces of Fontana, must be considered as belonging to the lymphatic circulatory system. Now, the canal of Schlemm communicates with the sclerotic veins, which can even be injected from the anterior chamber. It is therefore clear that this canal connects the anterior chamber with the general venous circulation.

A system of valves must, under normal conditions of pressure, prevent the blood from pouring into the canal of Schlemm, and consequently into the anterior chamber. However, the existence of this system of valves has not yet been made out. From a therapeutic point of view the arrangement is one of great importance, for by sections such as are made in sclerotomy, we may perhaps establish more direct communication between the lymphatic and venous currents, and thus directly relieve the anterior chamber.

I need not here describe the tissue proper of the sclerotic, composed as it is of fasciculi of cellular tissue, tightly bound together, and crossing one another at right angles. The fasciculi that are nearest to the inner surface of the eye have pigment cells interspersed among them in variable numbers.

Inflammation of the sclerotic is known as *sclerotitis* or *episcleritis*. But inflammation may attack the sclerotic and choroide simultaneously, and give rise to an affection known as sclerotico-choroiditis. This generally terminates in staphyloma of the sclerotic, to be spoken of later on under inflammations of the choroid.

Sclerotitis or episcleritis appears as a series of circumscribed centres, round the cornea, forming bulgings, the deep-coloured injection of which is an important diagnostic sign, enabling us to distinguish sclerotitis from other circumscribed inflammations of the conjunctiva, as phlyctenular or pustular conjunctivitis.

The bulgings of episcleritis have a dull, purple hue; and their greatest elevation is generally at a distance of some two or three millimetres from the corneal margin. If the summit of this prominence be examined, it will be found, in opposition to what obtains in a phlyctenula or pustule, to be covered with a network of conjunctival vessels, movable on pressure. Although the prominence seldom reaches the corneal border, the fact that it is completely covered by superficial vessels will at once enable the diagnosis to be made. This distinguishes episcleritis from other inflammations, where the most elevated portions are covered merely by epithelium overlying a layer of fluid more or less rich in leucocytes, and where, when the epithelium is shed, the fundus is seen to be ulcerated. Note, too, that the swellings of episcleritis never form ulcers, and that when such appear on the sclerotic, they are the result either of wounds or of some affection that has commenced in the conjunctiva, or choroid, such as epithelioma, gummata, etc.

Again, episcleritis may easily be recognised by the peculiar form of sclerosis it gives rise to on the cornea. It determines, in its immediate neighbourhood, a zone not unlike a well-marked arcus senilis (*Mackenzie*). This sclerosis has no tendency to invade the central portions of the cornea, but rather to remain confined to the portion immediately bordering on the scleral tumour. In this it differs sensibly from true parenchymatous keratitis, with iritis, accompanying anterior sclerotico-choroiditis, a disease which also often appears in centres, and might be mistaken for simple episcleritis.

The pure form of sclerotitis has also the peculiarity of leaving no traces on the sclerotic other than a slate-coloured pigmentation. The corneal sclerosis disappears, and no permanent synechia posterior remains to show that the iris had actively shared in a disease generally localised in the episcleral tissue. It is not thus with the various forms of sclerotico-choroiditis, which leaves as a rule very well marked and permanent scars on the cornea, with large adhesions of the iris and scleral ectasias.

Moreover, true sclerotitis is remarkably indolent. There can scarcely be said to be even slight oppression about the forehead, or uneasiness in the movements of the lids. Though an acute form of sclerotitis consisting even of but one prominence may be met with, it will last months, while phlyctenular conjunctivitis, excluding relapses, is soon cured. The chronic form of episcleritis, in which one prominence has scarcely disappeared before another is developed, may be mistaken for sclerotico-choroiditis, the course of which is very chronic, unless attention is paid to the manner in which preceding prominences have healed, leaving no traces except a slate-coloured mark, which will enable a diagnosis to be at once arrived at.

The disease attacks more particularly those who have suffered from rheumatism, especially the articular form, in the knees. I find this coincidence so frequent, that when a case of sclerotitis presents itself in a young subject, which is rare, I straightway tell him that he has a rheumatic diathesis, even although he may not as yet have experienced a single symptom.

The treatment should be strictly non-irritant. Aromatic compresses may be prescribed during two or three hours daily, and at night a compress bandage, which will retain a certain amount of heat about the eye. Atropine should be employed only to the extent of a few drops daily, and that not unless the attack differs in character from typical episcleritis by the presence of symptoms of iritis and pain. In true episcleritis all irritating lotions and collyria must be strictly prohibited.

The treatment from which I have actually derived the best results is the subcutaneous injection of pilocarpine, five drops daily of a 10 per cent. solution. The injections should be made by preference in the morning, in bed, so as to secure copious perspiration together with salivation. I prefer hydrochlorate of pilocarpine, and push the injection to six or seven drops if the amount of diaphoresis be not satisfactory. This treatment considerably abridges the tedious course of the disease, and I might show you patients in whom, after eight or ten injections, the bulging has grown less and less, and finally disappeared.

Simultaneously with these three injections, I regularly give 2 to 3 grammes (31 to 46 grains) of iodide of potassium. In the case of feeble persons, and anæmic women, I give preparations of iron, together with enemata of iodide of potassium of a strength of 2 grammes (31 grains) to 30 (℥viiss) of water. In order to prevent relapses, so common in rheumatic patients, I recommend hydropathy, and especially prolonged diaphoresis, by means of dry packing, and frequent sponging of the body, all except the head.

Debilitating treatment is strongly contraindicated; and all sanguine depletions, such as one might be tempted to practise on account of the redness of the eye, must be carefully avoided. As a rule, injections of pilocarpine are well supported. They do not exhaust the patient if care be taken to give plenty of nourishment, and to stimulate the appetite when required with tonics, especially quinquina.

It may perhaps occasion surprise that the chapter of sclerotic affections closes with sclerotitis, but in reality the sclerotic is hardly ever affected other than secondarily. Consequently, in treating of the diseases of the choroid, I shall have to return to the changes that take place in the sclerotic, and also to the deformities to which it is liable. The sclerotic itself is scarcely susceptible of ulceration or degeneration. In this respect it enjoys even greater immunity than the cornea, while its denser tissue opposes a much more effectual resistance to any processes of inflammation or degeneration which may be active in its immediate neighbourhood. In this way it forms a very resistant and stubborn barrier to tumours. If, however, these latter have been developed in the episcleral tissue about the pericorneal region, they may work their way into the sclerotic, as they do into the cornea, but with still greater difficulty.

Before quitting the external tunics of the eye, it is necessary to consider what course to adopt in cases of wounds or foreign bodies in the conjunctiva, cornea, or sclerotic.

The cul-de-sac of the conjunctiva may very often be occupied by foreign substances. Persons who travel much by rail are especially liable to this accident. The popular plan of removing such substances from the eye is both logical and efficacious. It consists in seizing the upper lid by the lashes, drawing it forcibly over the lower, and wiping its internal surface upon the row of inferior cilia, which thus perform the office of a brush.

Take great care how you prescribe collyria for catarrh, which has appeared suddenly in one eye, without first taking the precaution to explore attentively the whole conjunctival cul-de-sac. Nothing is more disastrous to the credit of a surgeon than to have mistaken for catarrhal inflammation an irritation which the removal of a foreign body has at once relieved. Among a thousand instances, I will relate only one. I was on one occasion sent for to an hotel in Paris, to see a gentleman seized with inflammation of the left eye, after he had washed his face with soap and water. He had at first consulted a well-known oculist, who had prescribed a collyrium of sulphate of zinc to remove the irritation, evidently considering it was due to the soap. The patient not getting any relief from the collyrium, but growing, if anything, worse, consulted me. On everting the upper lid, I had no difficulty in removing a piece of cigar ash.

However, it must not be imagined that being merely warned of the possibility of such a mistake will ensure your avoiding it. It is not, in fact, enough to simply evert the upper lid and make the patient look well down, but it is further necessary to pass a curette beneath the upturned tarsus, along its whole attachment, and to examine carefully the fold of the upper cul-de-sac. Foreign bodies of large size may lodge here and escape examination; for, after the lid has been everted, the patient may close his eyes tightly when the fold of the superior cul-de-sac will also be turned down.

Some twelve years ago a patient entered my consulting-room, and stated that while crossing the boulevard, a very large fly had entered his right eye, inflicting a regular blow on the eyeball. I found the eye considerably irritated, and watering, and everting the upper lid made a careful examination several times, neglecting however to sweep with my probe the upper cul-de-sac. I found nothing, and attributed the irritation of the eye to the blow given by the insect, which had evidently been severe. Finally, I dismissed the patient. Next day he returned, and on once more everting the lid, I perceived near the inner extremity of the tarsus, an enormous fly. I straightway removed it from its

M 2

prison in the superior cul-de-sac, where it had escaped discovery the day before, simply because the patient under the influence of pain had closed his lids very tightly. I was obliged to listen to his reflection, and a very just one too, that removal twenty-four hours sooner would have been very much more to his liking.

Not a summer passes but I have occasion to remove from persons coming from the country, portions of ears of corn, measuring sometimes 1 to $2\frac{1}{2}$ centimetres, and lodged in the superior cul-de-sac, above the attachment of the tarsus. The ends of these, when the lid is everted for examination are often concealed by mucus. When such patients are sent back cured, as it were instantaneously, do you suppose they can feel much confidence in the local doctor, who has from time to time varied his collyria, and who must now of necessity appear more or less of a blunderer?

In all such cases never give a prescription without being absolutely certain that no foreign body is in the eye. The removal of such is all the more urgently necessary in persons whose nerves are highly strung, inasmuch as its continued presence may cause serious reflex neuroses, manifesting themselves by convulsive tic of the face, or even true epileptiform convulsions. One is surprised at times, to find foreign bodies upon the globe close to the cul-de-sac, and completely hidden by granulations. Some of you have seen me remove a portion of shell one centimetre in diameter, which had remained in contact with the ocular conjunctiva for many months, causing no uneasiness and only slight conjunctival discharge.

Every day almost you may meet with cases of laceration of the conjunctiva. If the laceration be of small extent, and we are certain that no foreign body is present, a compress bandage at night is enough. In cases of large laceration such as a blow from the end of an umbrella may cause, the prolonged irritation of the eye may be very much lessened by closing the wound, even if ragged, by a few sutures of fine silk.

This union is urgently called for, when conjointly with denudation of the eye-ball, the conjunctiva of the lids has also been torn away. Here, if healing be allowed to take place spontaneously, it may entail the formation of a partial posterior symblepharon. You must not be discouraged by the fact that several days have perhaps elapsed since the accident, and that the raw surfaces are already covered with a greyish layer, as in diphtheria. This layer may be easily scraped off, and when so removed furnishes the requisite raw surface on which to plant the damaged conjunctival flaps.

The burns which you so frequently see here are caused in most instances by quick-lime, mineral acids, molten lead, etc. Among the worst are those caused by quick-lime. A few weeks ago you saw a lad of sixteen years of age, whose playmates had thrust lime into his eyes, in cruel sport. The case was seemingly a slight one; all that could be noticed was a certain haze over the cornea, and a pale gelatinous appearance of the ocular conjunctiva. The accident had taken place twenty-four hours previously; nothing therefore could be done towards neutralising the lime by any chemical reagent. *M. Gosselin* recommends the use of syrup, to form a saccharate of lime. I had to content myself with cleansing thoroughly the folds of the upper cul-de-sac, and checking any tendency to purulence of the conjunctiva by compresses soaked in carbolised water (1 part in a thousand), and instillations of eserine. Matters were apparently going on favourably enough, but the eyeballs becoming covered with granulations so extensive as to threaten to obscure the cornea, which still continued more or less hazy in its whole extent, I was obliged to repress these exuberant granulations by excision of the more prominent ones, and cauterisation with a five per cent. solution of chromic acid. In spite, however, of all my efforts, the lad left me with partial symblepharon of the inner halves of both upper lids.

If the case be one of burning with acids, and such are common enough, as the result of explosions in workshops or laboratories, or as acts of revenge, and if we are consulted immediately after the accident, the effects of the caustic must be neutralised by compresses of water with some alkali added (as Vichy water), and by thorough cleansing. Iced compresses should be used to calm the intense pain generally felt during the first few hours after the occurrence. When destruction of the mucous membrane has taken place on a large scale, and extensive symblepharon is threatening, we should not hesitate to graft a portion of conjunctiva upon the granulating parts.

You may have to treat burns caused by molten metals, for instance by lead which has been poured into an insufficiently dried mould. It may be that a drop of the lead will be spread on the ocular conjunctiva like a thin plate, easily removable with the forceps. In all cases of burning very thorough cleansing is called for; nevertheless there is nothing to be gained by tormenting a patient by searching for minute particles of metal, which may have worked themselves into the subconjunctival tissue. Such bodies become readily encysted without the least irritation. In such cases it may be possible to err from excessive zeal; thus, if all the grains of powder that a gun has projected into an eye were to be removed, dangerous irritation, such as the accident itself would never have produced, may be the result. Foreign bodies are still more commonly found fixed in the cornea. A day scarcely elapses here without my having to extract filings or other small fragments of iron from the eyes of workmen. Such bodies are easily removed by a simple cataract needle, or spud. It is generally more difficult to free the cornea from the concentric layers of burned tissue which remain if the fragment of metal which struck the eye has been very hot. At the commencement this small round patch adheres obstinately to the surrounding tissue, while at the end of a few days it may be detached easily enough, but only after the eye has been the seat of continual and severe irritation. The removal therefore of such foreign bodies should always be followed by ablation of the burned portion of cornea.

In patients who are somewhat unruly the removal of these fragments of iron, which, if of any size, are often deeply implanted, may be readily effected by keeping the lids open with a spring speculum, and fixing the globe with forceps. It is better to do so than to try and steady the eye by pressure with the fingers, for it is simply impossible to do this if the patient is at all nervous.

If foreign bodies have penetrated the cornea to such a depth that in attempting to extract them there is danger of their being driven into the anterior chamber, the eyeball may be steadied—the speculum being in position—by introducing the paracentesis-needle under the foreign body in such a way that it cannot be driven inwards. But this becomes a very delicate procedure if the foreign body be in the pupillary area. The greatest care is then required to avoid contact between the needle and the capsule of the lens. In such a case, after the needle has penetrated the anterior chamber, always direct its point upwards, towards the membrane of Descemet.

Another way of extracting foreign bodies when deeply situated, is by forming a small flap, or, better, by incising the cornea in front, or close to where they are, from behind forwards, as if keratomy, limited to the superficial layers, was to be made. As a rule, metallic foreign bodies are not sufficiently deeply seated to require such complicated methods, and you will scarcely ever see any of them resorted to in my practice.

There are two forms of foreign bodies which deserve mention on account of their liability to mislead a surgeon, much to his own detriment. I refer first to husks of millet, which, in the case of bird-fanciers, readily become fixed on the margin of the cornea, and simulate most remarkably a pustule, or small abscess. Every year patients come here who have during weeks been treated for ulcerative keratitis, and are cured the moment the foreign body is removed. The suddenness with which the affection has appeared, the uniform colour of the affected portion of cornea, the position near the border of the conjunctiva which the lesion occupies, and especially the limitation of the injection to the foreign body, together with the fact of its being more circumscribed than in cases of marginal phlyctenulæ or pustule, should put the surgeon on his guard, and save him from a damaging error. The slightest touch with a probe is enough to cause the husk to fall off. The same applies to insects' wings, which have sometimes remained for months on the surface of the cornea.

An error easier to commit, but also a much worse one for the patient, is to fail to recognise the presence in the cornea of a splinter of stone, yellow or grey in colour, around which a zone of inflammation has formed itself. Such a foreign body may easily be mistaken for a suppurating portion of cornea. Oblique illumination, and, if necessary, probing with a sound, or, better, a caoutchouc spatula, will remove all doubts. The same instruments may also be used to remove the foreign substance, the continued presence of which may rapidly determine great losses of corneal tissue.

In cases of wounds of the cornea, causing prolapse of the iris, no foreign body being present, the hernia should be removed, as it can be reduced only in small wounds of very recent date. If the patient presents himself shortly after the accident, I generally draw out the prolapse to a considerable extent with fine forceps, and cut it off closely, so that the cut portions may draw themselves back with some force, which will be all the greater if eserine has been used before the operation. All perforating wounds of the cornea should be treated with eserine in order to secure flat cicatrices, which will be formed under reduced intraocular pressure. This rule must be particularly followed in cases of gaping, jagged wounds, with entanglement of the iris, where no prolapse calls for excision. The continued use of the compress bandage is necessary in all losses of substance and penetrating wounds of the cornea.

As regards burns of the cornea, there is but little to be added to what has already been said as regards burns of the conjunctiva, with which these are generally associated. As all such burns, if they have extended to the deeper layers, are followed by suppuration and even perforation, I look on it as of the first importance to substitute eserine for the routine treatment by atropine.

Traumatic injuries of the sclerotic are far less common; nevertheless, at times foreign bodies will be found imbedded in its resistant tissue. You saw me a few weeks ago perform enucleation in a case where a grain of shot had penetrated some two months previously. Inasmuch as this eye, though only slightly painful, continued red, it was removed for fear of sympathetic inflammation in its fellow. The operation was decided upon all the easier as the wounded eye was somewhat atrophied, and useless for visual purposes. After enucleation, you saw that the pellet of shot, not having the force necessary to pass completely through the sclerotic near the optic nerve, was held fast, two-thirds of its circumference being outside. The same may occur with any body striking the eye with insufficient momentum to carry it through the sclerotic. It may best be dislodged by incision of the sclerotic with the point of a narrow-bladed cataract knife, after division of the conjunctiva, which, immediately over the foreign body, is, as a rule, uninjured. It may, perhaps, be torn at the distance of several millimetres away.

Ruptures and wounds of the sclerotic are especially dangerous, on account of the injuries which accompany and aggravate them, and of the consequences to which cicatrisation may lead. We have to consider how best to deal with such lesions. In cases of rupture, which are caused chiefly by compression of the globe against the walls of the orbit, the sclerotic bursting near the margin of the cornea, or between the insertions of the recti muscles, the conjunctiva is not as a rule torn, and the lens, if it has been driven out, will be found lodged beneath it. In such a case, surgical interference is not called for at the outset. A compress bandage may be applied, and if there be much pain, atropine used. The lens may be removed by incision in the conjunctiva, after the wound in the sclerotic has healed, should its non-absorption occasion any protrusion of the conjunctiva, or upper lid. Such eyes are, in general, utterly useless for purposes of vision, even after correction of the ametropia, inasmuch as rupture of the choroid, and laceration of the retina near the posterior pole, will always have occurred.

Wounds of the sclerotic should not be united, unless when they are of some size, and permit the escape of vitreous to such an extent that atrophy of the globe is threatened. For small wounds, I consider the compress bandage amply sufficient. You have seen a patient here some two months ago, who, while seated in a carriage, was struck by a fragment of broken glass. A three-cornered wound, close to the caruncle, and a centimetre in breadth, had been made in the sclerotic. I first saw the case twenty-eight hours after the accident, and as the vitreous humour was presenting in the wound, like a little bright vesicle, similar to a piece of glass, I explored it carefully with the indiarubber spatula, using all possible gentleness. This I did to make sure that no fragment of glass remained still in the eye. I did not apply sutures, feeling confident that no threads could be passed without causing the rupture of the presenting vitreous. You noticed that six weeks were required for union, and during all that time the patient wore his compress bandage. During the first few days, atropine and injection of morphia were given to relieve pain. The wound is now firmly healed, and I consider, from the position it occupied, that there is no reason to fear any ulterior accidents, such as detachment of the retina.

The course the above case took shows that no hard and fast rule can be established that all wounds of the sclerotic require artificial reunion. There can, however, be no doubt that properly bringing them together, will very much shorten the length of time required for healing. On the other hand it must not be forgotten that to insert sutures in a collapsed eye which has already lost a portion of its vitreous, demands a very skilled hand; for the result of any rough movement may be to hasten the advent of atrophy of the globe, which however at any rate is inevitable, if a very considerable escape of vitreous has taken place.

DISEASES OF THE IRIS.

LECTURE XVIII.

ANATOMY; HYPERÆMIA OF THE IRIS; IRITIS.

The iris forms the anterior and free part of the uveal tract. Two portions may be distinguished; one of these is about a millimetre in breadth, is adjacent to the edge of the pupil, and is traversed by numerous small folds which radiate towards the pupil. A dentated line separates the pupillary from the other portion of the iris, namely, the ciliary zone. This, besides being coloured differently, exhibits a series of from five to seven concentric plaits, surrounding the periphery. This ciliary portion, in a state of average contraction of the pupil, measures from 3 to 4 millimetres.

The endothelium of the anterior chamber, otherwise the epithelium of the membrane of Descemet, is continuous over the anterior surface of the iris, but without showing the same regularity in the arrangement of its hexagonal cells. Upon the posterior surface, commencing from the pupillary margin, the protoplasm of these cells is wrapped in pigment. They are piled up one over the other, leaving a barely perceptible quantity of cement between them. The great amount of pigment which the cells of this layer, known as the uvea, contain, renders their study peculiarly difficult.

The pupillary zone of the iris is occupied by the sphincter muscle, the nonstriated elements of which surround the pupil in concentric circles, to an extent about equal to that of the pupillary portion. In proportion as we approach the edge of the pupil, the muscular layer grows thinner, but near the junction of the pupillary portion, with the ciliary, it attains a thickness of a quarter millimetre, and is separated from the uvea by but very little cellular tissue.

The ciliary portion of the iris contains the dilator pupillæ muscle. This has its origin either in the sphincter, or between it and the uvea, and forms a series of contiguous radiating fibres, directed towards the ciliary insertion of the iris. The layer of radiated muscular fibres is in contact with the posterior surface of the iris. At the insertion of the iris, these radiating fibres bend backwards and form a regular muscular plexus, which surrounds this insertion like a ring.

The cellular tissue encircles chiefly the vessels, accompanies the nerves, and is spread over the layers of muscles; it is composed of stellate cells, containing more or less pigment according to the colour of the eye. While the muscular elements occupy preferably the deeper portions of the iris, the cellular tissue and vessels are, on the contrary, distributed more towards the surface.

The long ciliary arteries, conjointly with some branches of the anterior ciliary, form, in the anterior portion, the greater arterial circle of the iris. From the anterior border of this circle spring numerous arterioles, which pass into the iris through an attachment of each ciliary process, and radiating, arrive finally at the pupillary margin. Near the external surface of the pupillary margin, a certain number of these branches form a second or so-called "smaller circle" of the iris. It is the only one that really passes into the iris proper. The plexus of capillaries lies mainly under the sphincter (*Leber*). The veins coming chiefly from this plexus, as well as the terminal loops of the arteries of the pupillary margins, take a radiating course, and unite with the veins of the ciliary processes to join the vasa vorticosa. They do not empty themselves directly outwards.

The nerves of the iris, which are branches of the ciliary nerves of the choroid, form a triple plexus. One with very pale fibres (probably of sympathetic origin) is distributed to the dilator muscle, on the posterior surface of the iris. Another composed of extremely fine fibres passes to the sphincter muscle (motor fibres). Finally a third, with myeline fibres, forms a fine network on the surface of the iris, and probably contains the sensitive filaments (*Ivanoff*).

From a practical point of view, we must distinguish between true inflammations of the iris, and a morbid condition which may for convenience be termed simply *hyperæmia*. In many cases, indeed, this may be succeeded by true inflammation, which reveals itself by many characteristic symptoms, without however producing any true product of inflammation.

One most important symptom of hyperæmia is the change in colour of the anterior portion of the uveal tract. This is very clearly seen, as there is no cloudiness of the aqueous humour to obscure the view. A red or reddish-yellow hue becomes mixed with the normal colour of the iris, and alters it. In this way, a blue will become somewhat green; a brown, copper coloured; a grey, blue; and a yellow, green.

These very characteristic changes of colour in the iris are only observed occasionally, as when considerable effusions of blood have taken place in the immediate vicinity of the iris, for instance, into the vitreous humour, or the pericorneal subconjunctival tissue. The changes are due to imbibition on the part of the hæmatin, or to a solution of the same colouring material in the aqueous humour.

Long continued states of hyperæmia have the peculiar effect of impairing the colour of the iris by intermixture of a grey tint, resulting from atrophy of the cells of the stroma. With age, all eyes undergo a more or less analogous change, which, jointly with the development of an arcus senilis, impairs their lustre and vivacity.

Another valuable sign of hyperæmia is the sluggishness which the iris exhibits in contracting. Mydriatics and myotics exert but a feeble action on it. You will hear me at times remark that an iris must be pretty free from irritation, when in a case of suppurative keratitis, complete myosis can be obtained by eserine; or when in other affections a maximum dilatation follows atropine. The absence of irritation is also further shown when the duration of the physiological action of these drugs undergoes no reduction, when, in other words, they do not act in a merely temporary fashion.

With the presence of inflammatory products hyperæmia becomes inflammation, be they in the form of exudation or of cell immigration or proliferation. If we form a classification according to the varieties of such products, we shall be able to distinguish three grand forms of iritis—viz., 1, simple or plastic; 2, serous; 3, purulent or parenchymatous. As regards causation, we cannot upon it establish any clear distinctions between the various forms of iritis.

1. *Simple* or *plastic iritis* will, according to the intensity of the

inflammation, be characterised by a more or less well-marked pericorneal injection with exudation. While some cases occur in which the pericorneal injection is extreme, and the iris has a markedly woolly aspect, others are met with in which the eye is scarcely reddened, and in which the inflammation of the iris might have escaped notice, had not one or two synechiæ been present to prove its existence.

The iris has lost lustre not so much owing to the epithelium having been shed (of which fact no histological demonstration has yet been given), as from the exudation on its surface, and the mingling in part of this exudation with the aqueous humour, which thereby becomes cloudy. This cloudiness might lead us to suppose there had been some alteration in the epithelium of the cornea, were it not that its reflex is as bright as ever. The dull look and the pericorneal injection are quite sufficient for purposes of diagnosis. This will be made absolutely certain by the presence of sluggishness of the iris, which may be best seen by covering the sound eye, and then alternately covering and uncovering the affected one.

One of the most valuable aids to diagnosis, and one which permits us to distinguish immobility of the iris resulting from inflammation from mere myosis, is afforded by a few drops of atropine. By these the degree of mobility and irritability of the iris can be gauged accurately. These instillations too have the further advantage of bringing into view any inflammatory products which, in the form of adherences, may be lying between the border of the pupil and the capsule of the lens. They effect this by causing irregular dilatation of the pupil, the edge of which will be bound down at any points where adherences exist.

The amount of the products of inflammation will vary sensibly according to the intensity of the iritis. Altogether transitory in some cases, in others they are capable of causing adherences both large and firm, even though composed of amorphous matter only, interspersed with pigment granules. Generally speaking, in simple iritis the products of inflammation are deposited on the surface of the iris, and more particularly near its pupillary margin. It may, however, happen as an exception, that a whole layer of exudation is raised up by the aqueous humour, and forms in the anterior chamber a vesicular body, simulating a dislocated lens (*H. Schmidt*). These vesicles, gelatinous in appearance, generally disappear gradually within a period of from six to eight days.

Although plastic iritis furnishes as a rule products easy of absorption, the duration and severity of the attack, together with frequent relapses, may result in permanent changes in the pupillary area, very disastrous to vision. On the one hand the margin of the pupil may be bound down to the capsule, causing complete posterior synechia; on the other, jointly with this, an occlusion of the pupil may supervene, in proportion as the retraction of the synechiæ bring the opposite edges nearer together.

2. The seat of *serous iritis* is not only in the iris proper, but also in the lymphatic spaces enclosed by the pericorneal trabecular tissue, otherwise in the spaces of Fontana and Schlemm. As regards the diagnosis between this and the preceding variety, it may be laid down that here the products of inflammation are wholly serous, and that if any coagulable deposits should be precipitated, they will not be found as in the exudative form, in the posterior portion of the chamber, but on its anterior surface. The deposits in serous iritis, which are arranged triangularly, and were known formerly as *punctated keratitis*, scarcely require to be recalled to your minds. As a result of these deposits, the endothelium of the anterior chamber and the tissue of the cornea may share in the inflammation, and various forms of sclerosis of the cornea, coupled with infiltration of cells from the uvea, take place. Patches of sclerosis on the inferior portion of the cornea, with spots of pigment intermingled, may reveal the nature of the affection after a considerable period of time.

Serous iritis produces, together with an increase in the depth of the anterior chamber, an alteration in the intraocular tension, which reveals some disturbance in the balance between secretion and excretion. At present it is not possible to say whether the alteration depends on an increase of secretion, or on interference with excretion. I will lay stress on one point, namely, that the affection is confined essentially to the excretory circle of the eye, and that the iris proper, is much less affected than in other forms of iritis. The old notion, in accordance with which this affection was called aqua-capsulitis, whereby it was connected with serous inflammations, would thus seem to be regaining its lost position.

3. *Suppurative* or *parenchymatous iritis* differs from the two other varieties by the fact that the products of inflammation are poured out in the stoma of the iris itself, causing swelling and thickening. The change of colour is here pushed to the highest degree, and a yellow tint predominates. The parenchy-

matous forms of iritis are also nearly always accompanied by the development of vessels.

The inflammatory deposits laid down in the tissue of the iris, consist either simply of leucocytes, or of masses of nuclei, or of newly-formed cellular masses. In cases of purulent infiltration the diapedesis which has given rise to such infiltration, will also as a rule, have diverted a certain proportion of white corpuscles into the anterior chamber, in other words, a hypopion will accompany a purulent iritis.

The accumulation of large masses of nuclei leads to the formation of actual nodules called gummata of the iris. Finally, the cell proliferation results in the formation of false membranes, which are traversed by freshly-formed vessels, and block up the area of the pupil. Of the three forms of iritis the one which furnishes exclusively purulent products, is that least liable to leave traces; while but too often the gummy and parenchymatous forms cause permanent changes, together with atrophy, and a very close adherence of the iris to the capsule of the lens.

Before touching on the treatment of the various forms of iritis, I will consider them from an ætiological point of view, under the heads of (*a*) syphilitic, (*b*) rheumatismal, and (*c*), blennorrhagic iritis.

(*a*.) *Syphilitic* iritis does not reveal its specific character, if it appears with secondary symptoms; it is only at the transition period which leads up to the tertiary stage, that it is accompanied by the peculiar nodules of gummy iritis. These nodules are generally situated either on the pupillary or ciliary border, and in the inferior and internal quadrant of the iris. It rarely happens that a gumma appears on the surface of the iris proper, and equally rare is it to see the nodules numerous enough to fill the anterior chamber, or to cause destructive ulceration of the cornea.

These gummata possess a very marked yellow tint, and are surrounded by copper-coloured tissue. On account of the resemblance they bear to collections of pus, the inappropriate name of pustules of the iris has been given to them. Like all gummata they are composed essentially of nuclei, and possess little cellular tissue, and few vessels. They may undergo caseous degeneration and absorption, leaving, however, in all cases a cicatrix, as is proved by the partial or complete atrophy of the iris which ensues, if it has been the seat of any large numbers of them. What applies to gummata in other parts of the body, is true also here, and their presence in the iris, is an irrefragable proof of specific infection, even although, which is rare, other symptoms be wanting.

(*b.*) The essential character of *rheumatic* iritis is that conjointly with the plastic inflammation of the iris, there is very marked inflammation of the episcleral tissue. In some cases the symptoms which arise from this, together with a slight sclerosis of the margin of the cornea, are the best marked; the iritis, properly so called, may consist merely in a certain sluggishness in the movements of the iris, and a slight exudation on the surface, which has dimmed its characteristic lustre. The constitutional nature of the affection may be easily recognised by the slow course it runs, by the persistent character of the pericorneal inflammatory symptoms, and by the frequency of relapses, which give rise to the formation of complete posterior synechiæ, and to the development of irido- or sclerotico-choroiditis, and sclerosis of the cornea.

(*c.*) *Blennorrhagic iritis* is peculiar in that it is made up both of serous and plastic iritis. It is correlated beyond all doubt with the rheumatic form, for we never see an inflammation of the urethra followed by iritis, without some joint having been attacked previously. If I distinguish it from rheumatic iritis, it is because it does not present the true anatomical character of the latter, and because it is a hybrid form, being easily cured, and leaving no traces, while reappearing very readily, whenever the patient has the least tendency to urethritis.

Reviewing rapidly the group of symptoms common to all forms of iritis, the most characteristic of all is pain. This results from the compression of the nervous filaments, by the products of inflammation. It will be the more intense in proportion as such products have been largely accumulated on the surface, and in the tissue of the iris, without having brought about atrophy of the nervous filaments by compression. The plastic forms are the most painful: the serous are only so when the intraocular tension is notably increased: while lastly, the purulent and parenchymatous may co-exist with a good deal of indifference on the part of the eye, so that the intensity of the pain may bear no direct relation to the severity of the inflammation. The pain very often assumes a marked character of periodicity, coming on in the evening, and being increased by the warmth of bed.

Another symptom common to all forms of iritis is the disturbance of vision. This is well marked in proportion as the aqueous humour has lost its transparency. Gummy and circumscribed parenchymatous iritis may at times occasion but little visual disturbance; in the serous form this symptom is always peculiarly well marked.

Other symptoms, such as photophobia, watering of the eye, sensibility to light, are generally wanting. Indeed, the absence of all symptoms in the appendices of the eye and lids, should suffice to direct the surgeon's attention to the iris.

From an ætiological point of view, it is interesting to note that iritis appears only in adults. If observed in a young subject, of less than ten years of age, it is either in consequence of a wound, or an inflammation of the cornea, or is the manifestation of a syphilitic or hereditary rheumatic diathesis. In young girls it may appear at the age of puberty, and be connected with menstrual disturbances. A pure form of iritis without glaucomatous symptoms, is rare after seventy years of age. Men are more liable to iritis than women, and the left eye more than the right. From some cause that cannot be explained, this eye is often the only one affected in spite of the undoubted existence of a constitutional cause.

Syphilis is the cause of from sixty to seventy per cent. of all cases of iritis, although the gummy form enters but slightly into these calculations. The thirty or forty per cent. remaining may be accounted for by a rheumatic or arthritic diathesis. Finally, I should mention, postvariolous and traumatic iritis, and iritis consequent on affections of the cornea.

LECTURE XIX.

TREATMENT OF IRITIS; IRIDO-CHOROIDITIS.

The capital point of treatment in all the various forms of iritis is to place the iris in a state of rest. This is effected by freeing it by atropine from the stimulating action of light. Atropine also fulfils another object by keeping the pupil fully dilated and thereby preventing the formation of posterior synechiæ, with subsequent pupillary occlusion, or complete synechia. Finally, a third advantage in atropine is the decidedly calming action it exerts.

The use of this mydriatic should not however, be pushed to excess, as, for instance, when twenty-four to thirty applications a day are made for a considerable time. An abuse such as this, deprives a patient of the rest he stands so much in need of, and soon determines saturation of the conjunctival tissues, as shown by simple catarrh, or follicular conjunctivitis, which is often very obstinate and accompanied by the characteristic rash of palpebral eczema. Such a method should only be resorted to very temporarily, in order to effect the rupture of some synechiæ that resist all ordinary treatment.

Further indications against the moderate use of atropine, that is, from four to six instillations daily, are to be found in the age of an individual, or in a predisposition to glaucomatous attacks. Moreover, when intraocular tension is increased, the action of the drug is much hindered, owing to its absorption being checked. We know from the researches of *Donders, Gosselin,* and *Von Graefe,* that atropine, to effect its specific action, penetrates into the anterior chamber; and further, we know that results may be obtained by employing the aqueous humour of an eye, into which some drops of this mydriatic have previously been instilled.

An actual contra-indication against atropine is only found in the case of those who have been long subject to iritis, and have been so saturated with the drug that intense conjunctival irritation has been produced. In such cases I have witnessed such an increase of irritation on each fresh application, that the patient himself became opposed to continuing a remedy which seemed to be doing harm, and this although the preparation used, which is a most important point, was perfectly neutral. I may mention also, but only to refute it, a charge made against atropine, namely, that dilatation too long continued, may cause a loss in the iris of the power of contracting. This never results, even after months of use; on the contrary, synechiæ formed on the edge of a widely dilated pupil, will be often easily torn through by the contraction, which follows somewhat slowly perhaps the discontinuance of the atropine. If a certain degree of dilatation does ever actually persist, it will be because the iris has become to some extent atrophied.

In cases where atropine does not fulfil its double purpose of dilating the pupil and removing pain, and especially where palpation has revealed an increase in the tension of the eye, the best means of obtaining the desired action will be to perform paracentesis at the margin of the cornea, with a specially made stop needle. You have often seen me practise paracentesis in patients of this class, who in spite of atropine were deprived of rest. Paracentesis once performed, I could tell them, without fear of practical refutation, that they would pass a satisfactory night. I do not indeed know of any more powerful sedative in iritis than this slight operation, which may be readily performed if you stand behind the patient and let him suppose you are simply going to apply a dressing.

If a patient refuses absolutely to allow the eye to be touched in any way, recourse may be had to injections of morphia, to relieve pain. These, though they have a myotic action, nevertheless aid the effects of the atropine. In cases of excessive tenderness of the eye, atropine will be best used in warm compresses. A solution of 30 centigrammes to 60 grammes (or 1 part in 200) of water should be made, and a teaspoonful of this poured into a bowl of warm water.

Another condition, necessary to rapidity of cure in iritis, is to enable the patient to enjoy a sound night's rest. I prescribe for this purpose 3 to 4 grammes (about 46 grains to ʒj) of chloral, either in syrup, or in the formula I use in my clinique, namely:—

Hydrate of chloral	3 grammes		(46 grains),
Syrup of bitter oranges . . . . Syrup of gum,* āā	15	„	(232 grains),
Distilled water	30	„	(465 grains),

to be taken at night in two doses, with half an hour interval between them. As a general rule, the patient should pass as much of his time as possible in bed, and the temperature of his room be relatively elevated. Cold is what iritic patients have perhaps most to fear from.

An excellent method also of treatment in iritis is warm belladonna and jasmine compresses, as recommended on page 118. Also, grain or linseed-meal poultices, placed warm on the eye and retained in position for some time, produce an excellent effect. At night, they should be replaced by a light bandage, laid over a thick layer of wadding, which may with impressionable subjects be advantageously made aromatic.

There are persons in whom the use of atropine rapidly produces very distressing symptoms of dysphagia and dryness of the throat. In such cases, pressure of the lachrymal sac should be made each time atropine is used, so as to prevent the alkaloid passing into the throat. With this gargles of black coffee may also be recommended; and the same advice applies to any indications of strangury.

It is more especially in children that all undue use of atropine should be carefully avoided, inasmuch as it may determine serious nervous symptoms, and interfere with nutrition. The action of atropine on the general health is undoubted: and it must be the more jealously watched, should there occur any check in the urinary secretion, whereby the system might as it were become saturated. The possibility of this is shown by the fact that at one time, when I was in the habit of using atropine before and after cataract operations, I generally had, in an annual average of from 250 to 300, several cases of senile delirium. This symptom has almost entirely disappeared, since I have more or less abandoned atropine in such operations. I may remind you that in those rare cases of genuine intoxication, accompanied by fever and delirium, injection of morphia will give instant and certain relief.

There are subjects in whom a true idiosyncrasy is met with, so that the use of the most perfectly neutral solution of atropine

* Sirop de gomme is composed of gum arabic 1, cold water 1½, simple syrup 50 parts. Mix and use as required.—Tr.

determines on every occasion swelling of the lids and catarrh of the conjunctiva. I must remind you that in cases where from abuse of atropine, patients have already contracted follicular conjunctivitis, this acquired idiosyncrasy will remain, and that years after, a single instillation will induce marked symptoms of irritation. An attempt has in such cases been made to replace atropine by daturine, but this preparation which can be obtained pure only with the greatest difficulty, shows even then a feeble but often very irritating action.

Crystallised hyoscyamine would appear to possess no mydriatic action (*Dor*), its extract alone having this property. Therefore, when this can be obtained genuine, it may be prescribed in a solution of 5 per cent. strength carefully filtered. In the absence of a preparation of hyoscyamine that can be trusted, it will be better to prescribe a collyrium of 1 part of extract of belladonna, to 10 of water, the solution to be very carefully filtered.

Fortunately we now possess a new mydriatic, produced by an Australian solanaceous plant, the *Duboisia myoporoides,* which is very active. The alkaloid of this has lately been isolated by M. Petit of Paris, and M. Gerard of London. Solutions of duboisine of equal percentage with atropine, are by far the more powerful. Maximum dilatation and paralysis of accommodation are attained very quickly. It remains only for physiological research to show to which of these two powerful mydriatics the preference ought to be given. What I can affirm, up to the present, is that eyes, which used to be very much irritated by the smallest installations of atropine, now bear excellently a solution of neutral sulphate of duboisine, which may be substituted for atropine, in doses of equal amount.

If we enquire what forms of iritis are most benefited by the employment of atropine, the answer evidently will be the plastic. The action of the mydriatic is of much less importance in parenchymatous iritis, especially the gummy and suppurative varieties. Indeed, in a case of serous iritis, in which the pupil is actually of itself dilated, and where a tendency to increase of pressure is present, there is what almost amounts to an actual contra-indication against atropine; at any rate two or three installations a day must not be exceeded. The general treatment must vary with the different form of iritis. In plastic iritis I never hesitate to prescribe preparations of mercury, which more than any other drug, checks the organisation of new tissue, or the consolidation of products of inflammation. I am accustomed to prescribe 1 or 2 centi-grammes* of corrosive sublimate daily, as follows :—

Hydrargyri-Perchloridi	. . .	0·30 centigrammes
Extract of Thebaia	. . . . .	0·15 ,,
Powdered liquorice	. . .	9 ,,

to be divided into 30 or 60 pills. One pill to be taken at the commencement of a meal, and before dinner a dessert-spoonful of a weak solution of iodide of potassium (1 in 50).

In very nervous subjects who complain of great pain, but whose general health is sufficiently robust, 5 to 8 leeches may be applied to the temple, preferably at night. It has also been recommended to place the leeches on the corresponding nostril, but this may provoke a disagreeable and obstinate hæmorrhage. I have no wish to deny that leeches may have a soothing influence, and may thus facilitate the action of the mydriatic, though I myself never adopt this plan. It is, to say the least, very unpleasant to the patient, and may even do him more or less injury.

I believe that a remission of all symptoms may be brought about with almost absolute certainty by paracentesis, the injection of morphia at night, (12 or 15 drops of a solution of 1 part of acetate of morphia to 100 of distilled water), and by a few grammes of chloral.

If an attack of plastic iritis have terminated in more or less numerous synechiæ, the question will arise as to whether any operative procedure should be had recourse to. A general rule is that atropine should be continued during three or four weeks after all symptoms of inflammation have disappeared. Synechiæ may then sometimes be seen to rupture tardily. The period of irritation once passed, atropine and eserine alternatively should be applied so as to break down any persistent synechiæ ; but we must not here fall into any illusions relative to the action of eserine, which in an eye under atropine will always be tardy and partial. The artificial rupture of posterior synechiæ cannot be considered indicated unless they have caused severe and obstinate iritic pain, or unless their presence evidently predisposes to relapses. Clearly, however, a relapse may also be due to the fact that the patient is still under the same constitutional diathesis as that which provoked former attacks.

Among the various procedures of artificial detachment of synechiæ, or *corelysis*, the one proposed by *M. Passavent* is incontes-

* $\frac{1}{6}$th to $\frac{1}{3}$rd of a grain.

tably the best. It consists in making a small peripheral opening in the cornea, and drawing out with forceps the fold of iris corresponding to the synechia; the margin of the pupil once freed, this fold is to be released. This method has one great advantage over all operations in which a blunt instrument is passed between the attachment of the iris and the capsule of the lens, namely, that the latter structure, which is so delicate and easily injured, need not even be approached. I think no one will accuse me of bias if I say that all the methods of *Streatfeild* and *Weber* have played a greater part in text-books than in actual practice.

When constant relapses have left numerous synechiæ, and when a rational and carefully followed out plan of treatment has failed to insure the eye from fresh attacks, it will be better to free the border of the pupil on a large scale by making an ample artificial pupil, superiorly, if we have a choice. This course should be at once adopted, if after the formation of a posterior synechia the eye commences to bulge forwards in the ciliary region, so as to interfere with the iritic angle, and thereby give rise, perhaps quickly, to glaucomatous symptoms. Oblique illumination will at once reveal in such cases the funnel-like aspect of the anterior chamber.

Even after iridectomy has been performed, treatment must by no means be suspended. Iodide of potassium, and preparations of mercury are specially indicated in rheumatic or syphilitic subjects. Do not suppose that you can count on the absolutely certain action of iridectomy as a preventive. I would further advise you not to proceed to iridectomy during the inflammatory period, especially should syphilis have been the predisposing cause. In such cases, everything will be gained by allowing a patient to pass first through the inflammatory stage, preparing him, during that time, by energetic mercurial treatment, for surgical interference. An actual attack of glaucoma only should compel us to depart from this line of conduct; in such a case, I should prefer to relieve any threatening symptoms by sclerotomy, to be succeeded after the eye had been freed from pain by a large excision of the iris.

Serous iritis, especially if true to its type, the eye showing but slight pericorneal injection, the pupil being unaltered and moderately dilated, and disturbances of vision, if present, being due to precipitates in the aqueous humour, may require a totally different plan of treatment. This is especially the case if there is any marked tendency to glaucomatous symptoms. Here antiglaucomatous treatment should be resorted to, eserine, for instance, substituted for atropine, repeated paracentesis or a sclerotomy performed, but with the precaution of always attentively watching the patient, so as to be certain that the pathological characters of the disease are not altering, nor a form of plastic iritis becoming tacked on to one essentially serous.

It should not be forgotten that here we encounter a variety which runs a much slower course than simple iritis; and persons under treatment must be told of this, so that their patience may not be unduly tried. Abundant perspiration is the only means capable of hastening the affection. I have also seen great benefit derived from injections of pilocarpine (p. 123). At the same time, I prescribe iodide of potassium in doses of 1 to 2 grammes daily, associating with it in weak subjects, preparations of iron and quinine. Diuretic drinks, amongst which milk is especially valuable, must not be forgotten in this treatment.

From time immemorial derivation from the skin has been recommended in this tedious affection. Though myself no advocate of a treatment, the efficacy of which is very far from established, one is at times obliged to have recourse to it, by the instances of the patient or his friends. When such is the case, I think the best plan to adopt is to produce over the nape of the neck an eczematous eruption, by means of applications, daily or every two days, of cantharidine, namely:—

Cantharidine	1 part.
Sulphuric ether, and . . . . . } Rectified alcohol, ãã. . . . . . . }	100 parts.

This application is far from being pleasant, and recourse should be had to it only if the serous iritis tends to become irido-choroiditis, as shown by the appearance of fine filaments in the anterior portion of the vitreous humour.

Parenchymatous iritis is evidently the variety which calls for most energetic treatment. Should a gummy form of it appear to be assuming at all undue proportions, mercurial inunctions of from 12 to 16 grammes a day (ʒiij to ʒiv), must be had recourse to. Together with the above frictions, I prescribe enemata of iodide of potassium, 2 to 3 grammes daily, further endeavouring to keep up the mercurial inunctions as long as possible (2 to 4 weeks), by rendering the mouth scrupulously clean, with gargles of chlorate of potassium. After this treatment, the iodide of potassium should be continued for one or two months longer. I have of late, in severe cases added to the above, injections of pilocarpine, instead of sudorifics such as decoction of Zittmann.*

Should patients rebel against such energetic treatment, together with the enemeta above described, a table-spoonful of syrup of Gibert morning and evening may be given and continued as long as possible.

Experience has taught that in pure parenchymatous iritis atropine must not be too much pressed in order to obtain dilatation at any price, when perhaps tough membranes or large nodules of lymph may oppose insuperable obstacles. Two or three instillations should be sufficient, nor should the eye be irritated by collyria too frequently repeated, more especially as atropine is quite powerless in such cases.

Another fact learned by long observation is, that in cases of iritis, where the tendency to proliferation of tissue is very marked, if an artificial pupil be necessary, too much haste should not be shown in performing the operation. Indeed, the attack may be easily brought back if an eye not yet healed be submitted to operation, while the newly-formed pupil may be blocked up completely. It is much preferable, therefore, to operate during the period of complete calm, and after the patient has undergone a course of treatment directed against the constitutional diathesis. Attempts have been made in cases where the whole anterior chamber was filled with gummy masses, to excise some of them, so as to hinder perforation, but no very brilliant results ever followed this treatment.

In those forms where the tendency to suppuration is plainly shown by the constant production of hypopion, poultices and warm fomentations are very beneficial. Moreover, poultices sprinkled with a solution of atropine, or moistened with infusion of belladonna or jasmine, are often sovereign remedies in the pain of parenchymatous iritis, and, if regularly employed, tend to shorten its duration.

* Sarsaparilla 400 parts (grammes). Digest, during 24 hours, in 24,000 grammes of water. Add

Sugar of alum (alum 4 parts, kino 1)	50 grammes.
Calomel	15 ,,
Cinnabar	5 ,,

Boil until reduced to a third of its bulk : then add

Senna leaves	100 grammes.
Liquorice root	50 ,,
Aniseed	15 ,,
Fennel	15 ,,

Infuse for a few moments and strain. Dose, half a litre morning and evening.

Buchardat, p. 260.—Tr.

In all cases of rheumatic or specific iritis, after the above treatment, the patient should be subjected to one especially framed to combat his constitutional diathesis. In this respect hydropathy, consisting mainly in dry packing, followed quickly by cold applied by means of a wet sheet, care being taken not to wet the head, has long appeared to me to be the best method. On the other hand, general treatment must not be credited with a power it does not possess, when, owing to anatomical alterations, causes exist in the eye itself which predispose to relapses. In many of these cases, therefore, it is useless to prescribe general treatment until the large segment of iris which is adherent to the crystalline has been freed by an iridectomy.

The great danger of all iritis is that by lapse of time or frequent recurrence it may finally change into irido-choroiditis. This affection is developed in numerous cases after simple iritis, though it may also appear at once and so mislead an inexperienced practitioner into supposing it simple iritis. When it appears from the first, we must distinguish between the truly spontaneous form or *cyclitis*, and that form in which the disease has been transmitted by the other eye, that is the *sympathetic* (traumatic).

As in iritis, so in these irido-choroidites we find plastic, serous, and parenchymatous forms. The *plastic* form is all the more difficult to distinctly see, because the products of iritis, poured into the anterior chamber or within the area of the pupil, more or less render it impossible to examine the anterior portion of the vitreous body, or to discover any of the inflammatory products, deposited there, from the anterior portion of the inflamed uveal tract.

Attention should be attracted to the iris, by the presence of any vascularity, if parenchymatous iritis is absent; for such a symptom will then denote some great disturbance in the circulation, such as could not be produced by inflammation confined exclusively to the iris. To this symptom is joined retraction of the anterior part of the uveal tract, causing in some cases great increase in the depth of the anterior chamber. Two other important points are the intense pericorneal injection, and great sensibility of the eye to touch, the pain being either common to the whole circumference of the cornea, or confined to a larger or smaller portion of it.

Serous irido-choroiditis, with the tardy course it runs, is generally much more easily diagnosed, because as the pupillary area nearly always remains clear, the existence of fine threads or of dust in the vitreous body at once reveals the nature of the case. In some cases the presence of these cannot be satisfactorily seen, owing to excessive deposits on the membrane of Descemet, extending perhaps over the iris, and accompanied with sclerosis of the lower portion of the cornea. We should in such a case, precisely because inflammatory products are present so abundantly, refer them not to simple iritis, but to serous choroiditis, and this without the slightest hesitation, for as soon as the pupil clears, examination of the vitreous body, the anterior portion of which will be occupied by numerous flakes, will show the correctness of the diagnosis. Palpation and pericorneal injection do not yield in such cases information of any great value.

Among the *parenchymatous* irido-choroidites the suppurative form does not present much difficulty in diagnosis. In this, without any well-marked symptoms of inflammation, we see hypopion produced suddenly, and at repeated intervals, but the aqueous humour shows no marked cloudiness. These frequent inroads of pus, easily caused by the presence of a foreign body in the anterior portion of the uveal tract, become complicated in time with symptoms of suppurative iritis, the intensity of which in no wise corresponds with any form developed originally in the iris itself.

Gummy irido-choroiditis is an affection which may be justly called unforeseen, when it breaks out in the ciliary body. Here, within the space of three or four days, a prominence like a staphyloma will appear on the anterior portion of the sclerotic, so marked that, in cases in which it is seated under the upper lid, one might almost be disposed to believe that previous examinations had not been made with sufficient care.

I now show you a patient, aged 40, who within the space of four or five days, having had for some time previously symptoms of simple iritis, perceived beneath the upper edge of the cornea a prominence as large as a bean, purple in colour, raising the upper lid considerably, and threatening to cause the eye to remain permanently open. Under the action of very energetic treatment, this staphyloma, formed by a gumma which had distended the fibres of the sclerotic, disappeared gradually. You can satisfy yourselves that of this grave affection nothing now remains but a flattened and deeply pigmented cicatrix, bearing no resemblance to any other kind of cicatrix, except possibly one produced by some unusual wound. Vision, which had in part been preserved, is now lost, but the patient esteems himself fortunate in that the form of the eye has not been altered, and that he has not been in any way disfigured.

The diagnosis will be much assisted if gummata in the iris happen to have preceded those in the ciliary body. As a rule a considerable cloudiness of the vitreous, and great diminution of vision, announce the danger which threatens the patient.

In the vast majority of cases irido-choroiditis is propagated from the iris to the fundus of the eye. The symptoms which guide diagnosis are first of all the comparatively slight changes in the iris as regards the amount of disturbance to vision, and secondly the alterations in the transparency of the lens, owing to impaired nutrition, a symptom which in no wise belongs to affections of the iris proper.

LECTURE XX.

SYMPATHETIC IRIDO-CHOROIDITIS; WOUNDS OF THE IRIS; TUMOURS; MYDRIASIS; MYOSIS; HYPHÆMA.

SYMPATHETIC irido-choroiditis following inflammation in one eye, or due to a wound of the other, is generally speaking, a form of plastic inflammation marked by certain peculiarities. There is first of all the remarkable tendency exhibited by the iris to become adherent over the whole, or greater portion of its surface, to the capsule of the lens, speedily bringing about complete posterior synechia. The anterior chamber may for the moment present an infundibuliform appearance. As the result, however, of similar adhesion between the ciliary body and the sclerotic, and of a movement of contraction in the adherent portions which depresses the edge of the lens, the anterior chamber may become wider towards its periphery, while the pupil advances considerably nearer to the membrane of Descemet.

If to this characteristic appearance be added an immovable and vascular iris, which in consequence of the occlusion of the pupil forms an extended plane, the appearance will be so remarkable that, without any history of the case, a diagnosis may at once be made. At this period of the disease, the tension of the eye, which earlier may have been increased, becomes reduced, owing to the obliteration of a considerable number of vessels in the most vascular region of the choroid. More or less disturbance of nutrition supervenes in the vitreous humour, which loses transparency, while the crystalline becomes opaque and partial, or total atrophy ensues.

In certain cases, generally those of young persons, this atrophy is only transitory, owing, perhaps, to the excretory territory of the eye having become once more free, and the pericorneal trabecular tissue having filled out, consequent on retraction of the ciliary body. The cornea, although like the whole anterior portion of the eye, flattened, regains as time goes on its normal curvature. The neoplastic masses undergo such a degree of atrophy, and the tissue of the iris becomes so thinned, that a very considerable amelioration in the pupillary area results. As the vitreous grows clearer, we may perhaps perceive that the posterior portion of the eye, and even the optic nerve, under the form of choroido- or neuro-retinitis, has shared in the inflammatory process. This affords an explanation of how it is that the impairment of vision persists in spite of the general improvement.

In a certain number of cases, the sympathetic inflammation commences under the form of serous irido-choroiditis. This, if it does not change its character, is much less to be feared. But unfortunately, in the majority of cases, and in spite of the best treatment, it assumes, eventually, the dangerous type of adhesive and retractile irido-choroiditis.

The numerous researches made relative to this affection have demonstrated that the nervous apparatus of the eye transmits the inflammation. But though it cannot be gainsaid that the ciliary nerves here play the chief parts, it is now proved that the optic nerve has also a considerable share in it. This is a fact which therapeutics should carefully note.

The greatest risk of sympathetic transmission is incurred when a foreign body, or a contracting wound, occupies the territory of the eye richest in ciliary nerves, that is to say the ciliary body. As more than ordinarily dangerous should be mentioned entanglements of the iris, of the ciliary processes, or of a portion of the capsule, in a wound on the margin of the cornea. Thus every attempt should be made to avoid operations that might establish such conditions, and to prevent by excision, capsulotomy, and iritomy, any dragging on the strangulated parts.

Wounds likely to contract, and irritating foreign bodies, are much less dangerous when they occupy positions beyond the zone of filtration and the ciliary bodies. It must not, however, be forgotten that wounds complicated by an escape of vitreous and luxation of the lens often exercise an action on parts at a considerable distance from the original seat of injury.

It is now proved to demonstration that, apart from all traumatic causes, the contraction of new tissue, itself formed from spontaneous intraocular inflammation, may exert as baneful an influence as any wound. Let me remind you that this contraction is sometimes powerful enough to cause detachment of the most anterior portion of the ciliary body. I regret to have to say that surgical intervention, in the form of an artificial pupil, may in such case favour the extension of sympathetic irritation to the other eye, which till then had remained unaffected.

The danger of transmission of inflammation after a wound, is at its height during the five weeks following the first week after the accident. During the first week itself there is no danger of sympathetic inflammation. Unfortunately there exists no period within which the danger can be said to have disappeared, and after twenty-six years I have seen an eye become a menace to its fellow. Displacements of foreign bodies, hæmorrhagic effusion, the gradual contraction of cicatricial tissue, the disturbance of calcareous or osseous deposits, may all open fresh paths for irritation; while, besides all this, external irritations of such eyes—as, for instance, the wearing of an artificial eye—may awake the dormant tendency to sympathetic inflammation.

As bearing on this, eyes which in consequence of glaucoma have undergone quasi-intraocular section of their afferent and efferent nerves are much less likely to be dangerous. So also an eye affected with large ectasias is not nearly so much to be dreaded as one affected with partial atrophy. The destruction of the intraocular nerves by suppuration would offer a perfect guarantee if only there could be any certainty that all the nerves, the termination of the optic included, had disappeared. Although the stumps of eyes which have suppurated may be considered as the least dangerous, they cannot be looked on as above suspicion; and therefore any treatment which should attempt by artificial suppuration to secure an eye from sympathetic inflammation ought to be condemned as radically bad. (*Arn. Alt.*)

It would be a great gain if the surgeon could in any way be warned of the danger threatening his patient. Not uncommonly, however, sympathetic inflammation bursts out on a sudden, without the slightest hint or warning having been conveyed, either by fatigue or impairment of accommodation, by pericorneal injection, or by the slightest photophobia. Careful inspection of the anterior portion of the vitreous with a plane mirror should always be made, in order to detect any transient cloudiness of the aqueous humour, or any fine deposits on the membrane of Descemet. These are intimations of approaching danger.

On the other hand, the irritability, photophobia, and flow of tears, which may be seen in an eye when its fellow has been injured, must not be straightway taken as manifestations of sympathetic transmission. Although I hold it is better to be over cautious in this matter, the removal of an eye, especially in young persons, is a sacrifice so serious that it must not be asked for without very urgent cause. To consider every eye which has lost the power of vision as a fitting object for enucleation, and especially for microscopic examination, is not to be sufficiently careful of a patient's interests. For this reason the proposal of *MM. Boucheron* and *Schœler*, to practise a sort of abrasion of the whole posterior part of the eye, by dividing the optic and ciliary nerves, merits every attention.

The principal object of all treatment in sympathetic ophthalmia should be to remove as speedily as possible sympathetic irritation, and this by enucleating the injured eye. As it has been alleged that after the first symptoms of the disease have thoroughly established themselves, even removal of the cause will have but little influence on the course of the affection, it is very advisable to watch a patient carefully, so as to be able to remove the organ so soon as any signs of danger show themselves. As a general rule, enucleation should be decided on immediately any of the prodromata of irritation are seen, such as fatigue, reduction in the accommodation, etc.

There need not be the slightest hesitation in proposing the operation in the case of an eye that is useless for vision, and causes pain, even though a certain interval may have elapsed since the original injury.

Removal, too, of any eye is justified when a foreign body is lodged within it, and when it is tender to the touch, even though the foreign body may have become encysted. The same remark applies to the case of any large cicatrix on a lost eye, if it is more or less sensitive when touched.

The position of any surgeon becomes truly painful who finds himself in presence of a case where a wound of one eye has induced sympathetic ophthalmia in the other, with such loss of sight that the wounded eye still preserves the better vision of the two. Ought a patient, under such circumstances, to be deprived of the organ which, in its functions, is the more perfect of the two, especially when its fellow is attacked with an inflammation which defies nearly all treatment ?

Here naturally one would gladly take shelter under any proceeding which should not necessitate the removal of an eye still to some extent available for vision, if only such a one could be found as effectual as enucleation. With this object *Von Graefe* proposed section of the ciliary nerves in the position corresponding to the wound which had induced sympathy of the affected eye. I must remark, however, that the somewhat coarse incisions which must of necessity be made in cases already far advanced, where there has been liquefaction of the vitreous and hæmorrhages within the eye, will not preserve eyes, still to a certain extent useful for vision, from partial or total atrophy. Moreover, this remedy by no means gives the same security against relapse as enucleation does.

In such a case there might be a better chance of saving the eye by extraocular section of the ciliary nerves, the adjoining surface of the optic nerve being closely followed with the scissors. The rectus muscle corresponding to the most sensitive portion of the ciliary region must be divided, so to enable the posterior segment of the eye to be more easily reached; then, with scissors closed, the optic nerve, which should be very carefully dealt with, is to be felt for, and the instrument being applied closely to the sclerotic, all the nerves within reach round the optic nerve are to be severed by small snips.

In all cases where an eye has been the cause of sympathetic irritation, and is itself hopelessly lost, it must be removed at once in order to allow of any hopes of success in the treatment of its fellow. Any halting between two opinions as to whether some other mode of treatment would not do as well, or as to whether some operation might not be substituted for enucleation, or any misgiving that enucleation, if practised during the active period of an inflammation, may aggravate the symptoms, is in such a case disastrous beyond measure.

Enucleation practised without delay, and followed up by very energetic treatment such as I described in severe cases of parenchymatous iritis (p. 184), may still yield most satisfactory results. I quote a case in point in my large work on Ophthalmology. In that case, enucleation performed the day after sympathetic irritation had appeared, did not prevent vision from temporarily being so much reduced so as to permit of a mere perception only of light, but eventually by energetic treatment, sight was completely restored.

An attempt must be made in enucleation to include a considerable portion of the optic nerve, seeing that we cannot know up to what point it has had a share in the inflammation. Hence the advice of *M. Hasket Derby* to resect a second time a portion of nerve, with its surrounding tissue, when in spite of enucleation, sympathetic ophthalmia is still progressing. However, it might perhaps be difficult to find many patients who would consent to a fresh operation.

In proportion as I recommend immediate enucleation when there is the slightest suspicion of danger to the other eye, not shrinking from the sacrifice of any injured eye, or any eye useless for vision, so do I equally dissuade from all interference with one in which sympathetic symptoms have appeared. The peculiar character of the inflammation, determining as it does extensive adherences of the iris, and union between the capsule, the newly-formed membranes and the atrophied remains of the iris, the tendency to contraction of the new plasma deposited upon the ciliary bodies, finally the share taken by the anterior portion of the vitreous humour, which becomes liquid and opaque, are all so many good reasons for rigorously abstaining from any meddling with such an organ as the eye (*Critchett*).

We feel indeed sometimes compelled by the acute suffering which a patient with an attack of glaucoma, together with complete posterior synechia, endures, to resort to surgical interference; but such interference should always be limited to paracentesis or sclerotomy. You must never think of attacking the iris by excision, for however thin this diaphragm may seem to be after atrophy, even to translucence, you could not in the great majority of cases detach its remains from the capsule. Even were you to succeed in so doing, great irritation would result; while owing to occlusion of the new pupil, and aggravation of the functional state, any temporary benefit that might have been gained would be eventually more than lost.

Attention should be directed wholly to energetic mercurial treatment and subcutaneous injections of pilocarpine, in order to obtain abundant diaphoresis. Any improper use of atropine should be carefully guarded against, first of all, because when the iris is bound down to the capsule of the lens, this agent is perfectly powerless; and, secondly, on account of the tendency to glaucoma. In such cases I have sometimes obtained satisfactory results by the use of eserine, or a collyrium of pilocarpine, thus,

Hydrochlorate of pilocarpine	1 part.
Distilled water	100 parts.

By abstaining from all operations, and by pressing treatment vigorously, the inflammatory condition may sometimes be subdued, and the exudations deposited in the field of the pupil so far reabsorbed as to permit of examination of the fundus, with perhaps sight sufficient for the patient to guide himself. He will be fortunate, then, if he does not fall into the hands of some inexperienced practitioner, who by operations will try to improve vision, and thereby to a certainty expose him to a return of all the grave dangers from which he had escaped.

If the crystalline be opaque, while the field of vision is normal and the perception of light good, the temptation becomes excessive to try and restore some vision to such unfortunate sufferers. No operation should be attempted until several years have elapsed since complete extinction of the sympathetic ophthalmia, and unless there is every apparent prospect that surgical interference will not once more arouse the dormant symptoms.

In these cases the crystalline should be removed through a large linear incision, comprising the cornea and the iris. After the escape of the lens, a triangular flap of iris must be excised with the scissor forceps, the greatest care being taken to avoid any dragging of the ciliary body. But whatever care be exercised in this operation it will still be in most cases followed by occlusion of the pupil, a condition which must be subsequently remedied by iritomy. Knowing the complexities and difficulties which surround these operations, such interference ought only to be resorted to if the patient still preserves a fair amount of vision.

To direct aright the treatment of spontaneous iridochoroiditis, it will be necessary to seek out the causes to which its presence is due. In young women, or in those at the turn of life, it may often happen that there are uterine affections calling for special attention. Proper treatment in this direction will undoubtedly often exercise a favourable action on the course of the eye affection.

When occlusion of the pupil or complete posterior synechia has become developed, the same diffidence need not be felt as in the case of sympathetic ophthalmia. An artificial pupil should be made in good time, so that the surgeon shall not be taken unawares by the apparition of glaucomatous symptoms. These increase the dangers of the operation owing to the increased difficulty of avoiding entanglement of the iris in the large section which must necessarily be made. It is well, however, in these cases to wait for a period of calm, and to carefully avoid a too peripheral section; this, together with instillation of eserine, before and after the operation, will be the best means of preventing any entanglement of the iris in the angles of the wound. I have seen a previously sound eye become attacked after a badly performed iridectomy, and the affection return in the fellow eye with all the symptoms of sympathetic inflammation.

I have nothing to add as regards the treatment of these various forms of iridochoroiditis. They must be energetically dealt with according to the directions given for treatment in the various forms of iritis (see p. 178).

Very frequently attacks of iridochoroiditis are caused by some violence, with or without the presence of a foreign body in the eye. There will often arise much difficulty in giving a positive opinion, in these cases as to whether or not the wounded organ encloses some irritating substance. Both for diagnosis and treatment attention should chiefly be directed to the ciliary injection, its persistency, its tendency to appear on the slightest provocation, as also to any extreme sensibility of the eye, even where symptoms of atrophy have already appeared. Moreover, an attack of glaucoma in an eye where atrophy has already commenced, will necessitate the abandonment of all direct treatment, save and except immediate removal.

Wounds confined to the iris itself, occasioned by some concussion of the globe, generally take the form of a separation over a certain extent of the iris from its ciliary insertion. This *iridodialysis* gives rise to the formation of a double pupil, which may be readily detected with the ophthalmoscope. However small the rent in the margin of the iris is, light will be transmitted at the points where the membrane has been torn away. The danger of such a detachment becoming larger and eventually so complete as to determine an irideremia, appears to me quite imaginary.

As the result of a contusion or violent shock, another form of injury may be witnessed near the insertion of the iris. It is generally complicated with luxation of the lens, and consists in a partial (or total) *turning back* of the pupillary margin. The result of this is to place a portion of the iris in contact with the ciliary body, simulating thereby very exactly the appearance of an artificial pupil made peripherally. Here, however, the ciliary processes covered by the iris, cannot be seen with the mirror.

It would be interesting in treating a recent case of such an injury, to try up to what point repeated instillations of eserine might have the power of restoring the pupillary margin in front of the lens. As regards traumatic iridodialysis the only treatment of any use is to hasten the absorption of effused blood by means of a compress bandage, without cherishing the slightest hopes as to the possibility of reunion of the iris. The formation of a double pupil does not call for any interference.

But such is not the case, when by reason of some violence a foreign body has become impacted in the iris. An attempt at removal should here always be made before it has had time to set up symptoms of irritation. With this object an incision should be practised with the narrow-bladed cataract knife (but not with an iridectomy knife, which might easily push the foreign body inwards) between the foreign body and the margin of the cornea. An effort is then made to sweep the intruding substance away by the sudden rush of the aqueous humour. There is no occasion to be anxious as regards the prolapsus, which may easily be reduced if before and after the operation care has been taken to instil eserine at intervals.

In case the above plan should not succeed an attempt may be made to urge the body outwards with a caoutchouc spatula, which should be passed over it on its flat, but once introduced should be turned on its edge. If such a spatula be not at hand a Daviel's curette may be used, though this is more irritating to the iris. If the eye has already suffered a certain amount of irritation, and the portion of iris next to the foreign body has become adherent to the lens, then certainly the safest plan will be to excise this portion of it altogether with the foreign body included. To do this the forceps are to be introduced into the section open, and the blades passed one on each side of the foreign body.

No treatment other than that of removal will be of the slightest use in cases of *tumour* of the iris. Among those most commonly met with are epidermoid growths and cysts.

As regards the small epidermoid tumours (bead-like) which are occasionally seen in the iris after wounds, and which may contain a cilia that has been driven into the anterior chamber, they result from the actual grafting upon the iris of the piece of epidermis that was carried inwards.

True, greyish, semitransparent cysts, containing fluid, are also in at least four-fifths of all cases, of traumatic origin. Into their cyst walls no elements, other than those which the iris proper contains, ever enter, and therefore all these cysts must be looked on as caused simply by a doubling or pinching up of a fold of iris, with retention of the fluid secreted by it (the aqueous humour), and gradual distension of this fold. Such distension may also result from a horse-shoe shaped synechia having isolated any one portion of iris from the rest. Finally, true cystoid degeneration of the iris as a whole, is met with as a sequela of injuries sufficiently severe to have dislocated the lens into the vitreous, and to have more or less doubled the iris back on itself. A certain number of authors (*Sattler, Hosch*) are disposed to admit the formation of such cysts by a process of dissociation in the elements of the stroma of the iris, which the penetration of a tissue element has in some mysterious way brought about.

It is beyond all doubt the case that the various kinds of cysts, whether with solid or fluid contents, have a marked tendency to increase, and to more or less compromise the safety of the eye, threatening even sympathetic irritation in the other. Such cysts should therefore be removed as early as possible, before they have attained such a size as to render successive incisions and operations necessary. Simple puncture is quite insufficient. If the cyst be small, an attempt should be made to pass a narrow cataract knife between it and the corneal margin, without causing rupture; it may then be seized with forceps, the blades of which are dentated laterally and inferiorly. It is especially necessary in the case of epidermoid tumours to avoid tearing them at the moment of extraction. In the case of large serous cysts, removal *en masse* is a very difficult matter, for their walls will be ruptured to a certainty, and moreover the operation itself is dangerous to the lens. It should not therefore be attempted except where the irritation present in the eye renders it absolutely necessary.

Among benign tumours of the iris there still remain to be mentioned pigment spots and warts, or *nævi*, which never require to become subjects of treatment. To these also must be added granuloma of the iris, which may, however, call for particular treatment if its origin be traumatic.

Granuloma is a tumour observed almost exclusively in children, and represents neither more nor less than a granulation of the iris, which has as a rule been the seat of some inflammatory irritation. The granulation rarely fills the anterior chamber, or induces perforation, after glaucomatous symptoms have appeared. This tumour is generally developed on an iris which has been exposed owing to some previous perforation.

Granulation of a prolapse of the iris will be much more frequently witnessed as a sequel of wounds of the eye, or large perforations, and this to such an extent that actual tumours may be developed liable to be taken by an inexperienced observer for malignant growths. These granulomas bleed on the slightest touch, often last many months before drying up, and leave the eye considerably atrophied. Similarly to the granulomas developed occasionally in children after removal of a staphyloma, where sutures have not been inserted in the conjunctiva, they cause scarcely any pain, and eventually disappear spontaneously. No treatment such as cauterisation or removal is admissible.

I will here merely mention those very rare cases of melano-sarcoma, of true tubercle, or of leprous tubercle, of which the iris may become the seat; seeing that in the first of these affections only is immediate removal of the eye called for.

Before terminating the account of the treatment of affections of the iris, I must speak of the disturbances of function to which it is liable, and also of the alterations that are met with from time to time in the contents and form of the anterior chamber.

The abnormal dilatation of the iris which accompanies paralysis of the third pair of nerves is an incomplete form of mydriasis. To become complete, as when atropine or duboisine is used, the dilatation must be increased by irritation of the fibres of the sympathetic simultaneously with paralysis of the sphincter. Such a mydriasis is observed consequent upon disturbances in the eye; but it does not necessarily imply complete or incomplete paralysis of the ciliary muscle, or, in other words, reduction or abolition of accommodation.

It might be difficult to comprehend how any single cause could at one and the same moment act as a paralysing agent to one nerve and a stimulating to another, did not experiments on animals show that one and the selfsame irritation if applied to the fibres of the sympathetic stimulates, if applied to motor fibres depresses and paralyses.

Mydriasis is observed as an isolated and passing symptom, in paralysis of the third pair, and is then symptomatic of ataxia. It is also met with as a result of irritation of the sympathetic and spinal cord, as an early symptom of general paralysis, in certain forms of mania, in hypochondriasis, in some varieties of epilepsy, and at the commencement of epileptiform attacks. In children the presence of worms is often connected with mydriasis, as also spinal irritation caused by onanism. Also the intoxication produced by certain narcotics, and by the poison of diphtheria, are characterised by mydriasis, together with, in the case of the latter disease, paralysis of accommodation. As a general rule, mydriasis which leaves the accommodation untouched, is of spinal while that which paralyses it, is of cerebral origin.

Treatment must necessarily be based on a removal of the exciting cause. Therefore it becomes of the greatest importance to discover to what extent the accommodation has suffered, and also the amount of functional disturbance as revealed by the impairment of near vision. Reduction in the amplitude of accommodation will be more felt by the hypermetrope, who will thereby lose the power of distant vision, and in a greater degree of close vision. The emmetrope, by the reduction of his accommodation, will be only prevented from seeing near objects, while his vision for distance will have lost none of its acuteness. Finally, the myope will experience the least discomfort, for even with complete loss of accommodation he will still be able to see near objects if his myopia be sufficiently high in degree. Nevertheless, even with him distinct vision will be limited to a distance proportional to the amount of his myopia. The researches necessary to determine the foregoing points, need present no difficulty, even to those unaccustomed to examinations of this nature, more especially if it be not necessary to determine the amplitude very accurately, or express it in figures.

Inasmuch as we have now at our disposal two powerful myotics, eserine and pilocarpine, no one would dream of having recourse to the old methods of causing contraction of the pupil, by stimulating the conjunctival sac, or by irritating the retina or the accommodation. Solutions of the above myotics, of a strength of 1 part in 200, should be prepared, and one drop instilled into the eye night and morning. Care should be taken to allow longer intervals to occur between each application in proportion as the action of the drug tends to last. Its use should be omitted as soon as the contraction of the pupil has become permanent. If on the other hand, it be noticed that the action of the mydriatic remains unchanged during several weeks, the conjunctiva should no longer be harassed by a treatment that is evidently powerless for good. Weak continuous currents should next be tried. At night a *Trouve's* battery of two cells should be used, the positive pole being placed, by means of a binder, over the closed lids, the negative upon the back of the neck.

Abnormal contraction of the pupil is met with under two different conditions. There is a *spasmodic* form, in which the muscle of accommodation generally takes a principal part, and a *paretic*, in which only the dilating power of the pupil is affected, contractility of the sphincter and of the muscle of accommodation not being in any way altered as regards innervation.

The spasmodic form is met with most frequently at the commencement of cerebral affections, in meningitis, in the irritable period of apoplexy, in the excitement stage of intoxication from alcohol, chloroform, opium, and nicotine. It is also seen at the beginning of an hysterical attack.

The paralytic form is chiefly met with in locomotor ataxy, when the spinal lesions are well marked. In these cases atropine acts very feebly, but, nevertheless, it is easy to make certain that the contractility of the sphincter has undergone no change, for if the patient look suddenly at something placed close to him, under the influence of accommodation, the pupil will contract still further. The myosis sometimes disappears in ataxic patients, in proportion as symptoms of atrophy of the retina and paralysis of other nerves supervene; but it may also be found years after, when absolute blindness has become confirmed. Sometimes myosis may be met with as a sequel of direct injury of the spinal cord, in the cervical region. In other cases it may result from temporary compression of the cervical sympathetic, due to enlarged ganglia or to goitre.

Myosis scarcely ever becomes the subject of any special treatment; but it is necessary that the surgeon should be well acquainted with it as a symptom which may guide him to the diagnosis of various affections of the nervous centres.

I will mention merely in passing an extremely rare form of clonic spasm of the iris, known as *hippus;* and also of a tremulousness either of part or of the whole iris, which, when deprived of the customary support of the lens, swings backwards and forwards in the eye. This condition, known as *iridodonesis* calls for no special treatment, but is an index of any change of position in the lens.

Nor shall I stay to consider the changes in shape which the anterior chamber may undergo, owing to the various anatomical lesions to which the uveal tract is subject. The change in its contents must, however, delay us for a moment.

The aqueous humour may be mixed in varying proportions with pus, which, sinking down, forms an *hypopion*. The knowledge now possessed as to the origin of the leucocytes, which form the collection of pus, enables me to say that it is chiefly the vessels which pass close to the anterior chamber, in the ciliary body, and venous circle of the iris, which furnish it (*Stromeyer*). It may also, it is true, be formed in severe suppurating affections of the cornea, by migration through the cornea itself; but the greater portion will have generally entered the anterior chamber, at the moment of penetrating the cornea. The theories of the abscess having opened into the chamber by perforation, or suppuration of the epithelial layer of Descemet's membrane, are now almost wholly given up.

Thus, in suppurative iritis, the pus in the anterior chamber should be looked on as an invasion of leucocytes, in which the vessels proper of the iris play a comparatively minor part. Moreover, those hypopia which are so freely formed in purulent choroiditis, in the absence of all irritation of the cornea or iris, show clearly how easily this migration of leucocytes may be effected through the vessels of the ciliary body. The activity of this movement is sometimes so great that a variable quantity of red blood corpuscles are found mingled with the pus.

While collections of pus, arising from diseases of the ciliary body and iris, show a considerable degree of fluidity, those which occur as complications of corneal affections contain a large proportion of fibrinous and coagulable elements, and are often only to be removed as compact masses. In proportion as the collection of pus is rapidly produced, while at the same time the accompanying irritation is slight, the hypopion will contain fewer transformed leucocytes, and will be therefore fluid, and easy to remove.

The indications for treatment will be in accordance with the causes which have concurred to produce the hypopion; but as a general rule, if this occupy more than one third of the chamber, it should be allowed to escape. In the case of very fluid hypopia, simple evacuation with a stop needle, will be sufficient. Glutinous hypopia, accompanying suppurative affections of the cornea, require on the other hand very free incision, with a lance-shaped knife, followed if necessary by iridectomy; such hypopia may however, be evacuated better where abscess or ulcer of the cornea coexists, by means of the keratomy of *Sœmisch*. Let me remind you that eserine is a valuable agent in preventing the formation of pus in the anterior chamber. The deposits which are so rapidly formed in suppurative choroiditis, do not as a rule call for any direct treatment.

Collections of blood in the anterior chamber, the result of contusions, and constituting what is known as *hyphæmata*, require as a rule no other treatment than the compress bandage and atropine. On no account should blood, which has collected spontaneously in the anterior chamber, after iritis or glaucoma, be evacuated;

for when this is done, the relaxation of the eye consequent on paracentesis, causes a greater collection than before. These collections sometimes remain during months in eyes that have undergone iridectomy for the hæmorrhagic form of glaucoma. Repeated instillations of eserine, or pilocarpine, with large doses, of quinine, may here be of some service. Vicarious hyphæmata, supplementing the menstrual discharge, and those which some patients can produce at will, need only be mentioned as very curious and rare phenomena.

The anterior chamber may become the receptacle of foreign bodies of various kinds, which may remain there for considerable periods without producing any serious symptoms, especially if they be such as do not undergo oxydation or decomposition. Frequently these foreign bodies, such as remains of the capsule, fragments of steel, etc., have been impacted originally in the lens, and when this has become absorbed, have dropped into the anterior chamber. Their extraction, in accordance with the principles laid down when speaking of foreign bodies in the iris (p. 197), should be effected without delay.

I would also strongly insist on the necessity of removing forthwith any organic matter, such as ciliæ, portions of epidermis, small flaps of conjunctiva, which may have been driven into the eye, for their presence is very likely to conduce to the formation of epidermic or epidermoid tumours.

I will only notice in passing cases in which entozoa, and especially *cysticerci*, have been found in the anterior chamber. It is a singular circumstance that although the cysticercus is not particularly rare in France, and has been found in every other portion of the eye, there is no case on record where a cysticercus has been found in the anterior chamber in that country. If, however, such a case were to present itself, an incision should be made laterally into the vesicle, and due precautions having been taken not to wound the parasite, an attempt should be made to expel it with the rush of aqueous humour. In order to avoid as much as possible prolapse of the iris, eserine should previously be dropped into the eye; if this be done, any portion that subsequently presents in the section may be easily returned. The section itself should always be 3 or 4 millimetres in length. Excision of the iris ought only to be performed in cases where unusual difficulty has been experienced in accomplishing its reduction.

DISEASES OF THE CHOROID.

LECTURE XXI.

ANATOMY; SCLERO-CHOROIDITIS, ANTERIOR AND POSTERIOR.

The plan of these lectures will not permit of any very profound study of the anatomical structure of the choroid. I must therefore confine myself to giving you a short sketch of the peculiarities noticeable in this the vascular membrane of the eye.

Its essential portions are the vessels and non-striated muscular tissue, bounded by the adherent and anterior portion of the uveal tract. As a whole, it consists of a stroma, characterised by numerous stellate and pigment cells. Five layers are generally spoken of in the choroid; but it would be better to subtract from these the innermost one,—that is, the pigmental epithelium, which, by its filiform prolongation into the rods of the retina, belongs both histologically and embryonically to that membrane.

There are then four layers remaining, as follows: the anhistic or vitreous, the chorio-capillaris, the stroma, with its large arteries and veins, and the suprachoroidal layer. According to a most competent investigator, *M. Iwanhoff*, an exact histological division into four layers can not be made. Lately, however, the idea has found expression that not only can such a division be artificially made, but that it can be shown to exist as a reality by the fact that there are true layers of endothelium sheathing the vessels, and connected one with the other. This would explain the course which the amœboid corpuscles take in inflammation, in order to form purulent deposits in the choroid.

According to *M. Sattler* the pigment epithelium of the retina is first of all in contact with the vitreous lamina which covers the capillary layer or chorio-capillaris. Beneath this would come a sheet of endothelium, resting on very fine elastic reticulated fibres, not enclosing pigment cells, but only minute arterial and venous branches. This elastic network would be divided off from the coarser network of pigmented stroma, which contains the large vessels, by a second sheet of endothelium; and lastly, the layer of pigmented stroma would rest on a laminated endothelium, that is, on the supra-choroid.

The anhistic or vitreous membrane covers the choroid uniformly, from the optic nerve; but, near the ciliary body it loses its smooth aspect, presents cracks and inequalities, and forms the reticulum of the ciliary body, a network of minute grooves, in which the retinal pigment is laid down. In proportion as this network approaches the iris, its meshes become smaller, and in proportion to its distance posteriorly from the ora serrata, the anhistic membrane has a smoother surface.

The most external portion of the choroid is composed of a double sheet of membrane, formed by very closely arranged meshes of fibres. One of these sheets, with stellate and pigment cells, remains adherent to the sclerotic after the choroid has been removed, and has received the name of lamina fusca; the other becomes detached, and has been called the *lamina supra-choroidea*. Between the two is found, as *M. Schwalbe* has shown, an endothelium with cells, similar to leucocytes, and free nuclei.

From this layer, known as the supra-choroidal, fibres advance to form the stroma of the choroid. Consequently, between the most internal sheet, that is the suprachoroid, and the anhistic or hyaloid membrane, the layer of choroidal stroma exists with its characteristic pigment cells, its rich plexus of vessels and its chorio-capillaris. In proportion as we approach the chorio-capillaris, its fibres become fewer and thinner, and eventually only an anhistic substance, perfectly diaphanous, remains.

The elastic elements predominate in the posterior region of the choroide, while the cellular tissue abounds chiefly in the anterior, and occupies mainly the space between the ciliary muscle, and the remains of the vitreous membrane, the reticulum of the ciliary body. Even along the course of the vessels, it is extremely difficult in the posterior portion of the choroid to discover any elements of cellular tissue.

Beyond the ora serrata, the choroid is raised up into longitudinal folds, which to the number of eighty, or thereabouts, are continued to the insertion of the iris. This folded portion, covered by a thick layer of retinal pigment, forms, after it has left the ora serrata, together with the ciliary muscle, which it envelopes, the *ciliary body*. It is true that along the vessels the choroid encloses some non-striated muscular elements, but in man only in very small proportion, whilst in the ciliary body, these muscular fibres constitute a regular band, prismatic in form, the sharp edge of which looks towards the posterior pole of the eye.

The ciliary muscle is in contact by its external surface with the suprachoroid; its anterior is directed partly towards the spaces of Fontana, and partly towards the ciliary margin of the iris, which separates it from the anterior chamber. The whole of its internal aspect and a portion of its anterior surface, are furnished with ciliary processes.

The larger, that is, the external portion of the ciliary muscle, runs longitudinally, forming lamellæ parallel to the sclerotic. The most internal and anterior portion of the angle formed by the ciliary muscle, is occupied by the circular fibres or muscle of *Müller*. Between these two principal portions, is a third badly-marked layer of radiating diverging fibres (*Iwanoff*). It is known, that according to the functions which the dioptric apparatus of the eye is called on to fulfil, one or other of these muscular portions will be unduly hypertrophied. In persons who make special use of their accommodation, that is in hypermetropes, the circular muscle will be the better marked of the two, in myopes, who are obliged to relax their accommodation, the radial or external portion of the muscle of Brücke will predominate.

The choroid is supplied with blood through two main channels. Hence it follows, that as regards its nutrition, it may be divided into two portions. The posterior or choroid proper, is nourished by the short posterior ciliary arteries; while to the anterior portion of the uveal track, namely, the ciliary body and iris, blood is conveyed through the long posterior and anterior ciliary arteries. The most anterior portion only of the choroid receives an additional supply from some recurrent branches, the anterior ciliary arteries. On the other hand, all the blood from the uveal tract passes off by the venæ vorticosæ, excepting a very small portion coming from the ciliary muscle, which flows away by the anterior ciliary veins.

The arteries, which anastomose but slightly, are directed forwards, and dividing dichotomously, terminate in a capillary layer called the chorio-capillaris. This is characterised by the large size of the terminal branches. The interspaces of this plexus of capillaries are occupied by homogeneous amorphous matter, as is also the vitreous membrane which rests on the chorio-capillaris. This chorio-capillaris covers the whole choroid from the entrance of the optic nerve to the ora serrata. The whole of the venous blood is collected into five or six vasa vorticosa, which pierce the sclerotic near the equator of the eye.

The nerves of the choroid belong to the third and fifth pairs, and also to the sympathetic. The long ciliary nerves, two or three in number, the short from eight to fourteen, perforate the sclerotic near the optic nerve, furnishing numerous twigs to it, and passing forwards over the external surface of the choroid, to divide dichotomously and form plexuses, one of which is peculiarly well marked on the surface of the ciliary muscles.

A chief characteristic of the suprachoroidal nervous plexus, is that it is peculiarly rich in ganglionic cells. These masses of ganglia are met with again in the interior of the choroid, along the course of the nervous fibres which accompany the vessels. They stand in some peculiar relation to the vaso-motor nerves. The nerve fibres with dark outlines are most numerous in the muscular plexus; the ganglionic, mostly bipolar cells, which this contains, are smaller than in the suprachoroidal plexus and glandular bodies of the stroma. This plexus, some branches from which are recurrent, and may be followed close up to the ora serrata, is in all probability composed of motor fibres. Nevertheless, it has not been found possible to recognise the exact distribution of the motor and sensitive fibres, or those derived from the sympathetic.

In speaking of the circulation of the choroid, I already remarked that this membrane might be divided into two distinct portions; and the same is true from a clinical point of view. The portion receiving its blood from the posterior ciliary arteries is over almost its whole extent within reach of the ophthalmoscope; while the one supplied by the anterior and long posterior ciliaries, is quite beyond it. I have already noticed when speaking of iridochoroiditis, a form of inflammation confined to the portion of choroid nearest to the insertion of the iris.

Before entering upon the subject of true choroiditis, I still have a few words to say relative to *sclerochoroiditis anterior*, and *posterior*. The former of these affections may be met with in an acute, a subacute, or an absolutely chronic form.

Acute sclerochoroiditis like *episcleritis* appears in centres near the corneal margin, and bears a close resemblance to simple inflammation of episcleral tissue. Nevertheless, it is perceived that the disease here has less tendency to assume the form of isolated nodules; on the other hand it tends more to spread, and to involve healthy portions of conjunctiva in the pericorneal injection. As regards the cornea analogous facts are observed; thus the sclerosis is not limited so nicely to the inflamed centre, but spreads over a much larger surface, overstepping the limits of the sclerotic injection. But it is chiefly towards the iris that we have a proof that the uveal tract, beneath the affected sclerotic, is involved in the inflammation. Posterior synechiæ with vascularity of the iris adjoining the centres of episcleral injection soon become visible, together with cloudiness of the aqueous humour and increased depth of the anterior chamber.

Any doubts which might be conceived regarding the nature of the symptoms will be removed as the disease progresses. The centres do not in this case as in episcleritis fade away and assume a slate colour; nor does the sclerosis of the cornea simultaneously grow less, but generally speaking the inflamed parts lose their red blush and extend, while the cornea adjoining becomes so sclerosed as to appear like the sclerotic. In this way the line of demarcation between it and the staphyloma more or less completely disappears. Exceptionally, however, when numerous centres of episcleritis have existed, and when the exudation from the iris into the anterior chamber has been very copious, flattening and retraction of the anterior portion is met with, by which the sclerosed cornea is drawn down to the level of the sclerotic.

Subacute sclerochoroiditis from its very commencement exhibits less inflammation and swelling of the scleral tissue. Here scarcely any nodules are formed, but instead a very intense, somewhat purple scleral injection, which borders on less injected and less highly coloured portions. The corneal sclerosis is less in degree but greater in extent. Further, towards the iris the inflammation becomes more general, and the appearance of deposits on the posterior surface of the cornea, which is faintly sclerosed, shows that the pericorneal trabecular tissue has shared in the inflammation.

By watching patients attentively we may observe how adherences are slowly formed between the peripheral insertion of the iris and the sclerosed portion of the corneal margin. As intraocular tension rises or falls, the mode in which the inflamed sclerotic becomes paler, and assumes the bluish hue of a staphyloma, may be also seen. This staphyloma may be situated either at the actual junction of the cornea, when it is rightly called "*intercalary*," or in the region of the ciliary body as *ciliary* staphyloma, while in parts corresponding to the choroid it is termed *equatorial staphyloma.*

Chronic sclerotico-choroiditis is absolutely free from all the symptoms of irritation. It is met with chiefly as the result of perforation in infants, in cases where the iris has been caught in the wound, and entangled in the iritic angle, and has there formed adhesions. Along the whole corneal margin and in the ciliary body a series of staphylomata is gradually developed. The glaucomatous character of such changes, the result of adhesion of the periphery of the iris to the spaces of Fontana, is at once shown by the excavation of the optic nerve which accompanies them. This excavation may be recognised as soon as the fundus of the eye can be inspected with the ophthalmoscope, or by dissection after enucleation.

Generally speaking, the various forms of sclerotico-choroiditis terminate in staphyloma. This is explained by the fact that the inflammation is seated in the chief region of filtration of the intraocular fluids. The trabecular tissue about the iritic angle becoming inflamed induces adhesions with obliteration of this space, and consequently increased difficulty in the circulation of intraocular fluids.

What in the acute forms of sclerotico-choroiditis is produced only as the gradual result of inflammation is in the chronic met with from the first. Here the iris is forcibly drawn into a corneal cicatrix, and seals up to a great extent the iritic angle. Careful attention to the process of stretching which the adjoining parts undergo will show clearly to what the change is due. The periphery of the iris becomes largely adherent to the wasted cornea by means of an intercalary substance (*Schiess-Gemuseus*), translucent, and striated, and appearing as though an offshoot from the corneal tissue. This intercalary substance may extend beyond the insertion of the iris over the whole of the ciliary body, but becomes thin and atrophied wherever ectasias have been formed.

As regards the situation of ectasias, the intercalary staphyloma, occupying the sclerocorneal junction, must be carefully distinguished from a staphyloma of the ciliary region, and of the equator of the eye. The retention of fluids has generally, during the time an intercalary staphyloma is being formed, been such as to produce excavation of the optic nerve, and destroy any hope of restoring vision. But a few ectasias in or behind the region of the ciliary body by no means imply a like melancholy prognosis.

It must not be forgotten that extensive intercalary staphylomata are necessarily accompanied by lengthening of the suspensory ligament of the lens, with rupture and subsequent dislocation. In such cases, too, the vitreous body becomes more or less fluid, and is a source of danger in any surgical proceeding.

This affection, so destructive to the functions of the eye, runs, except in the acute forms, a very insidious course, resulting, perhaps, in the sudden apparition of a well-marked ectasia under the upper lid. It is only in cases which run a rapid course that the ciliary region is sensitive to the touch, or that true glaucomatous symptoms, with severe periorbital pains, distress the patient. These glaucomatous pains disappear, as a rule, in proportion as the staphyloma increases in size. The affection lasts years, until numerous staphylomata have in succession been formed. Intercalary staphylomata, consequent on large perforations of the cornea in infancy, are the sole exceptions. Here, within even two or three months the cornea and adjoining portions of the sclerotic may become very much bulged.

Anterior sclerotico-choroiditis developes itself most generally in subjects under twenty years of age, whose sclerotics allow of dilatation. If found in persons of middle age, it assumes more generally the form of sclerosis with flattening of the anterior segment of the eye. The same thing is often found in the case of women at the period of the menopause, and of men with rheumatic and arthritic affections.

The treatment of anterior sclerotico-choroiditis should be directed especially against the tendency which the iris has to form adherences within the iritic angle, and the formation of the intercalary neoplasm. It may, therefore, be anticipated that mercury will play an important part. With sthenic patients a course of inunction must be commenced (2 to 6 grammes of mercurial ointment, rubbed in morning and evening) together with enemata of iodide of potassium. In weak subjects I limit myself to the exhibition of syrup of Gibert, or iodide of potassium.

Simultaneously with the above treatment, I generally insist on copious diaphoresis induced by means of injections of pilocarpine (p. 123) which exert a powerful influence, and may be continued for weeks, if only the hours at which they are administered are so arranged as not to disturb digestion. The injection, therefore, is best given in the morning, on an empty stomach, while the patient is in bed. At the same time diuretic drinks, such as milk, and the mineral waters of Wildungen should be prescribed.

Particular attention must be directed to the position of the iris, to any changes in the shape of the anterior chamber, and to the intraocular tension. Atropine should not be made excessive use of, even though some synechiæ should have already been formed. So far as possible the iritic angle should be kept free by instillations of eserine or pilocarpine. Myotics have here the undoubted advantage of exercising an antiglaucomatous influence; and in the acute form of anterior sclerotico-choroiditis, of soothing the pain of the attacks.

If adhesions of the iris have already been formed at the periphery of the anterior chamber, an artificial pupil or a sclerotomy must be made without delay. The effect of an artificial pupil which frees the iris, and facilitates filtration, is often here very remarkable, so much so, that even small ciliary staphylomata in course of formation, will be seen to retrograde. The section must not however be made too near the periphery, and precautions should be taken by instilling eserine beforehand, to avoid all entanglement of the iris.

It must not be forgotten that the great aim of iridectomy is to prevent adhesions towards the iritic angle. Consequently every means must be tried of hindering the formation of any two points of firm adhesion, by entanglement of the iris within the wound, as these would quickly become developed into small staphylomata. So far, then, from the disease being checked by a badly performed operation, its evolution will be actually hastened. Too much care cannot be insisted on in cases where an intercalary staphyloma has been formed, and where the whole boundary line between cornea and sclerotic is bulged forward. Here the large incisions that are proper in iridectomy might occasion serious accidents, such as intraocular hæmorrhage, a large escape of vitreous, luxation of the lens, and great irritation of the eye generally, which, up to the moment of operation, except as regarded its deformity and weak power of vision, had caused the patient no trouble. In such a case it is certainly better to have recourse to sclerotomy, the danger of which is lessened, and the power increased, by a concomitant use of eserine.

In those rare cases where the acute form of this disease has induced sclerosis of the cornea, and retraction of the pericorneal tissue, as also in cases where well-marked sclerosis remains, after the inflammatory symptoms and after iridectomy, recourse may with advantage be had to abrasion of the conjunctiva (p. 117). I have endeavoured of late to abridge the slow course of the affection by performing this abrasion even during the inflammatory period. It seemed to me that it might thus be possible to hasten the cure, while reserving the right to perform an iridectomy two or three months later, if rendered necessary by any corneal opacities.

If sclerotico-choroiditis terminate in considerable deformity of the globe, with absolute loss of vision, an attempt may be made to lessen the size of the eye by means of a gold thread passed through the most prominent portion, and acting as a drainage tube, together with eserine and a compress bandage. Should these prove ineffectual, enucleation is the only alternative. With regard to this operation in children, it is well to insist on it in good time, before the volume of the eye has increased enough to influence the development of the face, or before the lids have become so stretched as to cause an artificial eye to sink in subsequently to a very unsightly degree. The advantages of partial removal over enucleation, are for the most part rendered null, by the hæmorrhage and suppuration consequent on the operation.

The affection which induces ectasia around the posterior insertion of the choroid, resembling that on the anterior segment of the eye, has received the name of *sclerotico-choroiditis posterior*. If a comparison can be instituted between this affection and the one just described, it will be with that form of it in which ectasias follow perforation without any symptom of inflammation. The ectasias around the optic nerve appear more or less in the same way. In this situation no acute or inflammatory sclerotico-choroiditis is found like that around the cornea.

In the vicinity of the posterior insertion of the choroid there must be evidently mechanical conditions analogous to those which preside over the evolution of anterior staphylomata, conditions which are but insufficiently understood as yet. This is much to be regretted, for the want of accurate knowledge as regards the ætiology of the affection necessarily exercises a very unsatisfactory influence on its treatment.

The purely mechanical causes which alone can have any real influence on the formation of a posterior staphyloma are:—

(1.) A congenital weakness of the sclerotic immediately around the optic nerve, implying a more or less complete absence of choroid in the same spot; an abnormal insertion of the sheaths of the nerve ; a peculiar arrangement of the vessels in respect to the mode in which the veins empty themselves. As the eye increases in size, this peculiarity contributes to their obliteration, and to circumscribed atrophy of the choroid.

(2.) Abnormal action of the recti muscles is also given as a cause of posterior staphyloma. The abnormality consists in an insufficiency of the internal recti, which leads to efforts the result of which is increased pressure, elongation of the eye, and actual detachment of the choroid around the optic nerve.

The insertion of the optic nerve on the inner side of the posterior pole of the eye (the macula), and the dragging caused by prolonged efforts of convergence, necessary in high degrees of myopia, may also exercise an important mechanical influence. Also, pressure of the oblique muscles has been stated as a probable cause. These, as being the muscles which determine the positions of the meridian, and act as opponents to the recti, may in the acts of converging and looking down which are so often required by myopes, exert such pressure on the globe that the stretching of its sclerotic in front of the optic nerve is rendered comparatively easy (*Giraud-Teulon*).

(3.) Lastly, the evolution of staphyloma has been attributed to too prolonged tension of the muscle of accommodation. This muscle requires a point of fixation towards the attachment of the choroid around the nerve, which may, it is supposed, cause actual separation of the choroid. The development of the longitudinal fibres of the ciliary muscles might, indeed, plead in favour of this suggestion, were it not that the myope uses his accommodation but slightly, and that the staphyloma is generally situated between the external border of the optic nerve and the macula, this latter point being absolutely fixed.

For my part I am inclined to lean towards the first of these theories, according to which a staphyloma would have a congenital origin. Functional disturbances in the eye, or defective hygiene, might then help on its evolution, but would not be sufficient to give rise to it. It should not be forgotten that staphylomata may be observed in all eyes, and that they become developed (or rather increased) in persons who in no way overtax their sight.

From a practical point of view two varieties of staphyloma must be distinguished. In the first, the staphyloma is absolutely stationary, and accompanied sometimes by a similar ectasia of the macula (dictyochisma centrale). In the second, in consequence of some functional derangement of the eye, it has become progressive and complicated with atrophic choroiditis.

The absolutely *stationary* staphyloma is met with in eyes of every shape, but chiefly in those which are myopic. It generally assumes a crescentic form of variable size, situated on the outside border of the optic nerve, and attaining its maximum in the direction of the macula. If but slightly marked, it gives the impression as though the outline of the scleral border of the papilla only was enlarged (the *conus* of the Vienna school). The characteristic feature of the stationary staphyloma is, that its boundaries cut sharply into perfectly normal tissue. The staphyloma represents a portion of choroid either absorbed or much wasted, and allows the peculiar reflex and lustre of the sclerotic to be seen through it. It is marked off by a well-defined margin, and generally pigmented. A careful study of the direction the retinal vessels take, at the moment of crossing this line of pigment, shows that in nearly every case the denuded choroid is pushed more or less backwards; this becomes very plain if the staphyloma be at all considerable in size.

Not only is the staphyloma clearly divided off on the side of the choroid, but the same is true as regards it and the optic nerve, which with its rosy hue is in strong contrast to the bluish-yellow of the staphyloma. This latter ordinarily looks outwards, more rarely upwards or downwards, and never directly inwards. In the portion represented by staphyloma, not only the choroid but the sensitive layers of the retina are more or less absent, as is proved by the increase in size of the blind spot of Mariotte.

The posterior *progressive* staphyloma, which is generally of larger size than the stationary, is without any distinct boundary line, this having been effaced by the choroidal atrophy in the immediate vicinity. Before actual patches of atrophy have formed at contiguous points, the neighbouring zone of choroid and the layer of retinal pigment exhibit distinct signs of atrophy. Certain portions of this layer contain small islands, where pigment has become diminished, and others where it has increased. The staphyloma grows by extending gradually further and further from the optic nerve, in consequence of progressive atrophy of the neighbouring belt of choroid; it bends round the nerve, and advances towards the macula, but very seldom gains it, for, owing to the elongation of the eye, this latter becomes further and further removed from the insertion of the nerve. There may also be formed in the neighbourhood of the staphyloma actual patches, which later on are absorbed by it. In this way—viz., by the formation of a patch of atrophy at the posterior pole—the junction of a staphyloma with the macula is at times effected.

The frequency with which symptoms of progressive stretching are seen about the macula, necessitates careful examination of this region in every case of staphyloma, in order to make sure that atrophy of the choroid is not imminent. This atrophy appears first of all under the form of trophic changes in the retinal pigment, which is more or less broken up. Here and there small islands are seen destitute of pigment, and perhaps alongside of these minute jet black spots. As time goes on, and owing to the progressive stretching of the parts, the breaks or small patches become larger; spots of considerable size, with rounded edges, sharply marked off, appear; these finally unite with the staphyloma, by this time, as a rule, circular—that is to say, it has spread all round the optic nerve.

The symptoms of atrophy which are seen towards the posterior pole, may in certain cases assume a more inflammatory character. On the macula a dark coloured patch of pigment appears of considerable size, often surrounded by a circle of extravasated blood. In the centre of the pigmented part, as it clears, a yellow patch becomes visible, which spreads gradually, and is at times surrounded by numerous rings of pigment. In proportion as this yellow appearance spreads, the centre of the affected portion becomes paler, presenting the characteristic signs of atrophy, and eventually laying the sclerotic completely bare.

Generally speaking, the rapidity of the progress of a staphyloma is indicated not only by the advent of indubitable signs of *choroidal atrophy* and *traction,* but also by disturbances of nutrition in the vitreous. Filiform opacities and floating bodies can now be discovered. These latter, which appear abruptly, are due to extravasation of blood, whilst the former are the result of a projection into the vitreous humour of pigment elements from the retinal epithelium. Simultaneously, disturbances of nutrition supervene at the posterior pole of the lens. Finally, in proportion as the staphyloma grows, the retina becomes as it were drawn down into it, and the boundaries of the optic nerve, together with any physiological excavation that may have previously existed, disappear, both becoming lost in the staphyloma.

In proportion as the elongation of the posterior pole of the eye increases the optic nerve undergoes displacement, which falls mainly upon its sheaths. These become more widely separate, and the vaginal space larger, while in consequence of traction the vessels forming the circles of *Zinn* or *Haller* atrophy, so that it is not rare to see nutrition seriously impaired in the nerve itself. But beyond doubt the great danger which menaces eyes attacked with progressive posterior staphyloma, and especially where the vitreous body exhibits certain changes pointing to increased activity in endosmosis and exosmosis, is detachment of the retina.

The surgeon who carefully watches the development of a posterior staphyloma, will become gradually convinced that it is due to a succession of mechanical causes, the result of which is progressive distension of the choroid. This membrane may present a series of consecutive symptoms of irritation, but atrophy the result of simple traction will be the predominant one. Treatment would certainly gain in efficacy, if we could get to know accurately the relations which exist between the mechanical causes and the resulting distension. However, as we are certain that undue application of the eyes, together with defective hygiene, are peculiarly favourable to the increase of a posterior staphyloma, absolute rest must be especially insisted on in such cases.

All efforts of the accommodation should be forbidden, and to ensure this, accommodation, especially in young subjects, should be paralysed for from six to eight weeks by atropine or duboisine, applied every evening. By the use of smoked or blue glasses, the eyes may be protected against excess of light. Simultaneously, while the patient is enjoying a period of absolute rest, iodide of potassium should be prescribed, together with, if the patient is delicate, preparations of iron and quinine. This treatment, it has been claimed, has caused considerable improvement in myopia, and has checked the progressive development of a staphyloma. Be this as it may, I look on rest, as complete as possible, especially in young subjects, where myopia has rapidly increased, as very urgently demanded.

Another important point is rest from all work when harmony of action in the muscles is very deficient. If the internal recti are so feeble that the convergence necessary for work at short distances causes weariness,—if the eye, when covered with a dimmed glass, wanders outwards at ordinary reading distance,—if this deviation is present very markedly, as measured by prisms of more than 14°, when the image formed on the eye is moved up or down, there should be no hesitation about dividing one or both external recti muscles, so as to render their action harmonious. By this method, for which very careful examination is necessary, *Von Graefe* used to assert he was always able to check the progress of myopia, and the increase of staphyloma. This treatment offers the serious disadvantage,—even if the incapacity of the internal recti is very marked,—of causing a diplopia, transient indeed, but nevertheless both annoying and alarming to patients. It is only, then, suitable in the hands of a surgeon in whom patients repose absolute confidence, and who can relieve their anxiety by assuring them of the ultimate success of the operation.

In all cases where unmistakable signs of atrophy of the choroid are already present, and where the vitreous exhibits opacities, I always prescribe derivatives, together with rest. I generally prefer the perchloride of mercury (1 to 2 centigrammes daily, $\frac{1}{7}$ to $\frac{1}{3}$ grain; see page 182), in conjunction with iodide of potassium (0·50 centigrammes to 1 gramme daily). At the same time I apply at intervals of a week Heurteloup's artificial leech on the temples at night, one and a half to two cylinders full of blood being extracted. The patient must remain in a dark room all the following day, so as to allow the congestion which always follows the artificial leech to pass off. The leech may be applied from four to eight times, its application being guided by the strength of the patient. Such treatment, especially when the blood is very rapidly drawn away, exercises an undoubtedly favourable action. It should be followed, during a period of from six weeks to two months, by iodide of potassium, in quantities of 2 grammes (31 grains) daily.

It need scarcely be said that the general health must be carefully attended to; and that great precision must be shown in the choice of concave glasses. The question as to whether or not weak concave glasses should be used for near vision, in order to prevent undue convergence of the eyes, must be worked out in each case, according to its merits.

LECTURE XXII.

HYPERÆMIA OF THE CHOROID; SIMPLE DISSEMINATED CHOROIDITIS; AREOLAR CHOROIDITIS; CIRCUMSCRIBED OR CENTRAL CHOROIDO-RETINITIS; SPECIFIC CHOROIDO-RETINITIS.

Before entering on the subject of choroiditis, properly so called, I will say a few words relative to the impossibility of diagnosing hyperæmia of the choroid. The colour of the fundus oculi is determined essentially by the quantity of pigment present in the retinal epithelium and stroma of the choroid. In many persons, this epithelial layer spreads a complete veil over the choroidal vascular plexus. But even without this obstacle, the greater or less quantity of pigment contained within the choroid determines how far the large vascular trunks, and their finer off-shoots, can be visible. The pigmentation, therefore, of the fundus of the eye will modify its general aspect much more than a mere slight change in the amount of blood in the vascular plexus could do; at any rate, it will render the estimation of this latter all but impossible.

Nor should it be forgotten that the light used will modify the appearance of the fundus in no slight degree. The illumination will vary according to the dilatation of the pupil, the kind of mirror, and the luminous source.

The impossibility of distinguishing veins from arteries, within the vascular plexus, which the absence of pigment allows us to see, is equally present if we try to distinguish active from passive hyperæmia. But besides this, the disappearance of pigment at various levels within the thickness of the choroid may expose vessels of various sizes. It results, therefore, that, with a most accurate knowledge of the anatomy, and the utmost precision in our methods of mensuration, it is not possible to arrive at any opinion as to whether the size of any particular vessels is altered or not, seeing we do not know to what layer of the choroid they rightly belong.

The single sign that might be called in to aid in diagnosing hyperæmia of the choroid, is the deeper colour of the papilla in inflammation, the contour of the nerve being unaltered. But the discovery of the retinal purple has now cast a doubt on the intensified colour being really due to greater injection of the capillaries of the papilla, and has suggested that perhaps the retinal purple may, as *Von Jaeger* thinks, extend also to the optic nerve.

Classification of the various inflammatory changes of the choroid is met by the same difficulties as is actual observation, owing to the arrangement of variously pigmented layers, one over the other. There is scarcely any form of choroidal inflammation which does not determine a change in the pigmentary epithelium of the retina. Therefore, strictly speaking, the term choroiditis should not be used, but should be replaced by that of retino-choroiditis. But from the very commencement of ophthalmoscopic observations, the habit was, so to say, formed of regarding as characteristic of choroidal changes, any alterations that the layer of pigment epithelium might present; and this, too, even when associated with inflammations confined to the most external layers of the retina, without any connection whatever with the choroid.

I shall now proceed to consider the various forms of choroiditis, namely: *plastic, serous,* and *parenchymatous* or *suppurative.* In the first are included, (1) *simple disseminated choroiditis,* (2) *areolar choroiditis,* (3) *circumscribed choroiditis,* or *central choroido-retinitis,* and (4) *specific choroido-retinitis.* I shall not say much about serous choroiditis at present, but shall return to it when treating of glaucoma. As regards parenchymatous choroiditis, I subdivide it into *metastatic* and *suppurative.*

(1.) *Simple disseminated choroiditis* is marked by the presence of scattered centres. In these, it must be allowed, certain alterations in the retinal epithelium play a considerable part; nevertheless, examination of the function of the eye, shows that they should rather be considered as alterations in the choroidal stroma. The change which these centres cause in the plane of the retina, assists greatly in determining their positions. This results not so much because they cause it to bulge forwards towards the vitreous humour (for this might also be occasioned by circumscribed œdema), but because the effect of their contraction is rather to draw it backwards.

We must at the outset distinguish between the various forms of disseminated choroiditis, and the changes effected in the fundus, when as happens in some forms of retinitis pigmentosa, proliferation of the cellular elements has displaced and transformed the pigment epithelium of the retina proper. On the other hand, the patches of pigment produced by proliferation of the elements of the pigmentary layer, must not be included among the inflammations of the choroid. Moreover, the test of vision shows that the morbid changes take place in the most external layers of the retina, that is in the sensory apparatus of the eye.

The true forms of disseminated choroiditis may attack, (*a*) either the vitreous lamina, or (*b*) the pigment stroma of the choroid.

(*a*.) Since the researches of *Wedl*, *Müller*, and *Donders*, it is known that the vitreous lamina of the choroid, especially its equatorial portion, may undergo a wartylike thickening, which raises it at certain points in the form of nodules. This is one of the changes consequent on age; but if it appears too early, or is excessive, or selects an unusual locality, it becomes an actual disease, capable of reducing vision relatively to the age of the subject.

This warty thickening may completely detach itself from the vitreous layer of the choroid (fig. 9), and become imbedded in

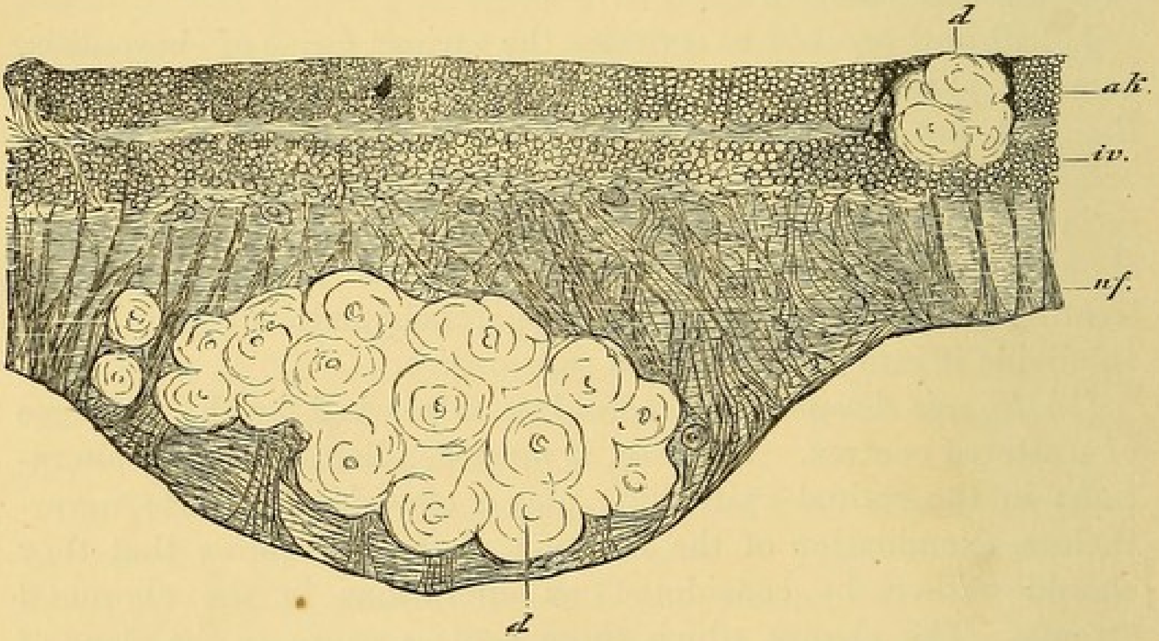

Fig. 9.—*d d.* excrescences of the vitreous lamina, one of which is in the granular layer, the other in that of the nerve fibres; *ak.* external granular layer; *iv.* internal granular layer; *nf.* layer of nerve fibres. (After Iwanoff.)

the tissue proper of the retina. Here it displaces the nerve fibres, and overtops the retina, giving rise to a peculiar reflex from the hyaloid membrane, and obliterating the smaller vessels. The most characteristic sign of this form of choroiditis is its situation. The disease may be as widespread as you will, but nevertheless the yellow prominent spots surrounded as it were by a frame of pigment, will never be found very far from the equatorial region of the eye, whereas they will always be at a considerable distance from the macula and papilla. It is only by making the patient look very obliquely, that the fundus of the eye can be seen, dotted over as it were with minute drops, which have destroyed the regular appearance of the epithelium, but without producing any actual patches.

I need not dwell on an affection of little importance in itself, and requiring only to be known by a practitioner in order not to be confused with other and more dangerous forms of choroiditis. No particular treatment is called for, inasmuch as it is little else than a manifestation of premature old age. At the most it may be advisable to recommend a strengthening regimen and rest from all continuous or exhausting work.

We now come to *disseminated* choroiditis properly so called, that form, namely, which occupies the stroma of the choroid. Inasmuch as they both occupy similar ground, areolar and circumscribed choroido-retinitis must be considered as allied to this variety. These three affections in their anatomical characters are very like one another, but the positions they occupy modify to some certain extent both their appearances and symptoms, and justify their separation clinically.

(*b.*) Simple disseminated choroiditis, if it attacks the pigment layer (as *M. Iwanoff's* valuable preparation (fig. 10) shows), gives rise to nodules, composed of amorphous exudation, traversed by a few fibrillæ, and probably formed at the commencement of the attack by an agglomeration of nuclei, which assimilates them to a gumma or miliary tubercle. Their presence is shown only by a slight toning down in the colour of the subjacent pigment, so that the fundus of the eye seems covered with badly defined yellow patches.

You saw here lately a young man who afforded a good example of these pale yellow spots round the macula and papilla of his left eye. They were arranged principally in the course of the vessels, and so placed as regards these, that the resulting appearance might be compared, not inaptly, to that of a bunch of grapes. In this case I pointed out the resemblance of this choroidal eruption, which became more plentiful towards the equator, with certain papular or roseolar eruptions. I also called your attention to the fact that these patches presented marked differences in form and size, and had no tendency to run together or to form irregular masses. In the equatorial parts of

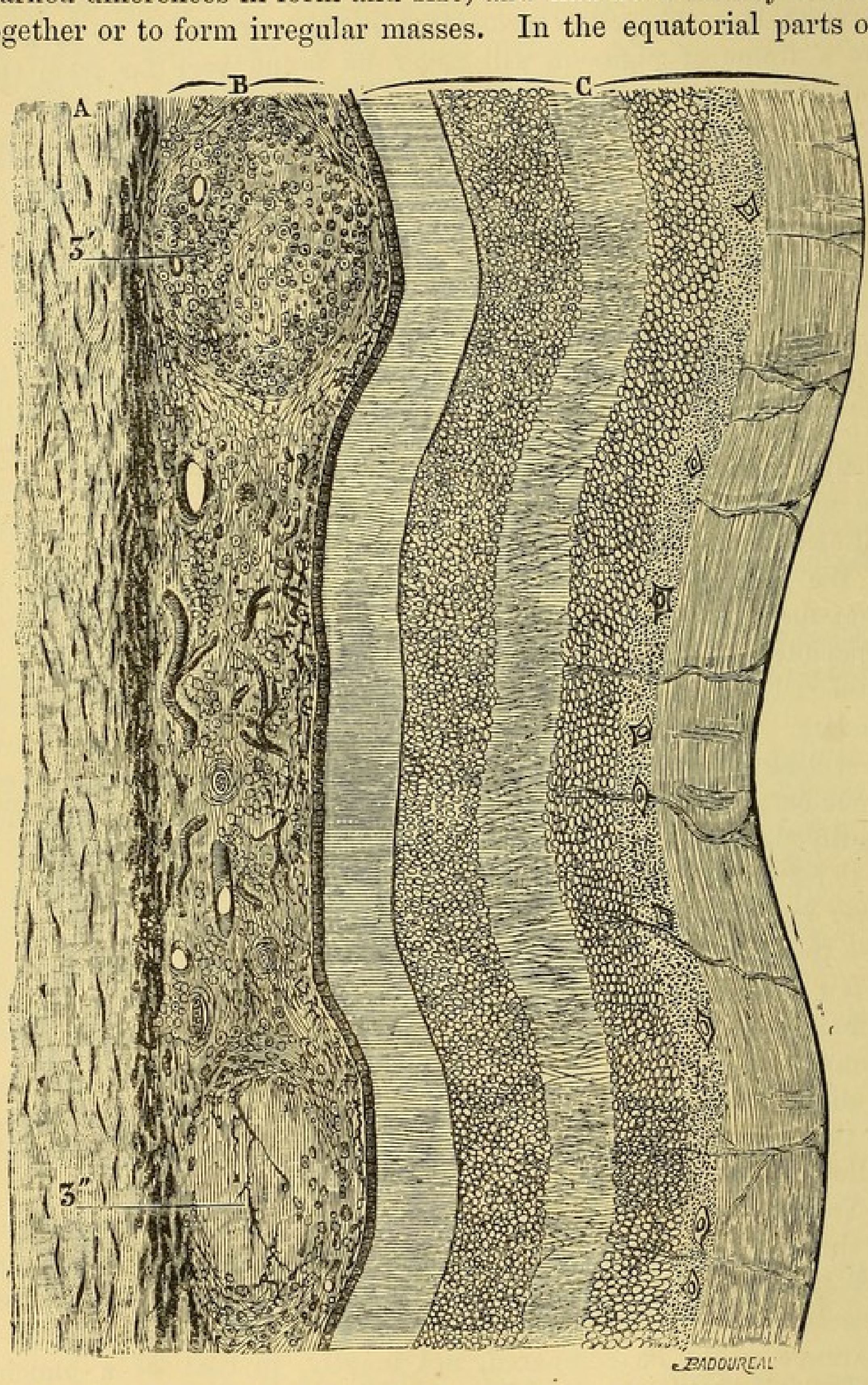

Fig. 10.—A. sclerotic; B. choroid; 3′, 3″, two nodules, one of which is composed of colourless cells; C. retina perfectly intact. (After Iwanoff.)

the left eye, and more particularly in the right eye, where the affection had first shown itself, its appearance had in the space of three months, completely changed. The nodules had become transformed into patches of atrophy, that is to say, had undergone cicatrisation. Where yellow patches once existed you now see white, surrounded by a border so dark, that it must evidently be due to proliferation of the retinal epithelium. By the side of the small irregular black marks, there were patches of larger size, pale yellow or blue in colour, in which here and there traces of wasted choroid, and an occasional choroidal vessel might be seen. By the alteration in the course of some retinal vessel, as it passed over these patches, you learned that actual contraction, was present, and that this had produced subsidence at the points where the patches were.

If you refer to the drawing of *M. Iwanoff* representing a section of the choroid (fig. 11) affected with this disease in its last stage, you will see that the nodules have in part disappeared, leaving only a dark stain where the proliferated retinal pigment has penetrated into the external granular layer. At other points, an actual choroidal cicatrix has been formed, while the radiating fibres of the retina have been involved in the cicatricial tissue, and become lost in its fibrous elements.

It will be readily understood how the ophthalmoscopic image must alter when the nodules, after acquiring a certain size, disappear, entailing greater or less destruction of the choroid, and leaving the sclerotic, to which the retina becomes adherent, more or less bare. The resulting images may be again considerably modified, in consequence of cicatricial contraction interfering with nutrition in adjacent portions of choroid, and leading to fatty degeneration of the cellular and pigment elements, and obliteration of vessels; in other words, to cicatrisation of the nodules, and atrophy of the choroid from tension. According to individual differences in pigmentation and arrangement of vessels, the ophthalmoscopic images, in one and the same disease, differ so much, that an inexperienced observer might take them for manifestations of totally different affections.

However extensive the changes may be, the vitreous humour will seldom share in them. Flaky or filamentous opacities are only to be seen in it when the arrangement of the patches is such as to show that the disease has extended considerably beyond the equator of the eye, or when their continuity implies a wide-spread choroidal atrophy.

The range and position of the malady determine in great measure the amount of functional disturbance. Very remarkable

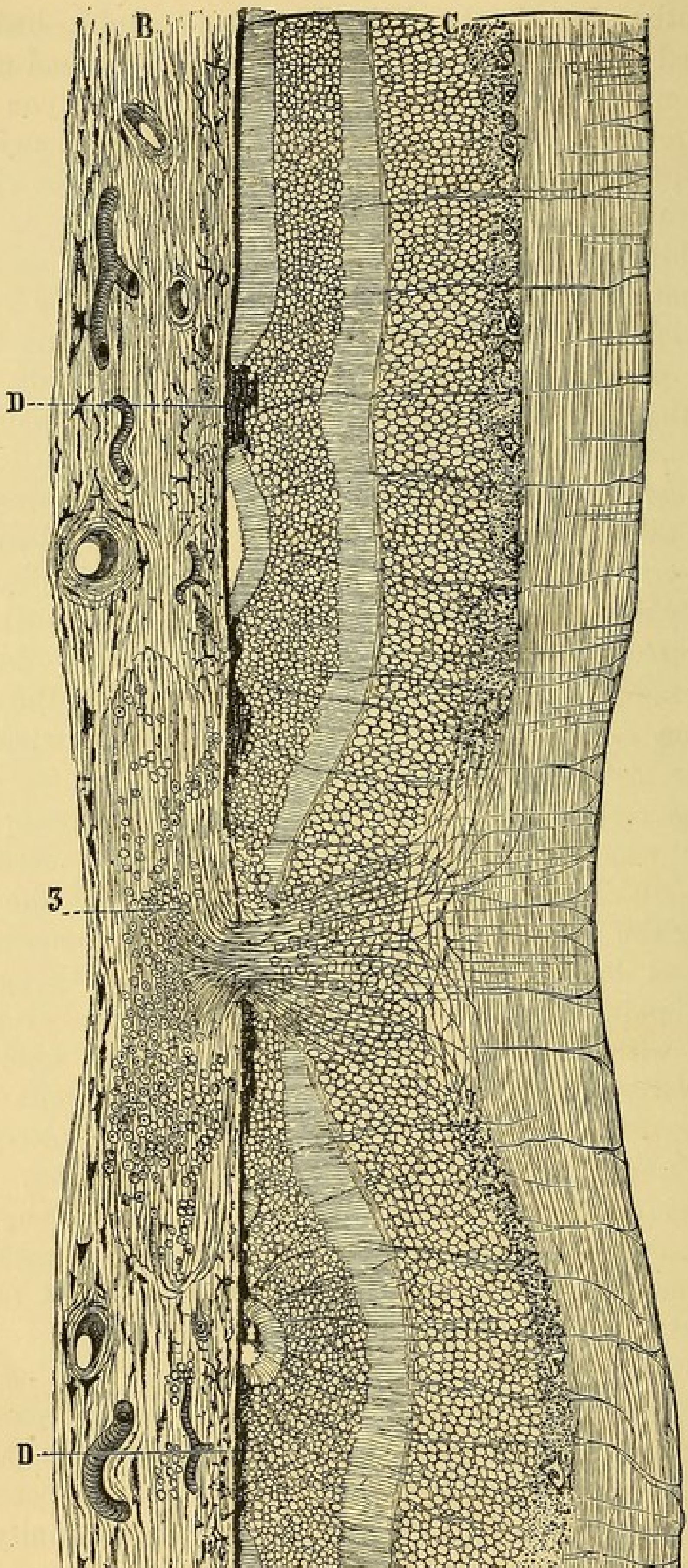

Fig. 11.—B. choroid ; C. retina ; 3. nodule on choroid to which the retina is adherent by its radial fibres ; DD. reunion of the retina and choroid. (After Iwanoff.)

ophthalmoscopic appearances may be witnessed while the patient complains but little of diminution of vision, that is, provided the lesions have not spread extensively in the region of the posterior pole. There the smallest patch will produce a central scotoma, and complete destruction of central fixation, while the ophthalmoscope will reveal nothing remarkable.

(2.) *Areolar choroiditis*, described by *M. Förster*, is clearly a simpler form of desseminated choroiditis. Here also there is present a form of exudation, with a tendency to the formation of retracted cicatrices. This, a preparation from a section through one of the nodules, as given in *M. Förster's* work, shows. The connective or areolar tissue which in part enters into the composition of the nodule has given to the disease a name scarcely correct, and one which it would never have received if the section had chanced to have been made, not at the moment of cicatricial retraction, but at that of development, when the nodule would have consisted mainly of small cells.

From a clinical point of view areolar differs from simple choroiditis in being developed more or less at and about the posterior pole of the eye, and around the macula. On the contrary, the typical choroiditis disseminata travels from the equator of the eye towards the macula and the optic nerve, reaching these points however but rarely, or at least very slowly. In the second place, in mature choroiditis disseminata the small patches of pigment (which represent offsets from the retinal epithelium passing over a nodule which has subsequently disappeared without leaving traces), and the cicatricial patches of atrophy are in no way correlated. But in the areolar form each small patch of pigment eventually becomes colourless at the centre, and constitutes a spot of atrophy variable in size but regularly formed. Besides this, symptoms of atrophic choroiditis due to traction are much less likely to complicate areolar choroiditis, and the appearances met with in the latter are more lasting than those in the former.

It often happens that areolar choroiditis clusters round the macula, but without actually trespassing upon it. Thus, cases will be found where the conservation of vision appears truly remarkable after the striking changes that have taken place at the fundus. Such a condition as regards function is never found in pure disseminated choroiditis if sufficiently developed to have gained the macula and circumference of the optic nerve. There will then be as a rule considerable disturbance of vision, and that

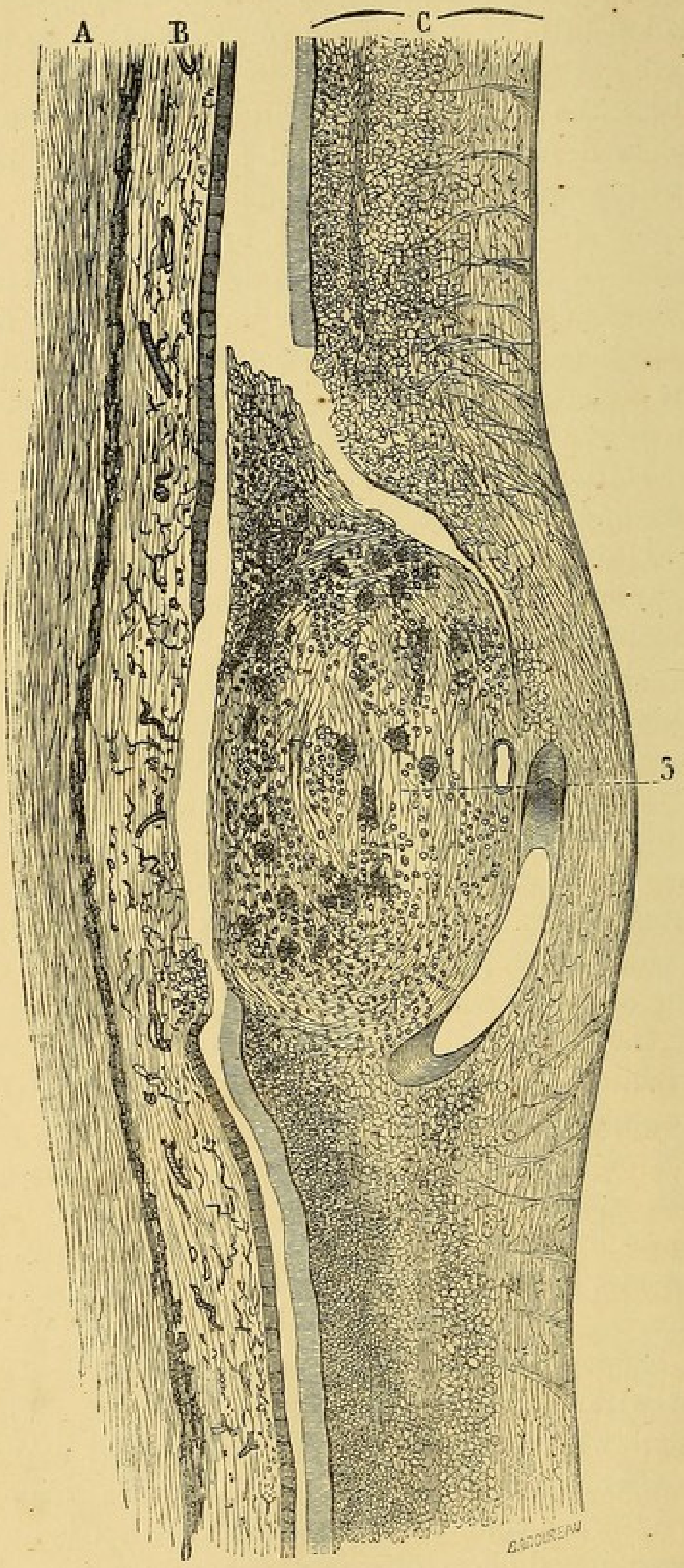

Fig. 12.—A. sclerotic; B. choroid; C. retina (macula lutea); 3. morbid centre, between choroid and retina. (After Iwanoff.)

in proportion to the duration of the disease, and to the more or less well-marked symptoms of choroidal atrophy superadded to it.

(3.) *Circumscribed choroiditis,* or *central* choroido-retinitis is a form of disseminated choroiditis. As a preparation made by *M. Iwanoff* (fig. 12) for my monograph, in *Graefe* and *Sæmisch's* work, shows, there is here merely the development of a single nodule (at times of two or three), occupying the site of the macula. The nodule consists of connective tissue with cells and agglomerations of pigment. After having attained a certain size, this nodule encroaches definitely on the retina, destroying its pigment epithelium and many of its layers. Close to the nodule itself the delicate nerve tissue remains absolutely intact, a proof that we have here merely the effects of pressure, and that the retina, so far as it is concerned, has not shared directly in the inflammation.

At the commencement of the affection the ophthalmoscope reveals a yellowish red spot at the macula either round or oval, and bulging forwards towards the vitreous. It appears more or less distinctly circumscribed, and in time assumes a well-marked yellow tint. If we examine a young and not very deeply pigmented subject, we shall be able to satisfy ourselves that the yellow patch covers the choroidal vessels completely, and that the retina overlies the swelling thus formed; for the retinal vessels may be seen to pass over the edge of a broad nodule.

In proportion as the disease progresses, this centre grows paler, its edges become pigmented, and while more distinct, lose their regularity. Gradually, small patches of pigment, scattered over the whole space occupied by the disease, become visible, while the bluish tint and marble-like lustre of the sclerotic is generally toned down by some remains of the stroma of the choroid, with here and there a few large vessels. Examination, more especially with a binocular ophthalmoscope, will now show that, simultaneously with this transformation into atrophied tissue, the cicatrix in the choroid has shrunk back, and drawn the overlying retina along with it.

The course of the disease is generally one of great regularity, except that, instead of a single morbid centre, there may be many, packed tightly one against the other, around the macula; and all alike undergoing transformation into contracted cicatricial patches. In the true form of central choroido-retinitis, scattered nodules are never found.

The characteristic feature of this form of choroiditis is that from the outset there is invariably present a *scotoma,* which the patient sees before him as a round grey spot, whenever he looks at a white surface. This, inasmuch as it can be seen, has been called a *positive scotoma.* But in proportion, as cicatrisation advances, central fixation becomes more or less destroyed, and the scotoma *negative,* that is rendering perception impossible within a varying distance round the point of fixation, but not being any longer cognisable by the patient himself. In the immediate vicinity of the scotoma, sensibility is intact, the patient still being able to read large type, provided he looks obliquely at the word he wishes to see; this may appear somewhat distorted, on account of the displacement of the retinal elements (metamorphopsia).

(4.) To complete the various forms of plastic choroiditis, I have still to mention *specific choroido-retinitis,* which, it is much to be regretted, has not for lack of material been yet accurately studied pathologically. It is a malady, however, which is so consistent in the course it takes as to admit of its clinical portrait being drawn with the greatest accuracy.

While in simple disseminated choroiditis the vitreous humour was involved only towards the later stages of the disease, symptoms of atrophy due to traction being well marked, and while in both areolar and central choroiditis, the media of the eye were always more or less exempt, in specific choroido-retinitis, the exact opposite to all this obtains. From the very commencement the vitreous is the seat of fine opacities, like dust. If the eye is made to look rapidly upwards and downwards, while the examination is being conducted with a plane mirror, delicate opacities may be seen to run together and rise like dust before the wind.

During the course of the affection a portion of the opacities may collect in the form of flakes or filaments, but the mirror will always show that the coarse opacities move in a medium full of the characteristic dust. In certain cases opacities may so increase as to render examination of the fundus very difficult; generally speaking, however, the light dust which is present in the vitreous humour either universally or in its anterior portion only, remains during the whole course of the affection, and is the last symptom which disappears.

Not only is the persistency of delicate opacities in the vitreous very characteristic, but it is a remarkable fact that the amount of dust present varies considerably from time to time during the course of the affection. Thus within the space of a few hours, remarkable changes may be noticed in the transparency of the vitreous humour. This will be perceived by the patient himself, who will tell you that his sight improves or diminishes often within very short periods.

At the outset the vitreous dust is not generally thick enough to hinder examination of the eye, and we can see that the fundus at its periphery is wholly intact. Around the optic nerve, and more rarely towards the macula, there is a slight opacity which obscures the outline of the disc, and following the course of the large vessels, becomes finally lost at a distance of two or three diameters of the papilla, from the point where they emerge. A faintly marked greyish halo seems to cover the disc, which is more highly coloured than in health, and assumes more or less the tint of the fundus. Occasionally at this period there may be seen around the macula a haze or an appearance of red or white spots on the choroid.

The delicacy of the opacity, which takes no definite forms, the absence of all patches and swelling of the retinal tissue, and finally the few alterations presented by the vessels in size or direction (the arteries are perhaps slightly smaller), forms a picture so characteristic, that after a moment's examination of such a case I lay the mirror of Coccius down to take up the plane one and examine the vitreous. The moment I become aware of the presence of dust in the vitreous, I make the diagnosis of choroido-retinitis, and can assert moreover that the patient has passed through the symptoms of the secondary stage. Although many of the patients thus affected are women, you will seldom hear them contradict me, as I tell them that an eruption of the skin preceded the impairment of their vision. My diagnosis was founded entirely upon the presence of dust in the vitreous, and the slight haziness round the papilla in one eye.

You will notice further that all the questions put as to functional disturbances resulted in answers so uniform as to be absolutely conclusive. Everything shows that, allowing for a more or less appreciable loss of vision, the power of perception decreases in proportion as the light decreases. The complaints made that vision is worse in the evening and at night is universal among patients suffering from double specific choroido-retinitis.

All patients who are able to compare objects as they are seen with an eye that is either sound or less affected than the other, declare that the size of such objects seems to diminish. This micropsia is the result of stretching in the sensory portion of the affected retina. The image being thrown upon elements which are less in number on account of the greater distance separating them, the impression resulting continues the same as if they had not been displaced. The object looked at therefore seems smaller than it does to the other eye, where the image is thrown upon a surface composed of the sensory elements normally distributed, and therefore more numerous.

A third very important and characteristic sign is the subjective perception of luminosities, called phosphenes, generally seen as sparking scotomata, and agreeing in position with scotomata actually found in the field of vision. It is when leaving a badly lighted room to pass into a brighter one, that such patients become aware, not of flashes or flames, but of yellow or reddish yellow spots, moving tremulously like rarefied air, as it ascends from some stove, or other heated object. This symptom is very constant and characteristic, and affords valuable information as regards the course the attack is taking.

As regards the perception of colours, this, in the early stage of the disease, is unimpaired. It is only when well-defined scotomata are present, that within their boundaries, green is no longer perceptible, and that blindness for the other colours follows in the usual order. This symptom is therefore of little value in practice.

As regards the course of choroido-retinitis, it may, after having shown at its commencement a perfect uniformity of symptoms, terminate in three different ways. In one series of cases, you will witness constant relapses, and an affection which drags on for months together. In proportion to the length of time the disease has lasted, the retinal vessels become smaller, the optic nerve assumes a yellow hue, and its outlines appear more distinct. The vitreous clears up, and examination of the equatorial portions of the eye at this stage will generally reveal small patches of atrophy scattered over the epithelial layer of the retina, in which, however, the choroid has no share. This termination, by *yellow atrophy* of the optic nerve, is sometimes merely apparent, and by energetic anti-specific treatment, the nerve may, up to a certain point, regain its normal colour and vascularity.

Much less frequent is it to find the characteristic appearances of choroido-retinitis so modified as to give rise to an actual disseminated choroiditis. But in such a case also, the presence of the vitreous dust during the development of the patches, which seldom attain any great size, will show its true nature. Here, in fact, the production of centres by proliferation of the retinal pigment epithelium is the predominating symptom, and is distinctly connected with the vessels. The elongated patches, formed at the moment the yellow atrophy of the nerve commences, assume an appearance very similar to that of the stellate corpuscles in retinitis pigmentosa. An error in diagnosis might here be easily made, if we had not, in the presence of small scattered choroidal patches, and in the previous history of the case, a means of correcting it. Greater care still will be called for where the patient complains of hemeralopia ; but this will then have been acquired late in life.

A third possible termination is by the development of extreme cloudiness in the vitreous, accompanied by appearances around the papilla of choroidal exudations, which spread to the vitreous, and cause what has lately been wrongly described as proliferating retinitis (*Manz*). In this affection, when the vitreous becomes sufficiently clear to permit of examination of the fundus, large spaces like bluish green streaks mingled with masses of pigment are seen bordering the vessels. These emanations present an appearance very similar to that of the cicatrices of large burns. I will revert to this form of the affection when speaking of the diseases of the vitreous humour.

LECTURE XXIII.

ÆTIOLOGY AND TREATMENT OF PLASTIC CHOROIDITIS; METASTATIC CHOROIDITIS; SUPPURATIVE CHOROIDITIS; TUMOURS OF THE CHOROID.

If it be enquired what the teaching of practice is, touching the ætiology of the various forms of plastic choroiditis, the answer may be made that affections of the posterior portion of the uveal tract do not differ sensibly from those of the free portion of the same, namely, the iris. In four cases out of five, syphilis is the important factor. Thus, as I have said, the form of choroido-retinitis just described is always occasioned by syphilitic poison, and from this point of view presents certain peculiarities well worth noticing.

I must remark, in the first place, that in a great number of cases it is preceded by iritis, that it follows quickly on that affection, and in some cases even becomes developed simultaneously with it. This is why it is always well to examine the fundus, should patients complain during the defervescence of the inflammatory symptoms of marked visual disturbances. This choroido-retinitis appears as one of the last manifestations of the secondary stage, and before the first tertiary symptoms have made their appearance. It is met with more frequently in men than in women, but is extremely rare in either under thirty years of age. I have only once observed it, in a young man of twenty-eight. As a general rule, patients with this affection range from forty-five to fifty years of age, and at the present moment you may see some women of nearly sixty among my patients.

It is difficult to collect information as regards the succession of symptoms; but, leaving out cases where iritis has previously existed, many years may intervene since the last manifestation of syphilis. The disease of the fundus of the eye is then the only symptom of its continued existence. Among private patients the appearance of cerebral syphilis (dementia, mania, or suicide) as an occasional sequela of choroido-retinitis, is to be feared.

The twenty per cent. of cases of choroiditis, which are not due to syphilis, are hereditary, and connected with the progressive development of staphylomata postica, complicating choroidal atrophy from stretching. As regards the areolar form, which, curious to relate, is found very frequently among tutors and governesses, it is possible, I think, to find an hereditary influence (perhaps syphilitic) for it.

Treatment in almost every case should consist of mercury. If the case be one of simple disseminated or areolar choroiditis, I am satisfied with one centigramme ($\frac{1}{7}$ grain) of corrosive sublimate, taken at breakfast, and in the evening (see formula for pills, p. 182), and with it one to two grammes of iodide of potassium. This treatment is to be persevered in for from six to eight weeks, during which the artificial leech should be applied once a week, unless weakness or advanced age contra-indicates it.

In cases of simple disseminated choroiditis in young patients, I have of late had recourse to a series of from fifteen to twenty injections of pilocarpine (see p. 123).

When the ophthalmoscope shows that no fresh centre of disease is developing itself, and that the above treatment, followed by iodide of potassium for several weeks in two to three grammes (31 to 46 grains) doses daily, has effected all the good it is capable of as regards improving vision, subcutaneous injections of strychnine may be tried, with the hope of stimulating the sensory apparatus. A course of ten injections will generally be sufficient (p. 32).

In the specific variety of choroido-retinitis the patient complains of the presence of a scotoma. Here we must act promptly in order to prevent the establishment of a cicatrix in what is the most important portion of the fundus. In these cases I prefer inunction, pushing it, according to the patient's strength, to 12 or 16 grammes (ʒiij—ʒiv approx.) of mercurial ointment daily, in two applications. To this may be added enemata of iodide of potassium of 2 to 3 grammes daily, with an injection of five minims of hydrochlorate of pilocarpine every morning. Every effort must be made, by keeping the mouth scrupulously clean by means of gargles of chlorate of potassium, and by sustaining the general health with nutritive food to prolong this treatment during six weeks. It should then further be supplemented by a course of iodide of potassium, freely administered in quantities of from 6 to 8 grammes (ʒiss—ʒij) daily as enemata.

I can produce instances where the above treatment has furnished brilliant results. Patients treated thus, in whom impairment of vision had progressed so far as scarcely to be expressed by figures, have recovered normal acuity. If however treatment does not appear to produce the desired effects, or, if what was gained at the beginning has been subsequently lost by relapses, I recommend you to place your patient, as it were, under lock and key, to keep him in constant darkness, and to allow him barely enough light in the room to guide his steps, waiting even till nightfall before opening the shutters for ventilation.

Rest for the affected retina, as I have heard *Stellwag von Carion* say in his lectures of twenty-three years ago, is in truth as rational as it is efficacious. Unfortunately it can be secured only with great difficulty. It necessitates an attendant who can be depended on, and who is capable of turning a deaf ear to the patient's entreaties. The above treatment has also the disadvantage, when vigorously carried out, of plunging patients into a state of prostration and moral dejection, which militates very much against nutrition. But nutrition is in these cases all-important in order to enable the mercurial treatment to be borne sufficiently long.

If you find that isolation in a dark chamber cannot be carried out, remember at any rate always to subdue the glare of daylight, out of doors by smoked glasses, in the house by having the rooms occupied by the patient very dimly lighted. Too long or too frequently repeated examinations with concave mirrors should also be avoided. By showing a little less zeal in ophthalmoscopical studies on patients who come to cliniques, you will not seldom be performing an act of humanity.

The long course of the affection I am speaking of, often requires the mercurial treatment to be resorted to more than once. It ought, if possible, never to be completely interrupted, but between the courses of inunction small doses of corrosive sublimate, or one or two spoonfuls of syrup of Gibert, or one or two Plummer's pills (0·25 centigrammes or 4 grains approximately) should be taken.

I now pass to the study of the *parenchymatous* inflammations of the choroid, among which I will first take the *metastatic*. This form generally affects the uveal tract as a whole, and would consequently be better named *metastatic irido-choroiditis*.

This affection has attracted the attention of specialists and practitioners less than it deserves, because its appearance is connected with such serious general symptoms that the condition of the eye, despite its gravity, passes almost unnoticed. The disease is a suppurative choroiditis, where at first diapedesis is localised in the vascular layers of the choroid, the products of inflammation being poured out beneath it, and ultimately beneath the retina, where they form a thick layer. Diapedesis is effected with such rapidity, that the purulent collections are often so mingled with red corpuscles as to have been taken for hæmorrhagic infarcts. Although metastatic inflammations of the choroid similar to these have been produced experimentally (*Virchow, Weber*), the most minute researches with the microscope have not as yet demonstrated in the choroidal vessels the presence of decomposing thrombi or embolisms.

The pathology of this suppuration of the uveal tract, which often spreads to the retina and the vitreous body, and may even lead to perforation of the sclerotic, has as yet been established only theoretically. If on the one hand irido-choroiditis be met with in affections which point to thrombosis or embolism, such as puerperal fever or pyæmia, sloughing of the umbilical cord, malignant pustule, or typhoid states following scarlet fever and small-pox, it is on the other hand found in a series of cases where the inflammation has been much less acute, and for which some other explanation is necessary. Such inflammation is witnessed as a sequela of meningitis, and more especially of cerebrospinal meningitis. It is characterised by numerous posterior synechiæ, and complete abolition of the anterior chamber, the crystalline lens being pushed forwards, while a whitish reflex occupies the field of the pupil. Simultaneously with this the cerebrospinal fluid which has been propelled along the sheaths of the optic nerve may escape under the conjunctiva, and produce great chemosis.

Generally speaking, the destruction of the anterior chamber, and the complete atrophy of the iris in an eye somewhat shrunken and tapered, reveals but too late the phases through which the disease has passed. At other times the symptoms may be much less intense, and even recoveries have been recorded. The affection fortunately does not often attack both eyes at once.

There can scarcely arise any question relative to treatment in a disease which, on account of the desperate condition the patient is in, for the most part passes unheeded. The brief description I have given of it will be sufficient to guide the surgeon in the diagnosis and management of a case.

Suppurative choroiditis is generally met with as the result of penetrating wounds or foreign bodies, and very often of perforation of the cornea. The rapidity with which the pus extends over the external surface of the retina, traverses it, and invades the vitreous, is enough to show that cell proliferation plays but a small part here, and that what was once supposed to be fissation of the cells of the stroma, is really decomposition. It is rare to find suppurative choroiditis limited to one spot; as a rule it spreads to neighbouring parts, and results in panophthalmitis. When such is the case, a gelatinous chemosis appears round the cornea, the globe of the eye (from the accompanying inflammation of the capsule of Tenon), becomes prominent, and the eyelids œdematous.

As a rule, the aqueous humour grows cloudy, hypopion is formed on a large scale, and the pus finds a vent either by ulceration of the cornea, or by perforation of the sclerotic near the recti muscles. The white reflex is here also the sign which demonstrates that suppuration has actually commenced within the eye. This, the total loss of vision had already rendered probable.

This form of choroiditis may become developed with great rapidity. In cases of penetration of foreign bodies, the sufferer may lose his eye within twenty-four hours, after intense suffering, which reacts on the general system, causing vomiting and a high degree of pyrexia. If the suppuration is limited, and if an abscess has formed in the choroid or vitreous only at the points of irritation, the symptoms may be less violent, the eye wasting away gradually but surely.

The tendency which suppurative choroiditis will display to run a rapid course and to spread, will depend on causes at present scarcely known, but which have no connection whatever with the severity of the original wound. If, for example, after some small incision, or slight perforation, suppuration of the choroid should at once break out, it may fairly be asked if infection does not in such a case play some part.

Operations necessitating the opening of the capsule of the lens where dacryoscystitis exists, are very likely to give rise to panophthalmitis, and require great caution on the surgeon's part.

Suppurative choroiditis, too, will suddenly break out years after the occurrence of the primary cause, which may be strangulation of the iris which has taken place in a former cataract extraction, or in an iridectomy for glaucoma.

Treatment will necessarily depend on the causes which have induced the attack. If in time, we should at once proceed to extract the foreign body, or free all adhesions of the iris. At the commencement of suppuration an effort may also be made to check further fatal progress by very energetic mercurial treatment.

In every case where choroiditis has become developed, consequent on wounds of the cornea or lens, if there be the slightest suspicion of contagion, I direct a gentle stream of a solution of hydrochlorate of quinine (1 part in 100 of water) every hour or two between the eyelids. This preparation is better borne than other disinfectants in cases where an eye is rendered extremely sensitive by traumatic inflammation. Instillations of eserine are here to be made from one to four times a day, according as they provoke more or less pain. I give in weak anæmic patients, such as children, large doses of quinine instead of mercury.

If the disease has already extended sufficiently to have for some days past destroyed all perception of light, all that can be done will be to relieve pain, and limit suppuration, so that the resulting decrease in the size of the globe may be as slight as possible. Often even this hope must be abandoned, if neither compresses of belladonna, nor poultices, nor injections of morphia afford relief. Here free incision into the eye will be the only means of ending the sufferings of the patient. Generally an incision should be made into the sclerotic with a narrow Von Graefe's knife, between any two of the recti muscles, and close to, but behind, the ciliary region. The section is generally easiest to execute upwards and outwards, but where a foreign body has penetrated, we should be guided by its supposed position.

All probing of the wound with the object of detecting a foreign body should be carefully abstained from, seeing that this latter will be expelled eventually by suppuration. This should be encouraged by warm fomentations. In most cases these painful probings result in nothing better than causing the suppuration to spread, and reducing considerably the resulting stump.

Bearing in mind the acute suffering of the patient, and the fact that the eye is already hopelessly lost, it may be asked whether enucleation would not be a much speedier method of cure than puncture of the sclerotic. Unfortunately there are cases on record where, after enucleation the sheath of the optic nerve has been invaded by pus, and where fatal meningitis has quickly supervened. Therefore in all such cases I would counsel extreme caution.

Some twelve years ago, a workman whose right eye had been destroyed by molten lead, consulted me for staphylomatous changes in the organ, and I performed a partial removal. Four weeks later the patient returned, begging me to enucleate the remainder, as he was unable to endure the pain that had reappeared in it. I did as he desired, but was not a little astonished to find that the optic nerve had become changed into a cord as thick as my little finger. The operation itself presented nothing remarkable, but after thirty hours the patient was seized with hemiplegia of the left side, and died six days later with all the symptoms of basilar meningitis, which the most active treatment had not been able to ward off.

The advice to remove every eye that is useless for purposes of vision where there is reason to suspect the presence of a foreign body, or where, from the nature of a wound, suppuration must follow, is perfectly sound, if we see the patient before suppuration has set in (*Warlomont*). But I would urge the greatest caution in all cases where chemosis of the conjunctiva, swelling of the eyelids, and particularly a white reflex from the pupil, denote that suppurative choroiditis has actually commenced.

I shall now rapidly run through the *tumours of the choroid*. Though they may seldom require active treatment, it is very necessary to be acquainted with them as regards their prognosis.

I need scarcely mention a second time those *hyaline excrescences of the choroid*, which occasionally form actual tumours, and which, when developed round the optic nerve, or when they have penetrated within the papilla, give rise to a tremulous reflex. This should be recognised, and not attributed to a more serious affection. This proliferation of the vitreous may be confined to the neighbourhood of the posterior portion of the choroid, the rest of the eye being perfectly free from these singular appearances, which are very much as if some spots of grease were floating over the papilla.

A far more serious affection is that of *tubercles in the choroid*, which *Guéneau de Mussy* apparently saw as long ago as 1837 in the choroid of a young girl who died of general tuberculosis. A description of the ophthalmological appearances were not given till the year 1855, by my friend *Von Jaeger*, and the microscopical examination was completed two years later by *Manz*. The numerous observations made subsequently have shown that the probability of the tubercular deposit being found in the choroid is in proportion to the rapidity of its evolution; that if, in miliary tuberculosis, the meninges are attacked, there will generally be a corresponding deposit in the choroid; and, that very often, when, as in children, diagnosis is difficult, examination of the eye may lead to recognition of the affection.

Nevertheless, there are exceptions to this rule, and cases may occur where the tuberculosis by no means runs a rapid course. With this fact before us we should be careful not to take every change dependent on atrophy, or every round patch, as a result of tuberculosis; for both tuberculosis and the various forms of disseminated choroiditis are common, and there would be nothing astonishing in the fact that they might easily be found together.

Both eyes are as a rule affected with tubercles, which will be recognised the more easily as they are situated nearly always immediately round the optic nerve. Sometimes only a single tubercle is met with, at others, as many as forty or fifty. The size of the mass may vary considerably. At one time the tubercle will be so slightly developed as scarcely to raise up or separate the retinal epithelium; at another, it may be as large as a small bean, and then not only will it plainly protrude towards the vitreous, but will also cause depression and absorption of the sclerotic.

The researches of *M. Poncet* have shown, that if choroidal tuberculosis can appear in the form of a miliary eruption (fig. 13),

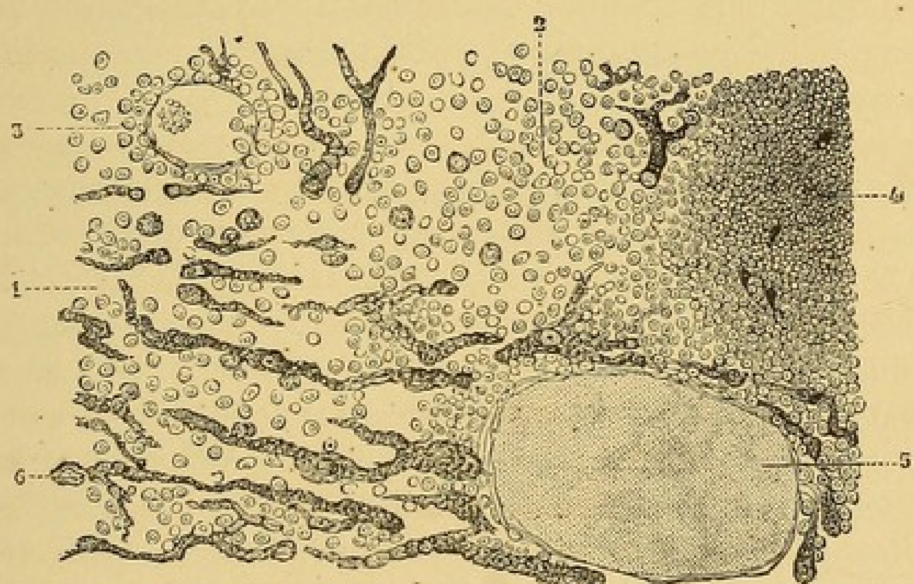

Fig. 13.—1. proliferation, elements little altered; 2. elements irregularly grouped; 3. proliferation round a vessel; 4. true tubercle; 5. vessel; 6. pigmented cellular tissue in course of proliferation.

it can also appear as a general tubercular infiltration (fig. 14). Although in such a case the vascular membrane will become appreciably thickened, while the retinal epithelium will remain unaltered, diagnosis must be a matter of considerable difficulty. It is only when the elevation in some spot exceeds a quarter millimetre, that the resulting parallactic displacement can be perceived.

The peculiar coloration of the tubercles will also attract attention. Here it is no longer the reddish yellow of the nodules of disseminated choroiditis which is seen, but a pale yellow, which

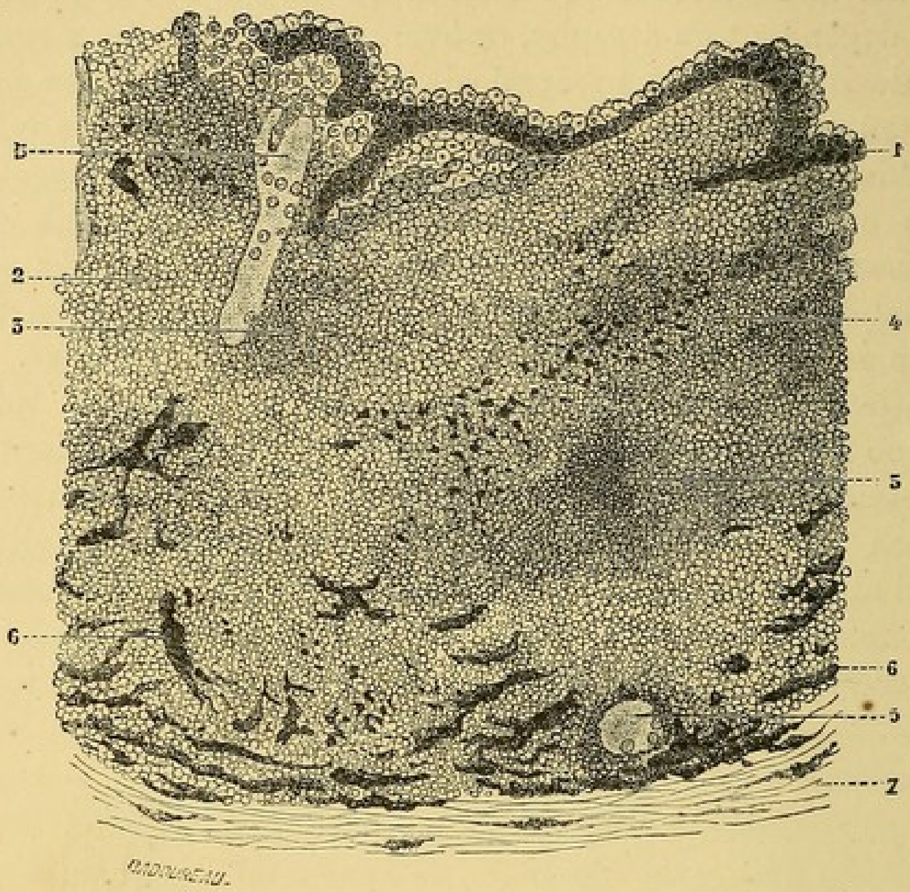

Fig. 14.—1. choroidal polygonal epithelium. Some cells are undergoing colloid degeneration. 2. metamorphosed tubercular elements ; 3. portions of tubercle pigmented and composed of cells undergoing proliferation (4 to 6) ; 5. permeable vessel ; 7. sclerotic.

never merges into blue or green. The contour of the tubercles is, if anything, more vague than that of the nodules of disseminated choroiditis. The ill-defined borders, the pale yellow or rose-coloured tint, especially conspicuous when the swelling is of some size and height, are all remarkable signs. They are the more characteristic, because in the various forms of choroiditis, the outlines and colouring become proportionably intensified as the eruption spreads. In it, too, the confluence of several patches destroy the originally rounded form of the eruption, whereas in tubercles, it is accurately preserved. In tuberculosis, the fact of numerous nodules having merged into one is never shown by cicatricial retraction, as in disseminated choroiditis. Tubercles become merged together, but at the same time form prominences.

Histologically choroidal is analogous to miliary tubercle, and according to *Cohnheim*, who has certainly observed more cases than anyone else, it consists in an aggregation of lymphoid cells, which have passed through the vessels by diapedesis. Such is probably the origin of tubercle, which may also be produced artificially in animals by injecting into their veins fragments of lymph glands, in a state of caseous degeneration.

It would be a point of the highest importance if it could be shown that the choroid may become one of the earliest centres of the manifestation of the tubercular diathesis. We might then in some cases improve the hygienic surroundings of a patient; while in others nothing would remain but to manipulate treatment in view of a fatal issue which is ever imminent, and generally follows very speedily on the localisation of tubercles in the choroid.

I will only mention in passing a benign tumour, the *myoma*, which may be seated in the anterior region of the choroid. Ophthalmic literature records but a single case, and it was observed in an eye enucleated at this clinique, and subsequently examined by *M. Iwanoff*.

The malignant tumours met with in the choroid are *leuco-sarcomata*, and especially *melano-sarcomata*. The former, or softer variety, commences generally in the internal layers of the choroid, and forms a white doughy mass; the latter and harder being confined chiefly to the external layers. It would appear that among the leuco-sarcomata there are some hard and fibrous kinds, which exhibit much less of a tendency to reproduce themselves by metastasis, while they also run a longer course than the white small-celled soft tumours. In such cases there are undoubtedly transitional changes towards fibroma, which mitigate the malignancy of the affection.

With regard to melano-sarcoma, and more especially the highly pigmented form of it, it is interesting to note that the eye is the only organ within which it ever appears. But from here it may readily produce secondary general infection. Still, as regards this, it is less dangerous than episcleral melanosis. The affection ought, therefore, to be diagnosed as early as possible.

When a malignant tumour has become developed in the ciliary region, its diagnosis may be established by attention to the following points. The iris will bulge more or less into the anterior chamber, while an object with rounded edges will be seen in the field of the pupil. The eye itself will not be irritable, nor will there be any history of injury such as could have caused detachment of the choroid, the only other affection with which the tumour might possibly be confounded. The growth of the mass, and the advent of glaucomatous symptoms, will eventually remove any doubts.

As regards tumours springing from the equatorial or posterior polar region of the eye, the diagnosis will be easy, unless they be obscured by a detached retina. If this be not very considerable in degree, the vascular retinal plexus may be distinguished with a strong light from a second layer of vessels, lying beneath it, and belonging to the tumour. The difficulty is not materially greater than if, as in the case of flat sarcomata, the retina had remained attached.

If, on the other hand, a considerable quantity of fluid has accumulated between the tumour and the detached retina, attention must be directed to the following points: namely, the unusual position of the detachment, which does not become united inferiorly as is generally the case; its having appeared in an eye to all appearances perfectly sound; the intraocular tension keeping high, or even increasing. The advent of glaucomatous symptoms, confirms the diagnosis only in cases in which a complete posterior synechia does not exist, for in simple detachment, which has been followed by complete adhesion of the pupillary margin to the capsule, an attack of glaucoma may likewise supervene.

On the other hand, the absence of symptoms of increased pressure in a case of circumscribed detachment unusually placed and which has not spread downwards, is no proof of a tumour being benign, inasmuch as a malignant tumour may remain stationary for years. Its retrocedence, which has been observed very rarely, is sometimes coincident with the development of inflammatory symptoms which have caused the obliteration of numerous vessels. Perforation may be induced by glaucomatous phenomena, with apparently well-marked atrophy, but by and by the disease will take a fresh start, a characteristic instance of which I have given in my monograph.

Diagnosis may be helped by the following considerations: this malignant tumour is scarcely ever met with in young subjects; it does not show itself before puberty, and generally speaking those attacked by it are between forty and sixty years of age. Though women, as a rule, are more prone to cancerous affection than men, they are less so to sarcoma of the choroid. It should be noted, too, that no hereditary disposition could be established either in the cases I myself observed, or in those collected with great care by *M. Brière.* Injuries would appear beyond doubt to favour the appearance of the growth; contusions on eyes which have long ago atrophied owing to irido-coroiditis, are especially to be dreaded.

Neither intra- nor extra-ocular melanosis has any particular tendency to spread rapidly. As regards the risk of general secondary infection, it has been clearly shown that the forms in which pigmentation is very marked are much more dangerous than the white sarcomata. If removed in time melano-sarcoma can scarcely be said to have a tendency to return, and I cannot recollect a single case of recurrence following enucleation. I have recently removed an enormous melano-sarcoma, which occupied the whole orbital cavity, and which unfortunately had not been recognised by the surgeon at the time of the patient's first visit to Paris. Some months back an artificial pupil had been made, under the impression that the affection was acute glaucoma.

Beyond all doubt recurrence is more likely to arise if glaucomatous symptoms have already appeared, a point which should induce us not to delay operation. Unhappily, when we advise the sacrifice of an eye which is still useful for vision, the patient will not as a rule give his consent; nor indeed does he do so until loss of sight and the intolerable pain of glaucoma have united to convince him that he must accept the loss of a useless organ.

In every case where metastasis to the sclerotic has already taken place, the blood should be examined before the operation, microscopically, in order to forecast the chances of secondary deposits. These will always select the liver, simultaneously or otherwise with other viscera. It is a remarkable fact that while melanosis of the choroid is not uncommon as a primary affection, it is never developed as a metastasis.

I will merely mention in passing the formation of *bony masses* in the choroid, which generally spread over the whole surface of the chorio-capillaris. Such ossification may be produced readily enough in eyes that have undergone partial atrophy, the result of parenchymatous or suppurative irido-choroiditis. The diagnosis may be established by palpation, such eyes always continuing more or less painful. They are also a source of some danger, if the bony plates have not closed in behind the atrophied iris, and so formed a rounded mass; for the rough points and projections are very likely to induce sympathetic irritation in the other eye. Enucleation is all the more indicated, as in such cases an artificial eye cannot be worn owing to the irritation which its enamel shell causes.

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Before closing this account of the diseases of the choroid I must occupy your attention for a few moments with the hæmorrhages, detachments, and ruptures, to which it is subject.

There is not much difficulty in localising in the retina the small flammiform extravasations which occur in the vicinity of the vessels, and extend to the most internal layer, that of the nervous fibres. Such, however, is no longer the case when large hæmorrhages have taken place, as is not uncommon, and when the blood has passed through all the layers of the retina. These great centres are bounded by curved or more or less straight lines, just like the large effusions in the choroid, which make their way through the amorphous membrane, and stretch along the retina, raising it up more or less. It is only when the hyaline membrane has offered enough resistance to the slighter extravasations that they can be distinguished from the larger retinal ones by their more uncertain outlines. To propose to be guided here by the course of the retinal vessels, which ought to pass over the subretinal patches, is to expect what is absolutely impossible. When the layer of extravasated blood is thick, and dark-coloured, there is no means by which the vessels can be distinguished from the subjacent parts.

It is true that choroidal hæmorrhages are less correlated with alterations in the vascular walls than are retinal, and that they are also found chiefly in choroidal atrophy from traction. Their presence gives a measure more or less accurate of the stretching to which the choroid has been subjected, and indicates a treatment such as has already been laid down when dealing with this subject (p. 216.)

Detachments of the choroid are very rare, except, indeed, a detachment which occurs in the ciliary region, from traction in certain forms of irido-choroiditis, or which accompanies the free hæmorrhage that follows removal of staphylomata. The detached portion of choroid presents in the field of the pupil, in the form of a rounded, regularly-formed mass, with a plexus of choroidal vessels upon it, and a perfectly smooth surface.

As regards the diagnosis some difficulty may arise between simple detachments of the retina or a tumour. Detachment of the choroid is distinguished from that of the retina, by its absolute immobility, and by its colour; for however dark a subretinal extravasation may be, it will never give to the retina the half-red, half-grey tint, of the choroidal detachment. The retina may indeed become subsequently separated from the detached choroid, and this may render its outlines and colour less distinct, but in general in such a case there is detachment of the anterior region of the choroid, upon which merely vestiges of retina remain.

Much greater difficulties have to be encountered in diagnosis when it comes to asserting the absence of a tumour, for it is well known that melano-sarcomata may become developed after injuries. We must in such cases be guided chiefly by the diminution in tension; not that this will be at all an infallible guide, for I have myself been guilty of mistaking a tumour for a detached choroid, in an eye in which tension had decreased considerably after injury. The enucleation subsequently made revealed the presence of a melano-sarcoma. It is true as a rule that softening increases in an eye in which the choroid is detached, whilst in one affected by sarcoma it progressively increases.

Examination of these points would then be conclusive, if we could follow patients a sufficiently long time, but generally speaking, the little relief we can afford renders them not very anxious to remain with us. The surgeon can scarcely arrive at any conclusion from the fact of there being no change in the appearance of an eye after two examinations even with a considerable interval between them, because melano-sarcoma often runs an extremely slow course.

The treatment that may be tried in a distinct case of choroidal detachment will be puncture and drainage, operations the more justifiable as the eye is on the highroad to destruction. For the various methods of treatment I must refer you to what I have said as regards detachment of the retina.

I will conclude the account of affections of the choroid by speaking of the *ruptures,* which it may undergo after contusion or shock. Formerly it was supposed that lacerations of the choroid were rare accidents. Now the evidence is such that we have been forced to allow that the eye scarcely ever receives a violent contusion, especially if driven back with more or less force into the orbit, without the posterior and fixed portion of the choroid being torn. It is very probable that similar ruptures are also produced near the anterior insertion; and that it is especially to them that the hæmorrhagic effusions are due, which make examination of the eye impossible, and at the beginning conceal the posterior rupture. The anterior are themselves concealed, owing to the situation they occupy.

It is difficult to say how far the retina participates in the rupture. Its epithelium, at any rate, constantly shares to some extent. The course of the retinal vessels over the rupture will enable us to judge to what depth it has penetrated into the delicate elements of the nervous membrane. This must be always more or less injured, for as the majority of these ruptures are either close to the optic nerve, or between it and the macula, we find in every case an impairment of vision too great to be accounted for merely by a tear in the basement membrane of the retina.

When the fundus is examined very recently after the injury, the ruptures in the choroid are seen as long yellow streaks with rounded edges, generally bordered by extravasated blood. The breadth of these yellow bands seldom exceeds a third or a half of the diameter of the papilla, while their length may measure from three to four diameters. They are very similar in appearance to the cracks in badly dried varnish on a spherical surface. Their position usually corresponds to that of the superior and external quadrant of the fundus, and, as a rule, they are met with in the vicinity of the optic nerve.

In proportion as the ruptures heal, the bands they form contract and assume a white tint, but never display the marble-like lustre of the sclerotic, which remains concealed by the uninjured lamina fusca. Generally speaking, the retinal pigment having become proliferated, forms a frame to these narrow cracks, the length of which has thus been so much curtailed that smaller ones may leave hardly a trace of themselves.

The attachment of the choroid by means of the posterior ciliary vessels which traverse it, but especially by its implantation in the sheath of the optic nerve, has a very great influence in determining such ruptures at points that are always identical. The want of mobility in the choroid in these situations would conduce to rupture at the moment of any shock which suddenly displaced it (*Sæmisch*). There are other authors who account for the accident by contrecoup (*Knapp*), or by the distension undergone by an eye when flattened against the orbital walls, a distension which would affect chiefly the equator, with the result of detaching the choroid from its posterior insertion (*Von Arlt*). Lastly, of late it has been suggested that it is the optic nerve being forced into the eye itself that plays the most important part in these injuries (*V. Becker*). The arrangement, according to the concentric bands of the papilla which choroidal ruptures take in some cases, is an argument in favour of their being caused by the nerve, against which the eye is, as it were, hurled at the instant of contusion.

Nevertheless, it must be remembered that bullets which pass through the face in the neighbourhood of the orbit, always rupture the choroid close to its posterior insertion. Here clearly it is the concussion of the choroid which tears it close to its attachment to the optic nerve, for here it cannot yield before the shock as readily as in more mobile parts, as, for instance, where it glides over the sclerotic aided by the supra-choroid.

As regards treatment. After cicatrisation has been effected with the aid of the compress bandage and atropine, great improvement in vision may be brought about by injections of strychnine (p. 32). These will not only lessen the after-effects of retinal shock, but will also combat the insensibility due to the contraction of cicatrices in the neighbourhood of the macula.

LECTURE XXIV.

ACUTE GLAUCOMA; CHRONIC IRRITABLE GLAUCOMA; SIMPLE CHRONIC GLAUCOMA; ÆTIOLOGY.

I NOW turn to a group of the most important diseases that can affect the eye. It is in the treatment of these that perhaps the most brilliant triumph of ocular therapeutics has been gained. If I speak of "an affection" I am consciously perhaps using a misnomer, for "symptoms" would be a more correct term. But as in every medical treatise a chapter is consecrated to jaundice, which is merely a symptom depending on various affections of the liver, or other organs, so I am justified in speaking, under the name glaucoma, of a symptom which may complicate many affections of the eye.

I believe I was one of the first to take this view of glaucoma, and to define it as "*the expression of a disturbance of equilibrium between secretion and excretion, with increase in the contents of the eye, and increased tension.*" The second portion of the definition is necessary to establish the glaucomatous character, as there may be another variety of disturbance, between secretion and excretion, in which the fluid draining away from the eye, is in excess of that secreted. In such cases the contents of the organ diminishing, tension diminishes also, causing what is known as *essential* (temporary) *atrophy* of the eye.

The increase in the amount of fluid within the eyeball, the augmented pressure, and the consequent increased tension within the envelopes of the eye, are facts of which, as standing in the relation of cause and effect, there can be no doubt. It may be said generally that all affections which tend to increase the contents of the eyeball, will necessarily have a distinctly glaucomatous character. The point to which research is still being directed, and on which discussion turns, is the real nature of the disturbance, which has destroyed the balance between secretion and excretion. Is the perturbation the result, as *Donders* holds, of increased secretion, or, as I was the first to teach, is it not rather very often, or always, due to retention of the intraocular fluid?

Before commencing to describe what is known clinically as glaucoma, I should like to call your attention for a moment to one point, namely, that the acuteness of the affection, or if you prefer, the intensity of the symptoms of irritation, so-called inflammatory, is a phenomenon interpreted differently by *Donders* and myself. My illustrious teacher looks on the inflammatory symptoms as a species of ophthalmia, tacked on as it were to an eye, the contents and pressure of which have undergone increase. I, on the contrary, hold that the acuteness of the affection and the inflammatory symptoms, depend on the degree and the rapidity with which the balance between secretion and excretion has been upset.

I have thought it necessary to lay stress on these few points, because they will enable you the better to understand the short sketch I propose to give of *glaucoma*. This I used formerly with my master, *Von Graefe*, to look on as a serous form of choroiditis, varying in intensity, but never causing any appreciable anatomical changes in the choroid.

Clinically there are three varieties of glaucoma: 1. Acute glaucoma, or an attack of glaucoma; 2. Chronic irritable glaucoma; 3. Chronic simple glaucoma. To complete this list there should be further added; 4. Absolute glaucoma; 5. Consecutive glaucoma; and 6. Complicated glaucoma.

1. *Acute glaucoma* appears in the form of an attack, that is to say, suddenly. If, which is rare, we see it at its commencement, the first symptom observed is increased tension. At this moment, with the ophthalmoscope, the blood may be perceived to pass through the papilla only during systole; there is therefore arterial pulsation. Together with violent circumorbital pain, the eye exhibits considerable redness; the pericorneal and subconjunctival injection, and the turgidity of the anterior ciliary veins being especially striking. The movements of the iris are sluggish. The pupil is gradually dilated to its full extent. The cornea becomes dull, its epithelium punctated, and insensible to touch. The aqueous and vitreous humours, as seen through the dimmed cornea, appear merely to have lost their usual limpidity, while the pupil assumes a greenish hue, to which the not very appropriate name glaucoma is due. If to the above, you add that at times there is slight protrusion of the globe with more or less œdema of the lids, and that owing to ischæmia of the retina, sight may be

reduced to the faintest glimmer of light, you have a picture of an attack of glaucoma.

You must not suppose that the pressure upon the nerve backwards, as revealed by the excavation of the disc, has any share in the abolition of vision. Depression of the papilla never exists at the beginning, as examination of an eye after the attack will show. In such a case, vision may have been destroyed for ever, and yet no depression of the nerve be visible. An extreme tenuity of the vessels, and an atrophic discoloration of the disc, are the only signs present.

The most characteristic symptom then of glaucoma, namely, excavation of the optic nerve, forms no part of an acute attack. This latter may even pass off, leaving an eye more or less uninjured. Most generally another and similar attack will supervene; or, after vision has returned to some extent, a form of chronic irritable glaucoma may develop itself. It is during the evolution of this, or when it has been accomplished, that the papilla yields to the increase of pressure, and becomes excavated. If vision is not re-established, after the first attack, if tension has not diminished much, and if dulness of the cornea persists, the glaucoma becomes known as *fulminans*. Note well that here the loss of sight precedes, while the excavation follows at some interval, the manifestation of increased tension.

There is nothing astonishing in the fact that a practitioner, who has not had special experience of such cases, should fail to perceive the gravity of the affection, inasmuch, as it is not accompanied by any well-marked symptoms of inflammation. The extreme violence of the circumorbital neuralgia, and the hemicrania, together with perhaps vomiting, directs attention in another direction. When a surgeon finds himself in presence of an eye with but little injection or watering, and merely somewhat dull looking, he will probably attribute the symptoms he sees to the neuralgia. The patient himself will not unfrequently confirm the error, by taking little heed of his more or less complete loss of vision, but complaining loudly of intolerable pain in and about the brow.

Nevertheless it is very rare to find that a patient has not received some warnings of the impending danger by *premonitory symptoms*. These prodromata are due to increased tension, not to inflammation. The most characteristic symptoms are, impairment of accommodation, premature development of presbyopia, in persons not over forty, and in the case of hypermetropes (who comprise from 50 to 75 per cent. of all glaucomatous patients), the fact of their being no longer able to use their ordinary glasses, but continually requiring stronger ones.

The patient's attention is also aroused by the appearance of a rainbow round every flame. This symptom is in my opinion due to very slight alterations in the epithelial layer of the cornea, produced by temporary increase in pressure, and is analogous to a similar phenomenon witnessed in most cases of conjunctival catarrh, where there is irregular desquamation of the epithelium.

It is not so common to hear a patient complain of seeing clouds or smoke from time to time rising up before him. This symptom is not inconsistent with perfect central vision; nevertheless careful examination will show that from the moment of its appearance peripheral sensibility has considerably diminished. This phenomenon is connected with compression of the vessels of the retina, making itself felt in the smallest branches of the arterial tree. A feeling of heaviness about the brow and flying pains are still less common.

If now we glance back over either the premonitory symptoms or the actual attack of glaucoma, we shall find ample evidence of irritation in the nerves and vessels, but none of genuine inflammation. The appearance of cloudiness in the aqueous or vitreous humours in an eye not otherwise affected must be explained by deficient transparency of the cornea, and more especially of its epithelial layer. Simple paracentesis, by relieving the excessive intraocular tension, will prove that all the media are perfectly clear. The cloudiness is due entirely to pressure, and is in no wise the consequence of an ophthalmia.

2. *Chronic irritable glaucoma*, the so-called *inflammatory*, may succeed an acute attack, after the symptoms of serous exudation and œdema, which were formerly looked on as inflammatory, together with the chemosis, swelling of the lids, and tension have disappeared.

Generally speaking, this form of glaucoma does not amount to an actual attack, but becomes developed gradually, the signs of acute irritation being wanting. At the outset, the plexus of anterior ciliary veins appears very distinct against the sclerotic, which has a dull leaden hue, thereby simulating an inflammatory injection which does not exist. This colour arises from the obstacles to the circulation, together with the obliteration of numerous fine vessels in the episcleral and scleral tissues. The cornea has a slight opaline tint, owing to the roughness of its epithelium, and the difficulties which its lymphatic circulation has to encounter. This dulness at once suggests cloudiness of the aqueous or vitreous humours, which however exists in neither of these media, at least not in uncomplicated cases of glaucoma.

In proportion as the disease progresses the cornea becomes insensible, and the pupil dilated, reacting imperfectly to light, and assuming an oval form. The symptoms met with in the iris are also entirely attributable to compression, and consist in atrophy first of its pigment, and subsequently of its stroma, which is reduced to a mere band attached to the periphery of the cornea. In an uncomplicated case there are neither exudations nor posterior synechiæ.

The alterations in transparency of the cornea, are peculiar in this, that at certain hours of the day, or on certain days, the membrane may recover its usual lustre and transparency, thus enabling us to see what is passing at the fundus of the eye. The only striking symptom to be seen is the depression of the optic nerve, and the formation of a more or less deep cup according to the time the affection has lasted. There is also evident embarrassment in the venous circulation, with at times an arterial pulse, which becomes apparent on the slightest external pressure.

What chiefly attracts the patient's attention is the progressive failure of sight. Not only does central vision become impaired, but the whole field gradually contracts. The patient, if his attention be called to the point, will at once recognise that the dimness is most marked in a direction from above downwards, and from within outwards, that it is getting progressively worse, and that the limitation of the field is spreading in such a way, as to leave only a narrow slit directed outwards, even this eventually becoming lost. The patient is also conscious that there are days and hours in the same day when his sight perceptibly improves. How often have I not heard observant patients say that this improvement seemed to coincide with a sensation of relief in the eye, which would then become less heavy and *hard!*

The pain may vary much according to the course of the disease. If this has been very slow, pain is entirely absent, and thus is explained the fact that careless persons will sometimes allow an eye to perish without paying the slightest heed to it. This form of glaucoma, if developed with sufficient rapidity, especially where remissions accompany the loss of sight, may coincide with dull periorbital pain, which the patient willingly enough compares to neuralgia.

I must once more insist on the fact that during the whole course of this, the commonest form of glaucoma, there is not one sign that could justly be attributed to inflammation.

3. Curiously enough, *chronic simple glaucoma* is regarded universally as the typical form of the disease. To show how easily errors in medicine may spring from illicit processes in logic, I may say that those who defend the inflammatory theory of glaucoma, while considering this simple form as the type of the disease, declare that in it every symptom of inflammation is absent. In the most considerable monograph which has of late appeared on glaucoma, from the pen of *M. H. Schmidt* in *Graefe* and *Sœmisch's* Encyclopedia, it is clearly stated that "*simple glaucoma* is the *type* of the whole group of *glaucomatous diseases*." Granted! but when the typical form is destitute of any symptom of inflammation, you must not rank glaucoma among inflammations.

The characteristic signs of glaucoma are increased intraocular tension, excavation of the papilla, and the regularity with which pressure acts on the retinal circulation, first limiting, and eventually abolishing, the field of vision. Absolutely nothing abnormal can be observed in the enveloping membranes of the eye, or in the media in simple glaucoma. Cases where cold feet or mental emotion have been followed by slight exacerbation of the symptoms, with roughness of the corneal epithelium (wrongly attributed to haziness of the aqueous humour), are not really simple, but rather chronic irritable glaucoma running a slow and mild course.

By palpation, either with tonometers or the fingers, an appreciable increase in the intraocular tension will be almost always found. If it be not, you may suspect you have made a wrong diagnosis. A *tactus eruditus* will in almost every case discover increased tension, and this taken in connection with sluggishness of the iris, and slight mydriasis, I consider as a most important sign, far more valuable indeed than excavation of the disc. For in this latter, morbid changes in the papilla, particularly if large physiological excavations existed previously, and the papilla had a deep and wide pitting where the vessels entered, may easily lead to the supposition that the nerve is depressed. In other words, the disappearance of the soft substance of the nerve, and the contraction of its tissues, may easily simulate compression, and displacement backwards.

If however there be true excavation from pressure backwards, signs of disturbance in the retinal circulation will not be absent.

Thus the veins will be flattened out and dilated close to the edge of the excavation. A very slight pressure with the finger will check the regular flow of blood in the arteries, and determine pulsation. Spontaneous pulsation is not found in this simple form of glaucoma. But in perhaps every case it will be found that in proportion as the papilla is pressed backwards, the pressure will bear most heavily on its external portion, that is, towards the posterior pole or macula, while the vessels will be thrust in a different direction, namely, towards the inner side of the disc. You should have doubts about the genuineness of every excavation, where this crowding together of the vessels on the nasal side is wanting, and where they have been merely displaced backwards towards the centre of the papilla.

In addition to the signs afforded by an excavation, the sides of which overhang in such a way that vessels lying against them are lost at a certain depth, being seemingly cut short at the edge, there is yet another. This is, that the choroid attached round the circumference of the papilla sympathises with the depression of the nerve, and becomes more or less detached. You will scarcely find a well-marked excavation by depression where there is not a corresponding detachment of the choroid. Cast a glance at the excellent plates XI. and XII. of *Jaeger*, published in our joint work (*Traité des maladies du fond de l'œil*), and say whether the drawing does not indisputably show, that the pressure which drives back the papilla detaches the choroid also to a greater or less degree, causing an appearance similar to a circular posterior staphyloma. The choroid behaves like the retina, which, under the microscope, appears as though it had been punched out. Neither retraction nor atrophy of the nervous tissue affects the neighbouring portions of choroid.

The last symptom which confirms the diagnosis after palpation, and the evidences of pressure on the papilla, will be how this pressure has affected the sensibility and circulation of the retina. Central vision will be compromised to a variable degree, but in every case is only slightly impaired at the commencement. It is the field of vision which contracts. Limitation always commences on the inner side, the inferior and superior portions being subsequently affected in turn. The visual field therefore becomes contracted in such a way as to assume the form of a slit, widening outwards. Sight continues relatively good so long as the narrow end of the slit has not passed beyond the point of fixation. If you find concentric limitation, or if a complete sector of the field of vision be absent, you should have some doubts, and before pronouncing positively should examine the visual limits of blue, red, and green. The persistence of the limits of vision for colours is in favour of the notion of limitation by pressure; the absence on the other hand shows a trophic alteration in the fibres corresponding to the portion of the field that is preserved, and therefore the case will be one not of simple depression of the papilla, but of a change in its nutrition.

You must not imagine that you can draw any conclusions as regards the functional condition of the retina, from the depth of the excavation. Some seven years ago I operated on a well-known provincial surgeon, who presented a remarkably deep excavation of his papilla. He consulted me first in 1870, and although the optic nerves exhibited deep pitting, and although intraocular tension was increased, he would not consent to any operation, his sight being normal, and the field of vision intact. The power of accommodation only had somewhat suffered. Shut up as I was within Paris during the siege, I did not see the patient again for eight months after this examination. Sight in the right eye by that time had considerably diminished, and the field of vision had become characteristically contracted. He therefore submitted without hesitation to iridectomy on each eye. Such cases confirm the view that it is undoubtedly more owing to the effects of pressure on the circulation, than on the nervous structures of the retina that the visual field becomes limited, and eventually abolished. The destruction of the field of vision takes place in the same direction as that in which it disappears when we induce anæmia of the retina by pressure.

The pure form of simple glaucoma, formerly described by *Von Graefe*, as atrophy with excavation of the optic nerve, when it has induced complete blindness, at times alters its character, assimilating itself to chronic glaucoma. I could mention cases in which a surgeon has hesitated to perform iridectomy, so slightly marked have the symptoms of glaucoma been, but where a true attack of this disease coming on, eventually caused both surgeon and patient to regret not having had recourse to the operation.

4. Under the name of *absolute glaucoma*, or glaucoma that has run its course, I include all cases where excessive pressure has eventuated in complete loss of sight. It is not necessary that symptoms of intense irritation should have been present during the affection; a typical case of simple may become and continue to be one of *absolute* glaucoma, without any change supervening other

than well-marked atrophy of the nerve, with contraction of the arteries, and a bluish excavation.

When symptoms of irritation accompany glaucoma, the cornea grows more or less dull. That portion of it exposed to the atmosphere while the lids are open, becomes dry and partly xerosed. The iris forced back towards the periphery of the cornea, is reduced to a thin strip, which may even become lost to view beneath the conjunctival limbus at the upper portion of the membrane. The crystalline advances ever nearer to the cornea, becoming opaque; while its cortical substance to a great extent obscures the green hue of the pupil.

The sclerotic, dingy in colour, and traversed by large dilated ciliary veins, assumes also a more or less dull appearance; the eye seems smaller in all its diameters, and under the finger feels as hard as a marble. Such an eye, where the ciliary nerves have been destroyed, may be completely insensible, and cause no annoyance to the patient. Nevertheless, in many such cases attacks of increased tension are revealed to the observer by hæmorrhages appearing in remnants of an anterior chamber, and to the patient by compression of the remnants of the optic and other nerves, whence pain and a white glare.

When the utmost excess of tension has existed for a considerable time, the form of the globe may be destroyed, either by atrophy consecutive upon obliteration of large numbers of vessels, or by necrosis of the central portions of the eye. This is followed by sudden perforation, and copious hæmorrhage, with suppurative choroiditis, which leads to complete disorganisation of the eyeball.

5. The three varieties of glaucoma just described, depend on causes to which I shall return later; but in all of them, it is to the destruction of the balance between secretion and excretion, that the symptoms are due in eyes which up to a particular moment had apparently been perfectly healthy. When, on the other hand, a similar disturbance takes place in eyes already diseased, we speak of glaucomatous complications, and of *consecutive glaucoma.* All affections become glaucomatous when together with other symptoms excessive tension is present, acting on the papilla and the nutrition of the retina.

The affections which most readily assume this malignant character are those which affect the excretory region of the eye. The classical labours of *Leber* have demonstrated that the principal excretory tract (*Leber's* tract, as I call it) is in the pericorneal region, and consists of the great lymphatic canals of the eye, namely, those of Schlemm and Fontana. It is through the trabecular tissue about the cornea (see fig. 17, p. 263), which includes several small lymphatic spaces in direct communication with the cornea, sclerotic, and anterior chamber, that the fluids destined to leave the eye must pass.

I may instance here the various forms of serous iritis and irido-choroiditis which, falling chiefly on this trabecular tissue, render it often so impermeable, that glaucomatous symptoms appear. The same phenomenon should occur in the various forms of the sclero-choroiditis which invade the most anterior portion of the uveal tract and the pericorneal region. Here the elasticity of the tissues in young subjects is such as to afford an explanation of why the effects of any disturbance should be more slowly exhibited on the papilla and retina. The affected parts become stretched and progressively wasted, and in this way render the channels once more permeable to the products of excretion. In proportion as the ectasia becomes developed, a distinct softening can be perceived in such eyes, in which pitting of the optic nerve has not yet had time to take place.

The excretory channels may be choked up by an obstacle applied directly against them. The thick masses of cellular tissue developed in general pannus of the cornea may act thus. The same will apply to the periphery of the iris. I have already, in the preceding lectures, pointed out how dangerous both large and small perforations, where there is adhesion of the iris, may become. In such cases, once the periphery of the iris has become bound down to the cornea, the symptoms of excessive tension will appear very quickly, and be accompanied by staphylomatous cicatrices, and depression of the optic nerve.

I have also, in speaking of the various forms of iritis, called your attention to the danger of total posterior synechia, or complete adhesion of the pupil to the lens. Here all interchange between the two chambers is intercepted, and the iris is forced by the accumulation of the aqueous humour against the space of Fontana. The funnel-like shape which the anterior chamber then assumes, together with the adhesion of the iris, may eventually result in the formation of very peripheral anterior synechiæ, always followed by glaucomatous complications.

There is another source of glaucomatous symptoms, namely, a purely mechanical one, resulting from subluxations, or injuries of the lens, with swelling up of its peripheral layers. If a lens is displaced laterally, so as to force the iris back into the angle of the anterior chamber, you will have, as in the young lad you see here, all the characteristic symptoms of chronic irritable glaucoma. The same will often happen when in consequence of wounds of the capsule, the lens swells considerably, and thus reduces the size of the anterior chamber, especially towards the iritic angle. I may perhaps remind you that very many slight subluxations are sometimes caused by the manœuvres of the needle operation.

The glaucomatous complications that followed division (or the needle operation) used formerly to be accounted for by the irritation of the iris, produced by contact of the cortical masses. But how can this explanation be made to tally with the facts which can so easily be collected in any large clinique? The anterior chamber may be half filled with flakes of lens substance, the nucleus may even fall into it, and yet there will be no symptom of glaucoma, if only the angle of the anterior chamber is not occupied by the iris, or the edge of a luxated nucleus.

I may further instance the development of glaucomatous symptoms following on intraocular tumours, and especially sarcomata of the choroid. When these tumours encroach on the ciliary region, and push the iris against the cornea, there can be nothing surprising in the fact that they become complicated with glaucoma. When they engage the posterior portions of the eye, in which position they do not so quickly become associated with glaucomatous phenomena, the symptoms have been explained by compression of the vasa vorticosa, with consequent disturbance in the circulation of the choroid. The anterior portion of this membrane becoming swollen, may push the periphery of the iris against the space of Fontana; but I confess that all difficulties as to the connection of symptoms here have not yet been solved.

6. I look on the *hæmorrhagic* as a form of *complicated glaucoma*. Here the symptoms of glaucoma are superadded to morbid alterations in the vascular walls of the retina, determining *retinitis apoplectica*. Varices and aneurismal dilatations, together with extensive changes in the walls, have been found in the retinal vessels. It is certain that similar alterations have occurred in other regions of the eye, and that the sclerotic more especially shares in them. The characteristic feature of these cases, which according to my experience, form about fifty per cent. of all glaucomas, is that with an increase of tension so slight as scarcely to be appreciated by touch, or by its effect on the papilla, or nutrition of the retina (there is no characteristic visual field), the disturbances in the retinal circulation nevertheless exhibit

themselves from the first by rupture of the degenerate walls of the vessels. Further the relaxation of tension produced by opening the eyeball may result in vascular lesions, most disastrous for the whole organ. Another noteworthy fact is that with only slightly increased tension the pain is often unbearable, continues after complete blindness, and obliges us to have recourse to enucleation.

I now come to the most important question of all as regards glaucoma, and one on which I have already touched in my definition of the symptom, that is, its ætiology. It is now nearly two years since I published in the "*Archives of Ophthalmology*" this sentence: "*According to Donders, the excess of tension in glaucoma is the result of hypersecretion; from my point of view, it results in the majority of cases from some check to excretion.*" This appeared shortly after *M. Knies* had given, in the same publication, a series of dissections of glaucomatous eyes, of which you have one of the most typical in fig. 15. In the same article he also stated that the pathological facts were such as to justify us in regarding as the essential point in the ætiology of glaucoma, the inflammation and induration of the structures round the canal of Schlemm. More recently, *M. A. Weber* in a large and diffuse work, in which the labours of his predecessors receive scanty notice, arrives at the conclusion that the causes of glaucoma, "considering the normal conditions of the eye, can be none other than mechanical, and that they must be looked for in progressive obstruction of its filtrating channels." The only difference between *Weber* and myself is that he uses the word "filtration," while I use "excretion." In the work quoted above, I have

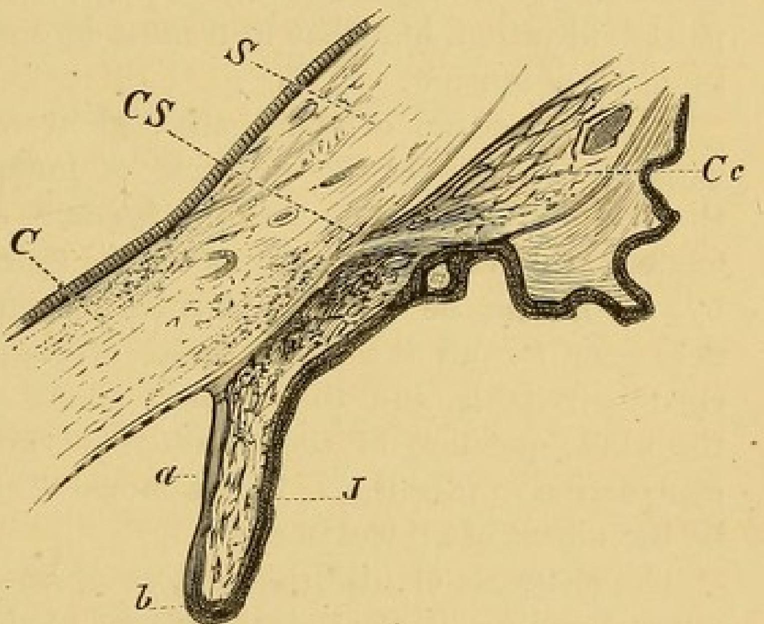

Fig. 15.—Structures bordering the canal of Schlemm. C. cornea; J. iris; S. sclerotic; Cc. ciliary body; CS. canal of Schlemm; *a*. newly formed tissue on anterior surface of iris; *b*. pigment of iris.

alluded to the fact that the channels of filtration discovered by *Leber* become narrowed by hyaline, or epithelial masses. It is now more than ten years since I insisted on the fact that the cure of glaucoma must be searched for in the re-establishment of filtration through a suitable cicatrix.

In a recent discussion at the Heidelberg Congress (1877), stress was rightly laid upon the following facts: namely, that occlusion of the space of Fontana is not an indispensable condition to the determination of glaucoma, and that all conclusions drawn from dissections must be received with caution; for, as *M. Pagenstecher* well remarked, after the glaucomatous process has lasted for some time, the ciliary body and the iris undergo in the majority of cases, though not in all, considerable alterations. But during the whole of the discussion, the speakers were distinctly in favour of the idea which I was the first to adopt, and teach in my lectures, to wit, that glaucoma resulted from impaired filtration, and that in it must be sought the causes of the increase of tension.

If in the group of consecutive glaucomas we find numerous cases which support the doctrine of impaired filtration, due to the iris and crystalline having become adherent in the iritic angle, and having thus obliterated the space of Fontana, this can by no means be held to furnish the fundamental conditions necessary for all the three types of glaucoma—the acute, the chronic irritable, and the chronic simple. The point on which the whole question of the ætiology of glaucoma hinges, is the obstruction to filtration. The removal of such obstruction should be the object of all treatment.

The channels of filtration are, according to Leber, 1, the pericorneal region; 2, the neighbourhood of the optic nerve. These, as I have always taught, are the sole points where the interior of the eye is without a hyaloid, amorphous membrane, quite unfit for filtration. The bulk of filtration undoubtedly takes place around the cornea, where the anterior chamber is, so to say, extended across the trabecular tissue of the angle of the iris, up to and underneath the conjunctiva. It is in this point that the lymph spaces of the cornea, sclerotic and internal membranes unite to form one grand space, called the anterior chamber. Any obstacles in the tissues, either towards the anterior chamber, or in the substances of the sclerotic, or towards the surface of the conjunctiva, may check filtration within this pericorneal region. This trabecular tissue is represented in an excellent manner in the preparation (fig. 17) which *M. Waldeyer* has been good enough to make for these lectures.

Besides the discovery of the obstacles which obstruct the channels of filtration, another important question remains to be disposed of. This is, how it comes to pass that once the vicious circle established, and the tension increased, this has always a tendency to block up the main channel of filtration more and more completely. To my mind it is the increase of pressure itself which, altering, though very slightly, the shape of the eye, disturbs and compresses the trabecular tissue of the iritic angle, and thus checks filtration in an ever-increasing degree.

In those forms of glaucoma which are absolutely free from symptoms of irritation, in which pressure is slight, and the dominant symptom is excavation of the optic nerve, it may be a question whether the proximate cause must not rather be looked for, not in the main channel, but in a minor one—namely, in the neighbourhood of the optic nerve. That idea of *anterior* and *posterior* glaucomas which the younger *Desmarres* put forth some ten years ago, when he attributed the affection to inflammatory disturbance, attaching to two different circulatory systems, should perhaps, as *Stilling* proposes, be resuscitated for the channels of elimination. To do so it would be necessary to understand more clearly how the vitreous humour, which, it is true, communicates with the anterior chamber only by the stomata of the ligament of Zinn, but whose nutritive channels are constantly open, rids itself by filtration (through its central canal) of the products of elimination. As regards the main efferent channel, which is well understood physiologically, we possess certain facts going to prove that obstruction is correlated with increase of pressure. On the other hand, as regards the functions of the minor and posterior channel, our knowledge is still very imperfect, and indeed, can scarcely be said to exist, as regards the obstacles which may be collected about this channel and may influence the intraocular tension.

At least this much is beyond cavil,—that our knowledge of the ætiology of glaucoma has gained considerably, since we have quitted the obscure domain of neuroses of secretion, and have reduced all cases to purely mechanical methods. I have long taught that the treatment of glaucomatous affections should be mechanical; and I think I have shown this conviction very thoroughly in my researches on ocular drainage. You must not be surprised that I linger so long over this question of the ætiology of glaucoma, for

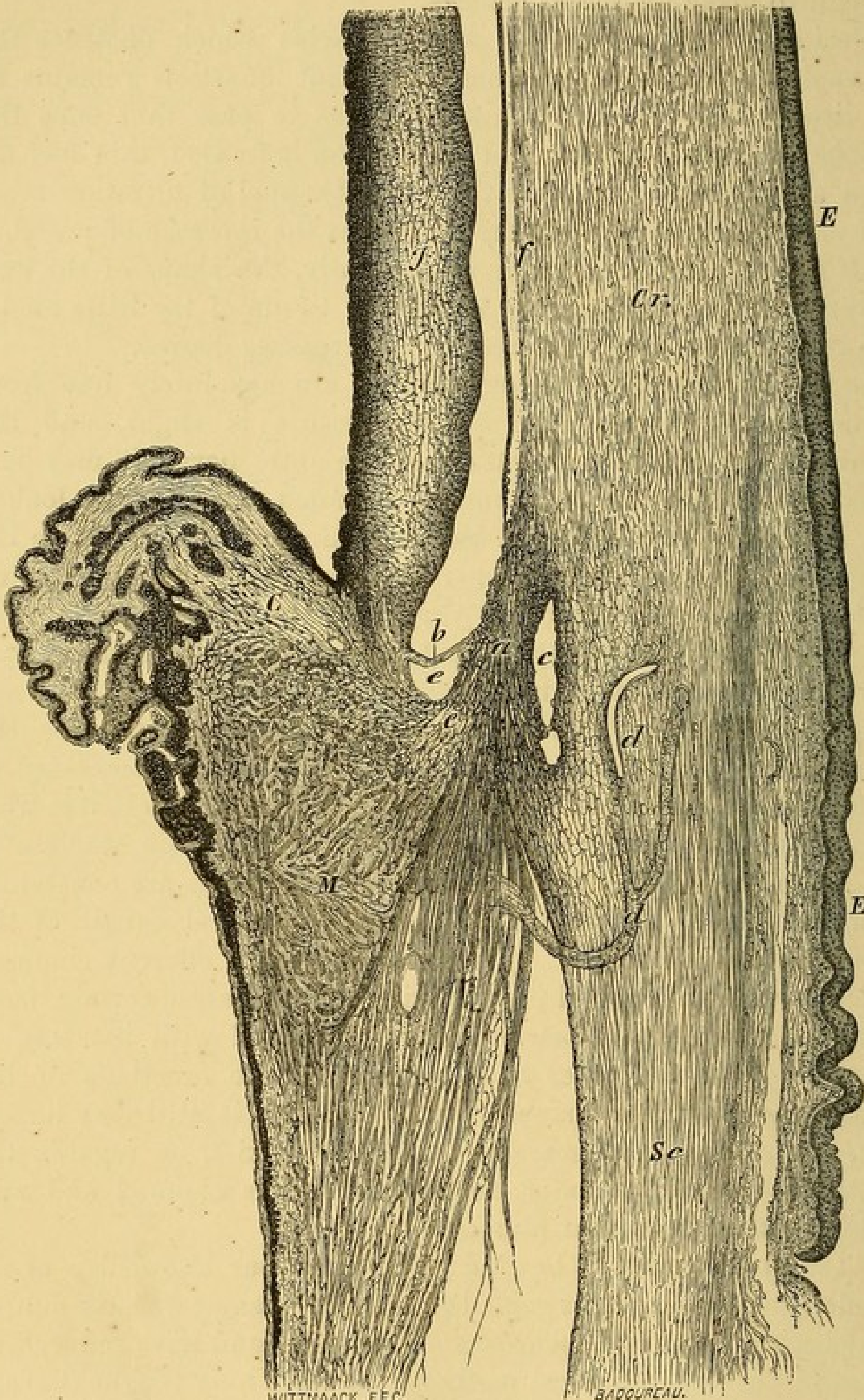

Fig. 16.—*a.* cavernous tissue; *b.* prolongation of the iris; *c.* canal of Schlemm; *d, d.* blood vessels; *e, e.* spaces of Fontana; *f.* Descemet's membrane; *I.* iris; *C.* ciliary body; *M.* ciliary muscle; *Cr.* cornea; *Sc.* sclerotic; *EE.* epithelium.

Fig. 17.—*a, a, a.* cavernous tissue of the iritic angle; *b.* iritic angle; *c, c.* canal of Schlemm; *d.* sclerotic; *e.* cornea; *f.* Descemet's membrane; *g.* attachment of iris; *h, h.* ciliary muscle; *i.* bridge of tissue placed between the two portions of canal of Schlemm; *k.* vein; *l, l.* communications between the spaces of cavernous tissue and the canal of Schlemm.

it sheds a flood of light on the path which therapeutics, to be of any real use, must travel over. I mean, we must study thoroughly the physical conditions under which a given pathological divergence will place an organ in order to meet this by remedies whose action shall equally be mechanical. It is by following faithfully this method that we shall in time arrive, not empirically, but inductively, at discoveries like that of *Von Graefe's*. By such a method, too, our speciality will continue to be in the future as it has so often been in the past, a guide to general therapeutics.

LECTURE XXV.

ÆTIOLOGY (*continued*)—TREATMENT OF GLAUCOMA.

Before entering upon the treatment of glaucoma it will be necessary to insist on some points in its ætiology which clinical observation has caused to be recognised, and which now admit of more easy explanation than by the "secretion" theory.

I will remark, first of all, that a want of elasticity in the sclerotic should be favourable to the development of glaucoma. In the first place it would not permit of any compensatory distension, by which a slight and transient increase in the contents of the eyeball could be balanced. In the second it would assist in establishing that vicious circle already spoken of, by which the afferent channels of filtration opening into the anterior chamber become compressed against the sclerotic with a force proportionate to the amount of the intraocular pressure.

Glaucoma, which forms about one per cent. of all diseases of the eye, does not generally show itself till the signs of age are becoming evident, that is to say, till after fifty. At this period fatty degeneration and calcareous deposits begin to show themselves in the sclerotic, and hyaline masses to appear in abundance in the region of filtration. There is therefore nothing astonishing, when once the eye has arrived at this condition of repletion, that the slightest drop, as in a vessel already too full, should cause an overflow. Such might occur, for instance, when conjointly with atheromatous changes, such as varices and aneurisms of the retinal vessels, there was also intraocular hæmorrhage. Such too is the case when the general state of dilatation of the vessels after atropine causes undue repletion, destroys the balance between secretion and excretion, and establishes a vicious circle rendering the condition permanent.

We are now in a position to understand how, in such eyes, congestion, lasting over a certain time, may suffice to overthrow the balance. It is to be noted that strong emotions have always been recognised as causes of glaucoma. In the same way it is well known that in some cases intense excitement, such as sexual passion, violent anger, or wounded vanity, is sufficient to cause the face to flush up for a considerable time, to inject the conjunctiva, and, as the vulgar saying is, to "make the eyes start out of the head."

From this point of view a fact related by *Fischer* is very striking. A lady sixty years of age, extremely sensitive to any losses at play, was deprived rapidly of the sight of her left eye by glaucoma. She was in consequence strictly enjoined not to touch a card. This advice was followed for some time, when unfortunately she yielded to temptation, and lost heavily at play. The same night she was seized with an attack of glaucoma *fulminans*, which, as the resource of iridectomy was not then known, rendered her hopelessly blind.

I will give you two other cases. A distinguished engineer in Paris left the city, during the siege, by balloon. He descended within the enemy's lines, and was made prisoner. This gentleman, whose age was fifty-six, was instantaneously affected with a diminution in vision, due to an attack of simple chronic glaucoma in both eyes. I performed iridectomy on the left in 1871; the other eye was not operated on, because the central portions of the field of vision had not perceptibly suffered. Repeated examinations, six years after the operation, showed that the improvement in vision was maintained in the left eye, while the right still preserved normal acuity.

A lady moving in good society was detected purloining an object of small value in one of the large and fashionable shops of the capital. Arrested and imprisoned, she was attacked with chronic irritable glaucoma in both eyes, which quickly determined deep excavation of the optic nerves, with considerable diminution in vision. But further damage was checked by double iridectomy.

It is in eyes such as these, predisposed as it were to perturbation of the balance between secretion and excretion, that the least irritation, such as that of a wound or foreign body, will induce not intraocular hypersecretion, but vascular congestion, sufficient to turn the scale. A similar accident in a younger subject would have found an eye capable of some compensatory distension, owing to the elasticity of its envelope. But congestion where an eye is affected by senile changes, and where the channels of filtration are scarcely adequate to carry off the normal accumulation of fluid will cause an increased tension, which, though slight, will be quite sufficient to establish the vicious circle I have already spoken of.

It was formerly impossible to understand why glaucoma appeared more frequently in certain races, such as the Jews, and in certain families. The truth is that in such persons the sclerotic is not very elastic, and the channels of filtration passing through this membrane are more easily interfered with by those senile changes which take place in every eye. On the other hand, where extreme immunity is met with, as among the Arabs of the interior, the remarkable suppleness of their tissues must be borne in mind, together with the complete absence of all tendency to formation of fat at any age, and consequently fatty degenerations. But how common in this race is glaucoma consequent on perforations of the cornea, which have suddenly checked filtration!

The formation of the sclerotic and the way in which the filtered fluid passes outwards, will also explain how it is that hypermetropes furnish the main contingent of victims to glaucoma. It must not of course be imagined that it is the glaucoma which induces the change in the shape of the eye, and renders it hypermetropic. If a slight alteration in shape should take place from increase of tension, in such a flat (hypermetropic) eye, it ought to be in the direction of making the eye more spherical, of increasing the radius of corneal curvature, and consequently the refractive power. But the most careful ophthalmometric measurements have shown that if such an alteration does really take place, it is so slight as to be incapable of affecting the refraction. When by any rare chance an alteration does occur, it is probably due to change in the form or position of the lens. As a general rule, it may be stated that no appreciable change takes place in the refraction; any such change falls on the accommodation, which is progressively destroyed.

No difference of any moment is found in the frequency of glaucoma in either sex, nor is the left eye more subject to it than the right, nor deeply pigmented eyes than those the reverse.

Let us now examine the facts which are supposed to support the theory of my illustrious master *Donders*, that it is hypersecretion which determines increased tension, and the other phenomena of glaucoma. Here once more I am using an unsuitable expression: it was not to support the theory of secretion that these experiments were undertaken. No! *jurare in verba magistri* imposed on the experimenters the task of *proving it.* They were guided by but one idea, and that was to find in what nervous region the irritation should be placed. See, moreover, with what inadequate means of research they entered on this campaign. The very distribution of the various nerves within the eye was scarcely known; nor had they any idea in what connection the so-called secretory nerves would be found, or whether it was the sympathetic or the trifacial which would play the important part.

Though mutually contradicting one another, they decided to accept the theory by which the trifacial must be regarded as the dilating, the sympathetic as the contracting influence (*de Hippel* and *Grünhagen*). Being in a dilemma, and obliged to admit that dilatation of the vessels by irritation of the trifacial, determined an increase of tension and glaucoma, while paralysis of the sympathetic, though followed by similar dilatation, did not have the same effect, (although the clinical fact of the instillation of atropine being followed by glaucoma pleaded strongly in its favour,) they met the difficulty as follows. They supposed that mere dilatation was not sufficient, but that by irritation of the trifacial, the resistance of the vascular walls to filtration was also diminished, and that in this way this latter was increased; while on the contrary, paralysis of the sympathetic though dilating the vessels, did not lessen this resistance.

But if they succeeded in increasing tension by irritation of the trifacial, they did not succeed in establishing that vicious circle, by which the tension once increased, it continues increasing definitely as symptoms of irritation reveal themselves: in other words, they did not develop glaucoma artificially.

To this criticism the reply was made that in the experiments, the irritation of certain nerves could not be kept up long enough artificially without producing exhaustion, but that clinical experience showed that affections, such as neuralgias of the third pair, were followed by an increase in intraocular tension and glaucoma.

Now excluding carelessly reported cases where the neuralgias were already connected with increased intraocular tension, I do not believe that in any eye not *predisposed* to become glaucomatous, the most intense and widely distributed neuralgia of the fifth pair, could induce an attack of glaucoma. Nor do I doubt that, in persons with premature senile degeneration, whose eyes are affected by notable diminution in the power of filtration, a periorbital neuralgia might, by causing congestion of the eye, induce glaucoma. Nor, moreover, do I refuse to allow what indeed

I know is the case, namely, that certain strong moral emotions may produce a similar result.

It remains for me to show how the irritation of nerves in the eye itself, due to the presence of a foreign body, must be interpreted in favour of an increase in the functional activity of the so-called secretory nerves. What clinical observation teaches is this, namely, that the presence of the same foreign body situated at the same point, can produce totally different effects, according as it be lodged in the eye of a young or of an old individual. It will be only in the latter case that the symptoms of irritation will tend to assume a glaucomatous character. Thus as regards foreign bodies, the irritation and congestion they give rise to, will not produce glaucoma except on eyes predisposed to it, by a narrowing or partial blocking up of the channels of filtration.

If I discuss thus carefully the ætiology of glaucoma, it is because it is one of the most important questions in the whole range of ocular pathology. The answer given to it must affect our whole treatment. And yet how little were men busied with such studies, when the action of iridectomy on glaucoma was discovered. I passed the winter of 1856–1857 with *Graefe*. His sole preoccupation at that date was to conceal the marvellous results of this operation, until he was satisfied that he was not being mocked by some fortuitous occurrence, or some delusion. Having attended the clinique of the elder *Desmarres*, *Von Graefe* had been struck by the remarkable results yielded by paracentesis in various affections of the eye, and glaucoma in particular. It did not escape him how much more prolonged the relaxation was in an eye, when the far more important paracentesis necessitated by iridectomy had been performed. It had been discovered that in glaucoma the eye became very hard; the means best suited to soften the eye were resorted to; the result was the happy discovery that glaucoma might be cured by iridectomy.

Great then became the difficulty of explaining the action of an operation empirically devised, against a disease itself but very imperfectly understood. But even in his latest works, while confessing that he could not solve the problem of the curative action of iridectomy, *Von Graefe* remarked that, even if he could do so, it would not add anything to the efficacy of the operation. He scarcely deigned to allude to my solution of the question, and remarked merely it was not a particularly happy one. Nevertheless, *Von Graefe* had by no means uttered the last words in this important debate on glaucoma, in which the great question was to explain the nature of the affection.

Although it is very probable that I shall during the whole course of my professional life, perform excision of the iris, as being the most certain operation against glaucoma, I am convinced that with the progress of knowledge, some other proceeding more simple and essentially more logical, will be substituted. Ten years after *Von Graefe* had made his discovery known, I published my opinion that excision of the iris was not really essential to the cure of glaucoma; and further, that it was performed solely because a large opening could not be made at the sclerocorneal junction without danger of strangulation of the iris.

By the removal of a portion of iris in the operation of glaucoma, there results unnecessary mutilation. Of this I have endeavoured also to convince surgeons as regards another operation, namely, the extraction of cataract.

But there also, you will often see me neglecting my own precept, and removing a narrow flap of iris, so as to obtain a neat section, capable of *establishing satisfactory filtration*, which as I laid down years ago, must be rendered thoroughly regular during the healing process that follows on such a large wound as that of extraction. In this operation iridectomy is but a mere *affair of cleansing the wounds in the capsule and cornea, and especially the iritic angle*. And I must say further, that I never meet with any specialist who can be considered competent to form an opinion in such a matter, but shares my views, and has abandoned the old notions about irritation of the iris being due to cortical matter, or to traction. It must be confessed that in the important operation of extraction a step useless and to a certain extent injurious cannot as yet be dispensed with; greater security is rightly preferred to greater perfection; but as in glaucoma, we shall eventually be freed from a difficulty which causes eyes to be unnecessarily mutilated.

How does excision of the iris act in glaucoma? Without doubt this operation owes its value to the section, a fact abundantly established by the numerous sclerotomies which have, up to the present time, been made (*Quaglino, Mauthner*). Their facts are also in direct opposition to the idea of *Ad. Weber*. According to him it is the drawing out of the iris at the moment of excision which frees it from the space of Fontana either by direct traction, or by permitting the aqueous humour to pass between the adherent parts. I have already sufficiently insisted on the relation subsisting between adherence of the iris within its angle, and glaucoma; and how will *M. Weber* explain the action of iridectomy in chronic simple glaucoma, where in the majority of cases this narrow corner continues free from all contact with the iris?

Apart from the re-establishment of filtration, it may be supposed that the section affords relief to the eye in yet another way. Thus, to those who admit that the canal of Schlemm is a lymphatic canal in communication with the veins, but kept free by a system of valves (not yet studied) from blood, save in rare cases, as in the hanged criminal examined by *M. H. Schmidt*, whose canal was found filled with blood,—to those, I say, who thus regard the canal of Schlemm, the action of the operation will be sufficiently explained by the establishment between the veins and anterior chamber of a more direct mode of communication.

The theory of *Exner* is that excision of the iris acts by causing a more direct communication between the arteries and veins of the iris. *Waldeyer*, whose opinion as an anatomist I sought as to whether such an arrangement could be explained anatomically, wrote to me as follows:— "The problem, to my mind, will never be solved by purely anatomical methods. If a section be made in the region in question (the angle of the iris), then, of course, a series of veins, lymphatic spaces, capillaries and arteries will be opened. But with what result? At once, and subordinate to conditions of pressure, the blood could pass into the lymphatic spaces, or the reverse; but this could only last for a short time. The contraction of the wound would obliterate the vessels so divided; although it is quite possible that later on there might be established a *durable* communication between the blood vessels and lymphatics. The vessels might recover their permeability, thrombi be removed, and therefore the establishment of such a communication between the lymphatics and veins clearly on anatomical grounds is not impossible; nor is it possible either for an anatomist to bring proofs to support his assertion."

What for the moment appears to me proved is that glaucoma results from a check to filtration, that the operation for glaucoma, to be efficacious, must be performed in the great filtration zone, and that it acts by restoring the balance between intraocular secretion and excretion. Furthermore, it seems to me established that the excision of the iris plays no essential part in all this. What still remains to be discovered is, whether the readjustment of filtration is effected by means of the section facilitating escape of the fluids, directly outwards (filtrating cicatrix), or into the venous current, or finally in both directions at once.

Patients themselves will occasionally call your attention to the particular mode of action of iridectomy. Many years ago I operated on a young officer for a glaucoma consecutive to perforation of the left cornea and strangulation of the iris. A large artificial pupil was made upwards, so as to free the iris as much as possible, and was successful in preserving a remnant of vision, and in relieving all symptoms of irritation. At the same time the opacity of the cornea began to clear away very perceptibly. The wound united with formation of a small cystoid cicatrix. Meeting my patient one day, I asked him how the eye operated on was progressing. Without the slightest knowledge of the discussion that had taken place relative to the method of cure in cases like his, he replied: "I still feel occasionally a sensation of weight in the brow, especially if I apply myself to work for any length of time; my eye appears then to become harder. I have, however, discovered a sure means of relieving myself from this annoyance. I knead my eye, as it were, with the lids, and as my mirror shows me, thus cause a certain quantity of fluid to filter under the conjunctiva, which remains raised up for some hours afterwards. So soon as I have accomplished this, I feel my eye relieved." The patient repeated the experiment before me, and I can vouch for the accuracy of his statement.

Without the slightest intention of detracting from the great services that *Von Graefe's* discovery has rendered to humanity, it is quite justifiable to seek for methods of perfecting his operation, and freeing it from certain features, either useless or hurtful. We are all the more justified in so doing because iridectomy, especially when the tension is high, is one of the most difficult of operations. The best operators are all agreed that to perform an iridectomy properly in glaucoma (without leaving any entanglement of the iris), is a very difficult matter. When the possibility of producing subluxation of the lens, and thereby a most malignant form of glaucoma, is considered, to say nothing of the serious risks of iridectomy in the not uncommon cases of hæmorrhagic glaucoma, I may be allowed to say that as an operation in glaucoma, iridectomy has not yet reached perfection. It becomes a duty therefore to endeavour to discover, if not a better method, at any rate one which may be applied in cases where iridectomy is fraught with actual danger. It is to this subject that I have of late directed my attention, though I cannot flatter myself that I have as yet arrived at any positive results.

M. Knies, at the conclusion of his work which met with such a justly brilliant reception, says: "The suggestion might also be made to open the sclero-corneal border, towards the anterior chamber in a more or less subcutaneous manner, as *Wecker* has already commenced to do, by leaving the peripheral section incomplete." It is in this direction that I have worked in my latest trials of sclerotomy. I have had sclerotomes made, varying in breadth from two to four millimetres (fig. 18), with lance-shaped points. With this instrument at a distance of one millimetre from the margin of the cornea I transfix the anterior chamber, but in such a way that the edge of the sclerotome shall form a tangent to the inferior or superior extremity of the vertical diameter of the cornea, and that it shall, as it passes through the anterior chamber, incise the angle of the iris in its whole extent (fig. 19). The section which *M. Knies* calls subcutaneous, with a sclerotome of two millimetres, describes an arc which, on a cornea of twelve millimetres diameter, measures $\frac{2\pi}{360}$ $(96° 22' 46'') \times 6 = 10^{mm} \cdot 09$. If on a similar cornea the operation were to be performed with a sclerotum of 3^{mm}, the section would be $12^{mm} \cdot 56$.

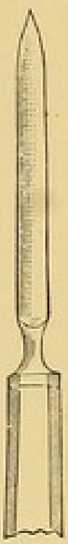

Fig. 18.

I have frequently performed this operation, and on one occasion in particular, on the left eye of a confrère attacked with chronic glaucoma. He has written to me lately, three months after the operation, that he is well pleased with the results so far obtained, which he thinks will be permanent. Nevertheless, I would not wish to pronounce as yet definitely between sclerotomy and iridectomy. Very probably the action of the operation could be greatly increased if the sclerotome were not limited to a tangential incision, within the region of the cornea, but allowed to pass half or one millimetre beyond, so as to make sure that the internal section described a complete arc, and also penetrated deeply, according to the position chosen, as regards the upper or lower border of the cornea, into the trabecular tissue of the iritic angle. In such a case narrower sclerotomes might be used, which would be much more manageable.

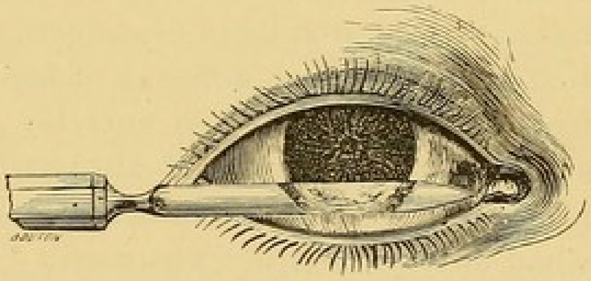

Fig. 19.

Formerly I used to perform sclerotomy with a simple *Von Graefe's* knife, but the necessity of executing sawing movements in order to enlarge the section, and the difficulty of obtaining two openings opposite to each other, and of equal extent, induced me to devise special knives. These enable me to make with an instrument two millimetres broad, two sections close to the corneal margin, each representing at the distance of one millimetre, from a cornea of twelve millimetres in diameter, an arc of $\frac{2\pi}{360}$ (24° 9′ 11″) $\times 7 = 2{\cdot}95^{\text{mm}}$. With a sclerotome of three millimetres these arcs would attain $\frac{2\pi}{360}$ (33° 37′ 23″) $\times 7 = 4{\cdot}10^{\text{mm}}$.

I do not here refer to sclerotomies as performed by *Quaglino* with an iridectomy knife, or by *Bader* and *Spencer Watson* with a Von Graefe's knife, in which a section is made the same size or even larger than that for iridectomy. These operations appear to me to be unduly exposed to a risk which must be avoided at all hazards—I mean strangulation of the iris. This may be averted by the use of narrow sclerotomes and eserine beforehand. Every sclerotomy should be preceded and followed by a series of instillations of this alkaloid; thus, two instillations may be made when changing the bandage, which the patient should wear for two days at a time. No one should ever think of undertaking in these days an operation for glaucoma, without having first placed the patient under the influence of eserine, though it should also be known that in acute glaucoma the action of the drug is very imperfect. I often wonder what effect Von Graefe can have obtained with extract of Calabar bean, in cases of maximum dilatation during attacks of glaucoma, when he recommended contraction of the pupil, as a means of facilitating the introduction of the iridectomy knife into the anterior chamber. The increased tension and the difficulty of absorption, even with the best eserine, produce a very imperfect action, which must have been almost *nil* when only the extract was used.

I will not weary you with the so-called myotomies of the ciliary muscle of *Hancock* and *Heiberg*. They were useful in showing that an internal incision of the trabecular tissue of the angle of the iris could exert a powerful influence; and they further tended to show that excision of the iris did not play an essential part in the operation for glaucoma. These operations are uncertain in their action, and are now abandoned.

It must be allowed that the difficulty is great in trying a new method when we already have at our disposal a puissant and established remedy, and this all the more so when it is a question of preserving the remnant of a patient's sight. Therefore, till some bold operator shall have consecrated himself to the task of proving that an effect can be obtained from sclerotomy, equal to that from iridectomy, I should advise you to adhere to the latter.

In two cases only do I strongly advise you to give up iridectomy and perform sclerotomy. The first is when you have recognised that the glaucoma is hæmorrhagic, for here the double incision with the narrow (2^{mm}) sclerotome will enable you to avoid the hazardous incision necessary in iridectomy. The second is in cases of glaucoma absolutum. Here sclerotomy ought always to have the preference over iridectomy, the operation being performed only in order to free the patient from his severe pain.

In such cases, instead of enucleating, and instead of making vain attempts to excise an iris already atrophied to the uttermost, instead of exposing yourself to the danger of dislocating the lens, and inducing serious internal hæmorrhage, together with increased pain, perform boldly a sclerotomy, which you may repeat if necessary, should its action appear insufficient.

A few words only as regards eserine in glaucoma. The purely empirical use of eserine by *Laqueur* was founded on the fact that atropine, under certain conditions, can provoke glaucoma. He asked himself then whether an antagonistic substance might not have, in a similar case, the opposite effect. Unfortunately, if atropine can induce glaucoma, eserine cannot remove it. This may be explained to some extent by the action of tension, and the difficulty of absorption; its action, however, is essentially antiglaucomatous, and purely mechanical. It is brought about as follows: the contraction releases the iris from its position in the iritic angle, and by constricting the whole vascular system of the eye, diminishes secretion.

Eserine is especially indicated under the three following conditions:

1. When by means of an iridectomy, or a sclerotomy, the pressure within a glaucomatous eye has been reduced, thus placing it in a favourable condition to receive the alkaloid. In my clinic, I now never perform any operation for glaucoma, without its being preceded and *followed* by instillation of eserine. If iridectomy has not yielded a satisfactory result as regards vision, a treatment may be prescribed, consisting of eserine as a basis, to which quinine internally in 20 to 25 centigramme doses daily (3 to 4 grains approximately), is joined. A course such as this often produces satisfactory results, and is more especially to be recommended where a patient will not submit to a fresh iridectomy or

sclerotomy, in an opposite direction. Unfortunately, this treatment cannot be very long continued, for the conjunctiva is not tolerant of the regular use of eserine, and rapidly becomes the seat of follicular conjunctivitis. In such circumstances, the instillations become painful and irritating. We are then obliged to have recourse to a less powerful antiglaucomatous collyrium, the active principle of which is hydrochlorate of pilocarpine. A drop of a solution of this substance of the strength of one per cent. should be instilled into the eye three times a day.

2. The use of eserine, conjointly with quinine, is formally indicated in all cases of threatened glaucoma. Inasmuch as it is known that the acute attack of glaucoma is easily followed (either owing to sympathetic irritation, or congestion in the eye not operated on, or mental emotion) by a similar attack in the sound eye, instillations may be made into it for some weeks after the operation. I recommend these installations to be employed at the moment of retiring to rest so that the visual disturbance caused by the myotic may pass unnoticed, and not induce any unnecessary mental disturbance.

3. The most valuable effect of eserine is that of preserving the eye from the risk of consecutive glaucoma. I should now never dream of treating perforation of the cornea, either spontaneous or traumatic in origin, coupled with entanglement of the iris, without the regular use of eserine. I have shown you a young patient whose right eye received a blow from an agate-marble. The inferior and external quadrant of the cornea had been lacerated and the wound extended 7 or 8^{mm} beyond into the sclerotic; the ciliary body was also torn across. After removal of the prolapse, the patient was placed under eserine together with compression. A flat cicatrix and preservation of a fair amount of vision has been the result. A mere trace of sympathetic serous iritis in the other eye, was happily checked by the same remedy.

A considerable number of eyes may thus be saved by using eserine instead of atropine. It is beyond doubt that the use of this latter agent must have aided actively, especially where there were large perforations in the development of consecutive glaucoma, and staphylomatous displacements.

I will conclude the treatment of glaucoma by stating what course you should take when you have to deal with absolute glaucoma, in which the eye is painful and subject to constant attacks, and in which the tension, already high, has become still more aggravated (internal hæmorrhage). The enucleation of an eye absolutely useless, would seem to be the most rational course, but generally, the patient will refuse to submit to it. Here, in addition to sclerotomy, drainage has proved useful in my hands. But this can only be had recourse to if we can keep the patient under observation, and, if necessary, remove the thread of gold. This latter should, if the eye is rendered at all irritable by the foreign body, traverse an extent of sclerotic five millimetres long, near the corneal margin, by a strip one centimetre in depth behind the ciliary body.

DISEASES OF THE CRYSTALLINE LENS.

LECTURE XXVI.

ANATOMY; ZONULAR CATARACT.

Not wishing to treat of diseases of the retina apart from those of the optic nerve, I shall in this place consider the affections of the crystalline lens. If you consult the classical work of *O. Becker*, published in *Graefe* and *Sœmische's* Encyclopedia, you will learn that 16·5 per cent. of all patients attending my clinique, or in other words about one fifth, are suffering from some morbid changes in their lenses. You must not however conclude from what you see here, that the frequency of diseases of the crystalline is really so great, for ordinarily it does not exceed five or six per cent. (*Cohn*, *O. Becker*). My clinique is, however, exceptionally rich in material illustrating diseases of the lens. The peculiar practical importance of the subject must be my excuse for entering into it at considerable length.

I should advise you to examine carefully a young albino, who has attended here for some time past. His iris contains only a trace of pigment, and through it the clear border of the lens, the space between it and the ciliary processes, and a fine membrane pleated like a frill and spreading between the ciliary processes and the edge of the lens, may be perceived. A similar arrangement is also to be seen in another patient, in whom the transparency of the iris is the more remarkable, because the colour of his eyes and hair betokens a much higher degree of pigmentation than in the foregoing case.

The examination of patients such as these two will enable you to see how the lens lies in apposition with the whole posterior surface of the iris, which it consequently renders slightly convex. The anterior surface of the lens is transparent and elliptical, the posterior parabolic. The slight convexity possessed by the anterior surface makes the posterior aspect of the anterior chamber very nearly a plane. Its diameters, which, as you know, change under all the varying impulses of accommodation, differ considerably according to the size of the eye and the extent of the cornea. Its equatorial diameter measures from 9 to 10 millimetres, its thickness from 3·5 to 3·7.

As regards the lens I shall mention only a few special points, which are interesting to the practical surgeon. It is enclosed in a capsule, and divided into two portions, the more resisting of the two being known as the nucleus, the other and softer as the cortical layer.

The *capsule* is an elastic membrane, varying in thickness in different situations. It is thickest near the anterior pole, where it measures two one-hundredths of a millimetre. The thinnest portion is at the posterior pole and is only equal to about half the preceding. Like all hyaloid membranes it thickens as age advances, but there is always the same relative proportion between its thickness at the periphery and the anterior pole.

The capsule is very elastic. Nevertheless, it does not turn over either in an outward or inward direction, as stated in most of the anatomical descriptions, but simply contracts and forms numerous folds. If you touch the capsule with the cystitome on the opposite side from that at which the instrument has penetrated, and draw this towards you, you will form a triangular flap, which will retract and give rise to numerous folds, without rising from the surface. If in cataract operations I have often occasion to remove a capsule which has become included in the incision, this is because it has been driven there at the moment of exit of the lens, and not because of any inherent power it possesses of turning itself outwards. Even with these extracted capsules you may see exemplified the strong tendency they have to roll up in the form of a cord. For all this, however, they do not appreciably change the arrangement which they had as they lay around the cortical substance.

This is a question not without importance in operative procedures. We must not suppose that it is possible with instruments to form definite flaps of capsule. If the capsule has not been in some way altered, the form of the instrument, and the first movements imparted to it, will determine the size of the opening, and the flap that will be formed. This latter immediately retracts, and folds itself tightly up. Any fresh incisions will fall, then, not in this flap but in the opening already made. This may be further enlarged by traction movements, and by assisting the flap to fold up as far as the equator; but you will never succeed in removing any portion of it.

The inner surface of the anterior portion of the capsule is lined with a layer of polygonal cells, finely granular, and enclosing nuclei and nucleoli. Towards the equator the regularity in the arrangement of these cells disappears. Their outlines become blurred and uncertain. The inner surface of the posterior portion of the capsule is not covered by any cell layer. Nothing is visible here except imprints of the terminal fibres of the lens, which may simulate the presence of a lining of cells.

The substance of the crystalline lens consists of fibres, which in a fresh state appear as moderately thick bands, striped longitudinally. Small transverse grooves surround the edge, but usually are only visible in places where a fibre has been bent backwards (*J. Arnold*). On section the fibres of the lens appear as hexagons, of which the two sides parallel to the surfaces of the lens are considerably larger than either of the four others which face towards its edges. These fibres vary considerably in consistency as they pass from the periphery to the centre. In the vicinity of the capsule they are soft, tear readily, and give exit to a central portion which is still less consistent, so that the term "lenticular canals" might almost be applied to them; but towards the centre their consistency increases to such a degree that in elderly persons it amounts almost to brittleness.

This increased density, which of itself would distinguish the nucleus from the cortical substance, affects moreover the volume of these crystalline bands in such a way that the fibres decrease proportionately as they near the centre of the lens. It is, however, somewhat difficult to see this arrangement on account of the alteration in thickness, which post mortem changes effect in the fibres, the extremities of which especially swell up rapidly. The fibres of the cortical layers and those of the nucleus also differ from one another in that the former alone possess oval, slightly granular nuclei. Moreover, whilst these nucleated fibres have smooth edges, others with dilated borders are met with in proportion as the centre of the lens is approached.

Union of the different fibres of the crystalline is ensured by a cement which binds the fasciculi together, so that their flat surfaces are directed parallel to the surfaces of the lens, and their edges towards its periphery, in such wise that the various fibres as they overlap one another form lamellar layers. In proportion to its proximity to the centre the thin layer of cement uniting the fibres diminishes, and is replaced by a still more intimate dove-tailing of the fasciculi by means of dentated edges.

I shall not now dwell at any length on the courses followed by the various fibres. They do not surround the organ as a whole; but, according to the layer they are in, break off at a point situated variably as regards the centre. They are reunited by means of sutures at regular intervals, constituting the stellate form of the lens. The anterior assumes generally the form of a Y inverted, from which lateral branches may sometimes spring. The same arrangement obtains on the posterior surface, but there the star is turned at an angle of 45° to 60°, so that the rays cut those of the anterior surface. There is, however, very little regularity in this arrangement. It becomes visible only when nutritive changes have invaded the lens or when the increase in density due to advancing age has made it more conspicuous.

What is of much more interest practically, is the manner in which the lens is secured at the sides by the zonula. This arises from the ora serrata, covers the processes, and separating from them passes towards the edges of the lens. In a longitudinal section of the eye, the edge of the crystalline is seen to be included in a triangle, bounded anteriorly by the zonula, posteriorly by the vitreous, and internally by itself, as the base. The apex of this triangle is formed by that portion of the zonula which is in contact with the ciliary processes. The zonula as it separates from these breaks up into fasciculi, united by a transparent intercellular substance. Independently of these fibres, the zonula displays near the ciliary processes numerous cells, badly defined, and enclosing a finely granular plasma with nuclei. The above fascicular arrangement is already apparent near the origin of the zonula at the ora serrata, and becomes more marked as the edge of the lens is approached. There the fibres open out to be inserted either on the anterior surface of the crystalline, on its edge, or on its posterior surface. The edge of the lens rests then on the felt-like mass of the terminal fasciculi of the zonula. The zonula itself does not open out at the edges of the lens in such a way as to give rise to a canal between its layers.

I now come to the most important alteration which the lens can undergo, namely, loss of transparency or *cataract*. According to the seat of the opacity, cataracts are divided into *capsular, lenticular*, or *capsulo-lenticular*. The lenticular cataracts may be *cortical, nuclear*, or *complete*. When the opacity is incomplete, according to the portion of the crystalline affected, we shall have either a *posterior* or *anterior polar*, a *central*, or a *zonular* cataract. According to the degree of consistency, cataracts may be further divided into *fluid* (lactea), *soft*, *mixed*, and *hard* (nigra, calcarea).

In practice the terms most generally used have reference to the origin of the cataract, and then the following are commonly employed, namely, *congenital* and *acquired*, or *juvenile* (traumatic) and *senile*. Lastly, according to the degree of the opacity, we speak of *complete* or *incomplete*, *ripe* or *unripe*, and with reference to the absence or otherwise of complications, of *simple* or *complicated* cataracts.

I shall speak of—1. Congenital cataracts; 2. Opacities of the crystalline acquired at an early age; 3. Traumatic cataracts; 4. Senile cataract; and 5. Diabetic cataract.

1. Congenital cataracts generally consist of: (*a*) opacities occupying only a layer, or a perinuclear zone of the lens, and leaving a transparent nucleus with perfectly normal layers beneath the capsule. This form has received the name of *zonular cataract*. Or they may consist of (*b*) a flaw occupying a very limited portion of lens, near its anterior or posterior poles, its centre, or the whole tract included between the anterior and posterior poles, or (*c*) again they may depend on an opacity which has invaded the lens as a whole, transforming it into a pasty mass.

(*a*.) The zonular cataract, of which you will meet many examples, forms a greyish layer round the nucleus, which according as it approaches more or less to the capsule, leaves, after dilatation of the pupil, a larger or smaller border of perfectly transparent substance. The opacity of the layer is often so faintly marked, that the tint of the undilated pupil is scarcely grey, while in other cases it is so pronounced, and gives such a peculiar reflex, that unless dilatation was resorted to you might suppose the cataract to be soft and complete. The opaque layers may be double or even triple, with processes passing towards the margin of the lens, but not extending up to it.

The visual disturbance caused by zonular cataract will depend altogether on the extent of the opaque layer. If a large zone has remained clear towards the border of the lens, vision may be very fair. Children so affected attend school where they are considered merely as short-sighted. And such, in fact, they always are, apart from the visual disturbance depending on the lens. When, on the contrary, the extent of the opaque layer is very great, and when numerous processes spread into the transparent parts, then even when the pupil is widely dilated, considerable difficulty may be experienced in reading large type.

Beyond all doubt this form of cataract may be congenital. I have seen it in infants of a few days old, but curiously enough I am the only writer who reports an unequivocal case, in which the growth of a zonular cataract was actually witnessed ; it was in a young girl, whose eye had been examined previously with the greatest care, and found quite free from any opacity of the lens. The child had been brought to me by a medical man from Brazil, being, indeed, his niece ; my opinion had been particularly requested as to whether the right lens was likely to become opaque, an opacity being present in a marked degree in the left. The right eye, which at the time I found absolutely free, became, later on, the seat of a perfect zonular cataract.

This form of cataract nearly always appears (though it did not do so in the above case) on both eyes at once, and may be found in each in different stages of development. The power of accommodation is generally much reduced. In all the cases I have met with here, I have observed a considerable degree of myopia, which may have been acquired by the necessity young persons are under of bringing objects very close to their eyes, and so making continual calls on their accommodation.

Convulsions and injuries to the head are mentioned as having produced zonular cataract. This never shows a tendency to become complete, except when the individual has reached the age at which senile cataract is common. A fact well worth noticing, and to which M. Horner was the first to direct attention, is that there is a simultaneous arrest in the development of the enamel of the teeth, and of one layer of the crystalline. Children exhibit on the enamel of their incisor teeth, transverse grooves, which expose the dentine, and become black from contact with the fluids of the mouth. As the development of the crystalline and of the enamel of the permanent teeth takes place at the same period, it is possible that these two facts may be dependent on a common cause, namely, rickets. I have observed this affection in some families, in which cataract, so to say, anticipated its time. Thus, for instance, a woman whose mother and grandmother were affected with cataract, developed the same affection at twenty or thirty years of age, and gave birth to a child with zonular cataract. Transmission may therefore take place in such a way that not only shall the cataract appear before the proper age, but be also limited to certain regions of the organ hereditarily affected.

The most important point here is how best to treat these stationary forms of cataract, on which, of course, medicine cannot exert the slightest influence. You have seen lately a young man twenty-two years of age, affected with double zonular cataract, of small extent, who during twelve years had been treated by a man who cured cataracts without operation. It was not until the death of this *confrère* that the parents decided to submit their son to double iridectomy.

Permit me to give you a piece of very sound advice: and that is, to operate on children as early as possible, however young they may be. Nothing impairs vision so much as absence of regular functional employment during the growth of the eye. I know well that many a professional brother shrinks from the difficulties of operating on a child only a few months old; indeed, you will often hear parents say that they have been advised to wait till the child was six or eight. Such advice is radically bad, for children thus deprived during many years of all regular exercise, so far as their vision is concerned, never recover it. Moreover, they also often become the subjects of a very disfiguring nystagmus.

The treatment of zonular cataract will depend wholly on the amount of lens margin remaining intact, and on the tendency of the opacity to spread or otherwise during the growth of the lens. Some instillations of atropine are therefore necessary, not only to permit a minute inspection of the lenticular margin, but also in children of a certain age to learn whether dilatation improves vision or not.

In the case of a zonular cataract of only 3 or 3½ millimetres in diameter, with a greyish tint, and, when the fundus is illuminated, more or less transparent in the centre, an artificial pupil should be made. On the contrary, with zonular cataracts white in colour, not pervious to light coming from the fundus, having a diameter of from 4 to 4½ millimetres, and sending numerous prolongations towards the edge, the needle operation is to be preferred.

I have lately adopted a combined method which I think is very practical. It is to perform on one eye, when the margin, or a portion of the margin, is still fairly transparent, an iridectomy, and on the other division. As such children are as a rule myopic, it is possible in this way to give them distinct vision for short distances in the eye which has the artificial pupil. In the other eye vision for distance will be good, either without glasses at all or with very weak convex ones, for the cataract operation will have corrected the myopia.

As regards the kind of operation to select, for children it should always be a carefully performed division. You must keep well to the surface of the lens, and above all avoid penetrating as far as the centre of the cataract, which always presents a considerable density and tenacity. For want of attention to this last point, it may be difficult to withdraw the needle, and a risk of causing subluxation of the lens will have been incurred. This subluxation accounts for certain symptoms of glaucomatous irritation which have been wrongly attributed to the swelling of the lens. If, on the contrary, the rule be adopted of directing the needle exactly over the surface of the lens, very large incisions may be made in the capsule, without danger of irritation, even though numerous flakes of lens matter should escape into the anterior chamber.

The division may be repeated if necessary three or four times to ensure complete absorption, which will require from four to eight weeks. I have been at times obliged, in patients of my own, as also in those operated upon elsewhere, to perform division on actual secondary cataracts. These consisted of deposits on the surface of the capsule, and necessitated a final operation, which in the end improved visual acuity very notably.

I do not think it practicably useful to perform extraction of zonular cataracts in children, as has been recommended (*Rothmund*). On the one hand such an extraction implies the formation of an artificial pupil, which is both annoying and disfiguring, and may be avoided by division. On the other, the restlessness of children, even when anæsthetised, renders clearing of the eye difficult, and increases the chance of opacities being left behind, which may necessitate a further operation.

If it be desired to preserve the lens, and with it the power, though diminished, of accommodation, the method I adopt is to uncover the lenticular margin by means of an artificial pupil made as narrow as possible, and not prolonged up to the border of the cornea, the eccentric portions of which are but little adapted for exact vision. It is necessary here to make the pupils narrow, not only to avoid dazzling, but also and indeed chiefly, because operating for the most part on young children, there is the danger of undue increase in the size of the pupil, as the eyeball enlarges.

The operative procedure which would in such a case seem most suitable, and which was actually for some time greatly in fashion, is the displacement of the pupil by, as Mr. Critchett suggested, the attachment of the iris to a wound at the edge of the cornea. The *iridesis* not only creates a narrow opening in front of the transparent portion of lens, but also by drawing the iris over it, conceals a large portion of the opacity. This opacity would be still further concealed by the contraction of the sphincter attached to the wound, whenever the patient was exposed to a strong light. Unfortunately, it has been found necessary to abandon all procedures which tend in any way to block up the main channel of filtration; and this, on account of the serious danger the eye is exposed to from the establishment of an anterior synechia near the corneal border. First of all, the consecutive glaucomatous symptoms assuming the type of irido-choroiditis, would be quite enough of themselves to prevent the adoption of such a method. But apart from this, the procedure would have been abandoned as soon as it had been found that the resulting cicatrix was faulty, and that in young subjects, small ectasiæ were formed at the site of the adhesion, very disturbing to vision, inasmuch as they caused changes in the curvature of the cornea immediately over the pupil. At the same time these might also be a source of danger to the patient, if later in life, the balance of filtration should be lost, owing to senile changes in the sclerotic, and in the parts immediately about the cicatrix.

Beyond all doubt, the best method of obtaining a narrow pupil in zonular cataract is iritomy. This allows us to limit the incision to a portion of the iris, without being compelled to extend it to the periphery. But more, as it is necessary to pierce the cornea and introduce the scissor forceps from the opposite side to that which will eventually be used for vision, the curvature of that portion of the cornea will not be altered; consequently, a guarantee is obtained against all artificially produced astigmatism. Unfortunately, it is a delicate matter to guide an instrument over the capsule of the lens. The pupil is strongly contracted, owing to the escape of the aqueous humour, and the manœuvre by which one blade of the scissors is passed over and one under the iris, requires a steady hand, and above all a very quiet patient, or in the case of children, one thoroughly under the influence of anæsthetics. I can show you here children operated on by iritomy; and you will allow that the narrow V-shaped pupil, with the apex directed towards the periphery of the iris, is beyond doubt just what was needed from an optical point of view.

In order to obtain, with less difficulty, a result somewhat similar to iritomy, I have performed in several cases of children a much simpler operation.

The inferior and internal portion of the margin of the cornea, is chosen for the site of the pupil, and should be pierced a little within or upon the sclero-corneal junction, with the bent stop-knife (fig. 20), as used for iritomy. The instrument is passed

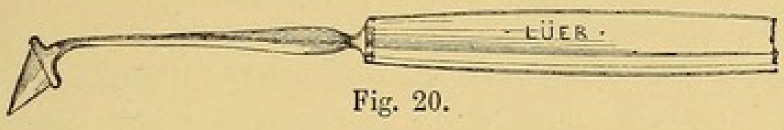

Fig. 20.

directly into the anterior chamber, parallel with the iris. So soon as it has advanced half its own length into the eye, that is so soon as its point has arrived close to the margin of the pupil already contracted by eserine, it is to be rapidly withdrawn, in order not to permit of the escape of the aqueous humour. If now a fine forceps be introduced into the wound, the sphincter will throw itself as it were on the slightly open blades, and thus a narrow portion of iris near the edge of the pupil can be drawn out. The iris is to be cut off close to the forceps. Slight rubbing with the caoutchouc spatula, and one or two instillations of eserine, will quickly cause it to retract within the chamber.

As you perceive in the case I now show you which was operated on some days ago, the pupil bears a considerable resemblance to one made by simple incision. It differs only from that obtained by iritomy, in that the strokes of the V are more rounded; while owing to the position and narrowness of the incision, it shares the advantages peculiar to iritomy pupils. It does not actually reach the edge of the cornea, and a good-sized strip of iris conceals a portion of the edge of the lens, as the ophthalmoscope shows.

To further reduce the section until the introduction and separation of the blades of fine forceps become impossible, and to force us to seize the margin of the pupil with a blunt hook (Critchett), is tantamount to sliding back into all those difficulties and intricacies from which we are trying to escape; and that by substituting a limited iridectomy for an iritomy, while the latter will beyond all doubt yield results superior to those obtainable by any other method.

As complete a correction as possible of the ametropia (astigmatism, myopia) is indispensable in children who have undergone iridectomy. Glasses must be selected as soon as there is any reason to believe, namely after two or three months, that the process of cicatrisation can no longer influence the cornea. Besides this the strictest hygienic conditions should be enforced, so as to check the increase of myopia, to which such patients have a particular tendency.

LECTURE XXVII.

ANTERIOR AND POSTERIOR POLAR CATARACTS; COMPLETE CONGENITAL CATARACT; JUVENILE CATARACT; TRAUMATIC CATARACT.

(*b.*) Opacities are often met with in the antero-posterior axis. These *partial cataracts* are not necessarily limited to any one layer, but may extend to several. They are known as *anterior* and *posterior polar*, and as *central* or *axial* cataracts. These various forms of opacity should, strictly speaking, be called partial cataracts only when they remain absolutely stationary, and are not merely the forerunners of a loss of transparency which later on will become more complete. They may be considered as arrests of development, but the notion which formerly obtained, namely, that the lens was for some time opaque, and only became transparent towards the close of intra-uterine life, is now quite discarded. But an arrest of development may be admitted in the sense of a want of harmony in the minute structural relations of the organ, which would be quite sufficient to provoke a definite though partial opacity.

The most common of these circumscribed cataracts is the *anterior polar*, which appears in the form of a white circular opacity, variable in size, and situated in the same plane as the surface of the iris. It always occupies the centre of the pupil, while its surface may be either level, or considerably raised in the form of a cone entering the anterior chamber. In the latter case it is called a *pyramidal cataract*. Evidently in either case, that is whether the surface be flat or prominent, the same change has taken place.

Anatomical investigation has shown that the capsule passes intact over the opacity. The only difference to be noticed is that it is thinned at the summit of a well-marked pyramid, and folded towards its base (*Poncet*). The capsular epithelium is wanting over the whole surface of the opacity, which is, itself, composed of fusiform cells, similar in arrangement to the lymph spaces in the cornea (*O. Becker*). This tissue penetrates, according to the superficial extent of the cataract, more or less deeply into the lens, where it comes in contact with lenticular fibres, dragged and pressed out of shape by the abnormal tissue of the cataract.

It is very difficult to distinguish accurately, the true congenital anterior polar cataract from the acquired. Beyond doubt, both one and the other result from an abnormal contact of the capsule with the membrane of Descemet. When intra-uterine perforation of the cornea has taken place, or when, from some malformation the anterior chamber has been developed either very late or very incompletely, other irregularities may be correlated with this cataract, such as persistent pupillary membrane, microphthalmos or buphthalmos. The opacity of the cornea, at the spot where perforation has taken place, may under these circumstances be very slight, or, indeed, absent. On the other hand, in all cases where the cataract has become developed consecutive to perforation after birth, the opacity at the corresponding point of the cornea can always be readily seen, especially if examined with the plane mirror, and oblique illumination. In these cases of circumscribed corneal and lenticular opacities, vision may be fairly satisfactory. But in the true congenital forms, and especially in those complicated with other deficiencies, there is more or less well-marked nystagmus, with irregular astigmatism, and very indifferent vision.

The *congenital posterior polar cataract* is far more rare. Great caution is required not to confound this small sharply defined, brilliantly white spot, with those greyish stellate opacities, so common in retinitis pigmentosa, where they are found already in existence when this latter affection is congenital. The true posterior polar cataract advances somewhat into the vitreous, but presents an even surface towards the lens. The opacity here is beyond all doubt connected with a persistent hyaloid artery, and cases are seen in which the end of this artery remains attached to the posterior surface of the lens. This variety of cataract is sometimes extremely well marked in cases where the hyaloïd artery has continued entire. Here it connects the posterior portion of the capsule and the optic nerve together, much as the filiform band which sometimes attaches a pyramidal cataract to the posterior surface of the cornea.

Central and *axial* cataracts exhibit an intensely white, well-marked opacity. They are very rare and are generally found in eyes in which development has been arrested (microphthalmos). They are of little practical interest.

The cataracts I have been treating of are very often double, and require treatment only if they are sufficiently extensive to interfere with vision when the pupil is contracted. These opacities may call for special attention in the case of children should they, as the lens grows, lose their partial character and tend to become complete. Before deciding on the particular operation to adopt, a most thorough functional examination should be made, both with and without atropine.

If, after dilatation of the pupil, considerable improvement in vision takes place, and if the growth of the cataract has evidently ceased, recourse may be had to an artificial pupil. This is in these cases allowable, because we can generally count on a sufficiently large portion of transparent lens. It should be made upwards, so that the upper lid may lessen the diffusion of light and the glare, and ought, as in zonular cataract, to be as narrow as possible.

In the case of young persons, when the cataract has numerous lateral offsets, with a tendency to become complete, division should be preferred. But when a pyramidal cataract is well marked, or even when the patch representing an anterior polar cataract is thick and widely spread, the absorption of such a mass can scarcely be counted upon. In such cases I have adopted the plan of marking off the anterior opacity by a division, limited to the capsule, so as to obtain softening of almost the whole of the lens. Three or four weeks after the operation, the softened cortical masses may be removed through a linear section, and the operation completed by extracting the pyramidal or opaque portion with forceps.

In the case of a posterior polar cataract, this procedure would assuredly expose to the risk of partial loss of vitreous. It is, therefore, preferable to force the opacity downwards at the last division. The vitreous humour, which, at the moment of the rupture of the capsule, presses towards the cornea, will help to remove the opacity from the field of the pupil, and so prevent its interfering with vision.

(*c.*) We find many children affected with mature cataracts, which the parents declare existed at birth, and that on both eyes. It will not do to trust too implicitly to the testimony of parents in such cases, or imagine that these children were really born with complete cataracts. Very often the cataract was partial and within the first years of life has rapidly become complete, while occasionally the remains of a zonular cataract round which the opacities have grouped themselves may be discovered.

All true congenital and mature cataracts, are soft or fluid; when they have continued for many years, more or less of the fluid contained within the capsule becomes absorbed. Such cataracts may even be eventually so reduced in size that the two layers of the capsule contain only the *débris* of the lens. The two layers of capsule have folded up and given rise to a form of cataract known as the *siliculose* (*arida siliquata*).

When we come to consider the rapidity of growth of a lens during the earlier years of life, it is to be expected, that the change from a partial to a complete cataract, the swelling, the loss of fluid, and final shrivelling up, should be compressed into a comparatively short space of time. But it is scarcely possible that such a course could have been completed during intra-uterine life. Therefore, all the shrunken cataracts found at the moment of birth are adherent cataracts, complicated with old-standing intra-uterine irido-choroiditis, together with greater or less reduction in the size of the eye (microphthalmos and nystagmus). Curiously enough, simple congenital cataract is not correlated with any malformation of the eye. If, therefore, the advice given above has been followed, and an operation performed as early as possible, far better vision will be secured than after partial cataracts dependent on arrest of development.

It is absolutely necessary for treatment, that we should know the consistency of the cataract. As regards this, the size of the anterior chamber, which increases in proportion as the lens loses its watery constituents, will afford valuable information. Further, the appearance of the opacity which, so long as the fluid has not been withdrawn, preserves its anatomical arrangements, will furnish up to a certain point useful indications. Soft cataracts have a uniform tint, broken only here and there by some round whitish spots, seemingly resembling a deposit on the posterior surface of the anterior capsule.

The operation to be selected will depend entirely on the age of the patient. In proportion as children are young, and therefore prone to violent fits of crying, operations such as the linear section, which necessitate large incisions, should be avoided. In a child of six or eight years old, with a swollen lens, there is an advantage in the linear operation, over division; namely, that it shortens immensely the duration of treatment. Inasmuch as the cortical masses require always six or eight weeks for absorption, and that it may not be possible to keep children so long under observation, a large division of the capsule should be made first (keeping carefully to the surface of the lens), and eight days later, the resulting masses may be removed. This may be effected through a small opening (of 4 ^{mm}) made with the stop knife, the corneal section being sufficiently central to avoid all risk of prolapse of the iris should the child cry or struggle violently after the anæthesia has passed off.

In the case of soft cataracts, already perhaps considerably reduced in size, an operation combining division with extraction may be performed. With this object a simple stop needle or one somewhat broader is to be used, which should be introduced laterally, at the middle of the upper and outer radius of the cornea. With this needle the capsule is to be torn, care being taken not to push the instrument too far back. At the moment the capsule is pierced, the anterior chamber becomes filled with a milky fluid, and if care be taken, when withdrawing the needle, to make it dilate the aperture slightly, the whole of this fluid can be removed and a perfectly black pupil obtained. This manœuvre becomes impossible, if both the anterior and posterior capsules have been divided at once. The vitreous humour then fills the anterior chamber, drives the fluid masses back beneath the iris, and opposes their exit. The pupil, which had appeared for a moment black, becomes again opaque, after a few hours, and the cure is delayed.

In shrunken cataracts should extraction or division be preferred? The choice between these operations must be determined after the pupil has been thoroughly dilated, and the extent of the cataract clearly made out. If it be seen, after maximum dilatation, that the leaflet of cataract extends but slightly towards the periphery, that a certain free space exists between it and the border of the pupil, allowing of the zonula being seen, it will be better to choose the linear section, made with an iridectomy knife introduced at a distance of 2½ millimetres from the corneal margin. It will suffice then to seize the cataract with small dentated forceps, and draw it out by gentle lateral movements. If the operator hesitate about undertaking such a task, which always demands great steadiness of hand, division must be performed. This latter, indeed, should always be selected when the shrunken cataract extends beyond the utmost dilatation of the pupil, and is, moreover, of a certain thickness. On no account should any attempt at laceration with the needle only be made; for there would be great risk of the cataract turning over, the moment an attempt was made to force the needle into it. All efforts to penetrate it will be fruitless, and will only result in pushing it into the vitreous, from whence, as soon as the needle is withdrawn, it will assume its old position. In such a case, as Bowman first recommended, two stop needles should be passed in diagonally, the surgeon standing behind the patient. With the first of these which should transfix an upper and inner radius of the cornea, the cataract is to be steadied, while with the second the laceration of the portion thus fixed is effected. It is much easier in this way to obtain fair vision than a perfectly black pupil. The slightest opacity which remains, though it may not in the least interfere with vision, is a source of great uneasiness to mothers. Therefore, if there be any possibility of an extraction, I much prefer it, as it offers the great advantage of comforting parents, and convincing them that "nothing has been left behind in the eye."

2. *Juvenile cataract* is met with in persons approaching, or just past the age of puberty. It presents itself under three tolerably distinct forms. In one the opacity commences at the nucleus, or at any rate in the more central layers of the lens. The pupil has a milky appearance, well marked towards the centre, but shading off towards the periphery. This opacity becomes, in time, complete.

In the second variety, occurring also in the young, the anatomical formation of the lens, particularly the anterior stellate arrangement, appears from the first remarkably distinct. A greyish tint later on becomes visible in various portions: at first it does not invade the layers nearest the anterior capsule, but spreads more rapidly than the preceding variety, and eventually occupies the whole pupil. This latter assumes a uniform grey tint, while the opacity still maintains its stellate appearance.

There is a third variety characterised by the appearance of a diffuse opacity, best marked towards the centre, but radiating somewhat irregularly, and in places reaching the edge of the lens. White dots and patches appear simultaneously in the opaque portions in juxtaposition with the anterior capsule (punctated cataract). This variety requires much longer to become mature than the preceding; and I have lately had occasion to operate on a young lady, where twelve years had elapsed before it became ripe. The lens in this case was flattened, and its contents like milk. When incising the capsule with the cystitome, I had barely time to turn the instrument on its edge, so as not to wound the posterior portion of the capsule, and the operation was over.

The best operation in juvenile cataract is linear extraction. This will give its best results if the exact moment be chosen when the softening of the lens is complete, and the opacity has extended up to the edge of the pupil, that is, when there is no longer any dark portion, (improperly called "shadow,") between the pigment of the uvea, and the opacity. In that form where the opacity commences at the centre, and runs a somewhat slow course, the cataract may be matured by a needle operation carefully limited to the capsule, a week or fortnight before the extraction. We must be careful not to be misled as to the consistency of the lens by the size of the anterior chamber. A shrunken cataract with inspissated contents should not be extracted by the linear operation, as great difficulties might have to be encountered. Extreme caution is necessary at the movement of opening the capsule, in cases of these milky cataracts.

3. As the majority of cases of wounds of the lens are met with among young persons, I shall proceed at once to speak of (*a*) *traumatic cataract*; (*b*) *foreign bodies*; and (*c*) *dislocations of the lens.*

(*a*.) *Wounds of the lens* may be caused by any shock to the eye which ruptures the capsule, or by a blow with any hard substance. There is also no doubt that, apart from lesion of the capsule or rupture of the zonula, any violent disturbance of the lens may cause, perhaps months later, the development of a cataract. If an opacity appears soon after an injury, whether the lens has been dislocated or not, there is almost a certainty that the capsule has been lacerated, perhaps posteriorly, and that to this has been due the rapid formation of the opacity.

In wounds of the lens, and anterior capsule, without other injuries to the eye, the prognosis used formerly to be grounded on the extent and depth of the wound, the amount of swelling present, regard being also had to the patient's age, and the amount of irritation in the iris, and eye generally. I think that now we may absolutely leave out of consideration the extent and form of the wound, and need be anxious only about one point, namely, whether subluxation of the lens has occurred or not simultaneously? This may be produced readily enough should the foreign body have penetrated deeply into the substance of the lens, and should this latter, owing to the patient's age, possess a tolerably hard nucleus.

You will meet with frequent opportunities of witnessing how certain lesions of the crystalline, to all appearance formidable, turn out to be quite the reverse; and, on the other hand, how simple punctures may be followed by very alarming symptoms. I would therefore strongly urge upon you, in such cases, the necessity of carefully noting the shape of the anterior chamber (if it has had time to become re-established), as also the position of the iris. Your prognosis and treatment will be dictated by this inspection. If convinced that the injury has caused no change in the position of the lens, then, as regards the mere wound, and supposing no other complication, such as entanglement of the iris, to be present, the prognosis will be favourable. The result of such a wound will be aphakia, which is always unpleasant in the case of a young patient, unless he be very myopic. No fear need however be entertained as regards any irritation resulting from the accident.

Very often all treatment may be suspended. There will be no occasion to hasten absorption of the lens by one or more needle operations, unless the wound in the capsule should have healed very rapidly. Only in cases where the iris shows signs of irritation, and some synechiæ have formed, can any advantage be derived from the use of atropine. During the process of resorption the pupil may, if required, be kept dilated by two or three instillations of the mydriatic.

Treatment must differ totally from the above when the wound of the capsule is complicated with luxation of the lens. The anterior chamber is then of unequal depth, being more or less destroyed on one side, either because the iris has been either forced against the cornea, or been drawn towards it by a synechia produced at the moment of the injury. Such cases are always serious, even if the laceration of the capsule be confined to a mere puncture. Within a more or less brief period you will have symptoms of consecutive glaucoma, such as periorbital neuralgia, etc. Should the patient at this juncture not be submitted to the proper treatment he will lose his eye. Such a termination may be expected if the disturbance to filtration, caused by an injury of this nature, goes unperceived, and the damage done to the capsule is alone attended to. An attempt may then perhaps be made to prevent the supposed irritating effects of the contact of the cortical substance with the iris, by means of repeated applications of atropine, pressed all the more if the ciliary pains increase, until the advent of the glaucomatous symptoms is actually brought about. These once established, recourse used to be had to paracentesis and extraction, but often with very unsatisfactory results.

We ought, as soon as the existence of a dislocation of the lens is suspected, or the iris is perceived to be adherent to the cornea, to abstain carefully from the use of atropine, combating at the same time any increased tension by eserine. If convinced that in spite of several instillations daily of this myotic, pressure is still increasing, and the periorbital pains continuing, iridectomy should be performed, its position to be determined according to that of the most contracted portion of the anterior chamber.

Practical experience teaches that interference should be limited to the above iridectomy, and this more especially if the operation be performed shortly after the injury, for then the chances of the half-softened lens passing through an opening of moderate size are slight. Remember that iridectomy is a comparatively small matter, and is rarely followed by bad consequences, whereas extraction places the eye under very different conditions as regards liability to infection. In treating, therefore, an eye already injured, there is every inducement to protect it, instead of inflicting a fresh wound of perhaps equal severity. This course is the more advisable, inasmuch as extraction, owing to the adhesion which exists between the capsule and the lens, and the want of retractive power in the former, gives but very unsatisfactory results. In the most fortunate of such cases it will be necessary to perform a second operation in order to free the pupil from secondary opacities.

You have lately seen a case affording an excellent instance of the advisability of the practice I recommend. A smith, thirty-five years of age, presented himself here last August, with a splinter of steel in his right eye, which had determined a traumatic cataract. The wound took place three days before he came here, and the little fragment could be seen partly in the torn iris, and partly in the lens. M. Masselon in my absence contented himself with an iridectomy, including the foreign body in the portion of iris he excised. The symptoms of irritation rapidly became less, and the patient was allowed to depart, with a recommendation to return within six months, should vision not be re-established. He returned the following February; his eye was then free from all irritation, but presented symptoms of a soft cataract, while an adherent cicatrix of the capsule could be seen near the site of the iridectomy. A small opening was made with an iridectomy knife, to permit the entrance of the cystitome. The instant this penetrated the capsule, the pupil became black, except at the spot occupied by the cicatrix, which however was scarcely apparent. The vision thus restored to the patient has since continued perfect.

It must be allowed that many of us in practice show more or less inconsistency. Thus there are not a few surgeons who from over-caution and anxiety to unite all possible chances of success, in cases of perfectly simple cataracts, leave an interval between the two steps in the operation of extraction. They first make an iridectomy, and then later on remove the lens. Yet these very men would not hesitate a moment about submitting an eye considerably irritated, to the complex lesion of iridectomy and extraction. If there be really any advantage to be derived by this interval of delay in any cataract operation, it would clearly seem to be in traumatic cataract. In such cases the idea that should be uppermost in your minds is to excise a large segment of iris as near the periphery as possible, avoiding carefully all entanglements. Both before and after the operation, eserine should be used; and all meddling with the already injured lens avoided. No attempts should be made to remove any cortical substance which does not escape spontaneously with the aqueous humour.

You will never see me depart from this doctrine of iridectomy in all wounds of the lens with luxation, except when, in spite of the excision of an ample portion of iris, acute pain and symptoms of irritable glaucoma continue—in other words, when the check to filtration has not found sufficient compensation in the iridectomy already performed. Now, to remove the lens under the existing conditions of intraocular pressure would be an operation which in all probability would be followed by a considerable escape of vitreous, with perhaps atrophy of the globe, from hæmorrhage and prolonged irritation. I prefer therefore to perform on the side opposite the original iridectomy, either a sclerotomy or a second iridectomy, every possible precaution having been taken against an escape of the vitreous humour.

Briefly, then, the great object is to prevent the advent of traumatic glaucoma. No attempt to perform either extraction or the needle operation in a traumatic cataract should be made until the eye has recovered its normal conditions of filtration—that is, of tension. The choice between the two operations will be dictated by the amount of lens that remains in the eye, by the age of the patient, and by the greater or less capacity he possesses of dissolving the cortical masses. When such a case is encountered in very young children, or when the cataract is much diminished in size, I prefer laceration with two needles. If a large portion of lens remains in the eye of an individual approaching or already past the age of forty, recourse should be had to combined linear extraction. This is an operation which it is always better to postpone till from six to eight months after the original injury to the lens.

(*b.*) I have but little to say about *foreign bodies* in the lens. These frequently penetrate through a small opening, which becomes cicatrised over. The presence of such bodies does not necessarily determine a change in the whole of the lens, but, as is seen in simple wounds of the capsule which have healed, the opacity may even to some extent become improved. As foreign bodies are generally met with in young subjects, and as these bodies are as a rule fragments of metal which readily become oxidised, the resulting salts will impart an unusual tint to the soft masses, which will readily permit a diagnosis to be made. Generally speaking, when a foreign body is but half imbedded in the lens, and is not causing irritation to the iris, all immediate interference should be abstained from. It will be more prudent to preserve an expectant attitude, and not to proceed with the extraction until any irritation that may be present has passed off, and the cataract become ripe. The combined method will be the best to adopt, the incision being made close to the foreign body, if this can be seen ; if not, then by preference downwards.

LECTURE XXVIII.

LUXATIONS OF THE CRYSTALLINE LENS; SENILE CATARACT.

(*c.*) *Luxations* of the lens may be either *congenital*, and they are then known as *ectopia lentis*, or *acquired*, when they are either *spontaneous*, *traumatic*, or *consecutive*. The displacement of the lens may be incomplete, constituting a *subluxation*, or *complete*, that is, total. The change of position, induced spontaneously, may take place in either a transparent or a cataractous lens: as a rule, all lenses luxated by violence become opaque.

Ectopia lentis is generally met with in both eyes, and that more or less symmetrically; frequently, however, it is better marked on one side than on the other, so that the field of the pupil after artificial dilatation is more free in one of the two eyes. This malformation, which is due to the irregular closing of the choroidal fissure, and to an unequal and tardy interposition of the vitreous, between the lens and the retina, is often met with in various members of the same family and is hereditary. Such eyes, owing to imperfect development of the zonula, are destitute of the power of accommodation; while the ectopia has a tendency with the growth of the eye and the vitreous to become worse. I have been able to satisfy myself of the truth of this in young children whom I have examined at long intervals, and in whom the luxation of the lens, upwards and outwards, had evidently become more pronounced.

This fact is important as regards treatment. As a rule, all such eyes are highly myopic, as becomes evident when the patient uses the portion of pupil behind which the lens is. The lens itself is more rounded, while, frequently, its longitudinal diameter is reduced, so that the myopia may be complicated with irregular astigmatism. In such cases, no slight service will be rendered by removing this myopia by operation, and so permitting vision at the side of the displaced lens. In very young subjects this operation may be indicated where, even after dilatation, there is little more than a narrow crescent free between the border of the lens and that of the pupil.

Operative interference, the only treatment of any use in such cases, should consist in the formation of an artificial pupil by iritomy. Were an attempt to be made to form a pupil by excision, great difficulty would be experienced from the liability of the vitreous to escape, and the iris to become wedged against the ciliary body, in which position it would be almost impossible to seize it.

Iritomy exposes to no dangers of this kind. With a stop knife, a small incision just sufficient to admit the scissor forceps is made in the cornea, about the middle of the radius which corresponds in direction to the displacement. There is no difficulty in gliding one of the blades beneath the free edge of the iris, without injuring the lens. Care must be taken not to push the scissors too far towards the periphery of the iris, which should not be incised. Every advantage can be obtained by a pupil which does not reach quite up to the edge of the cornea.

Spontaneous luxation may take place in a transparent lens. It is observed in such cases almost without exception in conjunction with fluidity of the vitreous, and changes in the suspensory ligament. From an embryological point of view the zonula forms a portion of the vitreous humour, and hence up to a certain point this explains how it is that with softening of this latter, the lens may become detached, at first partially, but eventually owing to its own weight and movements completely (*O. Becker*). A similar luxation is sometimes met with in cataractous lenses, where it may save the patient an operation. Some ten years ago, I extracted a mature cataract from the right eye of a man aged sixty. The operation on the left eye was postponed for a year though the cataract was ripe, and presented nothing abnormal. I saw my patient a year later, and he then enjoyed sight in both eyes. His lens had gradually sunk down, and the upper portion of the pupil had consequently become free. Later on the whole pupil became so, and vision was then as perfect on the left as on the right side.

In this case it was difficult to say to what the luxation of the lens was due; for, in the other eye an absolutely similar and older cataract had existed, and the vitreous had shown nothing abnormal, either during or after the operation; and as far as the ophthalmoscope could show, the same conditions were common to both eyes. At any rate, here we cannot admit the ingenious mechanism described by M. O. Becker, who asserts that every one attacked with cataract, if he could only live long enough to pass through all the retrogressive phases of the affection, would eventually be cured by a similar luxation. The cortical substance as it gradually loses fluid, becomes shrivelled, and by irritation of the epithelium of the capsule induces capsulo-lenticular cataract. The patch so formed draws the peripheral portions of the capsule towards itself, and either detaches them from the suspensory ligament, or at least so alters the hold this latter has that luxation of the lens follows any quick movement of the head. This is probably the truth about many a so-called miraculous cure of cataract.

You may perhaps remember a case which occurred here lately of spontaneous cure of cataract by intra-capsular luxation of the nucleus of the lens. The case was also of interest as affording a proof of the potent effect on filtration of freeing the main efferent channel of the eye. A man of fifty years of age, who had been operated on by a colleague for cataract of the right eye, came to consult me for a Morgagnian cataract in his left. Before undergoing the second operation, he was seized with an acute attack of glaucoma in the eye, accompanied with great pain and hardness of the globe. A large iridectomy removed the glaucomatous symptoms, and restored sight to what it was before this complication. The large pupil which now existed was admirably suited for demonstrating the ease with which the nucleus of a Morgagnian cataract could be displaced in accordance with the movements of the head. After some time the patient informed me that sight was returning, and indeed it was evident that as the nucleus was being displaced towards the lower portion of the pupil, the fluid and milky portions of the cataract were being absorbed, leaving over the whole extent of the artificial pupil, two transparent folds of capsule. These rested one against the other so as to permit of very fair vision.

Traumatic luxations are induced by rupture more or less direct of the suspensory ligament. They are divided into *incomplete* luxations or *subluxations*, and *complete*. In subluxation the lens does not leave the field of the pupil, but retracting by a movement due to its own elasticity, is displaced in an opposite direction to that of the rupture. In proportion to the extent of this latter, the lens will sink by gravity, the result being a reduction in size of the anterior chamber.

If in this combined descending and tilting movement, it be the upper edge of the lens which approaches the cornea, that is which tilts forwards, leaving the lower part of the iris without support, the consequences will be much less serious than if the same edge should be directed posteriorly, forcing thereby over a large extent the iris against the angle of the anterior chamber, and in this way directly producing a serious obstacle to filtration. This cannot happen in the first instance on account of the progressive descent of the lens. As soon as the lower portion of the iris has been driven against the cornea, symptoms of irritative chronic glaucoma will quickly begin to show themselves. Surgical interference is here rendered very difficult on account of the readiness of the vitreous to escape as soon as ever the incision for iridectomy has been made. There is, therefore, a risk of further displacing the lens, of inducing serious intraocular hæmorrhage, and of increasing the irritation.

Under such circumstances, sclerotomy may be resorted to. The knife used should be two millimetres in breadth, and the section be made opposite to the luxation, so that the sclerotome may traverse the upper corner of the chamber; the border of the cornea should be immediately over the middle of the sclerotome, to insure the iritic angle being thoroughly divided, while both the wound of entrance and of exit should be very small (p. 272). At the same time, a free use of eserine must be made. If, in consequence of this subluxation, when all irritation has passed off, a cataract should become developed, it will be better to confine treatment to re-establishing vision, by means of iritomy. This should be practised in the same manner as described for ectopia of the lens, and should be preferred to extraction. For, with extraction there is a very considerable risk of the loss of vitreous humour, which has been rendered fluid by the injury, with, perhaps, eventual detachment of the retina after a long interval.

In *complete luxation*, the lens may be driven into the vitreous or may escape through a rupture in the sclerotic, either lodging in the conjunctiva, or traversing all the envelopes of the eye. Under such circumstances, treatment can have but little influence. On the other hand, you may find cases where either spontaneously, or as the result of some shock, the lens has become disconnected from the zonula, and follows the motions of the head, appearing alternately in the anterior and posterior chamber. The lens, after having been very moveable, may happen to be retained within the anterior chamber, and becoming attached inferiorly by its edge, may ultimately give rise to very marked symptoms of irritable glaucoma.

A case came under my notice last year in which the left lens exhibited this mobility as the result of severe shock. The patient could at pleasure bring his lens into the anterior chamber, by bending his head well forward. A fortnight before he came to consult me he had luxated the lens into the anterior chamber; and it had not since returned to its proper position. Symptoms of such severity had in the interval shown themselves, that the patient urged an operation. Before attempting this, I tried very simple mechanical treatment. I made the patient lie with his head low, while I shook it violently, with the fortunate result of inducing the lens to fall back again into the posterior chamber. This once obtained, I immediately instilled several drops of eserine into the eye, nor did I permit the patient to move until the pupil was well contracted. The glaucomatous phenomena disappeared at once. The patient quitted Paris, taking with him the advice to continue the eserine so as to keep the pupil constantly contracted. In case the collyrium should later on be badly borne by the conjunctiva, it was to be replaced at once by pilocarpine.

Where a similar reduction cannot be effected, and where the presence of the lens in the anterior chamber gives rise to marked glaucomatous symptoms, it becomes absolutely necessary, in order to save the eye from perforation and destruction, to perform extraction. This is a perilous operation if the following precautions are not observed; at intervals of some hours a drop of strong solution of eserine (1 per cent.) should be instilled into the eye before commencing; the section should be linear, made downwards, and not too peripherally; the lens should be fixed with a broad needle so as to steady it. This stage terminated, Critchett's flat curette is to be passed under the lens, and after making sure that this has been securely seized, it, and the needle, and curette are all withdrawn simultaneously. The assistant will at once close the eyelids, no speculum being allowable for fear of causing a dangerous degree of pressure.

I will close this account of luxations by mentioning the *consecutive* forms. These are met with in cases of ectasiæ which have been formed where the zonula, in contact with the anterior portion of the uveal tract, has been subjected to straining and consequent destruction; or again, where the iris, having become closely adherent to the capsule, has been drawn into a corneal cicatrix, and has displaced the lens to an extent sufficient to rupture its normal connections. These consecutive luxations need never become the object of any special treatment.

4. By far the most important variety of cataract is the *senile*, that is, the cataract observed at the period when general senile changes begin to manifest themselves. I must remark that precocious senility does not tend to hasten the advent of lenticular changes. What are the changes in a lens which exhibits the signs of age? They may be said to consist in the loss of fluid in the mass generally, which assumes a horny-like hardness, more marked as the centre of the nucleus is approached. A shrinking of the fibres, the dentated portions of which become more closely dovetailed, gives to the lens a deeper hue, amounting sometimes almost to blackness. This appearance, however, in no way alters the transparency of fine microscopical sections, even when made in apparently opaque portions.

Is it this drying process which forms the characteristic feature of senile cataract? Certainly not; for, though in certain rare instances, lenses may be found dark in colour and compact, while they never become quite opaque, or prevent fingers being counted at a certain distance, such is quite the exception. Pure phaco-sclerosis (*Pauli*) is most certainly not the prototype of senile cataract. But the process is nevertheless an essential factor in ts evolution. Let us examine for a moment what takes place in a very common senile change, the growth namely of a gerontoxon or lenticular arcus senilis.

If you dilate the pupils of elderly persons widely, you will notice towards the periphery of the lens, at an equal distance from its edge and its anterior surface, a series of small opacities forming a circle, from which spring little points which advance but a short distance towards the poles. At the same time oblique illumination will show the sutures of the fibres which go to form the anterior star-like arrangement, while there will also be visible a general blue reflex from the anterior layers. This at times may be so marked that examination with the plane mirror may be necessary, in order to demonstrate that, except for the circle of small opacities, the transparency of the lens has in no way been affected. When a lens in this condition is examined under a microscope, it will be seen that the changes on which these opacities depend, consist merely of a wide separation of the fibres in the portion corresponding to the opaque ring, while the fibres themselves have undergone no appreciable changes.

How can this process of old age be explained? Clearly it is connected with the movement of shrinkage in the nucleus. This becoming sclerosed, draws towards it the perinuclear layers, and this attraction is propagated in succession to the layers nearest the capsule, and even at last to the capsule itself. Where can this process of displacement meet with a check? Doubtless at the spot where the capsule is attached, and where the more peripheral layers are in contact with it. Where, then, must any separation of the fibres, to be followed in time by opacity, of necessity take place? Surely at some distance from the zonula, between the layers in contact with the capsule, and those more intimately united to the lens. As a matter of fact, clinical experience confirms completely this theoretic reasoning. The arcus senilis of the crystalline represents, more or less, the imprint of the substance of the zonula upon the capsule; an imprint conveyed for a certain distance into the lens substance itself.

This severance of the elements of the crystalline, as seen at its commencement is perfectly harmless; but gerontoxon of the lens when it becomes generalised throughout the cortical layers, necessarily produces, by its extension, disturbances in nutrition, to be followed by dissolution and breaking down of the fibres; this represents the true senile cataract.

I attribute, then, the formation of senile cataract, which shows itself chiefly in the cortical layers, and assumes beyond doubt mainly the character of *phacomalacia,* to purely mechanical causes. These gradually occasion loss of elasticity and cohesion, induce severance and breaking down of the fibres, with formation of products capable of absorption (fat, myeline).

The dissociation of the fibres which, in the first instance, causes the opacities, and which is only subsequently followed by impaired transparency due to anatomical changes, and disappearance of the lens elements, may it is plain, result from two different sets of causes. In one, the dissociating action works in a *centripetal* direction, resulting in, to my mind, true senile cataract; in the other, in a *centrifugal,* or, in other words, the subcapsular and peripheral layers, tend to become dissociated in consequence of nutritive changes in the perinuclear layers. Such changes, while they may be associated with senile alteration in the lens, assume more the character of disease, and are beyond doubt dependent on nutritive disturbances and other morbid changes of the uveal tract and vitreous humour.

In the true senile cataract, where phacomalacia has commenced by shrinkage of the nucleus, which continues perfectly transparent, and only shows signs of a gradually increasing sclerosis, we find, after removal of the lens, an eye perfectly sound and functionally unimpaired.

On the contrary, in a cataract which simulates as it were senile cataract, where dissociation has extended from the periphery to perhaps the most central layers, and where the phacomalacia is not restricted to the cortical substance, nutritive complications of other parts of the eye are to be feared. The exit of the lens will be in such cases peculiarly difficult, owing to the viscous nature of the cortical masses; nor can the cataractous portions which have become adherent to the capsule be detached as in the senile, where the loosening has been as it were prepared before hand. In a word, the removal of the lens will be difficult, and the result to vision unsatisfactory, on account of complications.

It must not be supposed that true senile cataract must always be preceded by a regularly disposed gerontoxon. It is a senile change, not met with in all old persons, and not presenting any analogy either in regularity of form or histological structure with the corneal change from which it takes its name. It may be that the shrinking of the nucleus, taking place more or less regularly and slowly, may be the cause of the absence complete or partial of lenticular gerontoxon. Finally, as the result of a process of condensation taking place simultaneously with that in the central layers, a complete or incomplete lenticular arcus senilis may be met with, without there being any other nutritive changes.

It becomes then very necessary to be able to distinguish cases in which the lenticular changes will probably continue stationary, and as mere senile symptoms, from those where they will be progressive and will conduce to cataract. The subject is important as enabling the surgeon to recognise when he should keep silence touching certain slight hazy appearances in the lens. By so doing he will avoid alarming his patient with the prospect of cataract, when it may never, or at least not for years, be developed.

There are three peculiar signs connected with the breaking down of the cortical masses. I may say at once, that the fact of a gerontoxon being general, is no argument that it will become progressive. Senile changes may appear in the form of mere narrow stripes, in one or more sectors of the lens, and yet be essentially progressive in character. The first sign to give warning that an opacity situated at the equator is about to increase, is that the process of breaking-down is no longer limited to the edge of the lens, but in some places prolongs itself into the neighbourhood of the poles. Further, with the plane mirror, the presence or absence of a similar breaking-down should be looked for towards both poles and near the sutures, together with stellate opacities radiating towards the equator.

The second sign is the tendency or otherwise of the degeneration to spread, and the fact that it is well marked or the reverse. If the fibres have been dissociated, fluid will occupy the intervening spaces. The greater the quantity of fluid thus accumulated, the more will its solvent and destructive action on the lens tissue have to be feared. Therefore the greater the distance between the spaces or radiating opacities, and the greater the breadth which they preserve in their course towards the poles, the stronger will the presumption be of progressive increase. But the presence of a mere crack, or of very fine narrow striæ, even if here and there they be of some size, are less indicative of cataractous changes.

The third sign to be looked for will be given by the following conditions: namely, that owing to the formation of spaces filled with fluid between the separated parts, the destructive action to tissue nutrition of the changes that have supervened will be already visible. Mere shrinkage will give only the anatomical formation, the arrangement in sectors, and the sutures peculiar to the lens. If there be other appearances, such as dispersed points, or small patches scattered through the cortical masses, then the inference may fairly be drawn that a *dissociating* action of the cataractous process is present along with a *solvent.*

The study of these changes could be pursued with much more certainty, and the course of the affection, as regarded the procession of symptoms, would be much more regular if centripetal senile changes were not so often associated with centrifugal. These latter act in a reverse direction, and are determined by the ebb and flow of the endosmotic currents (changes in the filtrative power of the capsule) in the cortical layers. They are to be attributed not to senile changes, but to disturbed nutrition, dependent on alteration in the vascular membrane, *i.e.*, the uveal tract of the eye.

The ease with which both these influences, each alike, tending to cataract, though with varying intensity, may be at work, renders it impossible for the most experienced surgeon to make any accurate forecast as to the rapidity with which a cataract will become ripe. It is, therefore, advisable to resist the solicitations of a patient, and decline to state at what period a commencing cataract will probably become mature. It happens but too often that a surgeon damages his own reputation by declaring that in a case just commencing, a fair amount of vision may be preserved for months, or even years, when perhaps in the space of a few days, sometimes of twenty-four hours, the opacity will have become general. It may be the same if an opposite opinion be given, and the date of the maturity of a cataract be fixed within a more or less brief period. The given date arrives, but nevertheless the patient sees well, and continues to do so perhaps for years afterwards. It is better, therefore, to keep simply to a statement of probabilities, or even to say boldly that we do not as yet possess the data necessary for pronouncing with any certainty as to the course the disease will run.

LECTURE XXIX.

CORTICAL CATARACT; NUCLEAR CATARACT; CAPSULO-LENTICULAR CATARACT; DIABETIC CATARACT.

THE different forms of senile cataracts are (*a*) the *cortical;* (*b*) the *hard nuclear;* (*c*) the *capsulo-lenticular.*

(*a*) The commonest form, the *cortical cataract,* is confined as its name imports, to the cortical substance, and presents, according to the age of the patient, or rather according to the age he was, when his cataract commenced, a nucleus more or less voluminous and transparent. Therefore, to include, as O. Becker does, among the nuclear cataracts, that form which is found in persons under fifty years of age, and which consists of a very thick layer of cortical substance, round a very small, scarcely sclerosed nucleus, seems to me scarcely to be justified by facts. The earlier the age at which a cataract becomes developed, the more will the processes of softening and dissolution be found to have invaded the already sclerosed fibres of the nucleus. Morgagnian cataracts afford in this respect information of value, as showing to what an extent solvent action may affect a nucleus, leaving actually at times nothing but a very thin layer of sclerosed tissue around the centre of the lens.

In the course which a cortical cataract generally runs, the opacity resulting from dissociation and softening of the fibres is seen first of all in the same position as the gerontoxon, viz. in the intermediate layers, between the capsule and the nucleus. Thence it extends simultaneously towards the poles and the surface of the lens, but tends to invade less rapidly the layers nearer the centre. The regularity of evolution in the senile cataract is marked in proportion as it exhibits the characters of senility; that is, as it is free from complications. On this point examination of what remains of vision will be conclusive in aged persons. On the other hand, when cataract appears in persons whose age does not account for it, or if nutritive changes have taken place in delicate, feeble individuals, scarcely over forty, the regularity of evolution no longer exists; here retraction with dissociation of the fibres may have commenced from a nucleus scarcely formed, nevertheless the disorganisation of the fibres advances centripetally, and the peripheral layers of the lens, which are better nourished, may long preserve complete transparency.

Although the student is now no longer taught to make a regular study of the degree of consistency of a cortical cataract, so as to adapt the size of the section to the bulk of the lens, or rather the nucleus, and although the fact is now recognised that a section of a certain size should always be made, so as to allow a cataract of whatever dimensions to pass out easily, it may be of use nevertheless to know how to recognise cases in which owing to the extent of the portions already sclerosed, the exit of the lens may be expected to be somewhat difficult.

I have just said that not only the age of an individual, but more especially the period in which the cataractous changes first appeared, will influence sensibly the size and consistency of the cataract. For the moment I omit all reference to any retrogressive changes, which may exercise a notable influence on the size of the lens, and to which I will return anon. If a person verging on seventy is the subject of a ripe senile cataract, the cataractous change can have affected only a comparatively thin layer of cortical substance. This will present a greyish appearance more or less modified by the extent of lens sclerosed; this sclerosed portion will impart a brownish hue, deeper in colour according as the sclerosed portion is denser, in other words in proportion to the length of time that has elapsed since the commencement of the sclerosis.

On examining a ripe cataract such as this, it will be perceived that the pupil towards the centre, has a brownish tint, and that it is only at the edge of the pupil when dilated, that a greyish shade at all predominates. On the other hand, if a man under sixty, the subject of complete cortical cataract, be examined, the sclerosed nucleus which has not had time to attain any great size, will appear through the thick cortical layers as a mere brown or yellow shadow, while a grey colour will predominate very perceptibly over the whole field of the pupil.

There are two other circumstances, however, which may have an effect on the colour of a cataract, and the knowledge of which will be some guide as to the consistency of any lens which it is proposed to extract. So long as the cataractous changes are limited to the breaking down of the lens elements, and so long as the appearance presented by the opacities is such as to recall the anatomical disposition of the tissues, the cortical substance will be sufficiently diaphanous to permit of the sclerosed and yellow nucleus appearing through it. Once the process of fibre destruction has invaded the cortical layers, they lose their striped and stellate appearance, and assume a uniform tint which will to a much greater extent, even if the layer be thin, conceal the subjacent nucleus. The clear greyish blue has given way to a uniform light yellow tint.

The second condition which may guide us in forming an opinion is the retrogressive changes which a cataract undergoes. Generally speaking, once the cortical masses have become dissociated and softened, they lose fluid, shrivel up, and form around the sclerosed nucleus, a more or less diaphanous layer, which peels off in flakes, and is brittle when extracted. Adhering somewhat to the sclerosed portion, so as to form one whole, such a cataract is easily disengaged from its capsule; from this has resulted the not very accurate term, "ripeness." A close inspection of such a cataract will show that a uniform grey tint is spread over a yellow or brown nucleus, with an appearance not unlike a spider's web, which fades away from the periphery towards the centre of the pupil.

If, on the contrary, owing to peculiar conditions of capsular filtration the capsule does not part with the fluid it received at the moment of the breaking down of the cortical masses, these will become transformed into a milky grey or white fluid, in which the nucleus will float, or rest, according to the positions of the head. It will be small in proportion to the length of time that has elapsed since the cataractous changes commenced. These *cataracts of Morgagni* present a uniform greyish blue tint, broken when the patient's head is bent forward, by a darker crescent, the extent of which will be a guide to the size of the yellow, or brownish-yellow, nucleus.

A change of colour may also obtain in cataracts which have been complete for many years (without having become capsulo-lenticular). Here, owing to the length of time that has elapsed, such changes must have taken place at a period when the nucleus was of but small size, and when the dissociation of the fibres could proceed simultaneously both towards the periphery and the centre. If, owing to loss of fluid, condensation of the softened and dissociated masses has taken place, a lens will then be found which has completely lost its original form, and consists of a disc scarcely, if at all, thicker at its centre than elsewhere. On examining the pupil it will be seen that a white tint predominates, while other irregular appearances are also present, more especially at the peripheral parts, which recall the striæ and sectors of the lens and are due to granular deposits.

I have spoken of ripeness as regards a cataract. Strictly speaking, this stage is reached in a cortical cataract, when all the peripheral non-sclerosed layers of the lens have been affected by the softening which follows dissociation. The shrinking of the cortical substance from loss of water, and its becoming fitted for operation by being loosened from the capsule—a mechanism which takes place in only a limited number of cases—exerts no particular influence on the process of ripening.

I now therefore call all cataracts ripe in which the layer beneath the anterior capsule has as a whole undergone cataractous changes, either by softening or total liquefaction, or retrogression and condensation. When, therefore, the grey, light blue, or white tint, due to the presence of the above stages, advances uniformly towards the whole border of the pupil, I consider that the cataract is ripe. If, on the other hand, there exists between the opacity and the border of the pupil a dark or black ring, of whatever size it be, in such a way that the iris projects an apparent shadow on the cataract, it is not ripe.

This question is of less importance than formerly, for now we are guided, not by an appearance of more or less ripeness in a cataract, but rather by the amount of disturbance its presence causes to vision. It is this consideration, together with the certainty that the alteration in transparency is not associated with any complications at the fundus, which decides us to perform the extraction. This simplification arises from the fact that, by means of large sections, and the sacrifice, if necessary, of a portion of iris, an easier passage is afforded to a lens whose cortical substance, owing to the cataractous changes not being complete, is less disposed than a ripe and retrogressive lens would be, to leave the capsule. In such cases, provided the senile character of the cataract is well marked, the cure will take place with perfect regularity.

It is surely a very great step in advance to be able, not merely to restore sight after it has been lost, but also to spare a patient the misery of watching the progress of his own blindness. I may remind some of you of the case of a patient, in whom the advantages of operating on an unripe cataract was very strikingly shown. A musician, an artist of great ability, and conductor of a well-known orchestra, consulted me for an affection of his eyes, which depressed him beyond measure. I found he had an incomplete double cataract, with sight sufficient to allow him to guide himself, but not to read music (with — 9 D. S. = $\frac{1}{40}$ in the left eye, and $\frac{1}{50}$ in the right). He had consulted many oculists, who had all advised him to wait till his cataracts should be ripe. On the other hand, the manager of the theatre had named a limited time within which he must either return to his duties or resign his post. I saw nothing that contra-indicated my performing the two operations upon him at intervals of a week, and I was thus enabled to restore excellent sight in both eyes.

I might give you many similar examples, but will content myself with mentioning an operation I performed some years ago. It was on the oldest member of the *Institut*, the translator of Virgil, who, though perfectly able to guide himself, suffered intensely from being deprived of his books. Unfortunately, this patient, who was operated on at the age of ninety-two, did not live long to enjoy the restoration of his sight, by which nevertheless he had been enabled to resume his favourite studies.

Such cases speak strongly in favour of operating on patients as soon as they are deprived of the chief pleasure which their age permits—namely, reading. Therefore I would recommend you to direct your inquiries less to the fact whether the lens is ripe, but more to finding whether the loss of vision is in proportion to the extent of the opacity, whether the opacity in the lens is taking the normal course of a senile cataract, and finally, whether the state of the intraocular tension enables you to exclude all suspicion of deep seated complications.

Once reassured on these points, you must not overlook two other important ones as regards operating on unripe cataracts. First of all, adopt the combined method, and be chary neither of the extent of the corneal section nor of the amount of iris excised; secondly, clear the pupil, just as if you had to free it from opaque cortical masses. In this way the transparent masses of lens substance will be cleared away, and the pupil will at once acquire a deep black tint very different to what it had when encumbered with the *débris* of the lens. Here oblique illumination and functional examination will both be useful in showing whether the pupil has been sufficiently cleared. After the operation a patient should easily distinguish by means of a lens of + 16 D. the hands of a watch.

(*b.*) The *hard, brown,* or *black nuclear* cataract, according to the tint the lens takes, is not a distinct variety from a pathological point of view. It is a cortical cataract, which has become developed tardily, and incompletely, in a lens where sclerosis has largely affected the perinuclear and even subcapsular layers. Such cataracts are constantly met with in persons advanced in years who have largely developed corneæ and lenses. As you may have noticed in a case of double black cataract which I operated on, the lens which had been attacked the first exhibited a dark brown tint, almost black, on a white ground, but yet continued perfectly transparent. In the other and more recently attacked eye, the lens showed only a well-marked brown discoloration. The complete restoration of vision after ten days is a proof that this peculiar condition of the lens had nothing to do with any complications.

Having had many opportunities of operating on such patients, in whom I always take care to allow for a lens of considerable size, I have become convinced that the explanation generally given of this black appearance—namely, that it is due to old hæmorrhages, and to the absorption of hæmatine by the lenticular matter—is wrong. The ignorance of too many operators in regard to the bulkiness of these cataracts, owing to which they force them through insufficient openings, results in trouble and difficulty, where none need exist—at least, so far as the cataract itself is concerned.

Nuclear cataracts never become perfectly ripe. Vision also, in old persons, is never absolutely lost, and, consequently, any surgeon who, from ignorance of this fact, were to wait till such cataracts became ripe, would condemn patients to remain all their days in a condition bordering on blindness. In these cases the process of sclerosis has affected such a large extent of cortical substance, that nothing remains to undergo breaking up and softening but a very thin subcapsular layer. Even this change takes place so slowly, that at the point where it commenced the softened layers lose their fluid, and become united once more with the sclerosed nucleus.

A peculiar phenomenon is generally present in those who are the subjects of progressive cataract; it is that vision becomes ameliorated as the desiccated cortical masses shrivel up. Thus, as a rule, such patients experience great improvement in sight from the use of atropine. Inspection of the dilated pupil will show very few striæ either radiating or central. I have always seen operations on such cataracts turn out successfully if the operator has borne in mind that the cataractous changes cause no reduction in the bulkiness of these lenses. Therefore the largest section is here necessary in order to afford a free exit.

(*c*.) Among the *capsulo-lenticular* cataracts, two varieties can be distinguished with sufficient distinctness. The first is one in which opacity of the capsule is superadded to a complete and retrograding cataract; the second is where, simultaneously with the cataractous changes, the anterior capsule becomes the seat of opacity in the neighbourhood of the anterior pole of the lens.

In the first variety, a larger or smaller white patch is seen, with irregular and angular boundaries, and always at a distance of some one or two millimetres from the periphery of the lens. It is easy to make out that this patch rests on a lens, the cortical substance of which has lost its fluid, and presents a spider's web appearance, beneath which the amber tint of the lens can be perceived. Here there are no radiations due to breaking down of cortical substance, no large pearly looking striæ, no shadow from the iris, in other words, no longer any transparency in the affected portion towards its periphery.

I look on the recognition of the growth of this opacity as very important, for if the operation be carefully performed, the patient can be relieved from his cataract. In the first place, the combined method should be preferred for a capsulo-lenticular cataract. In the second place, it is well not to insist too absolutely, and in a routine way, on opening the capsule in the centre of the pupil. There the cystitome might readily become entangled at the lower edge of the opacity, and a risk might thus arise of luxating the lens, for the diseased capsule will not retract as it would if healthy. In such cases, you should, with the cystitome, coast along the upper border of the lens above the opacity, and form a button-hole slit in a healthy portion of capsule. The nucleus, with the cortical portions, will then readily escape.

The pupil should be cleared in the usual way; but this last stage of the operation must be completed, while the patient keeps his eye steadily directed to one point, so that the capsule can be extracted. The instrument best suited for this, is an iridectomy forceps. It is to be introduced into the eye, closed, and when near the capsule, is to be opened and one blade passed underneath the opacity. There should be exercised on the portion so seized, a lateral and steady forward traction, rather than a direct or continuous one, and this over the whole sac of capsule. I have never seen any accident arise from operating thus; on the contrary, when the patient by some sudden movement has caused the failure of the manœuvre, so that the opaque patch is torn away from the rest of the capsule, more marked symptoms of irritation have often followed, than if the whole capsule had simply been left in the eye, and all chance of a rapid and brilliant cure abandoned.

The retrogressive capsulo-lenticular cataract gives such excellent results, that one is tempted to try and find some means of producing in every case the same thickening and opacity of the capsule. In other words, an excess of caution may suggest waiting until every cataract is so ripe as to be in this condition. You are probably aware that the development of this opacity is attributed to a true inflammation of the anterior portion of the capsule, the result of shrinkage of the cortical substance from desiccation. It is supposed that cellular proliferation of the subcapsular epithelium takes place in almost every retrogressive cataract. It is upon this that the theory above mentioned is based (*O. Becker*), by which every cataract may be supposed capable of cure, by detachment of the zonula, and spontaneous luxation. As far as my personal observation goes, I should say that it would be wrong to count upon this occurring with any regularity. Indeed, I am acquainted with cases in which such cataracts, though complete for the last ten or even twenty years, have not as yet presented any of these changes in their capsules.

The second variety of capsulo-lenticular cataract, that, namely, in which the capsular changes appear simultaneously with those of the lens fibres, is frequently found in partially opaque lenses. The capsular opacity never attains the dimensions of the retrogressive patches, and is developed simultaneously with the cortical opacities, in the neighbourhood of the posterior pole. There is no such thing as a posterior capsular cataract. This variety of capsulo-lenticular cataract, which often gives rise to a very small central opacity with lateral processes, is due most probably to nutritive changes in the lens, superadded to the alteration which induces simple senile cataract. There may be just doubts as to whether such a variety of cataract is not something more than the expression of senile changes; this should make us examine the vision a second time, and with more care.

Generally speaking, I leave such a capsular opacity behind in the eye, for it is difficult to seize with the forceps, and on the least traction breaks away. But I am careful, during the act of opening the capsule, to apply the cystitome slightly beyond the opacity so as to draw this close to the section, and oblige the cataract, as it engages the wound to bring the opaque portion with it. In this way removal is easily effected.

5. The *diabetic cataract* does not differ essentially from ordinary cataracts, but a few words are necessary as regards its origin. Let me preface my remarks by saying that the presence of diabetes has no influence on the results of an operation. Among my patients there is at the present moment, a man aged 56, who has been operated on for cataract, apparently senile, and in whom the healing process has taken place very rapidly. Nevertheless, this patient has eliminated in his urine, which is very copious, the enormous quantity of 217 grammes (7 ounces approximately) of glucose daily. A continual thirst is the only symptom he complains of; he is a robust man, and declares that in all other respects he feels perfectly well.

You need not therefore consider that the existence of diabetes is the particularly unfavourable sign, as regards operations, which so many surgeons consider it to be. As bearing on this, I may mention the case of a well-known clergyman in Paris, who on two occasions while under my care for double cataracts, was restricted to diet suitable to the diabetes from which he suffered. It is now nearly ten years since the first operation was performed, and the patient still congratulates himself on the excellent result obtained by the double extraction. I am so persuaded of the slight influence that diabetes exercises, on the process of healing, that I never put any questions to patients, as regards the amount of urine they pass in the day, or their thirst, unless the development of the cataract is not in harmony with the age of the subject. The urine is tested in every case of juvenile cataract, unless there is an hereditary history.

Although diabetic cataracts are generally semi-soft rather than hard, and although phacomalacia is the characteristic feature of the opacity, I think that it is the removal of fluid which here plays the principal part. This has been shown by experiments on animals in which, when water was withdrawn from the blood, the lens became cataractous, recovering its transparency as soon as this was added.

In diabetic patients who pass much urine, the nutrition of the central portion of the lens suffers. The contraction and sclerosis which affect the more internal layers, separate these from the perinuclear; this gives rise to the presence of a liquid in the interior of the lens more or less charged with sugar, which takes up water, and thereby exercises a much more destructive action on the fibres than obtains under ordinary conditions. As such a cataractous process may exist in persons still far from old, in whom sclerosis of the nucleus is scarcely developed, we must of necessity have half fluid cataracts, with small nuclei. If the diabetes acts on lenses already considerably sclerosed, so as to render them opaque, then a peculiar phenomenon results. It is this, that the already softened masses rapidly lose water, so that, by the side of one layer or sector undergoing severance and destruction, there is another portion which is undergoing contraction and desiccation; the result is that these opacities differ little in consistency from ordinary senile cataracts, and attract no particular notice.

From the point of view of causation, I consider that desiccation, for instance the removal of water by copious perspiration, plays a very important part. Although the geographical distribution of cataract is not yet exactly known, it is perfectly well established that wine-producing countries, where men work long hours under a hot sun, are particularly fertile in cataract cases. The countries comprised within the line which limits the cultivation of the grape contrast very remarkably in this respect with those where the climate renders this industry impossible. I may mention to you certain regions in the United States where the paucity of cataracts is notorious. If the dispensaries of Boston, for example, furnish but from 2 to 3 per cent. of cataract cases, while the proportion in my clinique is 16·5 per cent., this must be something more than a mere coincidence. The suggestion that immigration into the United States has caused a relative disproportion between the old and young, will not explain so remarkable a divergence (*O. Becker.*)

Moreover, statistics are very difficult to draw up, for in the same town you will see in a popular clinique the number of cataracts running up to a high figure, while next door, though the actual number of patients may not be fewer, the proportion of cataract cases will be diminished one half. Such differences admit of various explanations apart from a popular name, such as facilities of transport, the wealth of the country, etc.; all which render it impossible to feel much confidence in tables, even when constructed from very wide observations. For instance, take the work of Professor *Becker* so often cited, and you will find that on a total of cataracts operated on by *Jaeger*, *Arlt*, and *Hasner*, there were 1288 men to 972 women, whereas my statistics furnish an equal number of each sex.

Hereditary transmission plays a most important part. I should not like to say how often I have operated on brothers and sisters. Two years ago I operated on twins forty-two years of age, each attacked about the same time with cataract, which was inherited from their grandparents.

It is much to be regretted that we have not a more complete analysis of certain cases of, so to say, instantaneous production of cataract in persons exposed during a variable time to intense heat. Such observations would shed light on the question as to whether loss of water in the central and worst nourished portions of the lens, shrinkage of the central layers, dissociation of the external parts, and the action of fluid, collected between the separated lens elements, are or are not the main factors to which the loss of transparency is due.

LECTURE XXX.

DIAGNOSIS OF CATARACT; COMPLICATIONS; TREATMENT.

Before considering the treatment of senile cataract, it will be well to consider the visual disturbances it occasions, and review the methods of research by which we can learn whether or not we have to do with only simple uncomplicated cataract.

The first complaint which patients, threatened with progressive cataract make, is, that their vision, especially for distance, is growing weaker. Partial and stationary opacities affect only the perception of light. Patients will tell you they are becoming short-sighted, while formerly (if they were emmetropic or slightly hypermetropic) their vision for distance used to be excellent. If this change be further inquired into, it will be found that in a certain number of cases concave glasses are of material service. These elderly individuals may give proof of this acquired myopia by abandoning their convex glasses for near vision (*Walther*). Indeed, they often congratulate themselves on a return of youth, because they can read once more without spectacles. In many cases this myopia is nothing more than apparent. It depends on the change of curvature in the lens (*Scarpa*) which has imbibed fluid, and also in some cases on the exclusion of its central portions from any share in vision, so that the marginal and most convex portions of the lens only are brought into play. Concave glasses do not improve sight, and then patients use for near objects either stronger spectacles or reading lenses. Objects, at a short distance, are relatively better seen, because the circles of diffusion do not increase in the same proportion as the enlargement of the image; such objects, therefore, although still diffused, are better perceived owing to the larger size of their images.

Ought the use of concave glasses to be allowed for distance to persons who have true acquired myopia? When the perception of near objects is decidedly rendered better by the enlarged images, which such glasses give, should they be given?

The answer is, Yes, if examination has shown that true senile cataract is present, and if the patient's age is such as to render all continuous or excessive efforts at accommodation impossible. For the rest, the patient himself is a very fair judge of this matter, and will desist from the use of such glasses if he find that they cause pain in or around the eye.

The changes in the index of refraction, which the processes of dissociation and imbibition cause, may give rise to irregular astigmatism and multiple prismatic action, with diplopia and polyopia, which will become apparent to the patient when he looks at any bright objects by twilight. Such patients also often complain a good deal of being dazzled when exposed to bright daylight. In such cases smoked glasses will be found very serviceable.

When an opacity is confined to the central portions of the field of the pupil, or when, though encroaching on the equator of the lens, it has left one or more transparent stripes in the cortical substance, a marked improvement in sight will take place as evening comes on, or if the patient turns his back to the light, and so dilates his pupil. In such cases weak solutions of atropine (1 part in 2000), of which one drop is to be placed in the eye two or three times a week, will be of service. If after some time the conjunctiva ceases to tolerate this, as shown by the patient saying that his eyes are beginning "to run," it must be replaced by a collyrium of extract of Duboisia myoporoides (1 part in 2000), which should be employed in the same way as the atropine. Care must be taken while employing this treatment to protect the eyes against all excessive light by means of smoked glasses, or, in the case of ladies, by veils, and to modify the glasses used for vision at short distances, allowing of course for the complete paresis of accommodation.

The opacity may have invaded the whole border of the lens, and extended generally from the equator to the poles, so that no segment is free from cataractous changes. In another case the plane mirror may show that the transparency is greater towards the central portions. Under both these conditions mydriatics are better avoided altogether. They cause great discomfort by increasing the diffusion of light, and with the glasses the patients generally wear by reducing sight. How often will patients complain somewhat as follows: "I could see well enough until I was examined; from that moment my sight suddenly began to fail." If by chance after any such examination the cataract has happened to progress more rapidly than heretofore, it will be difficult to convince the patient that the examination and dilatation of the pupil have not been in some way to blame for this result. Moreover, those subject to this kind of cataract will always give a negative reply if you ask them whether their sight improves towards evening. There is no improvement when the light is subdued; but, on the other hand, improvement takes place as soon as they bring the luminous source between the object and their eye, for the pupil then becomes strongly contracted.

Educated and intelligent patients may be instructed to make an entoptical examination of their own eye, by looking through a pinhole in a card, and directing their gaze towards any bright surface, such as the globe of a lamp. They will succeed without any difficulty in distinguishing the outline of the lenticular opacities, and will be able to inform you beforehand of any further deterioration that vision may have undergone, by pointing out fresh opacities. I may add that some inconvenience may arise from divulging this method of examination to nervous and hypochondriacal persons, for they will never cease practising it, until it becomes both fatiguing and injurious.

When the cataract is complete, vision is reduced to a mere quantitative perception of light; the reduction, however, never goes beyond this. In the case of senile cataracts, with sclerosed nuclei, and adhesion of the cortical masses, this quantitative perception of light should be very considerable. The patient placed in a dark room should be able to tell at once, at a distance of six or eight metres, when a small flame is obscured or not. Where a general softening of the cortical substance is present, or still more, when there is a large and thick patch of capsule lying behind a strongly contracted pupil, the sensibility to light may appear blunted, for such a cataract reflects the rays, and allows only a small number of them to pass through. Thus it may happen that the patient will no longer return distinct answers as to the presence or absence of the flame, once the distance has exceeded three to four metres. Moreover, be careful how you accept the answers of peasants who, for years, have been sunk in intellectual torpor, and who are quite incapable of giving the attention to your examination which is necessary to make it of any value.

On account of the difficulty of this method many able practitioners, taking a pride in minute research, have attempted to measure and express in figures the quantity of light seen, by means of specially devised photometers. But for the matter of that, by using a candle, always of the same size, great accuracy can be attained. Exploration by means of coloured glasses placed before the luminous source, has not afforded results of any practical value. In the first place, it must be observed that patients with senile cataracts, of which the nuclei are yellow or brown, are in the same condition as if they had yellow or brown glasses before their eyes. The blue rays will therefore be absorbed in proportion as sclerosis of the nucleus is well marked. As it is impossible to know what perception of colours the patient had before his cataract appeared, such examinations are very apt to lead an observer astray.

It is a more difficult matter to discover whether the periphery of the retina as well as the central portion is functionally perfect. The diffusion of light through an opaque lens will scatter the rays very uniformly over the fundus ; and it will be extremely difficult to draw any conclusions as regards the sensibility of a narrow portion of the periphery. The power of projection in a cataractous eye should be absolutely perfect ; therefore, if the patient be made to fix an object (the best will be his own hand held out in front), he should be able to define the position of a small flame accurately in every portion of the field of vision. You may also make this examination in another way, namely, by placing the patient before you, and directing him to look towards you while you throw the reflection of a small flame in succession round every portion of the cornea. The various displacements of the mirror cannot be followed by ear, and the patient should be able to indicate them to you. This examination, if carefully made, will even enable you to say whether the peripheral sensibility is in excess of the central, and whether, consequently, the macula is the seat or not of any alteration. At any rate this will be decisive as to whether a large portion of the periphery of the field of vision is affected or not.

It must not, however, be supposed that this method is in every case infallible. I now show you a patient with the condition of whose fundus I am acquainted from having examined it prior to the formation of the cataract. He is affected with partial detachment of the lower portion of his retina. He has excellent perception of light up to a distance of eight metres. If you make him look straight in front, and move a small flame in the upper portion of the field of vision, or if you throw a ray of light on the upper portion of the eyeball, you will see that he will indicate correctly the to and fro movements of the lamp. Nevertheless you may observe that he does not answer with the rapidity and confidence of a person who had nothing more than simple cataract.

His statements as regards the absence of phosphenes, when you move a small ivory knob over his sclerotic near the insertion of the inferior rectus muscle, are quite uncertain. Nay, more, you will perceive that he testifies to perfect sensibility at a point corresponding to the detachment of the retina. This phenomenon is to be explained by the movements of the neighbouring and undetached portions of the membrane. Here the hesitation is generally less than where the examination is made with perception of light, and I think that it is better to depend on the latter method. It is very easy of execution, and should be known by every practitioner, in order that he may be able to give an opinion on the suitability or otherwise of an eye for operation. It is very essential that this should be done before any patient undertakes a long journey to some skilled operator, only to learn that operation in his case is impossible owing to some complications which ought to have been discovered beforehand.

I will now consider certain changes which are liable to be mistaken for cataract, if recourse be not had to the ophthalmoscope, which will at once remove all doubts. Not a year passes but you will see patients coming to this clinique, hopelessly blind from chronic irritable glaucoma. Nevertheless, such patients have been sent here sometimes even by medical men, with the request that they may be operated on for cataract. It is marvellous how such affections can be mistaken for anything but what they are. Cataract causes a change only in the field of the pupil, which is bounded by a mobile and normally coloured iris. Chronic irritable glaucoma dims the eye, renders the outlines of the pupil immovable, and discoloured, owing to atrophy of the iris, besides producing a certain hardness in the globe. Nothing of the kind occurs in cataract.

But further, the complaints made by the patients in the two cases are totally different. It is very rare, indeed, for irritable glaucoma to become established without causing from time to time periorbital pains, or at least a feeling of weight in the brow. In cataracts such is not the case. There is present dazzling or fatigue, which comes rapidly on when the eyes are used; but nothing more. The glaucomatous patient will describe accurately the darkness, the smoke which rises up before him at certain hours of the day, quite independently of the intensity of the light. But the patient affected with commencing cataract, says plainly that the changes in his vision depend on changes in the amount of light, which cause the pupil either to dilate or contract. He describes accurately how his sight becomes more and more dim, though continuing very acute as regards the perception of light. Almost every glaucomatous patient mentions the *darkening* of his sight, insisting on the fact that he does not see equally well in every direction; but that objects appear to him more distinct if he looks outwards, that is, in the portion of visual field which alone is intact.

I am quite aware that it is not difficult for any man who is unaccustomed to examine an eye, to make a confusion between the two diseases at their commencement. But this is exactly why he should not pronounce an opinion with all the confidence of ignorance, and say to a patient, "You have a cataract beginning; wait till it is ripe, and then have it operated on." Surely, it would be better to do as I do here, and advise the patients to present themselves every month or so, that the course of the affection may be watched, and that the surgeon may be in a position, if the symptoms of glaucoma become more marked, to conjure the danger away altogether. This practice has also one great advantage, namely, that any practitioner accustomed to examine the eye, may, up to the last moment, satisfy himself of the absence of complications and changes in the deeper seated parts. Such changes might occasion a disagreeable surprise to surgeon and patient alike, when, after the operation, vision was found not to reach the expected standard.

A mistake not difficult to make is that of confounding a simple with a *complicated cataract*. However, even allowing a practitioner has not had much opportunity of examining visual acuities, either central or peripheral, or of recognising whether a cataract is suitable for operation or not, his attention might easily be drawn to any existing complications by merely putting certain questions. First of all, the patient will have been more or less myopic before displaying any changes in his lens. Vision did not at first fail gradually, but suddenly, as though a veil had been placed before the eye, concealing a part of every object, while it is only comparatively recently that the pupil has become white. If the detachment be partial, and behind the cataract, the patient, when the other eye is carefully covered, will in most cases declare that he sees the flame of the lamp better when looking at it sideways than directly. Of course, with complete detachment all perception of light is absolutely lost. Here direct inspection of the cataract offers no assistance to diagnosis, although it should be recollected that the very hard varieties exclude up to a certain point this complication; for cataracts complicated by detachment have generally thick and soft cortical layers, and a pale blue tint. In these cases touch may be of some service, for an eye affected with a complicated cataract shows, when compared with its fellow, a very considerable degree of softening.

Before touching on the curative treatment of cataracts, which is extraction, a word as to whether it is absolutely beyond our power to check their growth. As a matter of fact, you will scarcely ever find a patient who has been informed that he is affected with commencing cataract, but will immediately ask for some medicine capable of staying the progress of his malady. With the exception of cases of diabetic cataracts, in which attention to diet, coupled with the waters of Carlsbad (*Segen*), have succeeded in dissipating opacities, I know of no means of checking the growth of a senile cataract.

If, by chance, you should light on a number of the *Gazette des hôpitaux* which has appeared within the last few years, telling of the clearing power in the lens of weak continuous currents, you will see with what rapture this wonderful therapeutic agency has been welcomed. But alas! like so many other marvels in the healing art, it was not, after a certain lapse of time, even mentioned, because, forsooth, it involved the nominal expense of two cells of a *Trouvé* battery, and the trouble of wearing small discs at night, and keeping the tiny machine by one's side in bed.

Need I mention to you the preparations of ammonia and of phosphorus, with which some persons pretend to restore transparency to opaque lenses? I scarcely think so. There is, however, one incontestable fact, and that is, that patients undergo such courses with admirable patience for periods of ten or twelve years. Certain unprincipled quacks make capital out of the improvement that the retrogressive stages of ripe cataracts afford to vision, and also out of the fact that certain nuclear forms never go so far as total blindness.

Apart from the needle operation, which is suitable only to zonular, soft, or traumatic cataracts, and, generally, to infantile, the only operative method ever now practised is extraction, either simple, or combined with iridectomy. Although no operations have ever been the subject of so much anxious study as those for cataract, it may be affirmed that we have not as yet arrived at any definite and final decision.

Every one will at once acknowledge that soft and fluid cataracts, in persons who have not attained the age of thirty years, should be subjected to *simple linear extraction,* that is, an incision should be made with an iridectomy knife from 4 to 6 millimetres in extent, and perpendicular to the middle of the horizontal and external radius of the cornea. After having opened the capsule with the cystitome, it will be sufficient to produce a slight gaping of the wound, by means of Daviel's curette, or, still better, by the caoutchouc spatula, in order to give exit to the softened lens. Prolapse of the iris should be treated by replacing the membrane if necessary with the spatula, and by eserine.

It would be beyond my power to explain here the numerous operations for cataract, and I must content myself only with pointing out to you the actual progress which has been realised in this direction. The first great improvement, to which *Jacobson* has attached his name, consisted in abandoning the old flap sections which passed through the cornea, at a half or one millimetre from its margin, and bringing them out at the sclero-corneal junction. He further facilitated the exit of the lens, and prevented strangulation of the iris, by the excision of a large piece of that membrane. These modifications, which anticipated the suggestion of *Mooren,* some fifteen years ago, to make an artificial pupil before performing the flap operation, were the true starting points of all the progress since made. It cannot be denied, that by abandoning the old-fashioned incisions, and combining iridectomy with extraction, the number of recoveries has been considerably augmented, while the number of suppurations has been diminished, and the duration of the treatment curtailed.

A second and most important step in advance was gained a few years later (1866) by *Von Graefe,* who, while maintaining the peripheral section, and the iridectomy of *Jacobson,* urged that the flap method should be abandoned, and the *linear* as far as possible adopted in the incision. The resulting wound being much less inclined to gape, enables the globe to be fixed during the whole operation, and the section to be made upwards, so that the artificial pupil can be concealed beneath the upper lid.

Although my illustrious master, *Von Graefe,* has distinctly laid down that at all hazards the section must be made as nearly linear as possible, and care taken not to return to the curve of the old-fashioned incisions, I have not hesitated to depart from this precept, and modify the linear and peripheral section in two respects, 1st, by making a flap of two millimetres in depth, and 2ndly, by making this flap fall exactly in the corneal border. This change allows the lens to escape, and the wound to open more readily. Furthermore, the danger of an incision which approaches the ciliary body very closely, and which may produce troublesome intermittent hæmorrhage, and has actually been followed by sympathetic irritation, is avoided.

I should like to see the present reaction against maximum linearity of section carried this far, that while a flap of two millimetres in depth should be made with extremities touching the corneal margin, the apex should not be in contact with the upper edge of the cornea, but should rather graze the conjunctival limbus; it would thus be about half a millimetre below the upper margin of the cornea, according to the size of the conjunctival limbus. The reasons which have decided me to adopt this modification are the following.

1. It often happens, that we have to fall back on an old precept, namely, that a good cataract operation should not bleed. The blood scarcely ever comes from the iridectomy, but rather from the flap of conjunctiva, necessarily made when the knife passes under the conjunctival limb, which is detached with the free conjunctiva. A bleeding wound, and one difficult to clean thoroughly, is thus produced. Without the conjunctival flap, this incision is still slightly larger than the one which divides the sclero-corneal junction, its edges come together quite as well, and admit of the removal without difficulty of any fragments of capsule. Cleaning a wound is rendered very difficult when, as a preliminary step, a flap of conjunctiva has to be turned back, and search made with forceps between the lips of the incision for a portion of capsule. On the other hand, such a search does not present any unusual difficulty when made in a clean section and one falling in the cornea itself. Those of you who have witnessed many operations here, will have seen how often I have succeeded in extracting a large triangular flap of capsule, which I recognised was entangled by the fact of the want of exact coaptation in the lips of the wound.

2nd. Another advantage of placing the section thus consists in not being obliged to make such large iridectomies. We have, indeed, already left the epoch a long way behind in which *Von Graefe* recommended a certain amount of traction to be made upon the iris during iridectomy, so as to remove as exactly as possible a portion corresponding to the section, and thereby avoid all entanglement in the angles of the wound. You will perceive that I proceed very differently from this. I take hold of the sphincter with the forceps about the middle of the incision, and remove merely a small cone which scarcely reaches to the edges of the wound. This I do with the object of ensuring an artificial pupil such as I described when speaking of zonular cataract.

Another improvement which has been imported into the procedure of *Von Graefe*, which every day is losing more of its purely linear character, is due to the efforts made to render entanglement of the iris impossible. On this subject I am compelled, though not without reluctance, to bring my own name somewhat prominently forwards. Three years ago, when I made an attempt, to which I will again refer, to abolish, if possible, excision of the iris in the operation of extraction, I called on the chief manufacturer of the alkaloid of Calabar bean, *M. Duquesnel*, to prefer two requests: the first was to give me, for the trial I proposed to make, as neutral and pure a preparation as possible; the second was, that, in case my experiment should be successful, and the consumption of the article should thereby increase considerably, he would, in the interests of the poorer patients, make some reduction in his excessively high prices.

At this period (April, 1875) eserine had been but very little used in ophthalmic practice. With the exception of paralytic mydriasis, it was only used in a few isolated cases, more as it were by accident. The proof of this I have in the fact that at this date *M. Vée-Duquesnel*, who was the sole manufacturer of eserine, sold an extremely small quantity. In answer to a recent request, *M. Duquesnel* has sent me the following communication: "The manufacture of eserine at first was very limited, and did not improve till the publication of your articles. I give the most liberal estimate, when I say that during the years 1867—1874, the annual consumption amounted to 15 grammes; in 1875 it amounted to nearly 100, and to double this quantity in 1876."

In Paris *M. Petit* (pharmacie *Mialhe*) also prepares, though on a much smaller scale, *sulphate of eserine*. He informs me that the consumption of this article has tripled since 1875. It is since this date only that the manufacture has been undertaken in England and Germany, the latter country turning out an article very inferior to the Parisian. Having once succeeded in showing how useful eserine was in securing a proper position of the iris, and also the power it had over the secretion of the conjunctiva, all fears about using such an agent, even though it had hitherto been generally reputed irritating and painful, were removed. Not only did its use become general among all practitioners desirous of progress, in cases of large incisions, but both here and elsewhere its employment was extended to cases of suppuration and perforation of the cornea with very great success.

Whilst *A. Weber* and I pointed out the undoubted superiority of eserine to atropine in most corneal affections, *M. Laqueur* claimed for it a distinct antiglaucomatous action. This has been borne out by the manner in which large perforating wounds on the cornea have healed.

To me it seems beyond cavil that, should eserine ever really supplant atropine, the impulse that produced this result must be allowed to have come first from this clinique. While applying eserine as a rule to extractions, its action and valuable curative powers were of necessity studied from other clinical points of view. If as regards these powers the opinion of some fellow-practitioners to whom, as also to *M. Weber*, I was the first to demonstrate what eserine really was, differs from mine, the manufacturers of chemicals have at least some reason to think with me; the proof of this is, that from the date when eserine came to be used daily and abundantly, the price rose 25 per cent., or from 18 to 22 francs a gramme.

I employ eserine in small flap extractions, by the combined method, as follows: immediately after the exit of the lens, I instil a drop of a solution of 1 part in 200, and then clean the pupil and the wound, and, if necessary, replace the iris. If the ends of the divided sphincter are in good position, I abstain from any further application of the drug. The same collyrium should be employed second or even a third time, if either extremity of the sphincter does not descend quite as low as the other, showing thereby that a small fold of iris, which cannot be reduced with the spatula, has been caught in the angle of the wound. I do not think anything is to be gained by making numerous instillations of eserine before extraction, as *Hasket Derby* has recommended. It has appeared to me that by doing so the loss of vitreous has become somewhat more frequent, while examination of the cataract is rendered more difficult. In some patients a sensation of heaviness and pain has been produced in the periorbital region. Nevertheless it is interesting to perceive that colleagues as able as *Derby*, are now using eserine exactly as they were wont to use atropine before cataract extractions.

LECTURE XXXI.

MANAGEMENT AFTER EXTRACTION; SUBSEQUENT ACCIDENTS; SECONDARY OPERATIONS.

As a means of replacing the iris in the anterior chamber, the caoutchouc spatula is not inferior in efficacy to eserine (fig. 21). With it the iris is to be spread out as evenly as possible, so that

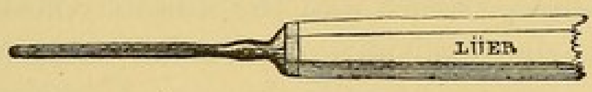

Fig. 21.

the pupil may resemble a keyhole in shape, or, in the new incision which I now make, a shell with its fuse. The suppleness of the spatula is perfect, and there is no danger of producing laceration of the posterior capsule, or of the zonula, or loss of vitreous. You have seen what care I take not merely to smoothen out the extremities of the cut sphincter, but also to guard against any adhesions between a fold of iris and the angles, or any intermediate portions of the wound. While replacing the portion of iris remaining, care must be taken, by suitable movements of the spatula, to prevent the intervention of any portion of capsule not grasped by the forceps at the moment the wound was cleansed. This cleansing must of course precede any attempt at replacing the iris.

How different is the form of the pupil now, after this final stage of the operation, from the one it had at the moment of extraction of the lens! For as you may have noticed it is not merely the faulty position of the cut extremities of the iris which induces me to smoothen it out, but also the excessive size of the pupil. You must frequently have seen how, under the combined influence of eserine and the spatula, the pupil has assumed exactly the shape it ought to have, and that without any symptoms of having been dragged upon during the passage of the lens.

Compare the form of these pupils with the drawings which *Von Graefe* has given of some of his own extractions, and you will be able to gauge the real progress that has been made since his time. To revert to large excisions, extending to the extremities of the corneal incision, and placed for the convenience of the surgeon inferiorly, is to abandon without a struggle all the progress which no man who is competent to give an opinion, can deny has been secured.

Moreover, who can fail to see that all combined methods should be performed with sections upwards, so that the artificial pupil may be concealed by the upper lid, and the patient be able at will to protect himself from excess of light? The greater facility which this is said to afford to the escape of vitreous, is an objection which will completely fall to the ground, if only a certain simple artifice be adopted, by which the globe can be protected from any pressure that the lids may make upon it.

The moment the excision of the iris has been completed, my assistant removes the speculum, and while the capsule is being incised, and the necessary steps gone through for the removal of the lens, keeps, by means of the small speculum which rests on the nose, the eyelids raised up from the eyeball. The assistant hands me the speculum in this position, and while I remove it I always keep it away from the globe. I cannot recall having ever seen an escape of vitreous during this latter manœuvre. This lifting up of the lids has the further advantage of protecting the cornea and its epithelium from the friction of the speculum. I am convinced that a speculum thus handled is, if anything, rather a safeguard against an escape of vitreous, supposing always that you can count on a somewhat skilful assistant.

I now come to the methods of *dressing*, and the treatment of the various complications which follow the operation of extraction, as now most commonly performed with the small peripheral flap. Within the last few years, our notions as regards after-treatment have undergone a great change. Skilled operators like *MM. Gayet* and *Gradenigo* have treated hundreds of cases at Lyons and Venice, without any dressing whatever. They report that they have had as good results, or even better, than when they used to employ bandages. Some of you may remember the case of a lunatic, upon both whose eyes I operated. She consented to the operation only on condition that no bandages were to be applied, and that the windows were not to be darkened. At night, she insisted on having a lamp close by her. Nevertheless, her recovery was as thorough and as speedy as that of the others.

To this tendency to suppress the use of the bandage, I have to a certain extent yielded, and for some years past have applied a bandage only to the operated eye, leaving the other free. This mitigation of the old treatment is highly appreciated by such patients as can see fairly well with their other eye, and it has been accorded without any bad results. I cover the operated eye with a small disc of fine linen, fill the orbital hollow with layers of very soft wadding, and then fasten the whole with one or two turns of a bandage of thin flannel, of from three to four centimetres in breadth. The object of such a dressing is to assist in preventing any undue movements rather than to keep patients perfectly still. Sometimes when I have proposed to remove the bandage, the patient has begged it might be left on, saying he felt more comfortable, and confident with the knowledge that his eye was protected.

I have of late tried the antiseptic method of *Alfred Graefe*, slightly modified. It is as follows: the eyelids and skin in the neighbourhood are disinfected by washing with a solution of one part of carbolic acid in 200 of water; a sponge being dipped in the solution and kept upon the eye till the moment of operation. During the operation and subsequent, dressing lotions of the same strength are applied, and the eye protected with a sponge as much as possible from the air. The operation ended, a piece of lint, prepared by having been soaked in a saturated solution of boracic acid, and dried, is laid over the eye. Before being applied, this lint, which is very stiff from the amount of acid it contains, should be dipped in a cold solution of 4 per cent. of boracic acid, and well wrung out.

The piece of lint fitting exactly, and having been pressed down all round the eye, I cover the orbital hollows and the edges of the lint with disinfected wadding (warmed on an oil bath), a flannel binder passing over the whole. The bandage is to be renewed every twelve hours. Generally speaking, when removed it forms a stiff and dry mould. Care must be taken on removing it, immediately to cover the eye with a sponge soaked in carbolic acid, exposing it as little as possible to the air. I cannot give any opinion as to the value of this dressing, till it has been tried on a larger number of cases. I may observe that I have already had a series of 184 to 200 cases without a single suppuration, although I used only the plain wadding dressing, which is not disinfected. What I can assert of the antiseptic dressing even now, is that it is not an absolute safeguard.

The dressing is generally renewed within six hours of the operation, the patient not being allowed to open his eye. It is changed three times daily during the four or five days following. It is then replaced by a loose silk shade, and protecting glasses. On each occasion of removing the bandage, the lower lid and the brow are washed with a sponge and warm water. To keep the bandage applied continuously for several days (eight has actually been proposed), seems to me both inconvenient to the patient and unpleasant for the surgeon, who is thus kept in ignorance of the course the operation is taking.

But a very few years ago it was thought necessary to treat every case of cataract extraction with atropine. Not only was this practice worse than useless, in that it stretched an artificial pupil to the utmost, whereas it should be as narrow as possible, but further the conjunctiva was thereby irritated, and often attacked with very obstinate catarrh, together with symptoms of inflammation which might otherwise never have been developed. *Von Graefe* recommended that instillations of atropine should be commenced from the third day. But a case might occur in which the capsule was on one side entangled in the cicatrising wound, and on the other, had formed adhesions with the iris. Artificial dilatation in such a case would necessarily cause direct traction on the partly-healed wound, with irritation, and even inflammation, all of which might have been avoided if matters had been simply left as they were at the beginning. I could narrate cases to you where patients had no hesitation in dating the first appearance of pain and irritation from the moment when atropine was instilled into their eyes.

In my own clinique I have long ago abandoned any such routine employment of atropine. I make use of this mydriatic only under the following circumstances; namely, when the iris is irritable and hyperæmic, when synechiæ have formed, and when considerable remains of cortical substance are present. In such case I drop atropine three or four times into the eye at intervals, and simultaneously inject twice a day under the skin of the temple ten drops of a solution of hydrochlorate of morphia (1 part to 20 of water). Should symptoms of iritis appear some days after the operation, I supplement the atropine by warm compresses of infusion of belladonna (p. 118), and at the same time order frictions of belladonna and mercury (5 parts of the extract to 10 of mercurial ointment) on the forehead and round the eye.

It is only the apparition of symptoms of irritation in the iris, as shown by ciliary pain, which obliges me to have recourse to atropine. But I abandon it as soon as I see a dilated pupil, and other symptoms of improvement. You have only to follow patients for a time, to convince yourself, that whenever atropine is used at all continuously, it will always increase the conjunctival secretion. Therefore, in most of these exceptional cases, the instillations are not continued longer than six or eight days. The greater number of the patients whom I have operated on, leave my hands without having been treated with any atropine at all.

The most formidable *accident* that can happen after extraction, is suppuration, either limited to the cornea, or spreading eventually to the whole eye. Our art made a great stride towards the prevention of such a complication by recognising that it was due to infection in the wound. The infection is due to the contents of the conjunctival sac, which, in most cases, have been conveyed from the lachrymal ducts and the margins of the lids. For this reason I carefully question every patient before operation as to whether his eyes water or not. As a preliminary step I endeavour to cure any catarrh, eversion of the puncta, blepharitis or dacryocystitis, which may be present.

The number of suppurations in my clinique vary from 1 to 3 per cent., according to the year. If you make enquiries among those whose sad fate this has been, you will find that, for the most part, they are very poor patients, who were afraid of not being received here, and consequently concealed the fact that they were suffering from some catarrhal affection. Since atropine has been abandoned, the number of cases where suppuration has appeared unexpectedly on the third or fourth day, has been greatly lessened. If I have not decided to abandon wholly the practice of covering up the eye, it is in a great measure because I have in it a guarantee against chance inoculation.

What shall I say of *Lister's* proposal, which is actually carried out by some practitioners, of operating under spray? In the first place, it seems to me, to complicate an operation, which is not at any rate suitable to the spray method. The jet of carbolised water must exert a more or less irritant action on the conjunctiva and tender skin of the lids. Nevertheless, such purely theoretic reasoning would not deter me from applying the method, which is certainly rational enough, if any surgeon could show me, that, since he has thus operated, he has had no fresh cases of suppuration of the cornea. Such has not yet been the case, but a most conscientious practitioner *M. Schiess-Gemuseus*, has published a series of cases which goes to show that even under spray, suppuration has occurred considerably oftener than in my clinique. This confirms the notion that inoculation does not, as a rule, take place during the actual operation, but after the eyelids have been closed, for then a more prolonged contact of the septic matter becomes possible.

The most characteristic sign of such injection is the persistence of pain at a time when all the painful symptoms directly due to the wound ought to have disappeared, that is to say, some twelve hours after operation. A still worse sign is when the patient has had several hours of perfect tranquillity, and the eye has not become painful until twenty or twenty-four hours after operation. In every case it will be necessary to remove the bandage, in order at once to discover to what cause this undue sensibility is to be attributed.

The dressing covering the eye may perhaps be found saturated with tears; and as soon as the lids are separated a flow of hot tears, free from all mucous discharge, may take place. In such a case the sudden appearance of pain is due to the wound having opened afresh, to the aqueous having escaped, and to more or less irritation of the iris. This latter may perhaps depend on hæmorrhage into the anterior chamber, the result of pressure. If the dressing shows traces of any yellow or green discharge, the eye is in imminent danger. The wound will now, even at this early stage, exhibit signs of purulent infiltration, with slight cloudiness of the aqueous humour, and a gelatinous chemosis.

The best course will now be to fall back on the antiseptic method, which sometimes gives very fair results, but which often, it must be confessed, fails completely. Two other methods of treatment also offer themselves. One is to deal with the affection as if it were a rodent ulcer; the other, as if it were some wound that had become infected from without.

In the first method a probe or caoutchouc spatula is to be introduced near the angle of the incision, passed into it, and the wound whose edges are now white, opened up afresh (*Alf. Graefe*). This having been effected, as will be known by the escape of the aqueous humour, a drop of a half per cent. solution of eserine is to be instilled into the eye every two or three hours. The bandage may be laid aside, and if the conjunctiva discharges but slightly, it will be sufficient before each instillation to pass a sponge, soaked in a solution of warm carbolic acid (1 in 200) over the lower eyelid. If considerable swelling of the lids with conjunctival discharge be present, I generally maintain compresses, moistened with the above solution and of the same temperature as the room, upon the eye, and renew them frequently. This necessitates an attendance day and night at the patient's bedside.

The second method of antiseptic treatment is indicated in cases where, on the first or second day after operation, a small white line appears near the corneal wound, the aqueous humour being clouded, and the iris discoloured and congested. At the same time the conjunctival discharge is slight, and the tears, though copious, are mixed with only a few yellow floculi. Here the great point is to keep the corneal wound clean. I cleanse it every hour, by causing a fine stream of a solution of hydrochlorate of quinine (1 part to 150 of water) to play over the incision.

The best method of carrying this out is to fill a small india-rubber syringe with the solution and let it trickle gradually over the wound. A light compress should also be kept upon the lids, and moistened from time to time with a small quantity of the fluid. The compress must be changed, and the eye washed with warm water, the instant the least discharge appears on the linen or the eyelashes. As a rule, I give in such cases large doses of quinine, namely 40 or 50 centigrammes (6 to 8 gr. approx.) two or three times a day. If there are very strongly marked symptoms of irritation in the iris, and great tenderness in the eye and superciliary region, I add 10 to 15 centigrammes of sulphate of atropine to the quinine solution. Any severe pain present should be relieved by injections of morphia.

There is no doubt that by such treatment an eye may be saved, or at least painful panophthalmitis, with subsequent shrinking of the globe, prevented. It is very difficult to pronounce as to the respective value of the two methods of treatment. The number of patients on whom I have been required to try them, has fortunately been small. Since the beginning of these lectures, I have had no opportunity, and I hope shall not have, of showing you a case of suppuration, out of the eighty-four operations which I have performed. I prefer the quinine treatment in all cases in which the conjunctival discharge is slight, and when the patient, from timidity or other reasons, will not allow the wound to be further interfered with.

There is still room for improvement in the after-treatment of cataract operations. It may, perhaps, be effected when men recognise that the symptoms of irritation in the anterior portion of the uveal tract, which appear generally towards the third or fourth day, are due either to direct pressure or strangulation of the iris, or to traction upon it by the capsule, as already explained. I have shown how in these cases atropine, far from exerting any calmative influence, may produce the worst effects by increasing the traction, and I have given instances where patients themselves have declared that each fresh exhibition of the collyrium caused the recurrence of pain. This is why I insist so strongly that atropine should not be used after cataract operations, unless there is a very distinct indication for it, that is, unless there be inflammatory irritation of the iris. You can quickly satisfy yourselves that the cases earliest out of the wards, and which give the best results, are just those in which it has not been necessary to use mydriatics.

When iritis, or choroiditis follow strangulation of the iris, and do not yield to atropine, to warm belladonna compresses, to mercurial inunction, or to mercury internally, are we calmly to contemplate the suffering of the patient daily renewed, and wait until the inflammation has exhausted itself? This, in most cases, will not occur till the pupil has become occluded. For my part I think the indication is, as soon as strangulation of the iris or capsule has been recognised as the active cause, to interfere at once and do our best to persuade the patient to submit to a further operation.

Capsulo-iritomy is to be performed as follows: a small opening is to be made in the cornea, similar to that for paracentesis, and from 2 to 3 millimetres in extent; through this the scissor forceps are to be introduced closed, the pointed blade being passed underneath the capsule and iris as it lies entangled in the wound, and both are to be divided. If the operation is carefully performed, and if during the whole time the speculum is kept up from the globe, it is possible, by rapidly withdrawing the scissors, to avoid all loss of vitreous humours. In this way the procedure is reduced to little more than a simple paracentesis.

One must have actually seen the results as regards the relief of pain and inflammation which so rapidly follow such an incision of the capsule, skilfully performed, before he can judge of its suitability or otherwise. These cases require the patient to be very thoroughly under control, otherwise he will not submit to fresh surgical interference. Not unfrequently a patient will not consent until the continued pain has broken down his resistance. When an operation is performed at a later period, the pain will always be relieved, but not the inflammatory process, or not with sufficient promptitude to prevent occlusion of the pupil. This in turn will call for a fresh operation.

I now turn to the secondary operations which may be rendered necessary after extraction, when a pupil sufficiently clear for visual purposes has not been obtained. I shall deal with three different conditions, (*a*) *simple secondary cataract ;* (*b*) *adherent secondary cataract ;* (*c*) *occlusion of the pupil.*

(*a.*) *Secondary cataract* may result from imperfect removal of a primary cataract. This may depend on the presence of a certain quantity of cortical substance, owing to the cornea and capsule having been incised over too limited an extent. Or again, the incisions may have been sufficient in size, but either some portion of diseased capsule has been left behind, or the subcapsular layers have adhered to it. Eventually it has become covered with hyaloid masses, with which the capsular wounds have united. Finally, although a cataractous lens has been completely removed, the posterior portion of the capsule may become coated with calcareous deposits, and thereby form a great impediment to distinct vision. Such secondary cataracts are slow in their evolution, and may supervene in spite of the most perfectly performed and successful operation. They are often connected with disturbances in nutrition, depending on changes in the uveal tract.

In the case of secondary cataracts which are free from all adhesions to the iris, and in which there are very few posterior synechiæ present to prevent full dilatation of the pupil by atropine, the only operation perfectly free from danger is that of division with two needles. A practical point may be noticed here, namely, that the needles should be held well slanting as regards the cornea, so that the lacerating movement may be made in a plane parallel to the iris. This is in order to avoid penetrating deeply into the vitreous humour. The eye should be fixed, and the first stop-needle inserted at the middle of the upper and outer radius of the cornea, if the left eye is to be operated on, but the superior and internal, if the right, the operator standing behind the patient. The first needle after the forceps have been removed serves to fix the eye and the secondary cataract. The second needle should then be introduced at the middle of the superior and internal or external radius, according as the eye be the left or right. The needle in the operator's right hand is for dividing, that in his left for steadying the cataract.

The needle operation if properly performed, and followed by instillation of atropine, is free from danger, and may even be performed on secondary cataracts of some thickness, when a considerable quantity of cortical substance is present. I occasionally utilise this method in order to break through one or two synechiæ between the iris and the cataract. With this object, I insert the fixation needle close to the synechia, carefully guarding the iris from all undue dragging. As regards vision, an opening in the pupil, however small, if only it be perfectly free from membrane, is all that is absolutely necessary. The remainder of the pupil being occupied by capsular opacities will not exert any greater influence on vision than circumscribed and stationary opacities of the lens: that is, it will curtail more or less the amount of light entering the eye.

(*b.*) If the irritation of the iris, during the formation of the secondary cataract, has been sufficiently intense to cause extensive union between the border of the pupil and the cataract, I do not practise the above operation. It is, however, suitable in the case of a very thin secondary cataract, which can be readily torn without causing disturbance to the iris or ciliary body. In such a case the sickle-shaped needle of *Sichel* may be used with advantage. But I think capsulotomy is here undoubtedly the best operation. I limit the incision to the capsule, if this is thin, but make it include the sphincter of the iris, if a certain quantity of cortical substance still lies interposed between the folds of capsule.

In either case a small opening should be made through the cicatrix of the original wound, with an iridectomy knife. This should penetrate not more than half its length into the anterior chamber, and be quickly withdrawn. The scissor forceps are then introduced closed, the sharp blade passed under the capsule, and two snips quickly given, so as to form a Λ-shaped incision, the apex of which is directed towards the corneal wound. The speculum having been raised up from the globe may be quickly removed, and any escape of the vitreous humour thus prevented. This operation gives very brilliant results with a minimum of danger to the eye.

If the secondary cataract is thickened and if there is the slightest reason to suppose it will not retract (and retraction must not be confounded with the gaping of the wound caused by the entrance of the vitreous humour into the anterior chamber), it will be advisable to utilise the contractile power of the sphincter of the iris. In such a case the section into the capsule is to be continued for a distance of $1\frac{1}{2}$ or 2 millimetres into the iris. It must not be forgotten that the cutting portion of the blunt-ended scissor forceps, when closed, does not go beyond the button, and that therefore, to obtain a section such as the above, this cutting portion must advance almost as far as the periphery of the iris. The sphincter, when divided, contracts forcibly, and draws with it the secondary cataract to which it is attached.

(*c*.) If, after an operation for cataract, occlusion of the pupil takes place, either from iritis or irido-choroiditis, iritomy should certainly be performed. It is here the only operation indicated, both because it can be executed without dragging upon the ciliary body, and because the stretching that the iris has already undergone, in bridging over the space occupied by the natural and artificial pupils, will be sufficient to ensure a large enough opening.

I take this opportunity of answering a criticism which *Von Arlt*, my esteemed master, directed against my operation, at the congress of Heidelberg (1877). Professor *Arlt* says that he has given up iritomy with my scissor forceps, because when he finds a thick layer of exudation behind the iris, he thinks it more dangerous to attack this and the iris at the same time than it is to make an iridectomy first, and then later on to tear the iris either with my scissors or with needles.

I am quite ready to admit that when there are thick masses of exudation to which an atrophied iris is glued down, the difficulties are great. I consider further that such cases are but little suitable for simple iritomy, which, exactly because of the existence of these adherent non-retractile masses, will not produce retraction of the iris sufficient to maintain an artificial pupil. The operation in such a case may be followed by the formation of still thicker masses, or even by atrophy of the globe. But I appeal to Professor *Arlt's* great experience, and would ask him whether he thinks such cases are better treated by the removal of a portion of iris, or whether there will not result from this an amount of irritation such as to forbid any ultimate interference with the underlying layer. I maintain, from an experience only less than that of my master, that the cases which underwent the second operation at his hands, would have done just as well with a single operation of iritomy.

On the other hand, I allow the perfect justness of *Prof. Arlt's* observation, when he says, that cases where the iris is doubly lined with a thick felt-like exudation, and a secondary cataract, may even after iritomy give rise to very serious trouble. But, as I have seen such cases turn out much worse under the operation of iridectomy with subsequent laceration, I have adopted another method, and that is to combine iritomy with iridectomy. Besides this, however, *Professor Arlt* will grant me, that whereas it may be quite possible in hospital practice to perform a second operation on an eye, if a first has failed, it may be extremely doubtful whether the same opportunity would occur in private practice.

LECTURE XXXII.

IRITOMY IN OCCLUSION OF THE PUPIL; RECENT MODIFICATIONS OF THE OLDER METHODS OF EXTRACTIONS.

Certain conditions which have accompanied occlusion of the pupil, such for instance as the duration or severity of the inflammation or pain, will afford valuable information as to the changes we may expect to find behind the iris. It will be mainly, however, by inspection of the eye itself, that we shall be guided in the choice of the second operation, which as a rule is the last appeal a patient will make to our art.

In one class of cases, the secondary cataract and the exudation from the iris will have blocked the pupil up with a white-looking membrane. But this obstructing membrane will not be endowed with that inherent power of contraction, the effect of which is to draw one edge of the pupil towards the other. The pupil itself will rarely have undergone any marked displacement, or have been dragged upwards towards the corneal wound. The iris will rather be situated in a plane, its tissues apparently healthy, and the anterior chamber properly formed. Finally, touch will show a normal tension, and pressure on the ciliary body will not cause pain.

In an eye with a good perception of light, excellent results can be obtained by simply incising the iris. The operation which causes least traction on the ciliary body, and least irritation to an eye just emerging from the complex process of cicatrisation, is, beyond all doubt, incision of the iris performed with my scissor forceps. I have now adopted the modification proposed by *M. Green*, which is to incise transversely the two adherent portions of the sphincter, a little above the inferior border of the pupil. There are, perhaps, some who would prefer either coarse sickle-shaped needles, which fill up the wound in the cornea, and retain the aqueous humour (*the younger Sichel*), or a narrow

Graefe's knife, in place of the scissor forceps (*Mooren*, *Snellen*). I would ask such if they really think they can deal better with the corneal tissue when manœuvring these needles in a wound, than when they gently pass the blades of the scissor forceps through an opening in the cornea, scarcely larger than would be required for a paracentesis. It does not appear to me to admit of question that the scissor forceps are the single instrument with which the iris can be incised without disturbing and dragging on the ciliary body.

The incision, which should penetrate into the anterior chamber, is to be made with a straight stop knife, at the middle of the outer radius, or slightly above it, if there be any displacement of the pupil. The knife should not be pushed across the cornea, quite as far as the stop ; but should be drawn gently back so as to allow the aqueous humour to escape slowly, and thus gradually reduce the intraocular tension. While the assistant raises the lids with the speculum, which must not be screwed tightly, the blunt scissor forceps are to be introduced, and the pointed blade passed under the iris. The other blade is to be advanced three millimetres beyond the border of the pupil on the side opposite to the wound. One rapid snip with the blades, which are to be at once withdrawn, will suffice to secure a perfectly oval black pupil. If the speculum be now carefully removed, all escape of the vitreous, to which, indeed, owing to the smallness of the corneal wound, there is no tendency, may be avoided.

If you have not the pointed scissor forceps at hand, the operation may be modified as follows : At the moment of withdrawing the stop-knife, leave it for an instant half in the wound ; owing to the escape of the aqueous humour the iris will then fall in front of the knife ; this must now be again passed in, so as to make a small button-hole incision in the iris which will afford a passage to the blunt scissor forceps. This manœuvre is perhaps easier than the one which necessitates the use of the button forceps, requiring, as that does, a good deal of skill in order to avoid passing between the iris and cataract beneath. I have merely stated that preference should be given to the button forceps in cases where there is reason to suppose that the vitreous is very fluid (a considerable loss having perhaps taken place during the extraction), or where the iritomy is performed shortly after the cataract extraction. In such a case it is probable that the iris, when transfixed by the knife, will bleed freely, rendering any movements of the forceps difficult in an anterior chamber filled with blood. In ordinary cases, when the operation is performed several months after the disappearance of all symptoms of irritation, and when the iris has recovered its normal appearance, I prefer the old-fashioned button-hole operation, which appears to me the safest way of cutting both the iris and the subjacent tissue.

I can show you cases in which I have obtained excellent results from such incisions, limited to the sphincter, with the formation of pupils which in their regularity strongly resembled normal ones. Among several others I now show you a patient, who, after extraction by the small peripheral flap operation, had incomplete occlusion of his pupil, which still allowed him, however, to count fingers at the distance of several metres. In this case a snip of the scissor forceps horizontally, through the sphincter, has re-established an almost circular pupil, very similar in size to a moderately dilated pupil, and permitting of excellent vision. Such cases must be compared with those in which a flap of iris is torn away by iridectomy, followed by laceration of the secondary cataract. It will then be understood how iritomy was welcomed by all who could observe facts with impartiality.

Nothing can be so prejudicial to iritomy as to claim for it a sort of infallibility, and therefore I will proceed without delay to mention those cases in which it is not applicable. Reasoning on the matter, it will be perceived that the operation depends on the power of the iris to contract, and must therefore necessarily fail so soon as this power is absent. Such is the case whenever, owing to chronic inflammation, or thick felt-like exudation between the secondary capsule and the iris, the latter has become atrophied. This atrophy may be the result of excessive traction, in cases where, for instance, the lower border of the pupil has been drawn into a corneal wound; or it may result not merely from dragging of the iris but also from accumulation of masses of exudation behind that membrane, so that the anterior chamber has been more or less altered. What can be expected from one or even many incisions in an iris, thus atrophied and bound down by firm adhesions, which even the presence of the fluid vitreous as it wells up between the edges of the incision can scarcely keep open?

But more than this. In an eye that has been diseased for months, where constantly recurring hæmorrhages into the vitreous have aggravated the nutritive lesions of the anterior portion of the uveal tract, a single incision into the iris may produce irritation sufficient, not only to close the wound, but even to induce partial atrophy of the eyeball. While ready to acknowledge that a mere iritomy is impotent in such cases, I must also be allowed to remark, as the result of a long experience, that the best operator under such circumstances will obtain a still less satisfactory result from the removal (often imaginary) of a portion of iris.

In such conditions, the only other alternative is to fall back on a combination of iritomy with iridectomy, which may be executed in two different ways. If the eye is found on touch to be free from irritability, and if I feel satisfied that the perception of light and the field of vision are normal, I pass a stop-knife through the cicatrix, or one millimetre below it, if the pupil has not been drawn too much upwards. I do not here confine myself to simply making a button-hole slit, but incising the cornea and aiding the escape of the aqueous humour by slight pressure, I enter the whole breadth of my instrument under the iris, and the subjacent cataractous masses. Dividing at once the cornea, the iris and the secondary cataract, I push the knife in a direction parallel to the iris, so as not to go too deeply into the vitreous, but rather to make the opening in the iris close to the inner lip of the corneal wound. By this, the introduction of the scissor forceps is greatly facilitated. I then pass in the blades of the blunt scissor forceps, make two incisions, directed from either angle of the wound, and converging towards the lower margin of the cornea. By this V-shaped section a triangle is formed, the base of which is represented by the transverse section in the iris made by the knife. The triangle is thus completely isolated. A portion of cataract the size of the triangle itself, adheres to it, and is drawn out with ordinary forceps.

In this way a perfectly black pupil may be obtained without the iris undergoing any dangerous traction or without any loss of vitreous humour. The assistant must carefully protect the eye against pressure from the eyelids by bearing these up from the globe with the speculum. This latter should not be screwed tightly, so that, if necessary, it may be removed at any moment during the operation.

Some of you may remember an old lady of 78, whose left eye was operated on by a small peripheral flap with iridectomy, and her right by a peripheral flap without iridectomy. In both eyes, and without the operations having been in any way peculiar, symptoms of iritis appeared on the fifth day. These symptoms, in spite of treatment, which in truth was necessarily mild on account of the weakness of the patient, finally terminated in occlusion of both pupils. An attempt at iritomy failed likewise in both. But as the patient could not consent to remain blind all her days, I proposed another operation on the right eye. I removed a triangular flap, according to the above plan, and was fortunate enough to obtain a large central pupil, which restored one sixteenth of vision, and enabled the patient to guide herself with ease.

The above combination of iritomy with iridectomy had already been proposed by *Mr. Bowman.* This eminent oculist used for this purpose very fine ordinary scissors, and proceeded as follows. He passed a small stop-knife perpendicularly to the horizontal diameter of the cornea, and at the middle of the external and internal halves respectively. The instrument traversed the cornea, the iris, and the secondary cataract directly. He then introduced the scissors through the external wound, and cut at right-angles to the ends of the sections already made in the iris, thus dividing off a square flap, free on all sides and centrally situated, which could be removed with the forceps.

Doubtless in making two incisions through the cornea, and in sinking the point of the knife deeply into the vitreous, there is the risk, where this is fluid, of causing such a relaxation in the tension of the eye, that it becomes very difficult to make the necessary incisions with the scissors. Moreover, the reaction which follows such wounds cannot but be considerable. But by directing the stop-knife carefully only once under the iris, and then passing in the blunt blades of the scissor forceps, it will be quite possible to perform the operation correctly, and avoid all excessive reaction.

I can point to other cases like the one I mentioned above, where this combination of two operations has succeeded in restoring a moiety of sight, but where neither iritomy alone, and much less iridectomy, would have produced any improvement. Therefore I maintain that in this matter, ocular therapeutics have made undoubted progress.

Before taking leave of the affections of the crystalline lens, I must linger a few moments over the many modifications, proposed of late years, with the hope of perfecting the operation of extraction.

The earliest improvement consisted in the adoption of a flap approaching the type of the small flap 2 millimetres in height, and in abandoning the territory of the sclerotic, and keeping strictly within the limits of the cornea. The sclerotic itself is ill adapted for accurate cicatrisation, and owing to the active filtration that takes place through its tissues may give rise to cystoid cicatrices. It must also be borne in mind that strangulation of the iris and capsule, when occurring near the ciliary body, is more liable to induce partial detachment of this important structure, and sympathetic irritation. The risk of transmission of inflammation is incontestably greater in cases where, following *Von Graefe*, an effort has been made to obtain the maximum of linearity, than in those where, as in the old-fashioned flap incisions, a certain distance from the corneal margin has been maintained. Nevertheless, in these operations strangulation of the iris, in consequence of prolapse, used to be common enough. The ciliary body, however, was not dragged on so directly, and the danger of strangulation of the capsule, when the iris was not interfered with, was much less.

The greater regularity with which a small flap heals, and the diminished risk of sympathy, are recognised facts which must always prevent any return to incisions in the dangerous region of the ciliary body, and the zone of pericorneal filtration. What is not sufficiently guarded against is allowing the section to fall within the cornea itself. When just now I recommended placing the summit of the flap somewhat within the sclero-corneal border, so as to graze but not detach the conjunctival limbus, it was chiefly to avoid entanglement of the capsule, and to secure favourable conditions for extracting its anterior portion. In the future possibly some instrument may be devised better than a cystitome for drawing forth the anterior leaf of capsule. If this could be done, a cure would be much simplified, and the formation of troublesome opacities rendered impossible.

With the object of avoiding strangulation of the capsule, and to render extraction not more severe than iridectomy, *Knapp* has proposed a method of opening the capsule analogous to what I have described in cases of capsulo-lenticular cataract (p. 315). He proposes to make a button-hole incision in the capsule, extending along the whole length of the wound, and the artificial pupil, either with an ordinary cystitome, or with a specially constructed sickle-shaped needle. This manœuvre is to be aided by slight pressure with the fixation forceps, the effect of which would be to urge the cataract towards the corneal incision. Nothing is easier than to execute this in practice; but experience only can enable us to judge whether the rapidity with which the wound would heal in the capsule, might not be obtained at the price of a much greater number of secondary cataracts. I must now revert to some other modifications that have been made in the corneal section.

To bring down the summit of the section still more below the conjunctival limbus, does not entail any serious difficulties, as regards the exit of the lens, but nevertheless has certain drawbacks. These are, that the iris cannot be removed up to its insertion, and if the spatula is not used to replace it, there is the risk of adhesion between the portion remaining behind, and the iritic angle, or of a bad fistulous cicatrix. By the employment of eserine, and the spatula, so as to bring the iris into proper position, this danger may be avoided. But it again becomes greater when the upper portion of the section is withdrawn from the margin of the cornea, and brought more towards its centre with the view of avoiding the necessity of iridectomy.

The incisions advocated by *Lebrun* and *Liebreich* are faulty in another direction. They necessitate a more complex mechanism as regards the exit of the cataract, and one whereby a voluminous lens would have to execute more of a turning movement. Besides this, the cleansing of the portion of capsule underneath the healthy iris, and between the summit of the section, and the margin of the corneal, is rendered considerably more difficult. However, no one will deny that where an eye with normal tension has a small nuclear cataract, and a soft cortical substance, easily separable from the capsule, sections such as these may afford a ready exit to the lens, may admit of the pupil being readily cleared, and may be conducive to a rapid recovery. But this also is beyond doubt, that while in a limited number of cases they may give brilliant results, they expose the majority to very serious dangers. Therefore they have never succeeded as yet in obtaining recognition as methods to be generally adopted, though easy of execution, and dispensing with the necessity of a speculum or any instrument of fixation.

I will not dwell on the transverse incisions in the upper third (*Notta*), or through the centre of the cornea (*Tavignol, Küchler*). All such operations violate the mechanical principles which should guide the hand of the operator in removal of the lens. No good cataract operation should affect any portions of the cornea, which are ultimately to serve for visual purposes, nor leave any traces of cicatrisation, either as opacities or as alterations of its curvature.

From this point of view, therefore, a limit exists as regards the section, which no good operator will transgress.

A further effort has been made in the direction of avoiding, if possible, the necessity of iridectomy in the small flap extraction. If this could be accomplished, an eye need not, in extraction, be incised more than to the extent of the simple section required to afford a passage to the lens. It is now three years since I communicated to the Academy of Sciences an operation by which I proposed to extend the small flap downwards for a distance of 2 millimetres on each side, giving it thus a depth of 4 millimetres, and leaving the iris intact. I thus hoped to modify the old proceeding of Daviel, by bringing the incision more towards the border of the cornea, thereby obtaining a section intermediate between the linear and the flap. Moreover, I included in this operation the use of eserine, and the reduction and smoothening of the iris by the caoutchouc spatula.

Subsequently, having made this section downwards, I lessened the difficulties of the operation, and was finally able to abandon the speculum, and all instruments of fixation, as soon as the counterpuncture had been made. This peripheral flap extraction has no claim to be adapted to all cases. I reserve it myself exclusively for hard, perfectly ripe cataracts, which are even somewhat retrogressive, without having become capsulo-lenticular. Also I prefer, if possible, eyes with slightly decreased tension, where the lens can be removed as a whole, and where the iris, when drawn out, will re-enter readily by its inherent power of contraction stimulated by eserine.

I have often taken occasion to show you some of the results of the above operations, in which the most careful inspection cannot discover the least trace of the cicatrix, which is lost in the sclero-corneal border. However brilliant such a result may be, I have not by any means given up the small combined flap extraction. It is both easier in execution, and where soft cortical masses are present, which separate readily from the nucleus, permits of the pupil being much more thoroughly cleared. But in very many cases I can scarcely say I regret having to remove a small portion of iris close to the sphincter, as thereby I obtain greater security against strangulation, and this especially in cases where comparatively little attention can be given to the patient.

So far then from wishing to advocate my method as one for general adoption, I reserve it exclusively for cases of perfectly simple and ripe cataract. I recommend it as complementary in some sort to the small peripheral flap, combined with iridectomy, and as being applicable in certain selected cases, in which we may not wish to be guided by mere routine in the performance or not of iridectomy. I look on the following as some of the advantages gained by this tentative effort on my part; namely, (1) the freer employment of eserine; (2) the method of replacing and levelling the iris with the caoutchouc spatula, and (3) the reduction of the capsule in all cases where it has been found impossible to extract it. All these points I learned during the time I practised the peripheral flap extraction without iridectomy. If the hope I once cherished of being able to render the method a general one, and to abandon the combined operation completely, has been disappointed, and if experience has shown that such cases only as are suited to large incisions and the preservation of a natural pupil should be selected for the operation, it is nevertheless to this attempt that I owe all the improvements above mentioned. This is my consolation for not having reached the goal I had looked towards at the outset.

As my object in these lectures is not merely to tell you what has been done in the past, in the way of improvement, but also of the efforts that are being made in the same direction in the present, I cannot pass unnoticed certain attempts which are still being made to remove the lens in its capsule. As I have myself operated on many cases by this method, I am in a position to give an opinion based on facts and not on mere theory. These operations have been many times taken up and as many times abandoned. At the present moment they are championed by no one except the brothers *Pagenstecher*. I will describe the manner in which these gentlemen tell us the operation should be performed, and I think you will agree with me that it violates all the rules which have been laid down for guidance in extraction operation. These are: in operating avoid all roughness or violence; be careful not to displace the pupil, or to enlarge it without some adequate object; do not rupture the zonula, and limit the wound to the parts anterior to the diaphragm marked off by the zonula.

Having opened the lids *as widely as possible* by means of a speculum fitting each eye differently, and having fixed the globe firmly near the lower border of the cornea, Von Graefe's section, with a conjunctival flap, is to be made in such a way that the centre of the wound shall be exactly above the point of fixation. The operator then removes a *large* piece of iris, "*passing*, so to say, with the blades of his scissors *well* into the angles of the wound." This is absolutely necessary in order to avoid as far as possible strangulation of the iris. This, however, will be a difficult matter to prevent, for all attempts at reduction become abortive once the hyaloid membrane has been broken into. This accident nearly always accompanies removal of the lens, but does not necessarily result in a loss of vitreous. The lens is then made to engage the wound by depressing the lower edge of the incision with a flat curette, and by "simultaneously rotating the eyeball strongly downwards." Very often the lens will not present in the wound, and then it becomes necessary to glide a flat curette behind it, "until the edge of this catches in the inferior border of the lens."

Even though all these steps may have been exactly performed, in 21·7 per cent., according to the statement of *M. Pagenstecher* himself, the attempt to extract the lens in its capsule will fail. In other words, in one patient out of every five, large cortical masses, very difficult to remove after rupture of the zonula, will to a certainty be left behind. In over two-thirds of the total cases a more or less considerable loss of vitreous will take place. As regards the final results there are from 5 to 7 per cent. of absolute losses, and perhaps 20 per cent. where the patients only recover sight sufficiently to count fingers at a distance of from one to two feet. In all this there is not much that is encouraging; the less so as the total losses where the procedure fails, amounts to 14 per cent., statistics very similar to those of the old extraction of Daviel.

This operation cannot be recommended, because in the first place it leaves the operator in uncertainty as to whether he has succeeded in performing the operation at all; secondly, because it tends more or less to cause opacities in the vitreous humour; and thirdly, and perhaps chiefly, because of the bad prognosis it affords as regards eventual detachment of the retina from loss of vitreous. If you read the monograph of *Pagenstecher* on the operation, you will at least mete out this praise to him, that by his sincerity and truthfulness he has certainly warned off all inexperienced persons who might propose to adopt such a method of extracting a cataract.

The chief indication for the operation is the fact that the capsule tends to become detached from the zonula. This tendency is exhibited by cataracts in which there is a capsulo-lenticular opacity, and in which the capsule is wrinkled and shrunken.

Here, however, I think a much better result would be obtainable by a second operation for the removal of the capsule (p. 315). There is another set of cases in which the lens is feebly attached to its suspensory ligament, those, namely, in which the capsule has not parted with the water which permeated it while the cortical masses were undergoing softening. Morgagnian cataracts offer, it is true, a certain difficulty as regards the removal of the small nucleus they enclose (*Martin* of Cognac), more especially if the capsule has not been torn along its whole equator by a rapid stroke of the cystitome. But even though the nucleus be easily displaced, a skilful operator will bear the fact in mind, and will be able to place the cataract at an angle to the incision such that gentle pressure will cause it to escape. You have not, with me, seen any accidents happen to the vitreous humour in such cases. It is, however, always liable to be lost in variable quantities, when, as in the case which has just been discharged from the wards, the Morgagnian cataract has a capsule of considerable thickness (*cataracta bursata*), and when this pouch is pressed out through a half-opened wound.

DISEASES OF THE VITREOUS HUMOUR.

LECTURE XXXIII.

ANATOMY; HYALITIS; OPACITIES OF THE VITREOUS HUMOUR; FOREIGN BODIES.

When giving some details regarding the suspensory ligament of the lens (p. 280), I stated that the zonula, from an embryological point of view, must be regarded as a portion of the vitreous humour. It is, in reality, neither more nor less than a continuation of the ciliary portion of the hyaloid membrane, which passes over the whole anterior surface of the retina, and was long described as its internal limiting layer. The gelatinous mass of vitreous is in direct contact with the posterior capsule, which embryologically represents the envelope of the vitreous.

Near the border of the lens, this gelatinous substance separates somewhat from the lens and zonula, leaving a space filled with fluid known as the *canal of Petit*. This is bounded in front by the zonula, internally by the edge of the lens, behind by the tissue proper of the vitreous. It finally becomes capillary in size, and is lost near the *ora serrata*, where it and the ciliary portion of the hyaloid membrane cease. By small openings in the radiating folds of the zonula, it communicates with the fluid behind the iris, or the posterior chamber.

Except for the striæ and folds in the anterior portion, which constitute the zonula, the hyaline membrane is perfectly homogeneous and smooth. Towards the retina, this uniform aspect is broken only by the insertions of numerous radiating fibres, which go to support that membrane. On the other hand, on its internal aspect, where the hyaline substance rests, there are numerous small flat cells, with nuclei surrounded by protoplasm, the contents of which are merged in the surrounding diaphanous substance (*Schwalbe, Ciaccio*). The distribution of these sub-hyaloid cells is very uncertain, which is sufficiently accounted for by their amœboid movements, and their origin. They are, according to *M. Schwalbe*, white corpuscles, moving over the membrane surrounding the vitreous, and were at one time considered to be the hyaloid epithelium. They are derived from the vessels of the vitreous humour and papilla.

Enclosed within this hyaline envelope is the mass of the vitreous humour. It increases in density towards its external surface; eventually it becomes more fluid, and is traversed by a canal with membranous walls. In man, the more resistant portion of the vitreous is formed of concentric and superimposed layers; while the more fluid nucleus is divided into segments, which radiate from the canal as from a central axis.

Although numerous attempts have been made to discover, between the gelatinous stroma and the nutritive fluid traversing it, any actual septum, they have all heretofore failed; it is probable that there exists here an arrangement similar to what obtains in the corneal cement and the lymphatic spaces. The cement has hardened into a channel around the lymph current, but no distinct wall can be demonstrated. In place of a resisting tissue, we have in the vitreous a gelatinous substance, and this renders the study of its relations, with the lymphatics passing through it, a matter of much difficulty.

In the centre of the vitreous nothing exists save a hyaloid canal, containing a limpid fluid, and traversing the stroma from the papilla to the posterior capsule (*Stilling*). This canal places the lymphatics of the anterior portion of the vitreous in communication with those of the optic nerve (*Schwalbe*). In the fœtus, it contains the hyaloid artery. When this vessel has become obliterated, it is not unreasonable to suppose that a passage may remain communicating with the space surrounding the lens, and hence that it might be possible as *M. Michel* has done in the pig, to inject the hyaloid canal from the canal of *Petit*.

While the embryonic vitreous contains abundance of cells, these are very rarely met with in the stroma once it has arrived at maturity. The same applies to those few and very delicate fibres, which are found nowhere except close to the *ora serrata*, and which go to strengthen those of the zonula. The cells that may be observed in a perfectly healthy adult vitreous are exceedingly few; they represent the various forms of amœboid cells, which change their appearances, simulating cells of different varieties.

They are all leucocytes which have imbibed fluid in their passage through the gelatinous vitreous, and having been subjected to pressure exhibit prolongations and dilatations. The separation of small rounded fragments derived from the protoplasm, and detached from the filiform prolongations of the leucocytes will very much complicate their study, unless the mechanism which presides over these changes of form be thoroughly appreciated.

Their various stages have been successfully followed by first colouring the blood, and then observing how the leucocytes, charged with the colouring matter, on their passage through the vitreous, underwent the transformations which give them the appearance of plexuses of stellate cells, with processes intertwined.

What place must we assign to the vitreous humour among the tissues, and how does it differ from the stroma of the cornea? The vitreous humour is a cellular tissue, without an endothelium. It is distinguished, however, from the cornea by other characters. Whilst in the cornea it was possible to isolate and recognise the component fibrillæ and cement, in the vitreous these are lost under the form of a gelatinous mass. The cement shows here so little consistence, that by its very fluidity it may be confounded with the nutritive lymph, which circulates through a medium which offers scarcely an obstacle to its progress.

It is a question, in the case of inflammation of the cornea, whether the fixed cells of the endothelium may not be capable of bearing some part in the inflammatory process (p. 106). In the case of the vitreous no such supposition is possible, seeing that an endothelium is wanting; hence inflammation there can only be considered as an intensifying of the normal phenomena of nutrition. Facts here show unmistakably that cellular immigration is very limited in conditions of normal nutrition, while in hyalitis it is pushed to such an extent that the whole vitreous is little more than a mass of leucocytes—in a word, an abscess.

The vitreous humour is perhaps the region of all others in which the effects of inflammation are seen most clearly; for the cell invasion is there not masked by the presence of any tissues undergoing destruction. The watery cement is there rapidly absorbed, while the *débris* of the fibrillæ destroyed by the immigration is quite insignificant.

I recognise three forms of *hyalitis*, or inflammation of the vitreous humour. According to the intensity of the inflammation, the affection may end either in *liquefaction*, *condensation*, or *suppuration*. The feature common to all these three inflammations is the same as witnessed in corneal inflammations—namely, the loss of absolute transparency, or in other words, the apparition of opacities.

Simple *liquefaction* of the vitreous humour or *serous hyalitis*, represents the mildest form of inflammation. It is met with most frequently in conjunction with chronic maladies of the uveal tract, especially with atrophic choroiditis from tension (progressive posterior staphyloma). *Condensation* of the vitreous humour is found in cases where, owing to prolonged irritation of the choroid, an immigration on a larger scale than in the preceding form has taken place. This has resulted subsequently in organisation of the amœboid elements, and the formation of tissue with a peculiar tendency to contract. *Suppurative* hyalitis is the acute and most severe form. The whole or a portion of the vitreous is transformed into a regular abscess, the tissue proper becoming absorbed and rapidly yielding before the invasion of leucocytes.

The study of the different forms of hyalitis is rendered very difficult by the fact that it is almost impossible to distinguish between cases in which the irritation has been transmitted from the choroid, and those in which it is due to some lesion of the vitreous itself, such as a foreign body. But as the treatment forms a part of that already discussed, when speaking of the various inflammations of the choroid, I need not delay longer over it now.

Solitary *opacities* of the vitreous, which have no apparent connection with alterations in the choroid, demand attention for a moment. Although we are accustomed when we see any cloudiness in the vitreous to attribute it to some affection of the choroid, unless it be the direct consequence of a foreign body, we are not always warranted in so doing. I have become convinced that hæmorrhagic effusions often arise from the papilla, and that extravasations of blood, which have taken place between the sheaths in the lymphatic spaces, may quickly spread to the vitreous humour, and, following the hyaloid canal, arrive eventually even at the posterior surface of the crystalline lens.

Pathologically there are two varieties of opacities; those namely which result from cell immigration, and those which result from destruction of the stroma itself. In the former must be included suppuration and hæmorrhage into the vitreous; in the latter those opacities which appear instantaneously around a foreign body, an air vesicle, and the crystallised matter met with after liquefaction (chronic serous hyalitis).

As to clinical symptoms I have to speak of, (1) *dust*, (2) of *filaments* and *flakes*, (3) and of *membranes* in the vitreous humour.

The *dust* of the *vitreous* has its origin in cell migration. This may be such, that the leucocytes escape in great abundance from the choroid, but chiefly from the ciliary body, and carry along with them molecules of pigment. It may also be due to breaking down of the stroma. I insisted at some length on the treatment of this characteristic alteration which accompanies specific choroido-retinitis, when speaking of that affection (p. 233). The rapidity with which this dust is absorbed and again reproduced, pleads in favour of an amœboid origin; while on the other hand, its quick movements in response to those of the eye, show plainly enough that the gelatinous stroma must have undergone a considerable degree of liquefaction.

2. *Filiform* and *flake-like opacities* are found either in the anterior portion of the vitreous, or in the neighbourhood of the papilla. They are frequently met with in certain varieties of choroiditis. If they appear suddenly in a healthy eye, there will not be much risk of error if you attribute them to vascular ruptures. These, in opacities of the anterior portion of the vitreous, will be due to choroidal hæmorrhages; in the posterior to hæmorrhage from the papilla itself, or to extravasations into the sheath of the optic nerve. I am convinced, as I have already said, that the whole vitreous may be invaded by hæmorrhage from the sheaths of the nerve. Frequent extravasations may induce a peculiar change, and render the vitreous not unlike a congeries of gelatinous and flaky opacities, which the elder *Desmarres* characterised with much truth as an "état jumenteux." Whilst occasional extravasations are absorbed sometimes with astonishing rapidity, these oft-repeated effusions become a most troublesome affection, and one very rebellious to treatment.

As regards solitary extravasations, I held, at one time, that their absorption was somewhat tardy; of late, however, I have been enabled to witness how, in young subjects, they may disappear with marvellous rapidity. Not long ago, I had occasion to examine a medical student, who, while travelling during warm weather from the south of France to Paris, suddenly found his left eye growing dim. Examination with the ophthalmoscope showed abundant extravasation into the vitreous; the effused blood came so close to the lens, that it could be seen with oblique illumination. The patient informed me that a similar obscuration had once before taken place in his eyes, but had disappeared within a few weeks. In spite, however, of what he then told me, I was none the less surprised to find, some fifteen days later, that the media were to all appearance perfectly clear.

The "état jumenteux" (fleecy condition) which is not uncommon in women with uterine complaints, or in those who have arrived at the climacteric period, is essentially chronic in its course, remitting at times during summer only to become aggravated during winter. Serious complications may supervene from it, such as detachment of the retina; while at times the whole vitreous may be filled with opacities so dense, that even without the complication above mentioned, the perception of light will be very sensibly reduced.

The most efficacious mode of treatment is, without doubt, one into which very active perspiration and salivation enters, such for instance as is induced by injections of pilocarpine (p. 123). These, it is true, must be employed for a very considerable time before any satisfactory results will be obtained. For, if solitary extravasations may be rapidly absorbed, this is no longer the case with repeated effusions of blood in persons of a certain age. Perseverance in treatment in such cases will bear good fruit, and I may add, that I have never seen any serious inconvenience result from a long-continued use of these injections.

I can show you a lady, aged thirty, who came to me with such cloudiness in both vitreous humours, that it was impossible to see the fundus of either eye. A very able oculist had actually diagnosed detachment of the retina in the left eye, which was the worse of the two. The patient could only, with the right eye, count fingers at the distance of two metres; with the left there was barely perception of light. A few isolated synechiæ showed that the uveal tract shared in the affection. During a whole year, except at the catamenial periods, this patient received a daily injection of four drops of a ten per cent. solution of pilocarpine. In addition to this she took from two to three grammes of iodide of potassium daily, and kept a large blister open on the back of her neck by means of cantharidine (p. 184). The result of this treatment, energetically and conscientiously carried out, and which at the beginning I supplemented by six applications of Heurteloup's artificial leech, was that, in the right eye the vitreous recovered its transparency sufficiently to allow the patient to read No. 1 of my test types; while with the left eye No. 3 could be read easily. Inspection of the vitreous still showed slight opacities, but I was able to assert that there was no detachment of the retina, nor any palpable lesion of the choroid.

Together with injections I prescribe two or three times a day, a one per cent. collyrium of pilocarpine, unless there are adhesions of the iris. I also give diuretics. Courses of milk, and Wildungen waters, are also excellent remedies. In cases where there is reason to fear detachment, the compress bandage must be worn for a long time and absolute rest in a darkened room insisted on.

Of late years the use of continuous currents has been extolled as a means of causing absorption of such effusions. The currents may be employed in two different ways. Thus, twice or thrice daily, a current from an eight or ten cell battery may be directed centrifugally through the eye (*Onimus*), the negative electrode being on the closed lids, the positive on the back of the neck (superior cervical ganglion), or on the mastoid process. According to *M. Onimus*, a centripetal current would be developed were the electrodes to be transposed.

Secondly, it has been recommended to transmit very feeble continuous currents at night through the temples, from a *Trouvé's* battery of two or three cells, by means of discs of metal secured by a bandage. The instrument is placed either by the side of or in the bed. Patients soon become accustomed to these continuous currents.

It will not do in judging of the results of this treatment to draw conclusions from results obtained only with very young patients. In such cases large effusions may, as we have seen, be absorbed at times spontaneously. In obstinate cases I am not as yet convinced of the efficacy of the above treatment. I should remind you, that currents of a certain strength (ten cells) may aggravate an existing state, by inducing symptoms of irritation about the iris, and causing precipitates on the membrane of Descemet. If therefore it still remains to be proved that such currents are serviceable, it must not be taken for granted that they are perfectly innocuous.

3. *Membranous opacities* often appear as one of the sequelæ of severe fevers, and of exudative choroido-retinitis, and have lately been described improperly as proliferating retinitis. In these cases these membranes are raised up like a tent in front of the papilla, and their prolongations spread over the surface of the retina, following the course of the great vessels.

Very fine *membranous opacities* are also found in certain forms of choroiditis, where the progressive posterior staphyloma, is complicated with true sclerectasia. The opacities are apparently due to rupture and contraction of the hyaloid canal. Finally, these membranes are seen forming as it were a septum in the vitreous humour, and rapidly producing atrophy of the nerve, with sudden and complete blindness. The blood has in these cases made its way from the papilla into the vitreous humour, after being effused into the sheaths of the optic nerve. Such membranes sometimes assume an appearance like the extended wings of a butterfly.

It can hardly be expected that any treatment however active will induce resolution of actually organised masses. Nevertheless, Von Graefe's attempt to tear such masses with a needle deserves to be mentioned. In his case the patient was only sixteen years of age, and it becomes now a question of how far the opacities would have been removed spontaneously. Operations of this nature are rendered very difficult by the fact that, owing to the excessive reduction in the transparency of the vitreous, the position of the opacities cannot be fixed accurately, unless they are situated close to the posterior surface of the lens, and visible by oblique illumination. When this is not the case the difficulty of ophthalmoscopic examination compels us as a rule to undertake the operation of laceration without the aid of the mirror. It must be performed after very careful previous examination, step by step, by entering a needle close to the equator of the eye, and making the laceration in the direction of the posterior pole.

I shall only mention in passing certain forms of liquefaction of the vitreous humour occasionally met with, under the form of *simple synchesis* and *sparkling synchesis.* Here crystals of cholesterine or tyrosine float in the fluid humour. These conditions require no special treatment. The presence of *foreign bodies* claims a moment's consideration. They may be seen plainly when they are in the immediate neighbourhood of the lens, if the examination has been made shortly after the accident, and if the substance itself is of such a nature as not to undergo change or decomposition (for instance a morsel of capsule), and thereby set up irritation in its own immediate neighbourhood. It must be borne in mind that the injury inflicted on the vitreous is very often not limited to the tract lying between the point of entrance and the foreign body itself. The latter may have come to occupy its position after having *ricochéed* from another spot (*Berlin*). Therefore, the amount of injury inflicted may really be much greater than appears at first probable. Moreover, symptoms of reaction supervene with such rapidity, that they cannot, in experiments on animals, be followed or watched for any considerable time.

Should the inflammatory reaction not be violent enough to lead directly to hyalitis and suppurative choroiditis, two other modes of termination are possible. The most desirable of the two is that in which the symptoms assume the form of chronic hyalitis, with a tendency to organisation and condensation of tissue round the foreign body, by which it becomes encysted. The leucocytes which form the cellular masses, generally migrate from the anterior and most vascular portion of the choroid in the track of the foreign body. Along the whole of this track cellular tissue is equally developed, so that eventually a kind of cord passes from the point of entrance to the foreign body, becoming, where this latter is heavy (for instance a grain of shot), a kind of suspensory ligament, which prevents further displacement when the vitreous later on becomes fluid.

It is, however, far more common to find an accumulation of leucocytes around the foreign substance. These enclose it in a circumscribed abscess. This may not at first seem to endanger the existence of the eye, so slight are the symptoms of irritation. It is only when these slight symptoms are apparently about to disappear that a sudden and alarming change takes place, which menaces destruction both to vision and to the very existence of the eye as an organ. These circumscribed abscesses as they are absorbed contract, their walls fall in, and the result is detachment of the vitreous humour and retina at points distant from the original wound. This is followed by chronic iridochoroiditis, general opacities of the crystalline, etc., in a word, by partial atrophy of the globe, which may continue tender to the touch, and thus become a source of the greatest danger to its fellow.

As I have already said, it is rarely possible to fix the exact position of a foreign body owing to the inflammatory disturbances it produces so rapidly. One exception must, however, be made as regards this, namely, the entrance of a *cysticercus*, which may be seen attaching itself, changing its position, and imbibing nourishment, until it comes to act like any other foreign substance. The only mistake that could possibly be made in such a case would be that of taking the entozoon for a partial detachment of the retina. This may be avoided by noticing the peculiar mobility of the vesicle, which exhibits true peristaltic action at intervals, moving its neck and head, armed with four suckers—that is, when these movements are not hindered by the opacities developed in their immediate neighbourhood. In addition to the motion, the peculiar coloration of this spherical body should serve to attract attention. The prismatic hues and the bright red stripe round its edges will distinguish it at once from partial detachment of the retina.

I need not spend more time on this subject, which is perhaps all the less important to us, as in France such an affection will not be met with once among fifty or sixty thousand patients. In those countries, however, where raw meat and raw food generally, enters largely into the diet of the people, they may be met with as often as once in every thousand cases (*Von Graefe*). In France the cysticercus has been removed only thrice from the vitreous (*Sichel, jun., Landolt*), and one of the cases occurred at this *clinique*.

The prognosis in cases where foreign bodies have penetrated to the interior of the eye is of the gloomiest. It may indeed be said that out of four patients three are doomed to certain loss of the organ; whilst in the fourth, the foreign body becoming encysted, may perhaps allow of the preservation of a certain amount of sight, or at least of the shape of the globe. One might be tempted from the printed records of such cases to attempt the removal of the foreign body; but these notices have been published with undue haste, and without the least reference to the results of the operation some two or three years afterwards. It is no doubt true that operations in the vitreous humour may at the outset appear to yield very brilliant results, but in the long run the very reverse is the case, and this in proportion to the quantity of vitreous lost during the extraction. The necessary wounds in the cornea or sclerotic heal up well, but as regards the vitreous itself, the contraction it undergoes, and the influence it exerts on the retina, and on the nutrition of the lens, very often give only temporary respite from the hard necessity of enucleation. This is called for to relieve the patient from an eye, which as time goes on, forms a nidus of unceasing irritation.

As a general rule, extraction should not be undertaken unless the foreign body is in the immediate vicinity of the lens, and unless by means of oblique illumination or of a laryngeal mirror fixed on the forehead, the movements of the instruments within the eye can be followed.

Two methods of operation are open to choice, namely, to perform the extraction through the cornea, or through the sclerotic. By the corneal method, the foreign body is extracted at one sitting, together with the lens. The crystalline may, if preferred, first of all be removed, and, when cicatrisation is complete, the foreign body afterwards through another opening.

It is plain that the more promptly we act when we have to do with all these accumulated wounds, the better the chance of success will be. For if we attempt to separate by an interval the iridectomy and extraction of the lens from that of the foreign body, the symptoms occasioned by the latter will in the meantime become worse, and all hope of saving any sight will diminish proportionably.

The second plan of operation is to make an incision in the sclerotic behind the ciliary body, and extract the foreign substance with the help of the mirror. The properties of the magnet have been utilised in the extraction of fragments of iron. The best course will have been taken when the section has been made so close to the foreign body—the position of which has previously been determined by the ophthalmoscope—as to enable it to be carried out of the eye by the first rush of vitreous. The necessity for introducing any instrument will thus have been avoided. With all instruments, even when the mirror is used, it is necessary to grope one's way more or less, owing to the difficulty of estimating the extent and depth of the movements made. This is owing to the degree in which such movements are magnified within the eye. Moreover, I think that, had the operators published the final results of their efforts at extraction, allowing an interval of two or three years to pass away, the temptation to imitate such attempts would be considerably diminished.

DISEASES OF THE RETINA.

LECTURE XXXIV.

ANATOMY; HYPERÆMIA OF THE RETINA; ANÆMIA; EMBOLISM OF THE ARTERIA CENTRALIS RETINÆ.

In a course of lectures on therapeutics a detailed account of such a complex structure as the retina can scarcely find a place. Nevertheless, it seems to me indispensable that you should have clearly before you the parts which in this important membrane of the eye belong more properly to the cellular frame, or to the sensory and conducting nerve elements. It is only by having always present to your minds the exact position of the neuro-epithelial and cerebral layers, as also the points in which the cellular tissue centres, that you will be able to analyse, as it were, the microscopical image of a diseased retina, to forecast the issue, and to supervise the treatment.

You have in fig. 22 a method of demonstration borrowed from *Merkel*, which appears to me highly practical. It will enable you to appreciate at a glance, what portion belongs to the nervous substance and what to the cellular tissue grouped round it. In this preparation the nerve elements are coloured red, the cellular tissue black. Commencing from the hyaline membrane of the vitreous body, the layers of the retina are in order as follows:—1. The layer of nervous fibres (*f, n*); 2. The ganglionic layer (*c, gl*); 3. The internal molecular layer (*c, m, i*); 4. The internal granular layer (*c, g, i*); 5. The external molecular layer (*c, m, e*); 6. The external granular layer (*c, g, e*); 7. The external limiting layer (*L, e*); and 8. The layer of rods and cones (*Bt*). You will notice the fact, that in proportion as you recede from the hyaline membrane, and approach the ninth layer, that of the pigment epithelium cells, which is not here figured, the *cellular tissue* diminishes, whilst the *nervous substance* takes its place in an increasing ratio.

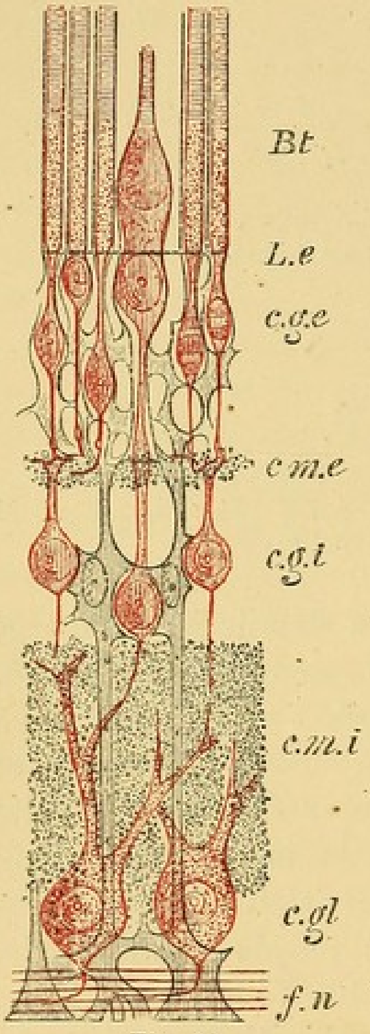

Fig. 22.

Secondly, your attention will be drawn to the existence of two kinds of cellular tissue, differing completely in structure and arrangement. A cellular framework, passes vertically through the retina, the fibres of which rest by a broad base on the hyaloid membrane. They traverse the numerous retinal layers, and having formed a lamina cribrosa, or external limiting membrane, end in the layer of rods and cones, which they surround, reproducing the arrangement found in all the tactile organs of sense.

On the other hand, there is a second portion of cellular tissue which spreads in layers parallel to the surface of the retina, and is interposed between the ganglionic layers, for as such we must consider the two granular layers.

The description of the retina will gain in simplicity if I at once proceed to consider those layers of cellular tissue, called molecular, one of which occupies a considerable space between the ganglionic and internal granular layers, while the other, situated between the two granular layers, is comparatively small. This arrangement is in accordance with the fact that the cellular tissue decreases in proportion to the proximity of the delicate tactile elements, the neuro-epithelial layers. While some anatomists have considered these layers as formed of molecules or granules, others have regarded them as forming a homogeneous mass, enclosing hollow spaces filled with a transparent substance. The latest work on this subject is that of *M. Kuhnt*, who had recourse to a very ingenious plan, namely, to allow sections of the retina, to which he had previously added pepsine, to digest under the microscope at a temperature of 40° C. This reagent digests the nerve elements, but leaves the cellular intact. The knowledge has thus been obtained, that these layers, as *M. Schulze* always maintained, are composed of extremely fine fibrillæ intercrossing in all directions, and reproducing in the retina the neuroglia of the optic nerve.

If we next examine the remaining portion of the cellular tissue, the supporting frame of the retina, it will be easy to comprehend the arrangement of the nervous structures. The radiating fibres, or fibres of Müller, as the section shows, rest against the hyaloid membrane, otherwise the membrana limitans interna, by a broad peduncle. The neighbouring pedunculi are juxtaposed to each other, so that if the envelope of the vitreous body be detached from the retina, the nervous membrane appears covered by a sort of reduplication of the hyaloid. From these pedunculi the radial fibres arise, and pass through the retina in a direction perpendicular to its surface. Even in the nervous layer, but still more markedly in the ganglionic, they exhibit a tendency to form leaflets, and to encircle the ganglia with these, which, according to *M. Schwalbe*, are the representatives of small endothelial cells. Arrived at the external molecular layer, the fibres of Müller again assume, before traversing it, their cylindrical outline. But in the layer immediately over the internal granular they become enlarged and spread out into nucleated endothelial cells. From these, as occurs so frequently with such endothelial elements (compare the cornea), little winglike prolongations insinuate themselves between the nerve elements, forming an actual supporting septum to the granules.

Towards the external surface of the granular layer the fibres appear once more with a cylindrical outline, and traverse this layer. Here the laminated arrangement of the fibres is once again repeated, but now for the last time. The leaflets unite towards the external surface of this layer, forming another continuous layer, which is only traversed by the ends of the rods and cones. This is the membrana limitans externa, and from these same leaflets arise the sheaths for the neuro-epithelial or tactile elements of the retina.

To recapitulate: towards the hyaline membrane the radial fibres, or fibres of support, widen their pedunculi and so strengthen this membrane; once arrived at the choroidal surface, they form the limitans externa, and support the sheaths of the tactile elements of the retina. During their passage through the retina, the fibres of Müller, as they traverse the ganglionic layers, break up into endothelial cells, but assume in the molecular layers the characters of solid stems of cellular tissue. Once close to the last ganglionic layer, namely, the external granular, they end by breaking up into endothelial cells, which eventually encircle the sensitive neuro-epithelium of the retina.

The *nerve tissue* must be followed from the fibres of the optic nerve, which have lost in their passage through the lamina cribrosa their myeline sheath. They spread themselves over the choroid, in a layer which is thinnest at the temporal and thickest at the nasal side, and is of medium thickness superiorly and inferiorly. It has not been proved that all the fibres end in a ganglionic cell in the ganglionic layer; a certain number of them, as they traverse the retina, may be distributed to it.

The *ganglionic layer* is met with almost over the whole of the retina as a single layer, the cells of which are massed together and superimposed one over the other near the macula. They are more widely separated as they approach the *ora serrata*. A perfectly limpid cement binds them together. At the inner (central) side of each ganglionic cell a fibre enters and passes out towards the periphery. This arrangement of ganglionic bipolar cells is well marked only about the macula (*Merkel*). Around the posterior pole of the eye are numerous processes springing from the periphery of such cells, which take an oblique direction as regards the surface of the retina; the peripheral offsets of the ganglions near the macula are all, without exception, radiated.

These offsets enter the *external molecular layer*. There it becomes impossible to follow them, and observers have only succeeded occasionally in establishing the passage of a peripheral ganglionic fibre, which after having passed through the molecular layer, terminates in a central prolongation of a granule of the internal granular layer.

The *internal granular layer* must be considered as a layer of small superimposed bipolar ganglion cells. The cells or granules composing this thick layer resemble ganglionic cells, the fine central prolongation of which cannot be traced into the internal molecular layer. The external prolongation is thicker and more apparent in proportion as the granule approaches the *external molecular layer*. Once in this layer the external prolongations of the granules subdivide in part, opening out like a fan, and passing to the granules of the superimposed layer, that is, the external granular.

In the *external granular layer* the fibres of the internal granular, which have penetrated unaltered, pass at once by a somewhat circuitous route to the cones. The fibres, which, opened out like a fan, can be followed only with the greatest difficulty. There is no doubt, however, that they do not terminate here, but are distributed to the granules and rods, and form a means of communication between them.

The sensory layer of the retina, that is to say, the layer of *rods* and *cones*, with the external granular, is called the *neuro-epithelial* layer. This must not be confused with the pigment epithelium, upon which it reposes. In this layer the cones and rods call for special notice. The cones are composed of tolerably thick fibres, which spring from the external molecular layer, and terminate close to the membrana limitans externa in a cone granule (*Merkel*). The thin portion of the cone, which consists of a nucleus and a protoplasmic substance, mingled with fibrillæ, is formed of small superimposed plates (*Schultze*). The rod, to which a fibre is attached, which is thin and long in proportion as the granule which it has taken up in its course is farther removed from the rod, is composed of two portions, namely, an external and an internal. The external alone is subdivided into thin superimposed scales, the internal is filled with protoplasm. This external portion differs only in one respect from the external portion of the cone, namely, by containing the retinal purple.

The *layer* of *epithelium* is composed of hexagonal cells, and lies between the anhistic membrane of the choroid and the retina proper. The cells have one, seldom two, nuclei and delicate prolongations, passing in for some distance between the sensory elements of the retina. The pigment is found in contact with the internal surface of this epithelial layer, but does not penetrate the cells, nor cover the prolongations over their whole extent.

To recapitulate: the arrangement of the nervous elements of the retina is such that a fibre leaving the most internal layer, and passing directly into the papilla, traverses three layers of ganglionic cells to reach the sensory elements. The most internal ganglionic layer is multipolar, the middle bipolar. As to the external, its ganglionic character is, as regards the cones, so far modified that the ganglion cells enter in part into the formation of the sensory element; as regards the rods, in a great number of them, a true ganglionic nucleated cell does not exist.

If the three ganglionic layers be considered as superimposed upon the conducting layer of nerve fibres, and divided off into pairs by the interposition of neuroglia, in the form of a molecular layer, the most external ganglionic layer forming a portion of the neuro-epithelial or sensory layer, we have only to remember that the various layers are supported by radiating fibres in order to bring to mind, on one hand, the distribution of the nervous and cellular tissues, on the other, the mode of succession of the various layers apparently so complicated.

Hyperæmia of the retina is recognised by an increase in size and length of the blood-vessels, which become thicker, more tortuous, and deeper in colour. This change in colour is due to the fact that as the lengthening of the vessels cannot be effected in one and the same plane, but must vary according to the thickness of the retina, the observer looks in places at a layer of vessels vertically. Therefore they appear deeper, or almost black in colour. Although this distension must necessarily bring many finer vessels which in a normal state were beyond the power of the mirror into view, the hyperæmia of the capillary layer cannot exercise much effect on the tint of the retina. The papilla alone will be affected by it, and will become of a somewhat duskier red. This, if the examination be not very carefully conducted, may lead to the supposition that the boundaries of the papilla are obscured.

In order to perceive these various conditions of hyperæmia of the disc, which vary considerably within physiological limits, it is necessary to employ the higher magnifying power which the direct method of examination affords. A moderate increase in the size of the image will enable you to see not only that the hyperæmia does not in any degree diminish the transparency of the tissue of the papilla, but that if its border seems effaced, this is owing to the absence of contrast. The examination will also show that where hyperæmia of the disc is due to some obstacle to the return of blood (passive congestion), the tint of the tissue is something more than merely diffused. In it there may be distinguished a reddish hue peculiar to the tissue proper, and another due to the apparition of numerous very fine branches radiating from a centre. In order, therefore, to be able to estimate hyperæmia, it is necessary to adapt your accommodation very accurately to the papilla. To do this, you must be able to use an ophthalmoscope, which permits of exactly correcting both your own refraction and that of the eye you are examining. You will perhaps allow me to give a few words of advice, which may possibly seem interested, as regards the choice of a refracting ophthalmoscope. Since *Loring*, *Cohn*, and myself recommended such instruments, the number of them has very largely increased. A stronger tendency is noticeable to adopt the simple disc-like mirror, which I was the first to advocate. The mirrors of *Loring* and *Knapp* are, with the exception of the lenses, identical with mine. There is another form of ophthalmoscope which, like that of *Landolt*, is based on the principle of a combination of different lenses and comprises a very numerous series of dioptrics, but it appears to me too complicated for ordinary practice. The small refracting ophthalmoscope (fig. 23),

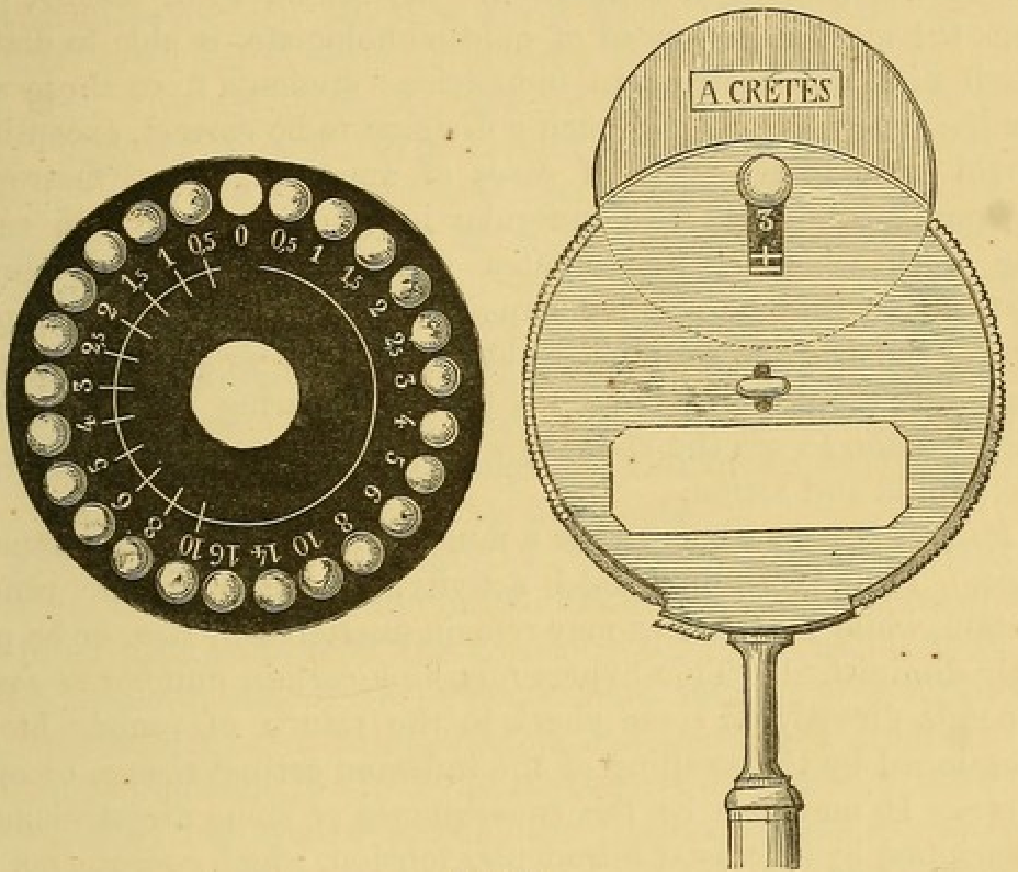

Fig. 23.

which gives a series of twenty-eight lenses, is extremely simple in construction and application. It is, moreover, lighter than the majority of such instruments, and so small that it can easily be worked close to the orbit and the eye of the patient, an important condition for the accurate control of refraction. This small ophthalmoscope, the lenses of which are quite large enough, and owing to the care taken in their manufacture are correctly centred, will answer every requirement of practice. Together with its very low price it has also, from the simplicity of its construction, the further advantage of keeping in repair, so that it lasts an indefinite time.

If the power of relaxing the accommodation be acquired, which it can be by practice with the upright image, it will be possible to draw an inference from the greater or less degree of repletion of the vessels. You should not be guided by the apparent size of the vessels, but by their diameters as compared with that of the disc, and by the relative size of the arteries and veins, compared with each other. An artery, in a normal condition, should not exceed two-thirds or three-fourths of the size of a vein.

Active hyperæmia is met with in every case where the eye is the seat of prolonged congestion. My friend Prof. *Jaeger*, perhaps the most experienced of ophthalmologists, is able to distinguish with this instrument industrious students from those who are the reverse. But, for such a division to be correct, exceptions would have to be made of cases of ametropia (hypermetropia, astigmatism, myopia with muscular insufficiency), for with such, any work whatever necessitates comparatively severe efforts. Hyperæmia may be studied experimentally by inducing congestion of the iris and conjunctiva by means of a drop of laudanum. You only require to examine a patient suffering from iritis and iridocyclitis, to see the changes which active congestion causes in the papilla and retina.

Passive hyperæmia presents a much more characteristic appearance. It induces increased activity, especially in the venous system, while the arteries may remain unaltered in size, or be possibly diminished. This hyperæmia, in a certain number of cases, depends directly on some check to the return of venous blood, occasioned by the swelling of the inflamed retinal tissue, or optic nerve. It may also be the consequence of some direct obstacle occasioned by increased intraocular tension, which compresses the veins at the point where they leave the eye, as is frequently seen in glaucomatous affections. It is well known that in those forms of heart disease which induce a state of general cyanosis, the obstacle to the circulation is felt in the retina, and affects the colour of the blood in the vessels. Anything which causes compression of the vessels within the orbit will produce a similar effect. I have recently shown you a patient affected with slight exophthalmos, in whom, for the last six months, all the external veins of the eye have exhibited very marked cirsoid dilatation. In such cases the veins may assume an almost varicose appearance. It is quite exceptional to meet with a case of congenital telangiectasis such as I have seen in the left eye of a boy of twelve years of age. In his case there was a plexus of large veins and arteries spread over the whole extent of the retina, with scarcely a vacant interval.

In describing the above morbid conditions, my object is not to advocate any special treatment in each affection. Such conditions are in reality signs of some more general malady; still, a knowledge of them is necessary for purposes of diagnosis, and may aid materially in determining your choice of therapeutic agents.

If, in his recent work, my friend *Von Jaeger* claims that the ophthalmoscope can be even more useful in general than in special medicine, it must be allowed that up to the present this has been a *pium desideratum*, and nothing more. In order to be able to pronounce whether a certain fulness or dilatation of the vessels exceeds the very liberal margin that physiology allows, demands a long practice. It is absolutely necessary to have mastered the refracting ophthalmoscope, to be able to control your accommodation accurately, and to know besides this the degree of magnifying power under which the fundus of the eye is being examined. In most cases a general practitioner cannot find the necessary time for studies such as these, which are even sometimes too much slighted by specialists.

I shall now speak of a condition the exact reverse of hyperæmia. *Anæmia* or *ischæmia* of the retina, when it is not the consequence of direct compression of the vessels in the optic nerve, or in the orbit, is the result of an excessive and prolonged condition of general anæmia. I must remark, however, that chlorosis has but little tendency to affect the calibre of the vessels or the colour of the disc, and this because of the constant point at which the intraocular tension is maintained. That dangerous form of anæmia known as "malignant" is marked merely by a peculiar alteration in the aspect of the fundus, which, owing to slight œdema, seems covered by a very delicate white veil. The vessels are thin, and often accompanied, near the papilla, by fine extravasations, which from their commencement exhibit white centres. Those extravasations, owing to their tenuity, disappear rapidly (*Quinke*).

The most marked ischæmia is found in those cases where some obstacle to the circulation arises in the central artery of the retina, as in embolism. This artery, after quitting the ophthalmic or one of its branches, deep in the orbit, enters the optic nerve, at a distance of from one and a half to two centimetres from the papilla. Recollect that the vein parts company with the optic nerve somewhat nearer the globe, emptying itself into the cavernous sinus, or less frequently into the inferior ophthalmic vein.

If an embolus has been formed in the central artery, and has completely occluded it, a very marked diminution in the size of the arteries will be visible. The embolus does not produce, or at any rate not at once, absolute bloodlessness. The veins likewise are much thinner, but increase in size towards the periphery, and as a rule, if not very much reduced, exhibit a wave-like pulse. In proportion as the retina has been more or less completely deprived of its nutritive blood supply, so will degeneration and nutritive changes appear more or less rapidly. For although a collateral circulation may be established by the small peri-papillary vessels, or circle of *Haller*, the nutritive effects of this compensation will be scarcely felt by the retina itself.

The earliest symptom is an opaline opacity radiating from the disc and following the course of the vessels. In the vicinity of the macula this assumes a milky appearance, which is often very conspicuous against a darkly pigmented choroid. The thinnest part of the retina, the fovea centralis, allows the subjacent vascular portions to be seen, and itself appears as a well-defined red spot. No hæmorrhagic patch is present, as the appearance of the macula might suggest, although indeed some hæmorrhages may occur from rupture of minute vessels, themselves the seat of thrombi. These, however, would not present the same rounded appearance. If a case of embolism be watched from the commencement, it will be seen that the disturbances in the retina begin round the arterial twigs that have been the last to be deprived of blood, namely around the macula. This latter appears under a high magnifying power as though dotted over with small white points, whilst striæ predominate near the disc, which often shows no evidence of disturbance for a considerable time afterwards (one or two weeks).

No other hæmorrhages, except those above mentioned, which are circumscribed and limited to the neighbourhood of the macula, are met with in embolism of the central artery. If after some days you should see others of a certain size attaching themselves to the edge of the papilla, doubt the correctness of your diagnosis. When these appear they are, as a rule, due to a certain condition closely analogous to the one I am speaking of, and not unfrequently confounded with it, namely, hæmorrhage into the sheath of the optic nerve.

The cases of true embolism of the central artery (such as have been demonstrated by dissection) terminate in complete atrophy of the retina and optic nerve. The retina regains its transparency; the arteries disappear so completely that the positions they occupied formerly can be recognised only by pale white lines. The veins are filiform, and can be followed for only a short distance. The disc atrophies, becomes white and tendinous looking, and at times so excavated as to simulate glaucoma. The great reduction in the calibre of the vessels will always show that a more or less considerable interruption in the circulation has at one time existed, due either to some obstacle (embolism) in or (hæmorrhage into the sheath) around the central vessel.

However, in both of those affections equally, the disturbance in vision is instantaneous if the attack has come on before nightfall. They are generally accompanied by phosphenes, and the appearance of a greenish-like fog, to which complete darkness succeeds. In some cases perhaps a small portion of the external and superior part of the visual field may remain intact. After vision has been completely destroyed for some days, this limited portion of the field may perchance become restored, permitting fingers to be counted, or the movement of a hand across the eye to be recognised.

The aura, that is the passing failure of sight, which in many patients precedes by some days the attack, has been witnessed in one case by *M. Mauthner*, who found it was due to a reduction in the size of the central artery, together with ischæmia, which disappeared rapidly. It has been accounted for by an embolus having been momentarily arrested within the central artery. This, however, does not explain what becomes of the embolus in the artery. I am much more inclined to see in these passing attacks of ischæmia, the signs of slight compression of the artery by an intravaginal hæmorrhage, the forerunner of that greater extravasation which later on will destroy sight. Therefore, these cases of aura have no connection with true embolism; except, of course, where an embolus has actually been found in one of the branches of the central artery after the aura; of this there are some examples cited by *M. Sœmisch*. Under such circumstances all the symptoms of ischæmia and consecutive atrophy are limited to the territory supplied by the obstructed branch. In most cases these partial embolisms are accompanied by hæmorrhagic infarcts, and by venous hyperæmia of the neighbouring parts.

Generally speaking, total or partial embolisms are found in conjunction with valvular disease of the heart. They are also met with in recent endocarditis, without any abnormalities in the cardiac orifices, in febrile affections, in rheumatism, pregnancy, and Bright's disease. They are common where general atheromatous degeneration exists, with aneurismal dilatation of the large trunks, and particularly of the aorta. Up to the present time no double embolism has been met with. If sight has been lost instantaneously in both eyes, and the signs of retinal ischæmia and atrophy have followed quickly, it is probable that the case has been one of hæmorrhage into the sheaths of the nerves. I agree with *M. Magnus*, that the re-establishment of the retinal circulation, while the blindness still continues, is better explained by slow absorption of large hæmorrhagic clots in the sheath of the nerve, than by reabsorption and canalisation of the embolus (*Leber*).

Treatment cannot avail much in an affection where the main channels of circulation themselves are laden with obstacles calculated to inflict the gravest injury on the nervous centres. In the hope of displacing the thrombus, it has been suggested that some sudden alteration in the intraocular tension might be made to act on the circulation. In this way a rapid withdrawal of the aqueous humour would perhaps produce a rapid rush of blood to the eye. When in these cases a paracentesis or iridectomy is made, displacement of the thrombus can of course only be expected if it is movable. Now, at the best this practice is useless, for if the embolus is small, it may be driven by the relaxation and subsequent afflux of blood forwards into the central artery, and thence into narrower spaces, which it will completely block up.

If, however, the surgeon is not quite certain whether the case is one of true embolism or not, but is nevertheless desirous of establishing conditions more generally favourable to circulation, he is justified in combating the ischæmia by means of sclerotomy. Care must be taken to withdraw the sclerotome very rapidly, in order to prevent the escape of the aqueous humour, and the sudden emptying of the eye. If, however, he feels convinced that he has to treat either embolism, or compression of the artery, depending on intervaginal hæmorrhage, then alike in each case he should read a warning to watch his patient carefully, and, by attention to general conditions, prevent, as far as may be, a repetition of these disturbing symptoms.

LECTURE XXXV.

RETINAL HÆMORRHAGES; RETINITIS APOPLECTICA; RETINITIS NEPHRITICA.

HÆMORRHAGES occur in the retina, consequent either on hyperæmia or anæmia, but still more commonly on vascular changes, such as atheroma or aneurism. I shall first notice those hæmorrhages which take place without any objective symptoms of inflammation in a healthy retina. They may be divided into three principal groups. First there are the flammiform extravasations, of no great thickness, which are found in the internal layers of the retina. The blood corpuscles are in such cases effused chiefly in the fibrous layer, and the resulting image outlines more or less accurately the course of these fibres.

Secondly, there are hæmorrhages which, while coming from the retinal vessels, have been profuse enough to break through the inner and outer layers, and to make their way to the anhistic membrane of the choroid. These effusions, which thus force back and compress the supporting cellular tissue of the retina, are marked off by curved or sometimes straight borders. As a consequence of this detachment of the framework of supporting fibres, the blood may be effused in a thin sheet, or may comport itself as though in a free space; that is to say, its colouring matter sinks down to the most dependent parts, whilst the fibrine and corpuscles occupy the superior. The extravasation thus exhibits various shades of colour dependent on gravity.

There is a third variety, some examples of which I have lately met with, and which are due to extravasation from the papilla. A patient, aged 60, was recently attacked with excessive dazzling, and with impairment of sight, so considerable as to render him unable to count fingers. What did the ophthalmoscope show? A small extravasation around the external edge of the papilla, together with a circular patch, which came apparently from the porus opticus, but did not reach the edge of the papilla. Neither arteries nor veins were perceptibly reduced in size. No other hæmorrhage existed at the fundus. You have watched this patient for some time, and have seen that little by little the edge of his disc became covered with blood, which, however, never extended a greater distance into the retina than would be represented by one diameter and a half of the disc itself. These circular effusions may disappear in a few weeks without leaving any traces. This variety of hæmorrhage, which is early indicated by subjective symptoms of compression, may cause repeated extravasations into the vitreous humour, until these finally occupy the place it filled.

These three forms of hæmorrhage comport themselves differently. The filiform or flammiform effusions, when single and small in extent, are generally absorbed with rapidity. It is not uncommon for this form to pass unnoticed, fresh extravasations having succeeded it. In all probability this variety of hæmorrhage is due to diapedesis. I may remind you, as bearing on this, of the extravasations which are met with in leucœmia, malignant anæmia, scurvy, and petechial typhus.

The second form of hæmorrhage is one diffused among the external retinal layers. It gives evidence in the arrangement of its boundaries that compression of the cellular tissue is present. These hæmorrhages are absorbed much more gradually. The form of hæmorrhage first mentioned might eventually leave no traces, but in this there is a tendency to subsequent fatty degeneration. This may be demonstrated by the presence of a small white patch, occupying the seat of the original hæmorrhage; or if the blood has been effused as a thin layer, there may only be a few faint indications of disturbance in the pigmentary layer of the retina, or a slight pigmentary residuum of altered blood.

The third variety of hæmorrhage, namely, that from the optic nerve, may, if slight, disappear rapidly and completely. If considerable, however, obliteration of vessels may ensue, together with atrophy, either limited to portions of the retina or spread over its whole extent.

The existence of hæmorrhages is not recognised by patients themselves unless there is compression of the retina at the points of central fixation, in which case a central scotoma will result; or again, unless the effusion be spread over such a large extent, as to considerably narrow the field of vision. If in such a case it affects the macula slightly, it will displace the delicate nerve structures of this region and will cause distortion of images, a condition known as metamorphopsia. Finally, all effusions which have come from the papilla are accompanied by symptoms of compression, and if considerable, will cause great impairment of sight.

The cause of these hæmorrhages must, in the majority of cases, be looked for in changes which have taken place in the walls of the vessels, whereby their power of resistance has become reduced. When the intraocular tension, which acts as a support to their walls, fluctuates, at one time excessive, at another deficient, they yield, and this the more readily, inasmuch as they have been weakened, probably either by fatty degeneration or aneurismal dilatation. Of this we have instances in hæmorrhagic glaucoma, and in hæmorrhages following iridectomy.

A second condition favouring hæmorrhage, and connected with diminished power in the vascular walls, is that of hypertrophy of the left ventricle or insufficiency of the aortic valves. These, by urging forward the pulse wave irregularly, favour rupture of the vessels.

Hæmorrhage also is very frequently met with as a result of alterations in the blood, as in Bright's disease, diabetes, anæmia during pregnancy, chlorosis showing itself at the age of puberty (with violent epistaxis), and in women weakened by lactation.

The importance that the diagnosis of such hæmorrhages may assume as regards blood changes in pregnancy, is strikingly shown by the following case. I was requested some five years ago to examine a young American lady, twenty years of age, who was in the seventh month of her pregnancy, and who complained that her sight had been somewhat dim during the last few days. Her husband begged me to examine her that very evening although to do this I had to disturb a large dinner-party, which neither the condition of her sight nor health prevented her taking part in. I found there was a very slight haziness of the retina in the neighbourhood of the papilla, in both eyes, and deferred further examination till the next day. At ten o'clock the following morning the ophthalmoscope showed on the left eye near the papilla, a small extravasation which certainly could not have escaped my investigation of the previous evening. Meeting a colleague in consultation, I informed him of this fresh hæmorrhage in the left eye, and the increased haziness of the papilla, and begged him to persuade the patient to allow premature labour to be brought on. I felt convinced that it would not be long before serious brain symptoms would declare themselves, and that in any case this primipara would not arrive at her full term without some accident. One of the most celebrated accoucheurs in Paris was called in in further consultation, but I was unable to convince him of the urgency of the danger. During the night which followed this consultation, that is to say four days after the first ophthalmoscopic examination, the patient was seized with convulsions, following each other in rapid succession. In all haste *Dr. Campbell* was sent for, but he did not feel justified in forcibly delivering a patient who lay unconscious and in a moribund condition. Death occurred the following night.

This is a very striking case, and will serve to show how necessary it is to attend to changes, slight in appearance, arising within the eye either from enfeebled resistance or rupture of vessels. It is quite possible that such may be accompanied by analogous lesions in the nervous centres of which the retina is a partial expansion. These hæmorrhages will furnish important indications as regards treatment, and especially as regards the general health, which must be carefully attended to.

For all these hæmorrhages, if due to some general change in the blood mass, I advocate tonic treatment, such as two or three lozenges of lactate of iron at each meal, preparations of quinine, and small doses at bed-time of rhubarb (40 to 60 centigrammes =7 to 9 grains approximately), in order to avoid constipation. Cold sponging with sea-water, may, by stimulating the functions of the skin, be of great service. If on the other hand we have to treat vascular ruptures, dependent on atheromatous degeneration of vessels, then the main object of treatment must be to prevent as far as possible all congestion of the head. One of the following pills I recommend to be taken every night.

Aloes . . . . } 1 gramme.
Jalap in powder and extract, āā. }
Divide into xx pills.

Derivation by means of warm mustard foot-baths at bed-time, followed either by wrapping the feet in flannel or by dry cupping on the back of the neck, may be prescribed. The use of Heurteloup's artificial leech can only be ventured on with robust patients, and this with the extra precaution of performing the operation at night, and compelling the patient to pass the next day in a dark room, and in a state of the most perfect repose.

It will not do to be too hopeful as regards the success of your treatment of hæmorrhages from atheromatous vessels. The constant repetition of such extravasations will quickly exhaust the sufferer's patience, especially if you have not taken the precaution to warn him of the peculiar course his disease may run. During the summer, patients may be advantageously sent to some purgative mineral springs. All sudden movements and violent exercises, such as riding, should be strictly prohibited. The compress bandage is of little use as regards hastening absorption, and may result in causing unpleasant congestion of the head.

I am scarcely in a position to say how far cold may act favourably in preventing these hæmorrhages. At any rate, there will be no indication to have recourse either to this agent, or to pressure, unless in the very rare cases of traumatic hæmorrhage. Should you be inclined to make trial of cold, it is to be borne in mind that in order to obtain any effects on the deeper portions of the eye, refrigerants must be continually applied, during at least one or two hours. The mere passing application of them will only have the effect of violently congesting the eye, and thereby inducing fresh hæmorrhages.

It is scarcely probable that astringents administered internally can exercise any marked influence on the retinal circulation. Nevertheless, in deference to their supposed effects, the most potent of them all may be prescribed, namely, perchloride of iron. Eight or ten drops may be given in half a glass of water, or two teaspoonfuls be taken daily of a mixture of 1 part perchloride of iron to 150 of water. Care should be taken not to derange digestion, and more especially, not to provoke vomiting.

It may at first sight seem strange how frequently the retina shares in any disturbances of the general circulation or nutrition. You will cease to feel surprise, however, when you consider that in looking at the retina you have spread out before you a terminal artery, with its finest ramifications. The ultimate capillaries are distributed in a tissue of remarkable delicacy and perfect transparency. Such conditions suffice to exhibit the slightest disturbances caused by any changes in the circulation. The disturbance of which I am now speaking would be still more strikingly shown if the intraocular circulation was not controlled and regulated by the internal tension of the eye, and if the loss of transparency which so quickly succeeds almost all these changes, did not hide the finer details.

I term *hæmorrhagic* or *apoplectiform retinitis* that condition in which, together with hæmorrhagic centres, there is indistinctness around the papilla, and in a greater or less degree along the large vessels. It however but very rarely reaches the equatorial portions of the eye. This haze, which may either be caused by œdema, or by slight hypertrophy of the supporting cellular tissue, stands in no relation to the number of the hæmorrhages. These may be very considerable, and yet not sensibly affect the transparency of the nervous membrane. On the other hand, cases are met with where there are only a few filiform hæmorrhages about the papilla, while nevertheless this may be surrounded by a grey or even milk-white opacity.

It is only in cases where the effusion is very great that any striking changes are visible in the vessels. Clinically we find several varieties. In some cases the disc is the centre of innumerable small flammiform radiating extravasations, which increase in size towards the equator. In such cases the arteries of the papilla will be found almost emptied of blood, and the veins relatively so. Owing to this, it becomes possible to follow them for only a very short distance.

In a second variety hæmorrhagic patches are met with, concentrated in one sector of the retina, and generally grouped round one of the large venous branches, which ramify in the neighbourhood of the macula. Amid a mass of filiform or circular hæmorrhages, patches of fatty degeneration may be early seen. Here it will be noticed that it is the arteries passing into this morbid centre which alone appear much diminished in size. The veins that pass out from it may show a considerable increase. The whole appearance recalls more that of a thrombus, with a hæmorrhagic infarct. Save for the œdematous haze which connects the hæmorrhagic centre with the papilla, this latter presents nothing abnormal, either as regards the arrangement or relative size of its vessels.

In retinitis apoplectica there may, according to the nature of the case, be variations in the mode in which the hæmorrhagic clots become changed into fatty patches. There is in this affection a more marked tendency to this change than in the extravasations, which occur in a perfectly healthy retina. Nevertheless, cases are observed where clots have disappeared from an œdematous retina without leaving any traces, and this more particularly when the number of hæmorrhages has been relatively few, and the retinal disturbance slight.

The hæmorrhagic form of retinitis depends beyond all doubt on vascular changes, and is the appanage of a more or less general arterial sclerosis. It is often associated with hypertrophy of the left ventricle, induced by valvular insufficiency, or stenosis, or by some obstacle to the venous circulation. It is remarkable that with very extensive arterial sclerosis, there may be no visible changes in the walls of the retinal vessels. Therefore, as the retinitis often remains localised for a long time in one eye, a comparison of the vessels of the diseased eye with those of the healthy will not reveal any differences.

The curious fact has been brought to light that retinitis apoplectica, although beyond doubt due to degeneration in the walls of the vessels generally, and connected with disturbances of circulation, may be limited to one eye. There are present at this moment several patients who might furnish proofs that it is not so rare to find both eyes attacked simultaneously, as some would maintain, and also that very frequently the disease appears on a second eye, after it had long remained unaffected. I do not, however, agree with *M. Leber*, according to whom the fact of this solitary existence in one eye is presumptive of embolism. I hold that a difference in the degree of intraocular tension in the two eyes, with more or less marked senile changes, might be sufficient to cause the affection to localise or even confine itself exclusively to one eye.

The affection seldom appears before the age of fifty. It may have existed a length of time unknown to the patient, unless a clot has chanced to occupy the centre of the macula, and give rise to a central scotoma. The prognosis is decidedly unfavourable. It is so, because it furnishes unsatisfactory evidence as to the resistance of the vessels in the nervous centres generally, and because it points to the possibility of grave lesions of the heart and kidneys, the existence of which had not perhaps been previously suspected.

Permit me to give you a case in point. I was requested some two years ago, by a lady whom I was attending, to examine the eyes of her son, forty-nine years of age. He had been out of health for some months, and at this date had been complaining for about three weeks of impairment of vision, sufficient almost to prevent his reading. Ophthalmoscopic examination showed me an apoplexy of the retina, characterised by a very few filiform hæmorrhages, especially in the right eye. Nothing abnormal had been found in the heart, or general circulatory system. It was only as a transitory symptom that a little albumen had appeared in the urine. The patient had been treated by the leading physicians of Paris for a liver affection, this organ being to all appearance considerably enlarged.

This was not the view I took of his case. I told the patient's mother that I considered an error had been made in diagnosis, and that it might be well to seek some further advice. A kindly feeling for those already in attendance prevented this hint being acted on. The patient died five months afterwards, and the autopsy showed the presence of an enormous cyst in the right kidney, which might possibly have admitted of puncture.

The appearance, therefore, of retinal apoplexy ought to be considered a grave sign as regards a patient's general condition. Besides this, as regards the sight, it is a very formidable matter. As a rule, the vascular changes and circulatory disturbances continue, and the attacks of hæmorrhage return on the slightest cause, until the sight becomes in time permanently damaged. If the effusions have not been very extensive they may become eventually absorbed, but will leave, even though not succeeded by any fresh hæmorrhages, a more or less distinct atrophy of the retina and optic nerve.

Our therapeutical resources are very meagre as regards changes in the walls of the vessels. We must in such cases confine ourselves to supervision of general conditions, with more special reference to the eyes. Any ametropia should be thoroughly corrected, and all undue efforts of accommodation and reading by insufficient light prohibited. The patient should also be protected against excessive light by means of smoked glasses, nor should he expose himself to any intense radiant heat. All violent exercises, all baths at high temperatures, and very warm beverages should be strictly prohibited.

It is useless to weaken patients by copious depletion and antiphlogistics, which always react in a disastrous way on the general circulation. The use of saline purgatives once or twice a week may exercise a salutary influence, and the same applies to small doses of acid. Thus, one to two grammes daily of the elixir of *Haller** may be prescribed. In persons with any tendency to obesity and with general atheromatous changes I recommend a course of Marienbad waters. In cases where there are obscure kidney symptoms together with retinitis, courses of Vichy and of Carlsbad waters will be of service. With the object of stimulating local action, dry cupping and the artificial leech have been recommended. The effects

* Composed of sulphuric acid of 66°, and rectified alcohol, equal parts of each—mix.—Tr.

of such methods must be carefully watched, lest they provoke dangerous congestion ; if clearly inefficacious, they should not be continued. The great point after all will be to secure mental and bodily rest.

I now turn to the so-called *nephritic* retinal affections, but though doing so, shall by no means quit the subject of retinal hæmorrhages. There are certain forms of retinitis in Bright's disease, which appear merely as simple hæmorrhagic retinitis, similar to what has been just described. But in the vast majority of cases, true nephritic retinitis is characterised by the appearance of patches of fatty degeneration, either connected or not with old-standing clots. Moreover, while in simple apoplectiform retinitis, cases were not unfrequent in which the affection was limited to one eye, or did not attack the second till late, nephritic retinitis generally commences simultaneously, or within a short interval, on both eyes.

In simple hæmorrhagic retinitis we had œdema of the retina, and apoplectiform clots, capable either of reabsorption, or of alteration into patches of fatty degeneration. In true nephritic retinitis, we have, besides this, sclerosis and fatty degeneration of the supporting fibres. I should mention that patches may be caused by cell-infiltration into the molecular and granular layers, and also by hypertrophy and gangliform dilatation of the nerve fibres. In some cases the infiltration of serum may determine circumscribed detachments of the retina.

The grouping of these various changes is also more or less characteristic. Thus the swelling and degeneration of the nervous fibres appears like a zone round the papilla. This at times determines a bulging of it forwards, so as to simulate a neuritis or a neuro-retinitis, due to some central lesion. Simultaneously with this alteration in the nervous fibres, fatty degeneration may appear in a zonular form round the papilla, and give rise to such a brilliant reflex, that the fibres appear as though they had preserved their sheath of myeline (fibres à double contour). Consecutively to the sclerosis and fatty degeneration of the fibres of Müller, a number of dots arranged in stellate fashion may become visible around the macula. Between these chief centres of localisation, circular patches of fatty degeneration may be seen here and there, which are due either to infiltration of the granular layer, or to hæmorrhage, the centre of which is already the seat of similar degeneration.

The fact that this affection is met with in various stages, also tends to increase the number and variety of its appearances. At first nothing is visible but passive congestion, and a blurred appearance around the papilla. With this are also small dots arranged like a star round the macula, and minute patches of fatty degeneration which are most common in the neighbourhood of the trunks of the great vessels. The second stage is where the swelling of the supporting tissue, and the varicose enlargement of the nerve fibres, has concentrated itself mainly round the papilla, presenting appearances which, owing to compression of the vessels, are very similar to those of neuro-retinitis. Finally, there is the third stage in which retrogression has taken place, and in which all the signs of atrophy of the papilla are thoroughly developed. Here, in addition to vascular degeneration (perivasculitis), there is the stellate arrangements of dots round the macula, which may occasionally assume a very brilliant appearance, owing to a deposit of crystals of cholesterine.

A peculiar feature in this disease is that the ophthalmoscopic image in no way corresponds to the functional disturbance. I can show you patients affected with nephritic retinitis, simulating, most perfectly, neuro-retinitis, in whom visual acuity is very slightly impaired. On the other hand, you will see cases of Bright's disease, where with simple œdema of the retina, and a few scattered hæmorrhages, there is such marked failure of sight, that the question arises as to how far it may not be the effect of uræmic poisoning. Great visual disturbance naturally ensues if the macula becomes the seat of a hæmorrhage, or has been partially detached, of which I have recently seen a case. With the above exceptions, the presence of relatively normal vision and perfect perception of colours, constitute the leading characteristics of nephritic retinitis. The retinitis appears, as a rule, in the course of the kidney affection, at a period corresponding to atrophy of the renal tissue, when the effect on the general circulation has determined hypertrophy of the left ventricle.

Once developed, the retinitis may present a certain degree of independence of action as regards the disease to which it owes its origin. It may improve or become worse, while the kidney affection is modified in an opposite sense. It is not as yet established what link there is between nephritis and the development of retinitis. According to the most reliable statistics, retinitis occurs in from 9 to 20 per cent.; others apparently less accurate give, out of 150 cases of kidney disease, fifty of retinal,—in other words, two out of three patients will not have any ocular symptoms.

There is little doubt that it is that form of nephritis which induces atrophy and contraction of the kidney, and affects the general circulation, which predisposes more especially to retinitis. It is not the form which causes the greatest disturbance to the general health which furnishes the largest contingent of retinal cases. For if, on the one hand, it be granted that many cases of Bright's disease escape notice, *quoad* retinitis, because the patients, being absorbed by their own melancholy thoughts, pay little heed to slight visual disturbance ; on the other, it is very often the oculist who first discovers the danger that threatens the patient, and so makes known the existence of the disease.

It is also certain that the apparition of nephritic retinitis in persons of apparently sound health is a bad augury, and must be looked on as the prelude to more serious symptoms. Some have therefore been disposed to think (*Von Graefe, Leber,*) that it was not entirely owing to disturbances in the circulation that the kidney affection appeared in the eye, but that there was also here a symptom of defective elimination of the toxic material from the blood, and of chronic uræmia. Hence it is that the appearance of retinitis, unless produced by some cause acting temporarily on the kidneys, such as pregnancy, exanthematous eruptions, malaria and syphilis, must be regarded as a very bad sign so far as concerns the character of the nephritis. In the absence of any manifest circulatory lesions, such as hypertrophy of the heart, it will make you suspect that elimination of the poisonous matter from the blood is being checked by the renal affection.

In treating nephritic retinitis it must always be borne in mind that the affected retina requires to be protected from every source of irritation. But further, no effort should be spared to supplement the deficiency of renal excretion, by stimulating other excretory organs. Complete rest for the eyes, a continued sojourn in darkened rooms, and the use of smoked glasses, are indispensably necessary. The cutaneous secretion should be especially attended to, and the use of flannel insisted on. Patients should be carefully guarded from all sudden changes of temperature, and be required to remain as much as possible in bed. When examination of the heart does not reveal any hypertrophy, I give cautiously injections of pilocarpine, namely, two or three drops of a ten per cent. solution, in order to determine a copious salivation, without excessive congestion of the head.

According to the peculiarities of the case, and to the stage of the nephritis, I prescribe diuretics. If the case be chronic in character, and free from congestion, the renal secretion may be stimulated by courses of milk, and by acids, especially nitric acid in lemonade ; thus :—

Water	1 litre.
Syrup	50 grammes.
Nitric acid	x to xv drops.

or in the form of a beverage, with the addition of nitrous ether ; thus :—

Distilled water	125 grammes.
Syrup	30 „
Nitrous ether	3 „
Nitric acid	xv drops.

Great care is requisite in the use of active diuretics. Above all it must be remembered that the patient's strength calls for support by nutritious diet, to which preparations of iron and quinine may be added, all strong alcoholic beverages being strictly forbidden.

The alvine functions should be regulated, avoiding at the same time irritation of the intestinal tract by very active saline or drastic purgatives. In these cases such waters as those of Pullna or Friedrichshall may be taken regularly at bedtime, to the amount of about a claret-glass full. Everything that can conduce to congestion of the head, and among others hot baths, which in these cases may lead to detachment of the retina, is strongly contra-indicated.

Antiphlogistic treatment may now be considered as almost abandoned. It is more especially unsuitable in retinitis accompanied by much fatty degeneration, and in that developed under the influence of chronic nephritis. It is possible that in a case of temporary albuminuria there might be some benefit in very cautious depletion, with Heurteloup's leech. But even then it should be remembered that to preserve the patient's strength is the grand indication, and that rest and tonics will accomplish this far more effectively.

LECTURE XXXVI.

DIABETIC RETINITIS; RETINITIS PIGMENTOSA; DETACHMENT OF THE RETINA.

It is well established that glycosuria, as compared with albuminuria, seldom gives rise to any specific form of retinal inflammation. The most experienced surgeon will not have had many opportunities of seeing *diabetic retinitis*, considering that *M. Leber*, in his important work on that subject, has been able to collect not more than some nineteen cases. Indeed, if nephritic retinitis is a bad omen, diabetic is assuredly a still worse one. The case which I have recorded in my treatise on "Diseases of the Fundus of the Eye," * and which was very like fig. 64 of the atlas appended to that work, was that of a young man aged twenty-one, who died a few days after the ophthalmoscopic examination, of cerebral apoplexy. The fatal character of the affection explains why it is so seldom met with in cliniques; for patients to resort to such places must be in a less shattered state of health than these patients generally are.

Although it may be said that both this and the preceding form of retinitis is identical, when compared together certain differences will be noticeable. Thus, the diabetic form appears never to be complicated with that remarkable sclerosis and hypertrophy of the cellular tissue around the papilla, nor with the varicose distension and gangliform dilatation of the nerve fibres, which give rise to those large white radiating patches around the disc, suggestive of the presence of neuro-retinitis. Among diabetic patients almost the only symptoms met with are those of congestion in the neighbourhood of the papilla, with simple hæmorrhagic spots, or yellow circular patches without hæmorrhage. The two other

* "Traité des maladies du fond de l'œil, et atlas d'ophthalmoscopie," par L. De Wecker et E. de Jaeger. Paris, Adrien Delahaye: 1870.

cases which I have since met with exhibited appearances very similar to that of fig. 64; but in these the congestion and the patches were less well-marked.

Diabetic retinitis attacks both eyes. It does not cause any great disturbance to vision, unless there be present with it some affection of the optic nerves, or some signs of central disturbance. Such complications will be accompanied by a considerable decrease in the perception of colours.

The oculist will have but little opportunity of treating this affection of the eye, for the patient's general health will soon remove him from observation. Here, even more, if possible, than in nephritic retinitis, it is necessary to abstain from all antiphlogistic or depressing treatment. The patient should be placed on an antidiabetic regimen, and if his means will not allow of other measures, he may be given internally carbolic acid, in solutions of a strength of $\frac{1}{10}$ per cent. This apparently exercises a favourable influence on the disease. If the season be suitable, he may be sent to Vichy, or, better, to Carlsbad. It need scarcely be said that perfect rest and protection of the eyes against all irritation from light, are absolutely necessary.

I mention only in passing, certain uncomplicated forms of retinal hæmorrhage, which have been met with in oxaluria, and in jaundice, accompanying cirrhosis of the liver.

I will now conclude my remarks on the varieties of retinitis apoplectica by mentioning those in which diapedesis plays the most important part. Under this heading I include *retinitis leucæmica*, and the form which is found in conjunction with *malignant anæmia.*

In leucocythæmia, retinitis would be more often diagnosed, if it caused greater impairment of vision. But the affection being localised chiefly near the equatorial parts of the eye, the macula often escapes, and central vision therefore remains unaffected. Leucocythæmic retinitis is characterised by the appearance of round clots, with a reddish border, the centre of the extravasation being occupied by leucocytes. The vessels are very pale, and the veins more especially are enlarged and tortuous. In certain cases a white border may be noticed along the vessels, formed in the wake of the white corpuscles, as they have escaped. Such widely-spread changes in the retina will appear the more remarkable when, as I have occasionally seen, they are associated with complete absence of all visual disturbance.

The *retinitis* of *malignant* anæmia is so constant, that it may be looked on almost as pathognomic. In this, equally with the preceding form, diapedesis gives rise to hæmorrhagic clots, the central portions of which are composed of white corpuscles. The first formed extravasations however consisted of the same dwarfed and decomposing red corpuscles as were found elsewhere in malignant anæmia.

I have described these two forms of retinitis, not so much with any view of laying down treatment, for with improvement of the general health they will disappear, but rather as examples of how valuable the ophthalmoscope may be in general medicine. I have already spoken of the various forms of choroido-retinitis, sympathetic and specific, under diseases of the choroid, and shall now pass on to *degenerations* of the *retina*, among the most important of which is the *pigmentary*, known as *retinitis pigmentosa*.

This condition is the result of a progressive congenital sclerosis of the retina, with or without infiltration of pigment. The proliferation of the cellular tissue follows a most characteristic course. It attacks and spreads from the portions of the retina which contains most cellular tissue, that is the periphery, towards the posterior pole. It attacks by preference the cellular tissue of the granular and neuro-epithelial layers. It is therefore more peculiarly destructive of the sensory portions, the conducting showing greater power of resistance. This may go so far that within certain zones the fibres may pass over portions of the retina which have been completely destroyed ; thus the formation of annular scotomata may be explained.

To this hyperplasia of the cellular tissue, proliferation of the pigment cells of the epithelium is joined. These probably by some peculiar amœboid movements, or by cicatricial contraction, are drawn into the degenerate retina, which may have become so thin that the fibrous layer is in contact with the retinal epithelium. Besides the above changes, must be added sclerosis of the retinal vessels, the sides of which become thickened at the expense of their calibre, which is gradually reduced and obliterated. There is here, then, progressive atrophy of the retina, extending from its edges to its centre. It attacks the sensory layers first, and finally destroys the conducting elements of the optic nerve. It thus recalls certain cellular proliferations in the nervous centres in general paralysis which *Luys* explains by a normal and gradual increase in the neuroglia as a result of a senile change.

Sclerosis of the retina, in the earliest stages, affords few ophthalmoscopic signs. If very young children, attacked with retinitis pigmentosa be examined, nothing abnormal will be found, either in the colour of the disc, the size of the vessels, or the surface of the retina itself. It is generally in young subjects that this non-pigmentary sclerosis is met with. It gives evidence of all those symptoms of retinal torpor which characterise the affection, improperly called retinitis pigmentosa. The disc is greyish yellow in colour, with a blurred outline and narrowed vessels. These appearances should make us examine without delay the outlying portions of the fundus. There we shall find the peculiar signs of the disease in the form of patches of pigment, not unlike bone corpuscles. These patches often follow the ramifications of the vessels, which seem lost in a reticula of pigmented striæ, increasing as the equator of the eye is approached.

Another curious feature in the affection is that the choroid remains absolutely intact, except for certain warty excrescences, which its anhistic membrane may become the seat of. Moreover, in very chronic cases, a sclerosis of the choroidal vessels may be observed, which gives them the appearance of being bordered by two yellow stripes, between which the blood flows. Thus, as I have shown you in numerous examples, these vessels as they lose the red filiform stream which passes through them, become thinned, and tend to run in straight lines. This relatively normal condition of the choroid, to which is often joined perfect preservation of the pigmentary epithelium cells, enables us to distinguish true pigmentary degeneration from the infiltration of pigment induced by specific choroido-retinitis. This latter is often followed by a spurious form of retinitis pigmentosa, but never without the presence of some circular patches of choroidal atrophy. The almost intact state of the choroid is likewise a distinctive mark, between congenital retino-choroiditis, which is generally unilateral, and in which perhaps hereditary syphilis may play an important part.

The appearance of retinitis pigmentosa is peculiar in this, that a slight haze seems to cover the retina, while at the same time the pigment stains can be distinctly seen. These do not spread to the macula or papilla for a very considerable time; indeed, I have really seen them there in only one case. Examinations, repeated at considerable intervals, will show that the patches have increased in number and have become closely packed together about the equator. Contrary to what obtains in the acquired or specific choroido-retinitis, the vitreous body nearly always is unaffected. But not uncommonly there is an opacity towards the posterior pole of the lens, which gives rise to a stellate cataract, when the patient becomes advanced in years.

The functional disturbance is as characteristic as the pathological changes, and consists in a concentric narrowing of the field of vision, which keeps pace with the process of degeneration. In cases where the field of vision is contracted to the utmost, almost perfect acuity of central vision exists. Nevertheless, the effects of the vascular sclerosis on nutrition manifest themselves even in parts which have not yet undergone degeneration. This is shown by a certain degree of torpidity, so that vision is not quite normal, except under the stimulus of a strong light. As soon as the illumination begins to fall off, myctalopia (wrongly described as hemeralopia) appears. This torpidity of the retina is the first symptom of degeneration, and that at a period when no objective changes can be seen in the excentric portion. A child will work without difficulty during the evening near a good lamp, but will see very imperfectly any distant objects in the room ; he will strike against something if he passes into a dimly lighted corridor. It is very rare, except where complications are present, to find that the perception of colours has been impaired, or to hear patients complain of the phosphenes, so characteristic of specific choroido-retinitis, or lastly, to find true hyperæsthesia along with the retinal torpidity.

The affection follows a very regular course, revealing itself at an early age merely by hemeralopia, and ending in adult manhood by complete blindness. I say advisedly the age of manhood, for most of those attacked with retinitis pigmentosa are men. Although most statistics give 20 to 25 per cent. of women, yet in this clinique, where the affection is not at all uncommon, it is the exception to find a female so affected. Again, when retinitis pigmentosa exists in a family, it attacks by preference the sons. There can be no doubt that hereditary influence is the chief factor in the production of this form of degeneration ; in 25 per cent. consanguinity may be regarded as the predisposing cause. In other cases it is often possible to establish the fact that congenital disease of the eye has existed in one or other parent.

It is also very probable that similar pathological conditions will be found in the nervous centres, that is, that a progressive development of cellular tissue of the neuroglia will have determined the extinction of some nerve elements. This view finds support from the following facts, namely, the frequent coincidence of idiotcy in children born with microphthalmos, and well-marked retinitis pigmentosa, and the presence of impaired intelligence, deafness, infantile paralysis, arrest of development in the limbs or the existence of supernumerary ones. On the other hand it must be said that the hereditary transmission of certain cerebral affections seems in some families to be confined exclusively to the sense of vision; the brain being absolutely unaffected. In large families boys are more frequently attacked than girls.

Another circumstance which lends weight to the supposition of sclerous degeneration of the nervous centres is, that in such families the early mortality is very great. It would be interesting to enquire what the expectation of life is in the subjects of retinitis pigmentosa. I seldom see any aged patients so affected; though of course it is true that, becoming blind at the age of forty or forty-five years, they are scarcely likely to seek further advice once the blindness has been confirmed. Syphilis does not apparently play any important part, except in cases of congenital and unilateral choroido-retinitis.

It is not without a purpose that I have dwelt thus long on the pathological changes and their final results in the pigmentary degeneration of the retina. My purpose is that in such cases you may realise that there is a limit beyond which therapeutics cannot go. In diseases of the retina and optic nerve, more than elsewhere in the body, true science should step forward and protect patients against useless and often painful methods of treatment. If I am absolutely opposed in all these cases to antiphlogistic and debilitating treatment, it is because they can exercise no influence whatever on the course of the disease. I would, however, strongly recommend a series of subcutaneous injections of strychnine at intervals. A solution of a strength of one per cent. may be prepared, and five or ten drops of this used according to the age of the patient, the greatest caution being taken in the case of young children. I am perfectly aware that no very brilliant results will be thus obtained; still it does not admit of doubt that these injections act favourably on the retinal torpor. With regard to this point, I may mention that patients are often willing to take journeys of considerable length in order to obtain a fresh supply of the injection, thereby showing that they have obtained a certain amount of benefit from it. The improvement is shown by the progressive impairment of vision having been arrested, and that in cases where functional examination scarcely justified the amount of satisfaction expressed by the patient.

I consider, too, that the employment of continuous currents of from six to eight cells, applied to the temples and mastoid processes daily, during two or three minutes, can be none other than beneficial. I use them in conjunction with injections. Along with this, strengthening treatment, cold sponging, and ferruginous preparations are indicated. The use of mercury should be avoided. It is difficult to see how this agent can be reasonably prescribed, except in very obscure cases, where the presence of some patches of atrophy in the choroid may arouse suspicion of a specific cause. In all true pigmentary degenerations, mercury acts unfavourably, and the same remark applies to all depressing methods in general.

It must be borne in mind that patients affected with excessive contraction of the field of vision experience great difficulty in guiding themselves. This is owing to the insensibility of those portions of retina which are still functionally serviceable with a moderately bright light. It is consequently necessary to correct most accurately any error in refraction, so as to obtain sharply-defined images on that portion of the visual field which still remains. Enquiry should also be directed as to how far hyperæsthesia of the retina is present along with torpidity. The former should be treated by reducing the intensity of the luminous rays.

I shall merely mention in passing *cystoid degeneration*, so well described by *M. Iwanoff*. It is a senile change, and extends from the zonula towards the posterior pole. It is an œdema of the cellular tissue, complicated by the presence of large spaces, and is met with in at least half of the eyes of all aged individuals, especially where there have been any nutritive changes in the lens. This cystoid degeneration never becomes a subject of special treatment.

I should here mention another form of degeneration, produced by excessive proliferation of the cellular tissue round the papilla. This gives rise to cellular masses, which bulge like a tent into the vitreous body. It is this condition which has been incorrectly named *proliferating* retinitis (*Manz*). This affection, which I described when speaking of the opacities of the vitreous body, has been considered by *Leber* as more properly a disease of that organ, and as having some connection with hæmorrhages into it. I may remind you of the appearance which I compared to the wings of a butterfly (p. 361), adherent to the papilla. These thick masses are, according to *Leber*, due to successive hæmorrhages into the vitreous. This would confirm my view, viz., that an irruption of blood very frequently takes place into the vitreous from the papilla.

This *peripapillary degeneration* is found under two conditions widely different. It may be seen in young subjects in connection with menstrual disturbance, with epistaxis, with oxaluria. On the other hand, I have seen it as a sequela of very acute specific choroido-retinitis following iritis, or complicated with irido-choroiditis.

In the first group of affections which I have just mentioned, where alterations have affected the sheaths of the optic nerve, or the papilla itself, tonic treatment such as hydrochloric or nitric acids (p. 388) should be given in conjunction with ferruginous preparations. A careful watch should be kept over patients so as to anticipate relapse, and to prevent any congestion of the head, such as might follow the use of excessively warm beverages or violent exercise. By unremitting attention to the case, and by giving later on iodide of potassium, and small doses of pilocarpine, a considerable resolution of the cellular masses in the vitreous, with a corresponding improvement in sight, may be obtained. In all cases where this degeneration is found in connection with specific choroido-retinitis, anti-syphilitic treatment is called for. Unfortunately, however, this offers but a small chance of success, so far as restoring satisfactory vision is concerned, for the degeneration in most cases travels beyond the papilla and includes the macula.

I now turn to a morbid condition of the retina, which I have made the subject of much research in my clinique. I have endeavoured to obtain some less discouraging results than those which attend the ordinary treatment. *Detachment of the retina*, for that is what I refer to, would be a surer ground for ocular therapy to work on, if we could learn more about the causes which induce it. In the mechanism of detachment we should recognize two agencies, each distinct and different. In one there exists actual traction forwards of the membrane in the direction of the posterior chamber; in the other, it is forced there by a wave of fluid behind it, which does not traverse but raises it up. *Attraction* and *repulsion*, then, are the two chief factors in the production of detachment of the retina.

As regards *detachment by attraction*, *H. Müller* had already called attention to the possibility of filamentous or membranous opacities, which were adherent to the retina, becoming contracted. These, as they tightened, would draw upon the nervous membrane. Later on, *M. Iwanoff* demonstrated that, especially in eyes affected with progressive distension (with atrophy of the choroid from traction) the vitreous humour might become detached in a mass, leaving between the hyaline membrane and the retina a layer of fluid. This will be larger in proportion as the vitreous has approached more towards the lens. If, after the gradual stretching of the envelopes of the eye, and the progressive repulsion of the vitreous, a laceration should from any cause take place between the hyaline membrane and the retina, the fluid which was previously in front of the retina may suddenly pass between it and the choroid, to which the pigmentary epithelium is attached.

The theory of *H. Müller* is here applied to the membrane which surrounds the vitreous humour, which, when it becomes detached under certain conditions, forms adhesions with the retina. Subsequently, as the detachment becomes larger, the retina itself shares in the movement. In this way the sudden character of the affection may be to a certain extent explained. The subretinal serous fluid has only to pass between the retina and the choroid; there is no need to invoke a phenomenon well-nigh inexplicable, namely, the sudden absorption of the vitreous humour in order to allow a vast sheet of fluid to accumulate behind the retina.

Such a mechanism is probable enough in cases where disturbances of nutrition, and symptoms of irritation have for some time preceded the detachment. But detachment may appear suddenly in eyes where the vitreous humour has shown no signs of disturbance. It is possible, as *M. Raehlmann* has actually shown, to provoke detachment of the retina artificially by injecting a solution of salt into the vitreous. Peculiar conditions of filtration may here predispose an eye and a retina, to all appearance perfectly healthy, to this displacement. If the vitreous body contains at any given moment an excess of salts as compared with that which the blood in the choroidal vessels holds in solution, a strong current will set towards the fluid containing the excess of salt, and this fluid must necessarily pass through the retina. As the serum of the blood contains a considerable amount of albuminoid substances in solution, the retina would in such a case, according to *M. Raehlmann*, behave like any other organic membrane, and would present an obstacle to the passage of fluid through it, great in proportion to the density of the latter. A fluid charged with albumen would in such a case accumulate behind the retina, which would become detached more or less rapidly according to the amount of serum required to dilute the vitreous humour. This mechanism will explain detachment of the retina by repulsion.

Another mode in which repulsion may be brought about is, compression of the choroidal vessels. This may be the result of a tumour, which may cause a quantity of fluid to transude from the external surface of the retina, causing detachment of this latter. The presence of a very small tumour may determine progressive and complete detachment.

It is clear that the exact process which takes place has in many cases yet to be learned. I shall endeavour to show how it is that glaucoma drives the retina back against the coats of the eye and excavates the optic nerve, while other morbid processes have a tendency to draw it forwards, towards the interior of the eyeball.

It is interesting to note that these two conditions may coexist together. Thus some of you may have seen me operate lately on a young American, who, eleven years ago, received a blow on his left eye. From this, detachment of the whole lower portion of his retina resulted. His parents refused to allow puncture, and medical treatment had been tried but had failed. A few years later a form of chronic simple glaucoma developed itself. The iridectomy which I made, showed me that the vitreous body was very fluid, so much so, that it presented as soon as the section was completed, though made very far from the periphery. In this case there was no subluxation of the lens which could account for the very unusual phenomenon of a glaucoma complicated by traumatic detachment of the retina.

LECTURE XXXVII.

DIAGNOSIS AND TREATMENT OF DETACHMENT OF THE RETINA; GLIOMA OF THE RETINA.

A FACT, important as regards the treatment of detached retina, has lately been established by the researches of *M. Poncet.* It is this, that the retina even when detached, may preserve its structure unaltered for a considerable time, provided its functions have not been previously impaired by some choroidal changes. If you consider the closely packed arrangement of the rods and cones in the prolongations of the retinal epithelium, it seems scarcely possible that detachment of the retina should fail to cause notable disturbances in such delicate structures. The layer formed by these is therefore, as might be expected, generally found considerably altered after detachment, even in cases where the eye has previously been to all appearance healthy. This is why retinal purple is not found on freshly-detached retinæ, and why a portion of retina, if reattached after absorption of the subretinal fluid, always shows a certain functional impairment, especially in the perception of colours.

It is no contradiction to this to say that after detachment perfect central vision may return. The loss of sight, during the period of detachment, can often be explained by the fact that the central portion was covered by a fold of retina, which had fallen over it. The subretinal fluid is highly albuminous (10 to 12 per cent.), and will coagulate *en masse* under certain conditions. It always contains a number of rods, torn from the retina, at the moment of the separation of this latter from its epithelium.

The ophthalmoscopic appearances are very characteristic. They depend on the change of position which has been effected in the detached portion, the refraction of which is altered as compared with other parts of the retina. The refraction will in fact be the same as that of a very hypermetropic eye, while the disc will keep its usual position, say, in a myopic eye, should detachment have occurred in conjunction with myopia. The change in the direction of the vessels, as they pass from the healthy to the detached portion, is a second important diagnostic sign. It must be borne in mind that in recent or even old-standing detachments which have occurred in eyes to all appearance healthy, the retina may preserve its transparency. In such cases it would require a very practised eye to recognise the faint grey reflex, which the descending portion of the detachment presents, as it sinks down to the plane of the choroid. The detachment must also have a certain degree of prominence, otherwise the vessels ramifying over it will not be distinguishable by their darker colour, nor can the absence be observed of that clear central line which is present under normal conditions.

The fact that the retina, although partially affected, will generally be detached *en masse* over a narrow space, and that it is not necessarily prominent, renders the diagnosis somewhat difficult in the earlier stages. It is not till after some time that the folds, the arrangement in terraces, and the tremulous movements of the membrane, afford an ample number of diagnostic points by which to judge of the change in its position.

Diagnosis during this period is greatly aided by the alterations in colour which the detached portion undergoes. The layer of subretinal fluid, if at all thick, will impart a light neutral tint to the detachment, although this may itself continue to be quite transparent. But it assumes a duller and greener hue, as the effused fluid becomes opaque and tinged with blood. A detached portion presenting this dull appearance will, according to its size, increase the difficulty of illuminating the fundus.

It is only in very old-standing detachments that remains of cellular tissue, pigmentary infiltrations, or deposits of cholesterine, in the form of bright patches, are seen in and about the folds. It is plain that the greater or less degree of tension caused by the subretinal fluid will exercise considerable influence on the preservation or otherwise of the normal appearances. If the serous portions of this fluid become absorbed, and the retina reattached in ridges, the *sublatio rugosa* of *Förster*, the appearances may be almost normal. Evidence of the change that has taken place in the position of the retina will be afforded only by the presence of numerous folds, which may be likened not inaptly to the small waves which a slight breeze raises at sea.

If the retina has been driven forward with sufficient force to produce rupture, and the subretinal fluid has passed in front of it, the detached portions which are not exposed to constant traction will continue in a much more perfect condition than other portions which are subjected to increased tension. These ruptures ought to be present in every case, if the mechanism were such as *M. Iwanoff* maintains it is. Generally speaking, they take place near the equator, and allow the details of the choroid and tapetum, which at times shows a considerable loss of pigment, to be seen through the ragged opening.

A fact of great interest, as regards treatment, is, that detachments, in the production of which inflammation of the retina has played any part, are comparatively rare (*Guignet, Lubinski*). Indeed, in numerous cases the vitreous humour and adjacent parts are perfectly healthy. Hence we may suppose that in such cases there was some pre-existing lesion of filtration, or some derangement in the exosmotic currents and the circulation.

The impairment of vision in detachment will depend on the extent of the detachment, the length of time it has lasted, and the tension. The impairment of sight will be due to torpidity of the retina, complicated with metamorphopsia, from displacement of the nervous elements, and the unequal traction they are exposed to. This torpidity may be such as to cause the loss of all functional power in the detached portion. So long as the central portion of the retina is not included in the detachment, or so long as this latter is not near enough to the centre to determine metamorphopsia, and so long, finally, as it is not covered by a loose fold of retina, central vision will remain unaffected.

In strongly myopic eyes, where the detachment has not taken place suddenly, the myopia may become corrected to such an extent that the patient is quite astonished at the improvement. In most cases a patient will tell you that the detachment appears like a cloud, rising from below upwards, and coming between him and every object. At a later stage this cloud changes into a grey or black curtain, stretching from above downwards, and eventually entirely abolishing vision, or permitting only a perception of light in the excentric portions (upwards and outwards) of the field. The preservation of sensibility in the retina explains how it comes that patients become aware of the detachment of their retinæ by this cloud, that is, by a large positive scotoma; and further, how it is that they often have subjective sensations of colour, at one time red, at another violet or blue, over the whole extent of the detached portion.

The suddenness with which the detachment supervenes, will, more than anything else, attract a patient's attention. In the majority of cases, however, he will have had previous warning by certain prodromata, such as phosphenes, sudden obscuration of vision, and a tremulous movement, which gives an impression as if water were flowing before the eyes. These prodromata are seldom seen except in eyes with choroidal atrophy from traction. They are completely wanting in eyes to all appearance healthy, in which detachment has come on suddenly, and unheralded even by metamorphopsia.

It is a favourable circumstance when the detachment has been produced with sufficient abruptness to cause laceration. In such a case it may remain stationary, as I have actually seen it do for fifteen years, allowing of the finest type being read. But it is only those ruptures, which occur simultaneously with detachment, which give any promise of this chronic course. Those which arise from some sudden increase in a detachment which has already existed for some time, do not produce the same favourable result. The progress of a detachment will be rapid in proportion as there has been some previous affection of the vitreous humour. In such a case there may be a tendency to destruction of the shape of the eye from complications, such as cataract, complete synechia posterior, and glaucomatous symptoms. I have myself seen such a course run through in the space of three or four months, in cases where there could be no question of any subretinal tumour.

Cases of spontaneous reapplication of the retina are very rare, though they are on record. I myself have met with one such instance, in the case of a very myopic patient. Here the detachment of the retina and its return to a normal position, took place twice. The patient forwarded me subsequently a minute account of the sensations he experienced at the moment of the detachment, and the subsequent reapplication. The traces of cicatrices, or of coagulated fibrine, sometimes met with, and so well figured in the Ophthalmoscopic Atlas of *Von Jaeger* (fig. 73–5), are in favour of spontaneous cure, however rare it may be.

Detachment of the retina, especially if a posterior staphyloma be present, has an unpleasant tendency to attack both eyes. This choroidal affection is of all others the one most frequently associated with detached retina.

Detachment may be of traumatic origin. It may result from a blow on the eye, from an abscess or tumour in the orbit, or from surgical operations, especially when they have been followed by loss of vitreous, or cicatricial contraction of the sclerotic.

Cases of *idiopathic* detachment are met with at certain ages, without any apparent cause, and possibly ought to be ascribed to that cystoid degeneration in old persons which *M. Iwanoff* has so well described. This form, as also certain cases where hæmorrhages from the papilla are the cause of detachment, have yet to be studied. Frequently, however,—and this is a point that should be remembered,—detachments appearing suddenly in an eye apparently healthy, may possibly result from the presence of a cysticercus, or a small tumour in the choroid (melano-sarcoma).

The disease occurs with about the same frequency as glaucoma, namely, in 1 per cent., and yet what are we able to do for it? If we turn to *Leber's* large work, we find this depressing avowal; "the affection is generally incurable, and sooner or later ends in blindness." Is not almost any effort therefore justifiable, which has for its object to save these patients from the hard fate impending over them?

The earliest attempts to treat detachment of the retina surgically, were made by the elder *Sichel*. The end which he had in view was, not to restore sight, but to relieve painful inflammatory complications, by puncturing the sclerotic below the detachment. Later on, when men had learned by the aid of the ophthalmoscope, that detachments often remained stationary, once rupture had taken place, *Bowman* employed two needles, which he moved in the same manner as in the operation for secondary cataract, and in this way tore the retina. *Von Graefe* and *Von Arlt* endeavoured with a sickle-shaped needle to perform division of the detached portion. These attempts may be considered as now definitely abandoned. They gave very few successes, and often caused rapid destruction of sight. The method was radically wrong, inasmuch as it did not respect the vitreous humour, which plays a very important part in detachment. It is now fifteen years since I proposed to draw off the subretinal fluid, by means of a trocar and canula passed in above the detachment. This method proved an unsatisfactory one, because it necessitated passing through and still more disorganising the vitreous humour, which had already undergone considerable changes.

At a later period I adopted the method of puncture of the elder *Sichel*, and passed a narrow Von Graefe's knife from the sclerotic to a point beyond the detached retina. If the knife be turned round about a quarter of circle, this method will permit of all the fluid both above and below the retina being drawn off. It should, however, be modified somewhat, as *Alfred Graefe* has suggested, namely, the knife should be kept below the detached portion, and not suffered to penetrate as far as the retina itself, which its point might easily still further separate. *M. Secondi* has recommended, under the name of *hydro-dictyotomy*, a combined operation, which consists in tearing the retina with a sickle-shaped needle, from the side of the vitreous, followed by evacuation, much as I did with a cataract knife.

In order to make certain of a continuous flowing away of the subretinal fluid, I conceived the idea of passing a gold thread, either single or double, beneath the detachment. This thread is left in position after having been twisted and knotted, and concealed from view, in the conjunctival cul-de-sac. There it remains, causing in most cases not the slightest irritation, as has been shown by patients being able to wear it during eighteen months or two years. The treatment has in some cases given excellent results, but it cannot be said to ensure perfect filtration. Moreover, it is necessary to watch the patient, as in some persons the derangement of the thread or some defective fitting of it during the operation will produce very sharp symptoms of irritation.

At the present time I once again have fallen back on puncture, but have modified it as follows: I use a narrow sclerotome, two millimetres in width, which I pass as peripherally as possible between the external and inferior recti muscles, close to the equator of the eye. If the position of the detachment is such as to necessitate it, I pass in my sclerotome between the internal and inferior recti. This should penetrate not more than four or five millimetres, or in fact as short a distance as possible, and then be rotated in about a quarter of a circle.

The fluid flows out generally at the moment the sclerotome is withdrawn, and forms a small swelling. After the operation, eserine should be at once dropped into the eye, and should be continued twice a day for several days. The compress bandage is then to be applied, and the patient placed in bed, in a dark room, where he must remain perfectly quiet for from eight days to four weeks.

With strong, healthy patients, fourteen days' confinement in bed suffices. But during this time, morning and evening, two grammes (30 grs. approx.) of mercurial ointment is to be rubbed in daily, every precaution being taken to keep the mouth scrupulously clean in order to avoid mercurial stomatitis. Two or three times a week a glass of Pullna or Friedrichshall water is to be prescribed morning and evening. This treatment I have now employed for a considerable time. It represents a combination of puncture, mercurial treatment, and rest, together with compression, as *Samelson,* and after him *Lubinski,* have so strongly recommended.

As showing what treatment may do even in this almost hopeless affection, I will ask you to pay particular attention to the two following cases.

The first is that of a gentleman, aged fifty-four, who has long been the subject of posterior staphyloma, and floating opacities in his vitreous. He is myopic to the extent of $2\frac{1}{2}$ D. (—16). Some six years ago he was attacked with detachment of the retina, for which the ordinary remedies, such as iodide of potassium, were tried. The detachment, which at the time I first saw him was very considerable, became subsequently complete, in spite of cupping and mercury. I refrained from interference with this eye, on account of the extensive morbid changes in the vitreous.

The patient was subsequently carefully watched, and, on account of the floating opacities which appeared in his vitreous, was placed on iodide of potassium. On the 1st of October, 1877, I found that one half of his right retina had become detached, and that he could not guide himself. Considering the disastrous course the affection had taken in the right eye, which at present presents a complete synechia posterior, together with symptoms of glaucoma, I did not hesitate to resort to puncture on the 4th of October. The patient remained in bed a fortnight, during which time he wore the compress bandage, and used eserine and mercurial frictions.

The retina has since that date become completely reattached. It is worth noticing that the vitreous humour is also much clearer, and that the boundaries of the staphyloma can be seen with remarkable precision. The patient can walk without assistance to my clinique, and can make his way through the most crowded streets of Paris. He can read number three of my test-types, and his vision for distance is S. = $\frac{1}{2}$.

I will now narrate a second, and not less interesting case. It is that of a lady, aged forty, whose left retina became detached, irido-choroiditis subsequently making its appearance. An artificial pupil was made on this side. The present condition of the eye is as follows: it is not sensitive to touch, is normal in size, is free from pain or irritation, and is absolutely without any vision whatever. It was under such circumstances that the patient was attacked last year with detachment of the right retina. Thus deprived of her remaining eye she became so despondent as to attempt suicide by starvation, but happily was not able to carry this intention out to the end.

It was therefore in the worst possible state of health that I received her under my care. For the first fortnight treatment was necessarily directed to relieving the vomiting, caused by her attempt at suicide. It was only after this had been done, that I could attempt anything with the left eye. I found vision reduced to bare perception of light, at a distance of six metres. There was a large greyish detachment of the whole inferior and internal portion of the retina. You saw me perform the operation of puncture in this case four weeks ago. Since then the patient has remained in bed, and mercurial frictions have been employed daily. As you perceive she can now count fingers readily at a distance of two metres.

It is enough to have seen a certain number of cases of which these two are specimens, to be convinced that one is not justified in abandoning such patients to their fate. Cases certainly occur in which all efforts are unavailing, but it is only by making successive attempts that we can ever arrive at better results. Simple punctures with the narrow sclerotome are perfectly harmless. Compression of the eye, and rest, injures no one. There remains then, in this treatment, only the mercurial frictions which can possibly alarm the most timid. They may be suppressed, if there is any reason to fear they could be hurtful in the case of delicate patients.

The attempts I have made to improve the treatment of detached retina have so far taught me some valuable lessons, of which the following are a few: all operations that have for their object to tear the retina, and all methods in which instruments necessarily traverse a vitreous, generally diseased, are radically bad; particular attention should always be paid to the tension in the affected eye; any relaxation following upon the operation must be compensated for by a compress bandage: this should be worn continuously for some time; pressure should be used to hasten reabsorption of the subretinal fluid, as generally in the case of other collections of serum. Aspiration of the subretinal fluid by means of syringes, is a proceeding utterly at variance with all that either physiology or experience teaches.

It happens not unfrequently that we have to treat patients affected both with cataract and detachment. In the absence of a second eye, permitting of vision, I do not think there is any contra-indication to extracting the lens. But the operation must be performed with all care. If possible, a speculum should not be used; any sudden escape of the lens or aqueous humour should be guarded against, as also any loss of vitreous. The compress bandage should be worn for a fortnight, and changed as seldom as possible. If necessary, drainage or puncture may be practised later on. Even under such an unfavourable condition, sufficient sight may be restored to a patient to enable him to guide himself.

In cases of detachment of the retina, where vision has been completely lost for years, great annoyance is sometimes caused by the continuance of flashes of light and phosphenes, due to irritation of the optic nerve by the tremulous movements of the detached retina. In such cases enucleation must not be thought of, but, instead of it, section of the optic nerve, with which, if pain is present, abrasion of the ciliary nerves may be conjoined, according either to the method of *M. Boucheron* or that of *M. Schoeler*.

It may happen that after the advent of a cataract, and the formation of a complete posterior synechia, glaucomatous symptoms may supervene. These may appear long after the original affection has destroyed all vision, and may call for iridectomy. I have already remarked (p. 398) that you must not suppose increased tension is pathognomic of a tumour. Simple detachment may cause synechia posterior, bulging of the iris, and eventually glaucoma.

I now come to perhaps the worst affection to which an eye is exposed,—I mean gliomatous degeneration. *Glioma* was for some time, owing to the resemblance its microscopical characters had to those of the granular layer, mistaken for a simple hyperplasia of that layer. But the error was soon discovered, for the fatal character of the disease showed it to be a very malignant neoplastic growth, and one moreover highly contagious. The glioma granules are small mono-nuclear cells, inferior in size to the elements of the granular layers. They are imbedded in a delicate fibrillar tissue, and hence a glioma bears some slight resemblance to brain tissue. The intercellular tissue is in some cases so developed, that a transition has evidently taken place, resulting in glio-sarcoma (alveolar sarcoma; fibro-sarcoma). Histologically, glioma is distinguished from the products of inflammation by the fact that in the latter the intercellular tissue is less in proportion to the cells present, and that these latter exhibit no tendency to organisation, but rather to severance and degeneration.

Glioma commences in the granular layers, more especially the external, and, as it grows, presses the internal layers of the retina towards the vitreous humour, or passes through them and appears at the side. As it becomes developed, it sends offshoots into the choroid which may propagate infection, and themselves become the seat of similar growths. The glioma cells thence make their way into the sheaths of the retinal vessels, and travel along the fibres into the optic nerve. Extension with glioma takes place along the course of the nerve tissue, while with malignant tumours of the choroid it spreads along the cellular tissue, which lines the sheath of the optic nerve.

When the malignant tumour has filled the cavity of the eye, glaucomatous phenomena, and eventually rupture, take place. From this may result either atrophy of the globe, which lasts for some time, or the immediate development of an enormous fungus. Following the course of the optic nerve, the affection wins its way into the cranial cavity, produces numerous centres of infection, and may even extend as far as the spinal cord. The bones of the head may be separated by the tumour, and become themselves directly infected. Or again, both cranial and facial bones may be indirectly contaminated through the blood-vessels and lymphatics. The liver is frequently the seat of secondary deposits, and the severed end of the optic nerve of a fresh growth.

It is most important to recognise the earliest symptoms of this redoubtable affection, which is probably congenital in origin. It attacks only very young children, becomes rare after the age of four, and has never been met with beyond the age of twelve years. It sometimes happens that several children in one family are attacked. Generally speaking a child is brought to you because, as in the little patient that you have lately seen here, where the glioma is double, it appears to be blind, or because, in certain conditions of light, the eye shows a peculiar white glistening reflex.

Examination with the ophthalmoscope reveals a rounded swelling, with vessels passing over it. It is white in colour, or pale yellow. In the neighbourhood of the principal growth smaller scattered ones are occasionally to be seen. It would scarcely be possible to mistake the disease for anything else, except perhaps detachment of the retina, or suppurative hyalitis. In detachment the colour is never as well marked as in glioma; and, moreover, there are no small irregular growths in the immediate neighbourhood. Confusion between it and a subretinal cysticercus is scarcely possible, for the entozoon is never found in children.

As regards partial suppuration of the vitreous, this is generally either traumatic or consecutive on cerebro-spinal meningitis. The swelling in hyalitis is also white, but fleecy-looking, without any vessels, for these are concealed by masses of pus. In a glioma, on the contrary, which has invaded the whole orbit, portions of the plexus of retinal vessels can still be seen. Once perforation has taken place, a glioma can only be confounded with granuloma of the iris, but this latter is distinguished by being stationary and smaller.

Treatment consists in as early a removal of the eye as possible. You will see at once how confident you must be in the correctness of your diagnosis before you can propose such an operation. A proposition such as that of removing an eye apparently healthy is always entertained by parents with great repugnance. You have just had an opportunity this moment of seeing the pain they suffer, when it is necessary, as it was in this case, to insist on the immediate removal of both their child's eyes.

If the glioma be small and the appearance of the pupil normal, simple enucleation of the globe will suffice, the optic nerve being severed as far back as possible. If the glioma have actually invaded the whole eye, it will be better to follow *Von Graefe's* advice, and, as a preliminary step, divide the optic nerve near the foramen. This is effected by introducing a curved and pointed neurotome along the external wall of the orbit, and putting the nerve on the stretch by drawing the eyeball strongly forwards and inwards. The usual enucleation will succeed this section of the nerve. The end of the nerve is to be freed, and the conjunctival wound brought together with a suture.

If a glaucomatous condition has actually developed itself and if (owing to posterior perforation) the eye is very much protruded, it will be advisable to remove the contents of the orbit (exenteratio orbitæ) including the periosteum. To effect this the palpebral apertures must be enlarged, the eyelids severed from their attachments, and the periosteum round the orbital edges incised. This can then, at a certain distance from the edges, be removed with a blunt instrument. A bridge of periosteum, of one or two centimetres in extent, should be allowed to remain near the external commissure, but the whole conical mass, formed by the periosteum and contents of the orbit, must be taken away. It has further been recommended to scrape the surface of the bone, and cover it with small pledgets of lint soaked in chloride of zinc. But by doing this, necrosis is rendered inevitable, whereas it may not always follow removal of the periosteum. The fact that there is on record one cure after relapse, obtained by completely emptying the orbit (*Volkmann*), even although in this case the optic nerve was not affected close to the foramen, imposes the duty of attempting similar operations. They are, however, very formidable on account of the hæmorrhage they give rise to. This cannot easily be controlled, owing to the depth at which the parts are situated. Moreover, compression of the carotid is impossible in children under the influence of an anæsthetic.

The surgeon must bear in mind that, if he does not remove the growth entirely, and particularly if he does not divide the optic nerve high up, he may witness a few weeks after his operation the budding of a fresh growth from the orbit, which will quickly assume very formidable dimensions. It is said that when removal has been complete and thorough, children, even though in a most feeble state of health, rapidly recover strength. Cases which have shown no signs of recurrence after a lapse of more than six years, are proofs that the disease, if taken in time, can be cured.

I shall finish this sketch of diseases of the retina, by mentioning a peculiar physiological condition. This you should be acquainted with, so as not to take it for a morbid appearance, or for the fatal malady I have just been speaking of. It consists in the continuation for a certain distance within the eye, of the myeline sheath of the nerve fibres. Patches of these *fibres à double contour* are often met with about the papilla, the whole or the greater portion of which they leave free. Such patches generally follow the course of the larger vessels, and terminate in flammiform processes near the periphery of the retina.

With a sufficiently high magnifying power it is not difficult to see that these pearly or yellowish-white patches break up into fibres, which partly overlie the large vascular trunks, and that they do not quit them until near the periphery of the patch. The vessels themselves and their walls remain unaltered. When these patches extend a considerable distance towards the periphery, they follow the distribution of the nerve fibres, and bend round the macula, which however, they never invade (the case reported by *M. Hirschberg* is, however, the single exception). An examination of the mode in which the *fibres à double contour* become scattered, and the fact that in spite of the changed appearances of the parts in the immediate vicinity of the optic nerve, the papilla itself is unchanged in position, and is the seat neither of swelling nor inflammation, will be sufficient to show that there are here no morbid changes. The direction of the vessels, which is normal, and their dimensions, which continue relatively unchanged, will confirm the diagnosis.

The disturbance of vision in such a case will consist merely in an enlargement of the blind spot of Marriott, corresponding to the size of the patch. It is, however, also true that in such eyes a certain amount of torpidity or congenital amblyopia may be met with. This will explain how it is that even after exact correction of any existing errors of refraction, the affected eye will be inferior to its fellow in visual acuity. Where such is the case, it would be quite allowable to attempt to stimulate vision by hypodermic injections of strychnine.

DISEASES OF THE OPTIC NERVE.

LECTURE XXXVIII.

ANATOMY; VARIOUS FORMS OF INFLAMMATION OF THE OPTIC NERVE.

Any very minute description of the histology of the optic nerve would be out of place in these lectures. Nevertheless, in order to make clearly intelligible certain lesions, which this nerve is subject to, together with their rational treatment, it will be necessary to consider at some length its sheaths, lymphatics, and blood-vessels, more especially those of its orbital portion.

The optic nerve possesses two sheaths. One of them is a prolongation of the dura mater, and passes, together with the nerve, into the orbit. During this course the external portion of the dura mater forms the periosteum of the orbit, while the internal accompanies the nerve, and forms its external sheath. Its internal sheath is formed by a continuation of the pia mater, or rather, the internal neurilemma which follows the nerve from the chiasma. The space comprised between these two sheaths is known as the *intervaginal* or *subvaginal space.*

The union of the two sheaths becomes really intimate only in the upper portion of the optic canal. Here the external layer is adherent externally to the bone, of which it forms the periosteum, but internally to the inner sheath of the optic nerve; this inner sheath is thus in a manner fixed to the bone, while the rest of the intervaginal space between the two layers is perfectly free, even where it passes through the optic canal.

The internal sheath of the optic nerve is in direct continuity with the neurilemma, and cannot be detached from it. But the external sheath may be readily subdivided into an external fibrous portion, and a thin layer similar in structure to the arachnoid, and which has received the name of *arachnoidal sheath.* The external sheath, though thus composed of a dural and an arachnoidal portion, forms in ordinary conditions but one sheath. Its two portions are separated by a capillary space which, near the point where the sheath becomes inserted into the sclerotic, disappears entirely. There is thus under normal conditions but one space between the sheaths of dura and pia mater, namely, the intervaginal.

The subdural capillary space situated in the external sheath itself, and separated from the intervaginal space, by the leaf of arachnoid, ends under normal conditions near the eyeball. But in most affections of the brain and its membranes, it becomes dilated near the insertion of the nerve into the sclerotic. There is thus formed a subdural space, separated by the arachnoid from the internal sheath, and the intervaginal space which becomes more or less destroyed. This space may be called the *subarachnoid.*

In health there is really only one intervaginal space round the optic nerve. In disease, however, the division of the external sheath into two layers, results in the interposition of an arachnoidal fold, between a subdural space externally, and a subarachnoid space, the latter being in intimate connection with the sheath of pia mater, and the proper nerve substance. Some morbid conditions must therefore be present before we can separate the neurilemma, or sheath of pia mater, the loose tissue, the *arachnoidal sheath,* and the fibrous envelope or sheath of dura mater from one another, in such a way that the sheath of pia mater and the arachnoid fold shall form a subarachnoid space, and the fold of arachnoid and the sheath of dura mater, a subdural space. These two spaces are normally thrown into one and form the intervaginal.

Near the insertion of the nerve into the globe, the subarachnoid space dilates into an ampulla. The subdural space, on the other hand, becomes obliterated by the union of the arachnoid with the dural fold. The two folds now united form the external two thirds of the sclerotic. The sheath of pia mater, on the other hand, attaches itself to the nerve to form its internal neurilemma, and is continuous with it as far as the choroid. There it forms the inner third of the sclerotic. The subarachnoid space extends a short distance under the choroid in a conical form, becomes finally shallower, and is only separated from the choroid by the thin portion of sclerotic formed by the pia mater sheath. The optic nerve is thus embraced closely by but one third of the thickness of the sclerotic; the remaining two thirds being lost in the external sheath of the nerve.

This subarachnoid space extends to a variable distance under the choroid, according to the shape of the eye. It gradually narrows down and terminates abruptly, forming with the intervaginal space, of which it is a continuation, an equilateral triangle (fig. 24, *sa*, right side). Generally we find the sub-

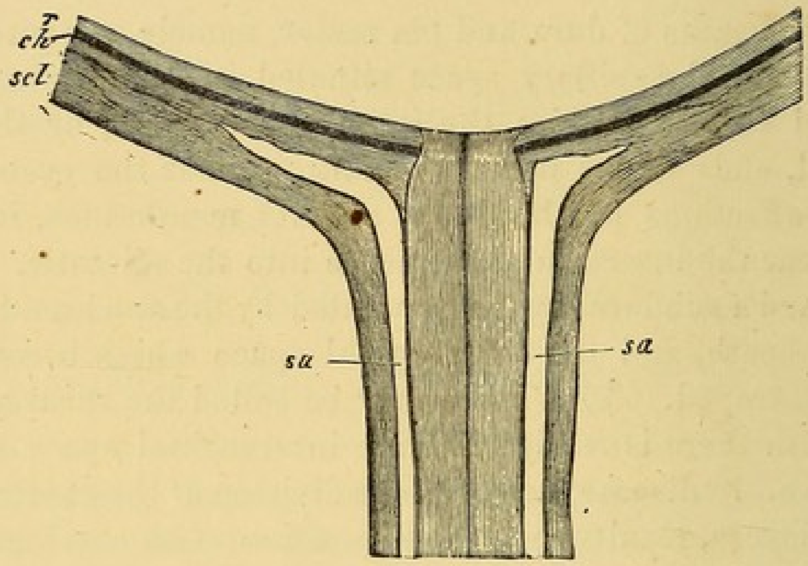

Fig. 24.

arachnoid space prolonged more on the external side of the globe than on the nasal. It becomes considerably enlarged, where, as this drawing (fig. 25), borrowed from *Von Jaeger*, shows the nerve tissue has atrophied and disappeared.

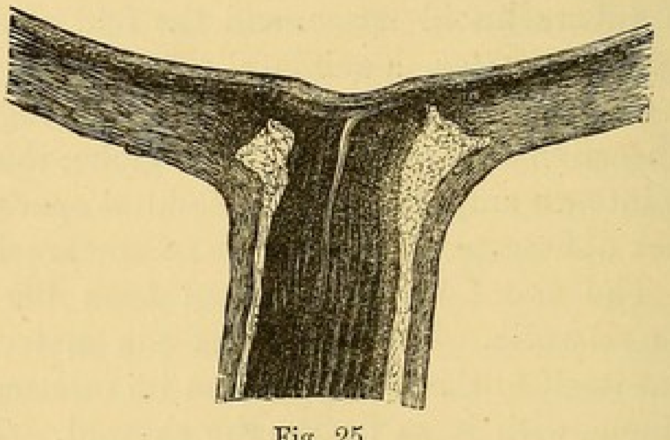

Fig. 25.

If we now examine the optic nerve from without inwards, we shall find a sheath of *dura mater* (fig. 26, *d*), very fibrous, dividing into various layers, near its insertion (fig. 26, *scl*) into the sclerotic. The fibrous tissue of this is honeycombed by canals, lined with very fine smooth endothelium.

The arachnoid sheath (fig. 26, *a*), which is attached to the external sheath by trabeculæ of cellular tissue, approaches, in structure, the arachnoid of the brain and spinal cord, quite as much as the external sheath does the dura mater. It forms a plexus of regularly disposed trabecular fibres, enclosing sometimes round,

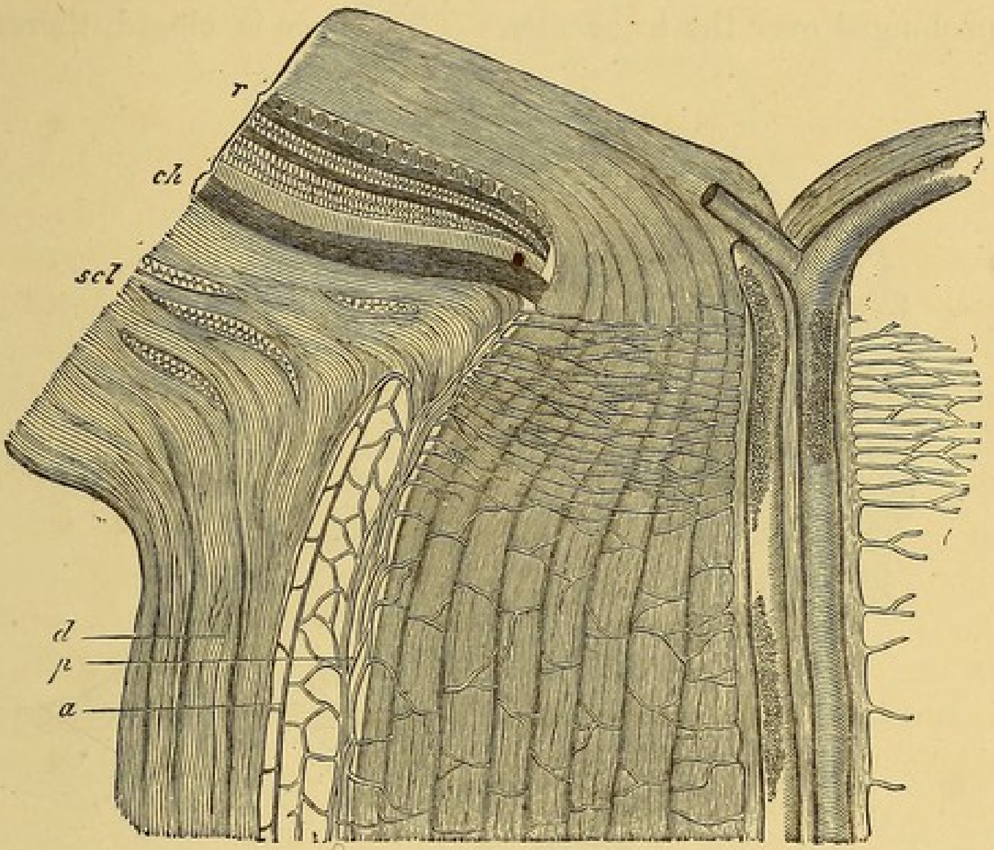

Fig. 26.

sometimes oval spaces. These are covered, as the drawing of *M. Schwalbe* shows (fig. 27), by a thin layer of endothelium, which is spread over the external aspect and lines the trabeculæ, which connect the two sheaths together. Thus the space comprised between the two sheaths, namely, the subdural space, is clothed with endothelium. Nevertheless, it is highly probable that the continuity of this is not perfect, but that openings exist between the dural and subarachnoid spaces.

From the internal surface of the arachnoidal sheath other trabeculæ spring. These do not, like those attached to the external sheath, follow a direct course (fig. 26), but form a network, whence numerous ramifications are given off (fig. 27). These form the subvaginal trabeculæ, and are inserted into the subjacent or pia mater sheath.

The sheath of *pia mater* (fig. 26, *p*), which, like the pia mater of the cord, directly surrounds the nerve, may be divided into an internal and external layer. The former contributes the cellular tissue found with the fasciculi of nerve fibres. The latter is composed more of cellular fibres, from the external surface of which the subarachnoid or subvaginal trabeculæ already mentioned are given off. The surface is further covered by endothelium, which is prolonged over the trabeculæ. This space is closed, therefore,

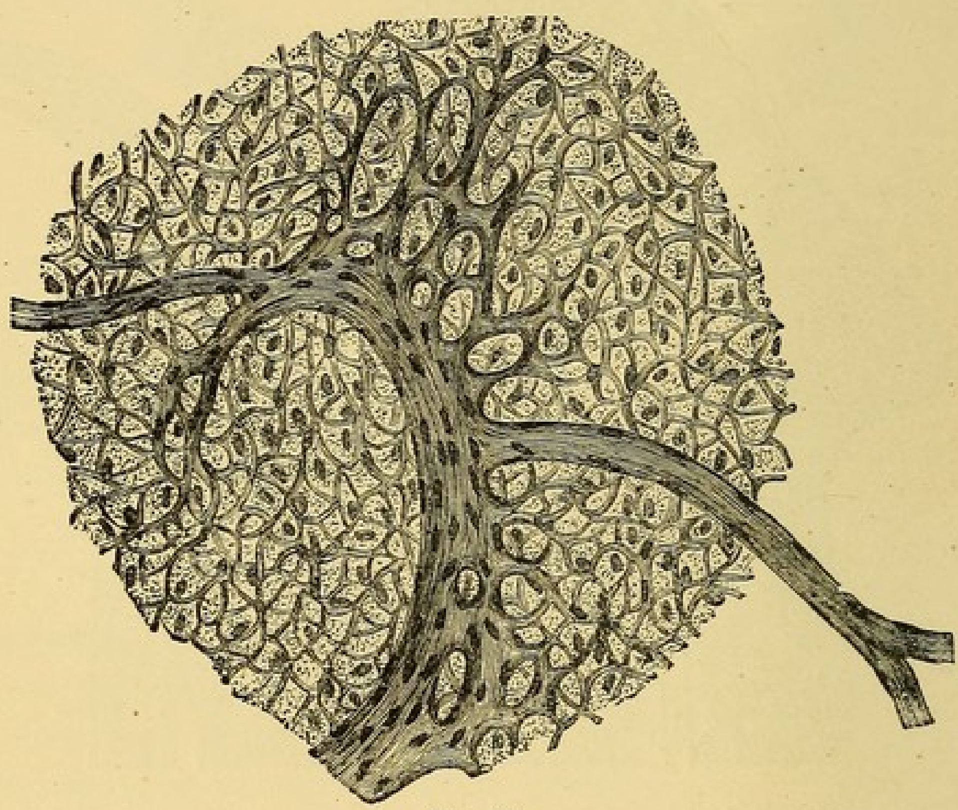

Fig. 27.

throughout by endothelium, which is met with again in the delicate interlacings of the arachnoidal sheath.

A glance at this preparation of *M. Schwalbe* (fig. 28), will show the arrangement of the sheath of pia mater within the nerve. The section of the nerve has been made just posterior to where the central vessels (fig. 28, *v*) enter, and shows the distribution of cellular tissue at that point. The arrangement of the perivascular cellular tissue imparts a horse-shoe appearance to a section when made in the same plane as the vessels. The manner in which the sheath of pia mater is fused with the cellular tissue proper of the optic nerve thus becomes evident.

The condition under which the blood and lymph circulate, are full of interest. The narrowest portion of the optic nerve is where it passes through the choroid, which forms a still narrower ring than that of the sclerotic. The thickness of the nerve, which generally is about three millimetres, is here diminished one half.

This diminution is accounted for by the fact that the nerve fibres, in passing through the lamina cribrosa, part with their sheath of myeline.

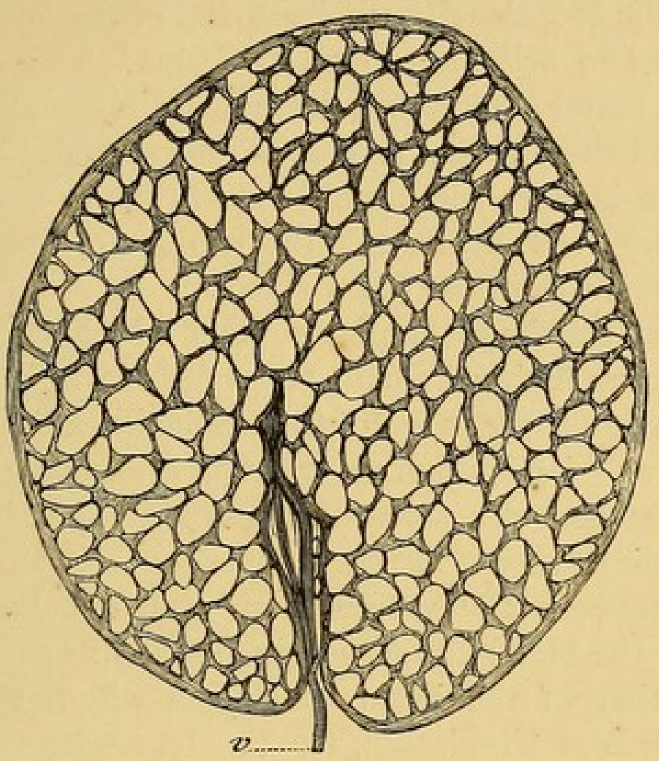

Fig. 28.

The offshoots which the sheath of pia mater transmits at its termination in the sclerotic between the fasciculi of nerve fibres, may be regarded as coming from the sclerotic, and form the lamina cribrosa. Numerous vessels, branches of the short ciliary arteries, pass through the nerve at this point, and constitute the circle of Haller. The profusion of vessels is here so great that the lamina cribrosa may be considered as a network of adventitious tissue. The vessels of the papilla come from the central vessels of the nerve, from the scleral ring, and from the external sheath. But there is no direct communication between the vessels of the disc and those within the cranium, as the vascular branches from the sheaths connect only with those within the orbit.

The lymphatic circulation is peculiarly important. As *M. Schwalbe* has demonstrated, the subdural and subarachnoid spaces communicate directly with the corresponding spaces of the cerebrum. There is, therefore, no difficulty in injecting these spaces from the brain. But they always fill simultaneously, nor can the injection be sent into either space separately. In proportion as pressure is used to make the injection run, the colouring matter traverses the external fibrous sheath, following, in all probability, the endothelial-lined channels within this sheath. It not only passes, however, along the external sheath, but also gains the subarachnoid space, close to the insertion of the nerve. It passes by the portion of sclerotic which is formed here chiefly by the sheath of pia mater, but accumulates at its internal surface, filling a space around the papilla, named the *perichoroidal space* (*Michel*). This injection is more successful in men than in animals, because it passes more readily through the canaliculi, lined as they are with endothelium from the dural sheath.

A system of canaliculi similar to that which traverses the external and internal sheaths, and the sclerotic immediately round the papilla, obtains throughout the whole intraorbital portion of the optic nerve. In the lamina cribrosa the network of canaliculi and lymphatics becomes somewhat less extensive, but the spaces which compose it become larger. The result is to facilitate communication between the subarachnoid and subchoroidal spaces. If, therefore, the blood circulation in the papilla is perfectly independent of that of the brain, the same will not hold good as regards the lymph circulation, for the lymphatics of the lamina cribrosa communicate directly with the dural and arachnoid spaces.

Let us for the moment leave out of consideration all cases where direct compression of the nervous tissue has determined atrophy; and where dilatation of the third ventricle (hydrocephalus internus) has caused a similar compression of the chiasma. Let us also neglect all cases where the retina has become the seat of morbid changes which have reacted on the optic nerve. When we have done this, there will still remain a series in which changes in the cerebrum or cerebellum, which have no direct connection with the optic nerve, are nevertheless followed by functional disturbances in the eye. Such disturbances, the ophthalmoscope shows, are due to an inflammatory condition of the nerve at its entrance into the eye; that is, to *papillitis*.

I must remark here that *Leber's* proposal to distinguish inflammation of the papilla, shown to exist by the ophthalmoscope, from neuritis, the existence of which we only know by induction, is thoroughly practical. The subtle distinction which *Von Graefe* drew between inflammation of the papilla, localised near the entrance of the optic nerve, and descending neuritis, spreading to the papilla and then eventually to the whole retina, has never been established, and has remained a pure matter of speculation.

What explanation can be given of this inflammation of the papilla in cerebral affections, in cases in which it is impossible that there should have been any propagation from the membranes of the brain along their orbital continuations, or from the intracranial to the intraorbital portions of the optic nerve?

Von Graefe, to whom we owe the discovery of inflammation of the papilla, suggested that compression of the cavernous sinus owing to reduction in the intracranial space, might influence the venous circulation. But if such compression were really present, although it might be quite equal to producing all the phenomena of venous stasis and œdema, it would not be equal to producing those of the inflammation, which beyond all doubt exists. It has been proved that the veins which bring back the blood from the papilla do not empty themselves into the cavernous sinus (*Seseman*). Consequently, this solution of the problem is necessarily untenable. Unable to find any explanation in circulatory influences, nervous were suggested, and the inflammation was attributed to a vasomotor neurosis (*Benedict*). This theory would have been tenable only if it could have been shown that lesions of particular regions of the brain produced such a reflex neurosis. But in reality all affections of the brain, such as tumours, which diminish the cranial cavity, may cause inflammation of the papilla.

After *Schwalbe* had discovered the communication existing between the intervaginal, and the corresponding spaces in the brain, *Schmidt* attributed the appearances of inflammation in the papilla, to pressure caused by fluid which was driven from the cavity of the cranium, and which passed between the sheaths, in other words to dropsy of the sheaths. Practically, this fluid, which is forced into the lamina cribrosa and perichoroidal space, may act as an irritant. The pressure, too, which it creates on the vessels will determine an amount of anæmia, quite sufficient in itself to induce inflammation (*Cohnheim*). Carefully made post-mortem examinations, that is to say, those in which the sheath of the optic nerve has been ligatured before the brain has been removed, have satisfactorily shown that this dropsy of the sheath is present in every case where the intracranial space has been encroached on. Cases in which this was apparently not the case could be explained by the fact of the precaution of ligature having been neglected.

This much then no longer admits of doubt, and has been accepted by all the best authorities. There is one point, however, which yet remains to be cleared up, namely, to what extent an inflammation of the sheath, a perineuritis, propagated from the membranes of the brain, is capable of causing accumulation of fluid within the sheath. Cases occur where such dropsy is met with in descending perineuritis. On the other hand, dropsy spreading from the sheaths may cause an irritation not limited to the vicinity of the papilla, but ascending. These are difficulties which more thorough pathological research will probably clear up. It is now known that dropsy of the sheaths may exist either with intracranial pressure or with inflammation of the papilla, or with papillitis combined with perineuritis. It is only in the latter that doubt can arise as to whether the accumulation of fluid within the sheaths is the cause of the inflammation. This is more especially the case when accompanying inflammation of the membranes of the brain renders it probable that the inflammation may have spread along the prolongations of the membranes into the orbit.

In order to be able to analyse, therefore, all cases in which the eye has become affected as the result of lesion of the nervous centres, we must proceed methodically. The best method to adopt will be that of *Leber*, and enquire how far each of the following influences may have been at work, namely: (*a*) dropsy of the sheaths; (*b*) perineuritis; (*c*) interstitial neuritis; (*d*) medullary neuritis. Nor must it be forgotten that the ophthalmoscope will show what is taking place only where the nerve joins the retina; the intraorbital portions of the same nerve are absolutely out of reach of our examination.

After glancing at these states and their ophthalmoscopic signs, I shall proceed to consider the diseases of the optic nerve, which depend (1) on the presence of morbid foci in the nervous centres; (2) on affections of their membranes and thrombosis of the sinuses; (3) on lesions of the orbit; (4) on idiopathic inflammations.

I shall now describe, chiefly from the standpoint of morbid anatomy, the alterations to which the optic nerve itself is liable; these are as follows:—

(*a*.) *Simple dropsy* is observed in all cases in which transudation of serum has taken place into the cerebral subarachnoid space, simultaneously with increased pressure, but not, however, in cases of suppuration. The sheath, close to its insertion into the globe, becomes dilated into a pouch, which may increase to three or four times the usual size of the nerve. The fibrous sheath is not abnormally injected. The trabecular tissue, which connects it with the internal sheath, becomes swollen by imbibition of the serum, filling the pouch. So soon as this accumulation, which is always bilateral, has reached a certain point, it becomes further complicated by strangulation of the papilla.

(*b.*) *Perineuritis* is found in company with this dropsy only occasionally. This inflammation attacks the fibrous sheath much more rarely than its inner layer, and thereby brings the arachnoid sheath conspicuously into view. The trabecular tissue which binds this intermediate sheath to the internal and external is not only œdematous, as in simple dropsy, but also becomes hypertrophied and infiltrated with leucocytes. The contents enclosed by the trabeculæ are more or less cloudy and mingled with white globules of a gelatinous consistence. When this perineuritis, which may be unilateral, attains a certain intensity, it will always become complicated with papillitis; when such is the case, the external fibrous sheath may, near the eye, visibly sympathise in this inflammation. A thickening of both sheaths, distinctly gummatous in character, is met with in syphilitic neuritis.

(*c.*) *Interstitial neuritis*, that is inflammation of the interstitial tissue, is found as a rule in conjunction with a similar inflammation of the sheaths. Infiltration by leucocytes of the trabecular tissue between the sheaths is transmitted to the insertions of the internal sheath, and the fasciculi bounding the nerve fibres. The result is hyperplasia of the tissue, and more or less complete atrophy of the nervous elements. This may sometimes proceed so far that the nerve becomes changed into a thin cord. But if the process has not been so acute, the proliferation will result in the substitution of cellular for nerve tissue with the characteristic appearances of grey degeneration.

(*d.*) True *medullary neuritis* may cause the above degeneration. This variety of neuritis does not commence in the sheaths or the interstitial tissue, but seems in a certain number of cases to have been propagated from the nervous centres, and chiefly from the chiasma. Granular and fatty cells resulting from absorption of the medullary elements appear, and eventually change the nervous tissue into a grey gelatinous mass, without any trace of nerve fibres. These changes may be induced by inflammation which had its origin in dropsy of the sheaths. But it is also met with in cases where these sheaths are absolutely healthy. It may be very slow in its course, and be due to compression of the chiasma, owing to dilatation of the third ventricle. It leads gradually to complete atrophy of both nerves.

The papilla in simple dropsy may show signs of œdema only with strangulation of the vessels; or there may be added to this, symptoms of hypertrophy of the cellular tissue, and varicose dilatation of the fibres. This will render the normal radiating striæ of the papilla very distinct, producing an appearance not unlike that of nerve fibres *à double contour*. The greatest degree of papillary œdema is found when the infiltration of leucocytes and the hyperplasia of cellular tissue have reached the retina, that is when a papillo-retinitis has been developed. This is generally confined to the external layers of the retina. This acutely inflammatory condition is followed by atrophy of the papilla, affecting more particularly the deeper layers of the retina (fibres and ganglions). In some cases a form of *peripapillary* inflammation may be developed (the *circumpapillary retinitis* of *Iwanoff*), in which the retinal tissue becomes raised up in an annular form, the papilla itself being much less affected. This inflammation does not, as might be supposed, occur simultaneously with perineuritis. Anatomical variations in the disposition of the sheaths afford the only possible explanation of why, in certain rare cases, the inflammation is confined to the circumference instead of to the centre of the disc.

The more acute a simple papillitis is, the more considerable will the œdema be. On the other hand, the prominence will seemingly be less in proportion as the retina shares in it. In simple strangulation from dropsy of the sheath, the papilla may appear like a grey mushroom, from the centre of which all vessels have disappeared. From it the veins will pass out contracted and deepened in colour. In proportion as the inflammatory symptoms become more intense, hæmorrhages with white or flammiform patches will change the aspect of the swollen disc. It then assumes once more a greyish tint, while at the same time it is invaded by atrophy which spreads from the temporal side.

Atrophy of the nerve, consequent on papillitis (*Leber's* atrophy from papillitis), may give evidence of itself by permanent changes in the vascular walls. These may assume the form of thin lines bordering the shrunken vessels. The atrophy of the nerve and of the retinal epithelium will show how far the peripapillitis has had a share in the inflammation at the entrance of the optic nerve. Generally speaking, the atrophied tissue of an optic nerve once attacked by peripapillitis, becomes peculiarly opaque, concealing the texture of the lamina cribrosa. There are cases, however, where atrophy and absorption have taken place, and have removed every trace of the preceding inflammation. Possibly in such cases the papillitis may have been limited to transudation of serum, and strangulation of the vessels.

I have stated the causes of inflammation of the papilla. Let us now see if it be possible to deduce from them any general and characteristic signs, which may guide both diagnosis and treatment.

(1.) *Inflammations of the papilla acknowledging as their cause morbid centres within the cranium,* will first engage our attention. I shall commence by speaking of *intracranial tumours.* It may be stated as a general law, that the growth of such tumours is always accompanied by inflammation of the papilla, for this has been observed to be the case in more than 95 per cent. of all cases (*Reich*). The absence of visual disturbance, the urgency of general symptoms, sometimes a sudden and fatal termination are all reasons why more attention has not been paid to the almost constant occurrence of *bilateral* papillitis. Neither the situation nor the nature of the tumour will exert any influence on the symptoms of the inflammation. Certain tumours at the base of the brain may, however, act more directly on the nerve, and cause atrophy by compression. This compression may even precede the symptoms of papillitis, and may also interfere with resolution. It would appear that the only circumstance which can affect the course of the papillary inflammation is, the greater or less rapidity with which the intracranial space is reduced. In this way, the nature of the tumour will have a certain importance, inasmuch as rapidly-growing tumours, such as sarcomata, may cause a more acute form of papillitis.

It is not uncommon to find very symmetrical strangulation of the disc, with contraction of the veins, and ischæmia of the retina. In such cases the ophthalmoscope will enable us to say that the stasis present in the disc, is due to the growth of an intracranial tumour. The mirror *alone* will, however, give no information as to its position or nature. If in consequence of the slow growth of the tumour, the symptoms of strangulation and inflammation are not well marked, there may be some hesitation as to the diagnosis between inflammation of the papilla and certain forms of retinitis. The same will be the case where atrophy has followed a similarly badly-marked papillitis, or where an inflammation has left no traces of itself. The conclusion that such a condition is due to an intracranial tumour becomes impossible at a particular stage of the disease, from the mere examination of the fundus.

Impairment of vision in such cases will not furnish any precise data. Derangements of circulation, and in the grouping of nerve elements, may arise from stasis only, that is from œdema, or from proliferation of cellular tissue, or from varicose dilatation of the nerve fibres. The less rapidly these disturbances have taken place, the less will the impairment of vision be. Nay! it may be difficult to find any at all, unless it be some enlargement perhaps in the blind spot of Mariotte. We must not be surprised to find at times a very slight impairment of vision accompanied by most striking ophthalmoscopic appearances. Tumours have actually been found in the substance of the optic nerve itself, separating and damaging the nerve fibres extensively, but nevertheless not destroying sight.

When compression of the vessels induces true ischæmia of the papilla, the same result must necessarily follow as is seen in cases of arterial pulsation. The field of vision will be contracted or destroyed agreeably to what is observed in the backward pressure of the papilla in glaucoma. The forcing back of the papilla may in these cases have the same result as regards progressive destruction of the field of vision as the bulging forwards has. The atrophy, however, which accompanies or follows this latter, almost always produces later on a less characteristic field of vision than glaucoma, in which atrophy is accurately correlated with the amount of pressure backwards.

The difference is rendered still more striking by another characteristic. Thus, in uncomplicated glaucoma, the perception of colour is not impaired in portions of retina where pressure has not destroyed the conducting nerve fibres. Therefore, if by operation the further spread of the disease is checked, these portions will preserve their normal functions. On the other hand the atrophy consequent on pressure backward and on the degree of papillitis makes itself felt over the whole retina, especially as regards the perception of colour. Just as there may be sudden and total loss of sight, as a consequence of instantaneous and intense glaucoma, so there may also be as the consequence of strangulation and ischæmia of the retina. The dropsy of the sheaths may, in such cases, have been caused by some sudden increase in the size of a tumour, or the development of an acute hydrocephalus.

Papillitis is found almost without exception on both eyes simultaneously. Out of 88 cases it was observed in 82 by *Anuske* and *Reich*. But owing to the anatomical disposition of the optic nerve at its entrance, the affection need not take exactly the same course on both sides. Thus one eye will often, to a great extent, escape, while the other will perhaps lose completely all power of vision, although its ophthalmoscopic appearances may differ little from those of its fellow. Total blindness is only too much to be feared if the inflammation of the papilla has been well marked.

Diagnosis will be aided not only by the ophthalmoscope, and the condition of vision, but also by the presence of symptoms of cerebral compression, such as may be elicited from patients themselves. These are severe headaches, vomiting in the morning, epileptiform attacks, etc. Such symptoms may, however, be wanting, if compression takes place slowly, and allows the nervous centres to become, as it were, tolerant of the pressure. In such cases, nothing more will be noticeable than a certain torpidity of the brain, betrayed by a loss of memory, a change of disposition, moodiness, indifference, etc. These symptoms will vary in degree according to the reduction that has taken place in the cranial cavity. Small tumours, by producing a hydrocephalic condition more or less acute and transitory, may produce symptoms of very considerable irritation. Consequently we cannot, from mere intensity of phenomena, draw any inference as to the size of the tumour.

Nor has it been as yet shown how far tumours situated at the circumference of the hemispheres, and about the base of the brain can determine inflammation of the membranes, which may be propagated along the sheaths of the optic nerve. It is to be borne in mind, too, that tumours may cause hæmorrhages, which may find their way beneath the membranes of the brain. Simple centres of cerebral softening (by embolism) do not cause inflammation of the papilla; but large accumulations of blood or pus in the hemispheres (not in the cerebellum) may do so, probably by giving rise to internal hydrocephalus.

In a few cases only can treatment exert any real influence, and these will be mainly in gummata of specific origin. In these, a course of mercury will sometimes act wonderfully, especially if iodide of potassium, in the form of enemata, be combined with it, to the extent of 2 or 3 grammes daily (31 to 47 grs.).

As regards treatment, the fact must be thoroughly recognised that both mercury and iodide of potassium will be efficacious, according to the rapidity with which a given quantity can be absorbed. Thus, while inunction during a fortnight of from 12 to 16 grammes of mercurial ointment daily (186 grs.—248 grs.) may produce marvellously good results, the same quantity of ointment extended over four or six weeks, will give very indifferent ones. This is still more clearly shown with iodide of potassium, 10 to 12 grammes (154—186 grs.) of which given daily by the mouth and in enemata, will rapidly cause improvement in cases which have remained unaffected by 2 or 3 grammes. Such vigorous treatment need cause no alarm, as, even if a syphilitic tumour is not present it can produce only beneficial effects, inasmuch as it will lessen the cerebral irritation (and consequently the pressure) caused by the tumour.

But in proportion as I would recommend energetic treatment so would I discountenance all unnecessary torturing of patients by setons, large blisters, repeated bleedings, and infinitesimal doses of biniodide of mercury, all of which simply exhaust, without producing any corresponding benefit.

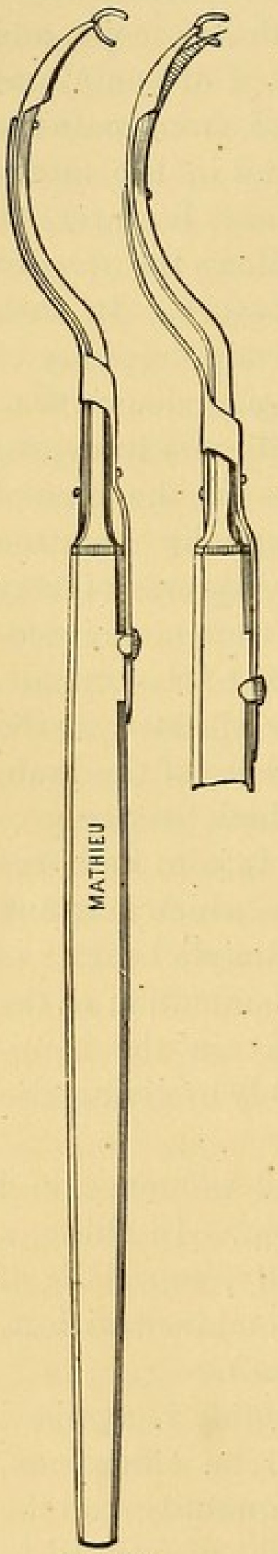

Fig. 29.

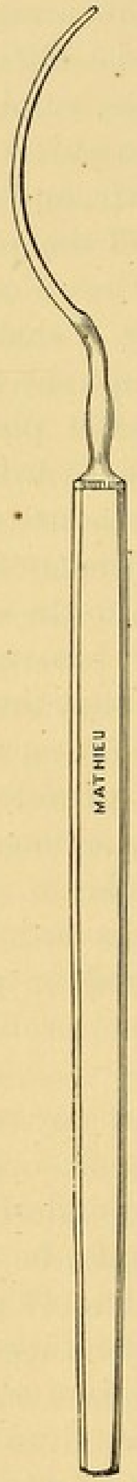

Fig. 30.

In the hope of perhaps relieving patients suffering from excessive cerebral compression with well-marked strangulation of the papilla, I have proposed establishing drainage, or what is perhaps better, tapping the cranial cavity by incising with a neurotome the external sheath of the optic nerve near its insertion (fig. 29). This operation has been performed in four cases, once by *Mr. Power*, and three times by myself, and produced a decided calmative effect. It might be very useful in preventing the evil results of strangulation of the papilla. The inner portion of the sheath of pia mater, which forms the inner third of the sclerotic, or in other words, the narrow ring through which the nerve passes, should be cut across.

In order to reach the optic nerve, the eye must be well drawn upwards and inwards, and the ocular conjunctiva divided freely near the equator, between the external and internal recti muscles. The capsule of Tenon should be divided with scissors, which are to be kept closed as much as possible. When near the optic nerve, a grooved director (fig. 30), is introduced through the opening in the conjunctiva, or a spoon such as that which *de Weltz* and *Trélat* use in enucleation to guide the scissors. This spoon is placed against the globe and in contact with the nerve, the eye being turned well upwards and inwards. The neurotome is then passed along the spoon, and the sheath incised. If it be wished to direct this incision towards the sclerotic ring, the spoon must be replaced by the neurotome, and withdrawn at the moment when this latter reaches the optic nerve. During the incision of the ring, the eyeball must be kept well luxated, by the neurotome only.

I am persuaded that as surgeons become more convinced that dropsy of the sheaths is correlated with cerebral compression, and that the cerebro-spinal fluid should in such cases be afforded a free vent, there will be less hesitation about making this opening. As a matter of fact, once the conjunctiva has been closed, it can cause no bad results, particularly if the cutting edge of the neurotome has been previously carefully set. If I have myself only occasionally performed this operation, it is because I have only occasionally met with suitable cases. It is an operation at once soothing and harmless and especially calculated to benefit patients prostrate with the torpor and coma of brain compression.

M. Benedict, and after him *M. Driver,* have recommended interference during the acute stage of the inflammation. This interference they direct more especially to the sympathetic nerves, which, as they allege, may induce congestion in the papilla, by stimulating the vasomotor fibres. Electricity in these cases is said to have had a beneficial effect on the headache, the vertigo, and the passing impairment of sight, as well as on the accompanying muscular paralyses. A battery of six to eight cells should be used; the positive pole is placed on the back of the neck, where it is to remain *unmoved* during the application, which should not be extended beyond two minutes. The negative pole is applied near the superior cervical ganglion or above the lower angle of the jaw, or over the closed eyelids. Too much caution cannot be taken in the use of such methods, where vertigo and marked symptoms of cerebral oppression are present. They should be at once discontinued if the headaches, instead of being relieved, are aggravated.

In treating the results of papillitis, that is atrophy, there need be no hesitation about having recourse to continuous currents, directed over the temples and the mastoid processes. In order to stimulate the retina, a series of injections of strychnine may be given along with the currents (p. 32). The use of these injections must of course be limited, nor are they indicated at all, until the cerebral symptoms have completely disappeared.

(2.) We meet with papillitis rather as *papillo-retinitis* in cases of *meningitis, thrombosis of the sinuses,* and in the acute form of *hydrocephalus.* In simple meningitis in children, competent observers say that papillitis or papillo-retinitis is rare. In such cases nothing is to be seen but simple œdema of the papilla, the result of dropsy of the sheaths (*Manz*). Congestion with slightly increased prominence of the papilla is not uncommon. It is possible that in these cases it is the fatal issue which anticipates the signs of compression in the papilla, and prevents their becoming more marked. On the other hand, however, children are from time to time brought here in whom a simple form of atrophy has succeeded slight congestion of the disc following meningitis.

It is chiefly tubercular meningitis in children, confined to the base of the brain, and the epidemic form of cerebro-spinal meningitis, which afford opportunities of studying directly the development of papillo-retinitis. As a rule it does not lead to extensive hæmorrhages or to white patches (*Leber*). These inflammations moreover do not attain to anything like the intensity of the papillary inflammation caused by dropsy of the sheath. The brilliant reflex, which depends on the prominence of the disc, and which is mentioned by most authors, is by no means pathognomic, but bears a relation to the youth of the patient.

Unless tubercles of the choroid appear in conjunction with tubercular meningitis, the accompanying papillo-retinitis, and hyperæmia of the disc present no characteristic appearances. Similarly thrombosis of the sinus determines an analogous form of abortive papillo-retinitis. This is sometimes noticed to be worse on the side where the thrombus is situated, and is seen in conjunction with chemosis of the conjunctiva and protrusion of the globe, which are far more significant signs than any inflammatory symptoms centering round the papilla.

Very frequently papillitis is met with in conjunction with congenital hydrocephalus in children. Generally simple atrophy of the optic nerves becomes developed in correlation with the increase in size of the head. Internal hydrocephalus, with dilatation of the ventricles, especially of the third, with flattening of the corpora quadrigemina, the tractus opticus, and chiasma is very rare in adults. In such a case the absence of all cranial deformity would render the diagnosis very difficult.

This short sketch may serve to show how useful, as touching the *nature* of the cerebral affections from which children may be suffering, it is to be able to recognise the presence of hyperæmia, or of inflammation of the papilla, or of inflammation of the papilla and retina. It is scarcely possible to draw any conclusions as to the *degree* of the intracranial pressure, or the reduction of space caused by the morbid products. We have no means of knowing when inflammation or compression of the papilla is due to simple dropsy, or to actual propagation of inflammation to the sheaths, in other words to descending neuritis. Hence, some opinion may be formed of the value of the so-called cerebroscopy. This has indeed been surrounded by a mass of elaborate details, which will appear very suspicious to any one who is accustomed to the ophthalmoscope, and knows, therefore, what it is to detect small differences in size or position in fidgety, nervous children. In adults inflammations of the papilla are sometimes to be met with, which, taking into account the cause (wounds, sun-stroke), the symptoms, and especially the course they run, must be regarded as depending on circumscribed basilar meningitis. This lasts, together with symptoms of irritation about the papilla, for some weeks, and then ends in more or less well-marked atrophy.

It is especially such cases, and cognate ones in children apparently free from tuberculosis, which can be very favourably influenced by the same energetic treatment as described for cerebral gummata. In children revulsive treatment should never be attempted, as it only robs them of a precious means of cure, namely, rest. Ice to the head, mercurial inunctions and calomel internally, will be the basis of treatment. The best means of dealing with the dregs of the disease, that is, the atrophy of the nerve, will be by continuous currents and injections of strychnine, remembering always how sensitive children are to this drug.

(3.) *Changes in the optic nerve resulting from disease in the orbit* (cranial malformations), exactly represent the way in which intracranial morbid changes act on the optic nerve. We find conjointly with tumours of the orbit, dropsy of the sheath, papillitis, and papillo-retinitis; with periorbital inflammation, descending perineuritis, and with acute inflammation of the adipose tissue, interstitial inflammation. Nevertheless, as a rule, the development of affections of the papilla and its neighbourhood keeps pace with the orbital affection. They are often evolved almost imperceptibly, or remain abortive, and do not induce atrophy for years. During all this period the traction on the nerve caused by protrusion of the eye will have been remarkably well borne, and no perceptible impairment of vision will have resulted.

The seat of the affection will be readily diagnosed by the fact that the papillitis is unilateral, and is accompanied by more or less exophthalmos. What is more difficult to decide is how far direct pressure has acted on the nerves and vessels, how far serous or sanguine effusions have taken place in the sheaths, or how far the inflammation has been propagated directly. This inflammation may be the result of orbital tumours, of periostitis, of caries or abscess, of extravasations of blood or of erysipelatous inflammations. Diseases in the cavities adjoining the orbit, as in the frontal sinus or antrum, from decayed teeth, may also influence it.

The discovery in each particular case of the cause to which the symptoms are due, is rendered the more difficult by our ignorance of the direction of the lymph currents in the sheaths. We are therefore unable to say whether or not the intervaginal fluid passes back into the cranium. If it does, then a slight degree of compression around the optic foramen will explain the œdema of the papilla, and the anæmia of the retina, as met with in certain cases of congenital hyperostosis of the cranium.

Owing to the variety of causes which can induce inflammation of the papilla, it is not possible to lay down any particular line of treatment. The great object of any line of conduct that may be adopted, should be to relieve the optic nerve as quickly as possible from any compression or irritation which may be present.

LECTURE XXXIX.

IDIOPATHIC AFFECTIONS OF THE OPTIC NERVE.

(4.) THE *idiopathic affections* of the optic nerve form a group of diseases which may be subdivided into *inflammatory* and *non-inflammatory*. The former will comprise: (*a*) *retro-bulbous neuritis*, (*b*) true *syphilitic papillo-retinitis*, and (*c*) *hereditary neuritis*; the latter, the various forms of *atrophy*.

(*a.*) *Retro-bulbous neuritis* is characterised ophthalmoscopically by a very considerable reduction in the size of the central retinal vessels, without their being however complete abolition of circulation, for pressure upon the eye will always cause arterial pulsation. There is moreover some slight œdema, and prominence of the papilla, while a greyish opacity borders the trunks of the main vessels. The cloudiness does not extend further over the retina than two or three diameters of the pupil. In cases which I have observed from their commencement, I have noticed that the ischæmia together with the pallor and the greyish cloudiness of the papilla, were the only symptoms afforded by the ophthalmoscope. Some days later, œdema would appear along the large vascular trunks, conveying the impression of fluid having come from the edge of the papilla and poured itself over the choroid. I have most certainly seen at this period a flammiform hæmorrhagic patch on the border of the papilla, which had no connection with any vessel, so that judging by appearances, it must have come from the edge of the disc.

The appearances of ischæmia of the retina together with peri-papillary œdema may persist for some weeks. After this, according to the severity of the disease at the outset, the circulation either becomes re-established, or signs of atrophy begin to appear, with perceptible diminution in the size of the vessels and disappearance of nerve substance, while the tissue in front of the lamina cribrosa becomes more or less deficient in transparency. As a rule, retro-bulbous neuritis appears suddenly, often in both eyes, is accompanied by periorbital pain, and has one characteristic symptom, namely, that pressure on the eyeball forcing the optic nerve backwards is accompanied by a certain amount of pain.

The subjective symptoms will vary according to the intensity of the affection. Thus cases have been known where blindness in one or both eyes has occurred in an instant. In such cases the amaurosis, which at first appeared so unaccountable, considering the slight symptoms of papillary œdema and anæmia, could later on be explained by the apparition of complete atrophy of the optic nerves. If the disease is not so severe as this, and if only partial atrophy occurs, its nature will be revealed by a more or less complete loss of colour, sense, and by the almost constant presence of a central scotoma. The cause of this is the ischæmia, which has become complete in the ultimate and finest ramifications of the central artery, that is to say, around the macula.

This affection is met with chiefly as a result of the suppression of normal excretions, such as the perspiration, or the menstrual flux. It is also met with in the course of febrile diseases, especially exanthematous typhus, small-pox, malignant scarlatina, measles, and in acute articular rheumatism. It is found in lead poisoning, and after diphtheria, and is frequently associated with a peculiar tendency to repeated attacks of epistaxis.

As regards the ætiology of the affection, I think that the suddenness of its appearance should exclude all notion of retrobulbous perineuritis or interstitial neuritis, and should dispose us, in the absence of actual pathological demonstration, to admit the possibility of some sudden compression of the circulatory channels, and the proper nerve fibres. Such compression might be produced by *acute dropsy* of the sheaths, by occlusion of the vaginal space within the optic canal, with retention of the intervaginal fluid, and, what to me appears the most probable of all, by *hæmorrhages* into this same space. The more I see of such cases, particularly when I can follow them from the commencement, the more I am inclined to agree with *Magnus,* and to believe that numbers of cases which simulate the course of embolism, should be attributed to intravaginal apoplexy. Let me remind you how common it is to see these retro-bulbous neurites, with the ophthalmoscopic appearances of embolism, follow immediately upon a fit of coughing, or vomiting, or straining, or after the patient has been exposed to severe cold, which has determined congestion of the head.

Starting from the proposition that the object here is to bring about resorption as quickly as possible of the sanguine or serous effusion, derivative treatment should find its proper share. The cutaneous and especially the salivary secretions should be stimulated by injections of pilocarpine. Warm mustard foot-baths should be prescribed, the feet being wrapped up immediately afterwards in warm flannel. It is well also, if the general health will admit of it, to have recourse to a methodical use of saline purgatives. Great benefit may also be obtained from a judicious employment of Heurteloup's artificial leech, which is to be applied six or eight times, each application being succeeded by a period of twenty-four hours in a dark room.

In the case of women, it is very necessary to pay attention to the menstrual function, and to any uterine affection that may be present. This, particularly if it be retro- or anti-flexion, should be treated without delay, and every effort be made to re-establish the catamenia.

It has been attempted to check retro-bulbous neuritis by direct treatment, especially by cold. Refrigerants may be employed with advantage if the catamenia do not return, and if there is some reason to fear temporary congestion of the head during the period. When refrigerants have been laid aside, they may be succeeded by periorbital inunctions of mercury.

In chronic cases, cutaneous derivation by means of large blisters, or by painting the back of the neck with cantharidine (p. 184), has been largely tried. Many authors do not hesitate to recommend their patients a seton, but I much doubt whether they would be prepared to make trial of it in their own persons. In such cases either a course or enemata of iodide of potassium, and, in the case of delicate patients, tonics, appear to me the most rational treatment.

When dealing with the after-effects of the disease, and if the atrophy is becoming more pronounced, I have recourse to continuous currents and injections of strychnine.

(*b.*) In the period of transition between secondary and tertiary symptoms, a form of *syphilitic neuritis* or *papillo-retinitis* is met with, which I am disposed to consider as a gummy form. The absence of all cerebral symptoms, except headache, which does not exist in all cases, leads me to think that the gummy tumour is not situated intracranially. It is quite possible for such a growth to be localised on the fibrous sheath of the nerve, and even close to its scleral insertion. I have shown some of you two cases of true scleral gummata, where the tumours were developed in the equatorial region of the eye, leaving the subjacent choroid intact. The same process may take place posteriorly in the optic sheath, and as *M. Horner* has actually succeeded in demonstrating *post mortem*, this gummy thickening may be met with even beyond where the nerve passes out of the orbit, so that both nerve and chiasma may become changed into a gummatous proliferation (*Von Graefe ; Arcoleo*).

The symptoms of retro-bulbous neuritis bear but slight resemblance to that strangulation of the papilla which causes papillitis, but in the syphilitic variety we have the most typical forms of papillitis, and especially of papillo-retinitis, the inflammation at times extending far on to the retina, and even invading the macula. The difficulty in diagnosis does not turn here upon the difference between a specific choroido-retinitis and a papillo-retinitis, which, indeed, is totally distinct from it. It turns rather on judging how far the gummy tumour is situated from the optic nerve and its sheaths, and whether it is not in some distant portion of the cranial cavity. A study of the concomitant symptoms will throw light on these points. Up to the present time I have met with papillo-retinitis only in acquired syphilis, not in hereditary. I may here remind you once again of the doctrines I have laid down relative to the treatment of specific tumours. A very thorough course of inunction must always be the first step towards a cure (see p. 425).

(*c.*) *Hereditary neuritis* and *atrophy* is sufficiently rare. Some six years ago a series of six patients, all members of the same family, presented themselves at this clinique and furnished *M. Prouff* with material for a thesis (1873). Since then I have met with other cases, in one of which, strange to say, there was direct transmission from mother to son. This form of neuritis has certain characteristics, which make recognition easy. If the case is examined in the earlier stages, a very slight papillo-retinitis, or rather an obscure retro-bulbous neuritis is visible with the ophthalmoscope. After a certain time, these signs of retinal effusion and papillary œdema disappear, leaving behind them atrophy, which is generally incomplete, together with a good deal of opacity of the nerve tissue.

As regards its influence on function, this neuritis is very similar to the retro-ocular neuritis described above. There appears at the commencement of the affection a central scotoma, in which both vision and colour sense are quite lost. If the sight does not become more impaired, the colour sense may possibly be preserved over the remaining portions of the field of vision. If the atrophy has spread extensively, but eventually become stationary, complete achromatopsia will result. We are sometimes surprised at finding cases in which the ophthalmoscope shows very extensive atrophy, and yet where vision is sufficiently good to enable the patient to walk about and direct his steps, the visual field not having undergone any perceptible contraction.

This atrophy is not, as a rule, directly hereditary; it passes by the first generation, but not the second. It is most commonly transmitted in the *male line;* thus, in the 55 cases observed by *Leber*, it only occurred in ten per cent. of females. It appears generally after the age of puberty, often about the twentieth year. Its most remarkable characteristic is the fact that it continues *stationary* as partial atrophy, no matter of how long standing it may be. It *always* attacks both eyes. It might almost be supposed that in these cases there was some peculiar hereditary malformation of the sheaths, favourable to occlusion of the intervaginal space. The treatment of this affection should be exactly similar to that of retro-bulbous neuritis.

I now pass on to the idiopathic affections of the nerve, which exhibit the characters of atrophy. In considering these I shall exclude atrophy of the papilla, after neuritis, as I have already spoken of this and shall consider only the following varieties, namely, (*a*) *atrophy from compression*, (*b*) *from want of transmitting power*, and (*c*) *grey degeneration of the optic nerve.*

(*a.*) *Atrophy by compression* may be the result of pressure on the nerve in its course within either the orbit or the cranium. Here inflammatory effusions and extravasations of blood, as also tumours, will necessarily play an important part. Within the cranial cavity compression may be due to distended vessels (*Türk*). Analogous effects can also be produced by a dilated third ventricle, or by the anterior lobe of the brain pressing on the chiasma, and giving rise to a tract of atrophy, which on one side may extend to the insertions of the nerves in the eye, on the other to the tractus opticus, and the corpora geniculata externa. As may be supposed, the causes which may lead to compression of the optic nerve are very various. I may mention as some of them, slowly growing tumours at the base of the brain, gummatous growths, and effusions, produced by chronic meningitis, and chronic hydrocephalus.

(*b.*) *Atrophy by interruption of conductivity* becomes developed consequent on destruction of the retina from chronic ascending atrophy, which however is not more rapid in its development than descending atrophy. In cases where it is evident that the corpora geniculata externa, and the tractus opticus are invaded, the signs of atrophy appear at a very late stage. These, on account of the partial decussation of the nerve, are localised on corresponding halves of the papilla. As some of the most common causes of interruption of conductivity, may be mentioned centres of embolic softening or of sclerosis, grey degeneration of the hemispheres, the changes premonitory of progressive paralysis, diabetes, etc.

While in cases of compression the nerve becomes more or less transformed into a fibrous cord, leaving the space which was once occupied by the nerve empty and shrivelled, atrophy from loss of conducting power exhibits on examination rather the character of grey degeneration, with a development of numerous amyloid corpuscles. Clinically there are no means of distinguishing atrophy due to compression from atrophy due to interruption of conductivity. Both these forms are by common consent included under the term *progressive atrophy* of the optic nerve. This is often to be distinguished only with the greatest difficulty from another form, also progressive, which I shall speak of later, as *grey degeneration.* This progressive atrophy, a consequence of compression or interruption of nerve conduction, also constitutes what is known as *cerebral amaurosis,* in contradistinction to *spinal amaurosis,* the result of the grey degeneration. In a general way it may be said that progressive atrophy is never found before the age of twenty or twenty-five. Atrophy appearing at a very early age will have been in almost every case preceded by symptoms of inflammation in the papilla, or of retro-bulbous neuritis.

Progressive atrophy shows itself by a constantly increasing pallor of the disc, which assumes a bluish white or greenish tint. But in addition to this the papilla loses substance, in other words, becomes excavated, while the lamina cribrosa appears unusually distinct. The boundaries of the papilla, as the atrophy progresses, become more and more clearly defined. The vascular tree diminishes but little at first, the vessels proper of the papilla alone fading away. According to the congenital conformation of the papilla, the wasting of nerve tissue will produce varying appearances. At times there will be only a general loss of tissue, shallow in proportion as the ganglionic layers and nerve fibres have participated in the atrophy. On the other hand, cases will be found where the nerve, owing to pre-existing physiological excavation, will be so depressed, as to simulate a glaucomatous excavation. Reduction in size of the arteries takes place in proportion as the atrophy of the nerve-fibres gains on the retina. It should be remembered that the distribution of the nerve-fibres within the eye may exercise great influence on the progress of discoloration in the papilla, and on the reduction in the size of the vessels. Therefore, in cases of partial atrophy, the thinnest layer of papillary fibres, that, namely, which corresponds to the temporal side, will alone be anæmic and altered in colour.

Functional disturbance should be correlated with destruction of nerve-fibres. Generally speaking the reduction in visual acuity corresponds with the concentric abolition of the field of vision, or with abolition affecting one or two sectors symmetrically, if the two eyes are attacked at once. There is no particular regularity in the manner in which the field of vision becomes contracted; as a rule, however, the upper and outer quadrants are those most frequently affected. Central scotomata, so common in neuritis, are only met with here exceptionally. It is also rare to find good acuity with very large reduction of the field of vision.

A characteristic feature is the progressive failure in the power of perceiving colours. The insensibility is first shown for green, then for red, after that for yellow, and finally for blue. A complete achromatopsia does not prevent the eye from perceiving the bright reflex of tints. Nor is there any correlation between loss of the colour sense and loss of visual acuity; indeed it may be said, in a general way, that the first sign of failing vision is scarcely ever given by any marked diminution in the power of discriminating colours. What can be predicated is, that the appearance of colour blindness is a symptom which portends with great certainty contraction of the field of vision, and loss of sensibility in its peripheral portions; for the reduction of the visual limits of green, red, and blue, precedes respectively losses of peripheral sensibility.

An entire abolition of the visual field for green, and a manifest reduction of that for red, while blue and white remain intact, constitutes an array of symptoms much less formidable than if there were complete loss of one sector, or manifest contraction of the limits of white. In other words, a general numbness affecting all the nerve-fibres, is less significant of progressive atrophy, than is complete abeyance of function in one portion of these fibres, with numbness of sensibility in the rest.

The prognosis will also vary, according as the obliterated portion of the visual field is marked off sharply or otherwise from the healthy portions; also according as the existing visual field shows appreciable colour dulness, as, for example, when the zone within which green should be perceived totally disappears. If the sector in which perception of white light has been lost is clearly defined on a visual field, where colours are perceptible, up to their normal limits (as in glaucoma), a process has taken place that is more likely to be localised than would be the case if insensibility to colour had already been shown in the portion of field sensitive to white light.

The main question before undertaking treatment, will be to learn by careful enquiry into the history and symptoms of the case, whether the patient is suffering or not from progressive atrophy, accompanied by ataxy; and also, as far as possible, whether the affection is cerebral or spinal. This is very important, for whilst antiphlogistic, antisyphilitic, and derivative treatment may, in the cerebral forms, find a fitting field, I am entirely opposed to them in spinal cases, which, indeed, have always seemed to me to be constantly aggravated by any debilitating measures.

Every case of cerebral atrophy ought to be carefully analysed, in order to discover if possible its cause, and to direct treatment to that. I can only here touch on the means that are most generally employed. Continuous currents deserve attention, although they are used quite empirically. A current of from 5 to 8 cells should be transmitted through the base of the skull, the positive pole being placed, as some advise, on the back of the neck, and the negative on the closed eyelids, or, as I prefer, on the temple and mastoid process. The applications are to be made daily, but not for longer than ten minutes at a time, care being taken to suspend or reduce the current if the patient should complain of vertigo or giddiness for any length of time afterwards. These currents may be continued for a considerable time, and if the patient is forced to go away, may be entrusted to an attendant.

Together with these, a series of injections of strychnine, ten at a time, with an interval of ten days between each series, may be prescribed. These injections should be inserted under the skin of either temple, alternately, and should consist of ten to twelve drops of a one per cent. solution of strychnine. It is true, unfortunately, that this treatment has been too much lauded considering its real value, and the same is also true of electricity; both may be powerless in the presence of such an affection as this. On the other hand the satisfactory results obtained in certain cases render it our duty to give them a trial.

You see before you a patient aged 48, who came to me with very advanced atrophy of the left optic nerve, since with the left eye he could not count fingers beyond 20 centimetres distance. In the right eye there was notable decrease in vision ($S=\frac{1}{3}$), and contraction of the field. The affection, which exhibited some obscure cerebral symptoms, first appeared after excessive fatigue, and grew worse rapidly. Treatment with continuous currents, with injections of strychnine, and small doses of iodide of potassium, sensibly improved sight, and enlarged the field in the right eye. It exercised a still more remarkable influence on the left eye, which, though almost deprived of sight, now possesses $\frac{1}{20}$. The field of vision on that side has also become considerably enlarged.

I also bring under your notice another patient, 44 years of age, who gives as the cause of his affection a fall sustained some ten years ago. I do not, however, think that that stands in any relation to the atrophy of his optic nerves. This patient was discharged from one of the hospitals of Paris, where he had been admitted for cerebral symptoms, apparently connected with chronic meningitis. These had completely disappeared, but it was necessary to guide him everywhere, as he had a bare perception of light at a distance of 6 metres. The discs in this case are pearly white, and slightly excavated. The arteries are somewhat diminished in size. After five injections of strychnine, the patient was able to find his way alone to this clinique, and, as you have seen, can now count fingers at 3 metres. The total number of injections given up to the present time is twenty. No change has taken place in the ophthalmoscopic appearances sufficient to account for this fortunate improvement in the symptoms.

Inhalations of nitrate of amyl, as lately recommended (*Steinheim*), have not, except in cases of amblyopia and amaurosis without any lesion evident to the ophthalmoscope, given satisfactory results. These inhalations should be employed with the greatest caution, seeing that the cerebral hyperæmia which they determine, may lead to dangerous results. The inhalations must at once be suspended if the congestion of the face and neck has been succeeded by pallor, and if the patient complains of much giddiness. Four to five drops, but never more, of the nitrate may be poured on a handkerchief, and inspired by the patient, who ought to be placed near an open window. These inhalations may be repeated each day and suspended after some ten trials, if no favourable result has been obtained.

(*c.*) The last form of atrophy of which I shall speak is *grey degeneration.* This medullary neuritis which is followed by grey softening, may be limited to the optic nerve, or may appear in conjunction with some alteration in the posterior columns of the spinal cord, together with myelitis of the lateral columns, or with isolated centres in the brain. In the preceding form of atrophy, namely, that by loss of nerve conductivity, I have already spoken of this softening of the nerve fibres, and of the apparition of granular and fatty cells. This change has arrived at its ultimate development in grey degeneration, so that the nerve on section is seen to have been changed into a gelatinous, grey, or yellowish grey mass, in which the nerve fibres have become fibrillæ, often enclosing amyloid corpuscles, the result perhaps of the final transformation of nerve substance into granular cells. Although they have undergone degeneration, the nerve fibres do not disappear completely as in simple atrophy. The nerve diminishes in size; its sheath becomes wrinkled and looser, but this process does not continue so far as to change the nerve into a thin cord of cellular tissue, as in simple atrophy. Nevertheless, the gradations between grey degeneration and atrophy the result of loss of conductivity, may be so insensible, that no precise line of demarcation can be drawn between them.

Grey degeneration may appear as islands in the substance of the nerves, or may be spread uniformly along their whole course, extending even to the optic crura. The situation and amount of the degeneration will exert a marked influence on the appearance of the papilla. The ophthalmoscope alone will not be sufficient to show what the nature of the atrophy is. Nevertheless, it should be recollected that the atrophic excavation and the structure of the lamina cribrosa will be conspicuous in proportion as the atrophy is pure and well marked in type. On the other hand, in proportion as the atrophy is due to grey degeneration, the more opaque will the disc be. A layer of tissue will conceal the lamina cribrosa like a veil, and the excavation will appear only at a late stage.

The influence which a pre-existing physiological condition may exercise over the ophthalmoscopic appearances must not be forgotten. Thus in eyes with a very deep physiological pit, the comparatively slight wasting of tissue caused by grey degeneration, may produce an atrophic excavation often larger than other varieties of atrophy, in eyes where owing to a small scleral ring, the papillæ were equally prominent all over.

It is therefore essentially by the simultaneous presence of other special symptoms that this affection can be diagnosed. But how difficult diagnosis becomes when the affection of the optic nerve is primary, and not transmitted from the vasomotor nerves, so that the disease exists without any cerebral centre of degeneration. In cases where grey degeneration of the nerves coincides with similar changes in the brain, or more especially in the cord, the diagnosis can be established by the presence of such symptoms as flying pains, a sensation of constriction as with a belt, cutaneous anæsthesia, failure of desire, absence of headache. If the number of men attacked with atrophy of the optic nerves be compared with the number of women, the former will be found to include about 90 per cent. of all cases. In atrophy following inflammation, the proportions are about equal in both sexes.

Another fact which it is important to note is that the degeneration does not, as a rule, become developed until after the twentieth year, and becomes rare after the fiftieth. It is rightly attributed to nervous exhaustion following excesses, and intellectual fatigue, or moral excitement, and especially a combination of moral causes, with disturbances of nutrition. Hence the frequency with which grey atrophy may be noticed among officers after long campaigns. Sometimes the spinal atrophy may be traced back to a wound, a fall on the kidneys, or some violent shock.

The difficulty of diagnosis is often a serious matter for the patient, for if grey degeneration be mistaken for one of cerebral origin, and be treated by depressants, the worst results may ensue. The energetic action that antisyphilitic treatment has in numerous cases of supposed specific origin (*Charcot*) certainly does not apply to grey degeneration, for I have frequently seen the disease rapidly progress under such treatment. All debilitating methods are absolutely inadmissible. On the contrary, hygienic means, baths, change of air, and a thoroughly nutritive diet, are all necessary to restore as much as possible the patient's strength. In these cases the regular use of continuous currents, and subcutaneous injections of strychnine may exercise great influence in checking the rapid course of the disease.

What shall I say of direct treatment applied to the spinal cord by means of bladders of ice, as some English physicians more especially have recommended? I will say that it is a severe method, best limited to occasional cases of injuries of the spinal region, and this the more, as the mode in which transmission takes place, if, indeed, there be transmission at all, is as yet absolutely unknown. I reject completely all derivative treatment, and especially the actual cautery applied to the spinal column,—a barbarous remedy, smacking strongly of the middle ages.

About fifteen years ago, nitrate of silver was looked on as having curative powers in ataxy and grey atrophy. But I have yet to learn that the number of ataxic patients has been diminished thereby. It may be given in doses of one centigramme ($\frac{1}{7}$th grain), in the form of a pill, and limited to two or three centigrammes daily. It has often the serious disadvantage of disturbing digestion, and then its action is always unfavourable. I may add that I have never known it otherwise, and the same will apply to iodide of potassium, and more particularly to the bromide. This last agent has the very grave drawback of sensibly increasing lassitude and weakness, and indisposing patients from necessary exercise. I may add, in conclusion, that I think tonic treatment, with abstention from all heating food, alcoholic beverages, and the abuse of tobacco, will, with injections of strychnine, and continuous currents, yield perhaps the least unsatisfactory results.

I shall pass rapidly over *tumours* of the optic nerve. These may be developed in its substance, either within the cranium or orbit.

Neuromata, myxomata, or *myxosarcomata*, only admit of treatment when confined to the orbital portion of the nerve. The proper treatment is extirpation, either by section of the nerve near the globe with preservation of this latter, or with removal of it, which is both more surely and quickly performed.

Before leaving the subject of the optic nerve, I should say a few words relative to those morbid alterations which take place in the optic centres, or the chiasma, and react upon the nerve. Such are those anomalies of vision known as *hemiopia*, and nutritive alterations in the nerve; these are symptoms which may also at times be found simultaneously with diabetes.

Hemianopsia or *hemiopia* is due to some disturbance in both optic nerves determined by one and the same cause. It thus establishes the partial decussation of the nerve fibres in man, which has been denied of late. Hemianopsia as a general rule is situated laterally, rarely, though I could show you an excellent example of this in a patient aged 70, superiorly. It is still more rare to see the inferior portions affected. Generally it will be either the two left or the two right sides of the retina, and the division between the two parts will be by a vertical line. The anæsthesia of the internal halves of the retinæ, causing temporal hemianopsia, are due to idiopathic affections of each nerve or to changes in the chiasma. The hemianæsthesia may not affect the entire half, but a single sector only, being perfectly symmetrical in both eyes.

Visual acuity is quite normal in this hemianopsia. When it is on the right side, it becomes much more annoying to patients while reading, as it prevents their seeing the word next to the one they are looking at. The persistence of the colour sense in the halves of the visual field that are still preserved, proves that one of the nerves is unaffected functionally. It is owing to the fact that the line of demarcation between the anæsthetic and the sensitive portions in hemianopsia does not pass exactly through the point of fixation, that central vision is and generally continues unimpaired.

The lesion which gives rise to *lateral* hemianopsia is situated in the left hemisphere if the left sides are anæsthetic; in the right if the right side; in the centre of the chiasma if the two nasal halves of the retina are insensible, and consequently if the hemianopsia is *temporal.* A glance at a diagram will at once show the connection of the various hemianopsias with the lesions that have given rise to them. It will thus be seen that if exactly one half of a retina is deficient, this must be attributed to impairment of half of one of the nerves which is affected beyond the chiasma. Anæsthesia of the outer halves of the retina is due to a lesion of the crura on the same side, that of the inner halves on the opposite side.

These explanations tally very well with the partial decussation, the existence of which has been established by *M. Gudden.* If total decussation were to be admitted, it would be necessary, in order to explain the various forms of hemiopia, to localise the seat of the compression always in the neighbourhood of the chiasma. Moreover, it would be further necessary that the action should be limited with mathematical precision to strictly circumscribed portions. In case such an arrangement obtained, what would become of the hemiopia found, beyond all doubt, as a result of apoplexies in the hemispheres, and which has no connection whatever with lesion of the chiasma? This hemiopia, conjoined with hemiplegia of the opposite side of the body, or with paralysis of the muscles of the eye of the same side, are exactly those which are most common, and they are also at times associated with aphasia. Moreover, the concomitant symptoms show even more strongly than the disturbance of vision that the seat of the lesion must be placed in one of the optic crura, or, better, near the chiasma, at the base of the brain; for impairment of sight is as a rule complicated with that of smell.

Although, generally speaking, hemiopia, if once established, offers little hope of cure, seeing that it is generally caused by destructive lesions either of or near the optic crura, the prognosis is favourable in one sense, namely, that the disease has no tendency to progress. Ophthalmoscopic examination ten or twelve years afterwards will show the corresponding halves of the papillæ atrophied, or more frequently half of the papilla of the eye in which the external portion was anæsthetic; for the nerve fibres are distributed more especially to the surface of the retina of the eye on the same sides as the cerebral lesion.

Hemianopsia scintillans or *scotoma scintillans*, may also by the greater or less rapidity with which it disappears be called *hemianopsia fugax*. This anæsthesia, which is preceded by hyperæsthesia, as shown by the appearance of a peculiar luminous vibration, which begins at the centre and extends over the whole of the affected portion, is frequently ushered in by violent neuralgia or other nervous symptoms. A colleague of mine happened to be attacked at my table with this hemianopsia, and became affected with true aphasia, and complete loss of memory, lasting about three minutes. The affection is not uncommon among studious persons, and in the upper classes, and may last many years. The best treatment is bromide of potassium to the amount of 3 or 4 grammes daily (47—62 gr.). Recourse may also be had to a metallic band, which you may notice I now always employ in spasmodic affections of the lids, in which there is no doubt it does good. The idiosyncrasy of the patient must decide what metal is proper to be used. The band should be applied round the forehead as soon as the aura, which is premonitory of the attack, is felt to be coming on. This aura may often be kept away by a stimulant, such as a glass of cognac, or strong coffee.

The affection, however, scarcely calls for any treatment, except in cases where it occurs frequently, inducing neuralgia, with hemianopsia, and eventually wearing the patient out. Change of air, hydropathy, the use of ferruginous preparations, and quinine, form the best treatment after bromide of potassium has failed.

I shall merely mention in passing certain very rare cases in which, with lesion of one hemisphere, there is no corresponding symmetrical hemianopsia, but complete blindness of the corresponding eye, with contraction of the field of vision on the opposite side (*Türk, Charcot*). A transient form of this affection is met with in hysterical patients. It consists in temporary anæsthesia of one eye, with considerable contraction of the field of vision in the other. I shall speak of this under amblyopia.

LECTURE XL.

AMBLYOPIA AND AMAUROSIS.

Among the *amblyopias* and *amauroses* which are met with without any lesion visible to the ophthalmoscope, I shall more especially treat of *amblyopia* by *intoxication;* and next of *amblyopia* following *hæmorrhages*, *hysteria*, *wounds*, of *spontaneous* or *reflex amblyopia*, and finally of *amblyopia* from disuse. I shall conclude with *hemeralopia* and *retinal hyperæsthesia*.

The most commonly met with form of toxic amblyopia is that produced by the conjoint abuse of alcohol and tobacco. Some authors are still doubtful whether tobacco ever alone produces it. Before going further, I must insist on the importance of your satisfying yourselves by ophthalmoscopic examination, and in other ways, that no errors in refraction exist uncorrected. Such might readily produce amblyopia; indeed, I have been before now surprised to hear the opinions of men often cited in these cases, who absolutely neglect this important preliminary examination.

Poisoning by alcohol and tobacco combined never appears suddenly, but on the contrary slowly, and supervenes upon any gastric disturbances, or any conditions of nutrition by which the patient has for some time been deprived of regular diet. I suppose such a number of this peculiar form of amblyopia has never been seen as during the two sieges of Paris. I had, during both those periods, ample facilities for studying the affection, which is characterised by certain well-marked signs, permitting it to be easily recognised.

Its presence is revealed to the patient by the difficulty he experiences in reading. The visual field is not contracted simultaneously with the impairment of central vision. Still, even at this period it is possible, with small squares of coloured paper, to show the presence of a central scotoma. At a later period, when the amblyopia has become intensified, this scotoma will be found to exist even for colourless rays, if the precaution be taken of reducing the light. Moreover, and this is remarkable, the loss of sensibility for colours extends over the whole field of vision, which however preserves its nornal dimensions. One is especially struck by the difficulty patients experience in recognising the colour yellow (gold coins for instance). Under the Commune many of the Gardes Nationaux came to consult me, because the dome of the Invalides appeared to them to be covered with silver. Another curious symptom is the persistence of coloured images. Patients also complain of a peculiar tremulousness of distant objects, or, as sailors express it, everything they look at seems covered with a sheet of moving water. Improvement generally takes place towards evening and on dull days.

In some cases the ophthalmoscope shows absolutely nothing; in others symmetrical discoloration of the temporal halves of the papilla, which are in sharp contrast with the internal half, that being highly coloured (hyperæmia). I myself have never seen general pallor of the disc, leading to progressive atrophy. Indeed the characteristic feature of the affection seems to be precisely that it has no tendency to undergo such change, although, when accompanied by pallor of the disc and well-marked colour amblyopia, it may be excessively chronic.

As regards treatment, the great object will be to diminish gradually the patient's consumption of alcohol and tobacco. An attempt should be made to relieve the gastralgia, dyspepsia, and sleeplessness that drinkers and smokers are subject to. Pepsine and pancreatine during meals, and bromide of potassium at night, before retiring to bed, will often exercise a very beneficial influence. In badly nourished and thin patients all depressing treatment, such as purgations, must be studiously avoided. Injections of strychnine are indicated in such cases, although their action may be slow. Santonate of soda has been suggested in doses of from 30 to 35 centigrammes ($4\frac{1}{2}$—$5\frac{1}{2}$ grains, approximately) daily. But although it has a significant action on the healthy retina, it seems to exercise no very beneficial influence in this affection.

Lead amblyopia is another form of the same affection. It may show itself in an acute form, having a certain resemblance to an attack of uræmic poisoning, and it may be present without any ophthalmoscopic symptoms, and without any alteration in the field of vision. Lastly, in some cases, together with occasional albuminuria, due to nephritis, badly marked signs of nephritic retinitis or papillitis will be found (suffusion of the retina with small hæmorrhages, and spots of fatty degeneration). Under those latter conditions it is possible there may be marked contraction of the field of vision with the amblyopia.

Apart from certain callings, which may predispose to lead amblyopia, I would direct your attention to the influence of certain dyes used for the hair and beard. In two cases which have come under my notice, this cause had evidently been the one to which the intoxication was due, and this fact should be borne in mind in dealing with fashionable people. Treatment must consist in eliminating the poison as quickly as possible by means of purgatives and sulphur baths. Injections of morphia may at the same time be used with advantage, against both the amblyopia and colic (*Haase*). A course of iodide of potassium in large doses will complete the cure. Should the amblyopia continue, after the disappearance of the other symptoms of intoxication, recourse should be had to continuous currents.

It is very rare to meet with any other forms of intoxication, capable of producing visual disturbance. But you may have recently seen here, a patient 45 years of age, who presented himself with peculiarly well-marked myosis. He was a morphia taker, who was accustomed to inject half a gramme of morphia ($7\frac{3}{4}$ grains) daily at least, which he confessed cost him from £16 to £20 annually. If a careful examination of the refraction had not been made with the result of revealing a very high degree of hypermetropia, the correction of which restored normal acuity, the impairment of sight would certainly have been attributed to intoxication by morphia. The patient, however, was interesting from another point of view. Being desirous to dissipate the ecstatic condition caused by the morphia, I injected three minims of a ten per cent. solution of duboisine. He was straightway seized with most extraordinary drowsiness, and had the greatest difficulty in reaching home. Once there he slept continuously for twenty-four hours.

Intoxication by *quinine* is extremely rare. You have seen here a young patient who having contracted intermittent fever in the tropics, determined to cure himself. He filled a large glass for about an inch with quinine, swallowed it all, and went to bed. He awoke both deaf and blind. Hearing and vision eventually returned, but the latter imperfectly. For though central acuity was normal, the visual field of each eye showed a peculiar symmetrical lacuna. There were in both visual fields, islands of blindness; the larger of the two occupied a considerable portion of the internal half of the field, and extended somewhat beyond the point of fixation : the smaller affected merely a small external portion. In these rare cases, so far as my experience goes, vision has returned incompletely, and I have never seen absolute blindness caused, as others have occasionally (*Von Graefe, Briquet*). I have not been able to watch the effects of injections of strychnine on the last patient, as only two could be administered.

Transitory amblyopia, or definitive amaurosis, is met with after abundant hæmorrhages, either from the intestines, the genital organs, or more rarely, the respiratory tract. In thirty-nine cases collected by *M. Fries* in his thesis, twenty-six resulted from intestinal hæmorrhages, nine from menorrhagia, two from epistaxis, and one from hæmoptysis. Some of you may recollect having examined a coloured missionary from Senegal, who during the voyage had been excessively sea-sick, and had vomited blood, whereby instantaneous and complete blindness had been induced. This patient, who was thirty years of age, had lost his right eye long before owing to an injury. I examined the left three weeks after the occurrence noted above, and found that the abolition of sight was so complete that the strongest light was not perceived. The ophthalmoscope did not show the slightest lesion of any kind. After a few injections of strychnine, together with a tonic regimen, vision, both centrally and peripherally, became perfectly re-established.

Impairment of vision may follow upon hæmorrhage either immediately, at an interval of a few hours, or even of several days (three to five). If the blindness has been complete, as in the last case, it is not likely to disappear, but if there is only a certain degree of amblyopia present, there is every reason to suppose that vision will be restored. A progressive loss of sight is extremely rare.

It is seldom that an opportunity occurs of making an ophthalmoscopic examination immediately after the loss of vision, which is generally bilateral. In such cases, however, the ophthalmoscope would reveal a slight hyperæmia of the retina in the course of the vessels. Occasionally, also, there would be a few hæmorrhages on the edge of the papilla, with contraction of the arteries. In some cases nothing is to be seen, but a variable degree of pallor of the disc, which presents appearances very like those of progressive atrophy.

In my opinion, and it is also the opinion of *Leber*, two totally distinct affections have been grouped together in these amblyopias and amauroses. In one of them we have to do with hæmorrhages, accompanied by violent retching. Here the presence of small hæmorrhages which, as I have satisfied myself in the case of a patient recently, come apparently from the circumference of the disc, shows in all probability that a similar hæmorrhage has taken place into the sheaths of the nerve. In the other case, the symptoms are due to actual loss of blood. This being excessive may induce, according to *Samelsohn*, anæmia of the brain, followed by a rapid drain of the cerebro-spinal fluid into the cranium. This fluid would then set strongly towards the intervaginal space, and so determine compression. The hyperæmia, and signs of retro-bulbous neuritis, countenance this view. It is also possible that in certain cases, where the loss has been slight, both the hæmorrhages and the ocular disturbance depend on some lesion of the optic crura. This will be rendered still more probable should the symptoms have been preceded by certain prodromata, such as cephalalgia, phosphenes, and temporary loss of vision.

Treatment should hinge chiefly on tonic methods, every precaution being taken to prevent any return of the hæmorrhages. *M. Fries* proposes in his work, which is the most complete on the subject (that of *M. Horstmann*, lately published, may also be consulted), to accept incision of the sheath of the optic nerve, according to my method. This would only be justifiable in cases of complete blindness, resulting from excessive loss of blood, before signs of progressive atrophy had become developed. It is useless to attempt, as has been done (*Colsmann*), to remove the ischæmia of the nerve by paracentesis or iridectomy, for the sudden emptying of the eye may hasten rupture of the vessels, which probably plays a considerable part in the production of the visual disturbance. If cases already of long standing have to be treated, it should be in accordance with the principles laid down when considering progressive atrophy (see p. 438).

Retinal anæsthesia may be caused by hysteria, or by injury, and either *spontaneously* or by *reflex action*. It may also arise from disuse.

Hysteria causes at times amblyopia, and an amaurosis characterised by peculiar symptoms. In slight cases, along with hemianæsthesia of the affected side, there is more or less amblyopia, and concentric limitation of the field of vision, with reduction in perception of colours. This is sufficiently well marked to attract attention only when the light is weak, and especially when the peripheral parts of the retina are examined. In severer cases, where hemianæsthesia occurs in conjunction with real hysterical or hystero-epileptic attacks, the amblyopia may increase, and on the affected side become allied with more or less complete achromatopsia. Absolute amaurosis may also become developed. There is always proportional contraction of the field of vision on the unaffected side, and slight achromatopsia. It is in cases such as these, that *M. Charcot* has demonstrated the existence of an ovary, tender on pressure, which pressure will cause momentary disappearance of the hysterical attack.

True hysterical hæmianopsias are rare, and so likewise is complete unilateral amaurosis. Nevertheless, I have been able to show you an example of it. It was the case of a lady twenty-eight years of age, in whom the disturbance of vision passed away in a few days. Ophthalmoscopic examination showed nothing abnormal, as indeed generally happens. The effusion round the disc, recalling retro-bulbous neuritis, which has been observed at times in severe epileptiform attacks, did not in this case apparently belong to simple hysteria.

It would be difficult to insist on too much caution as regards the snares and pitfalls which hysterical patients will lay for the medical attendant. Therefore you must accept with great suspicion any alleged sudden disappearance or reappearance of the colour sense in hysterical patients with anæsthesia.

The *traumatic* form follows some shock to the eye, head, or body generally (*Testelin*). I exclude of course cases where this shock has caused any actual intraocular lesion. I quote in my larger work the case of a young mechanic who was struck by a piece of wire on the lower left lid, which cut it. This eye lost all its sensibility to light, although at first the optic nerve showed no sign of any injury. Eventually, however, atrophy became manifest. I saw another case of the same kind during the siege of Paris. It was that of a man fifty-six years of age, whose left eye was struck with a pipe, the amber end of which, three centimetres in length, penetrated the fundus of the orbit, whence it was not extracted till three months afterwards. The eye was perfectly insensible, but did not, with the exception of slight exopththalmos present any changes appreciable by the ophthalmoscope, for the first four weeks. During this period I examined the patient almost daily in order to be able to compare the condition of the disc of the sound with that of the anæsthetic eye. Later on a most characteristic atrophy appeared. It follows from these cases that the anæsthesia may precede, by a considerable interval, any marked disturbance of nutrition in the nerve.

There are cases also where compression of an eye for a short time has produced permanent anæsthesia. As bearing on this, the case recorded by *Mackenzie* deserves notice. It is that of a person who in play pressed the eyes of another with her hands, and thereby rendered her immediately blind. The case mentioned by *M. Testelin* is also very remarkable. A drunken man went to sleep with his hand to his eye, and thereby lost the power of central fixation.

The shock of *lightning* also at times causes either permanent or transitory blindness. Here, however, other causes may come into action, such as dazzling or sudden effusion into the sheaths of the optic nerve. On two occasions I have treated ladies who, during a thunder-storm, had ventured out on the balcony, and had started violently back as the lightning flashed past them. In both patients there was a typical neuro-retinitis, which eventually determined complete atrophy of the papilla (*M. Brière* gives a similar case). In a certain number of cases the shock is evidently the chief factor in the production of blindness. This at times recedes, leaving behind it retinal hyperæsthesia, or concentric limitation of the field of vision.

Spontaneous anæsthesia of the retina is observed in general in young subjects (hysterical females) and infants, and may be connected with anæmia produced by sexual excesses, or by exhausting diseases. Here the sudden appearance and disappearance of visual disturbance, affecting chiefly excentric and, in a less degree, central vision, is very characteristic. Another point is the existence of a certain amount of hyperæsthesia along with the anæsthesia. The extreme sensibility to strong daylight which exists sometimes induces clonic contractions of the lids. By means of smoked glasses, of a somewhat deep tint, normal acuity of vision may at times be restored. Moreover, these patients generally exhibit some spasm of accommodation.

In such cases, where one must also be on one's guard against malingerers, no precise information can be derived from examination of the colour sense. In very marked amblyopia patients may have an exact appreciation of colour, while with very slight anæsthesia, there may be complete perversion of this sense.

Under the title of *reflex anæsthesia,* must be included all forms of hysteria where compression of the ovary can put an end to the anæsthesia, and where the aura is accompanied by a partial loss of vision. In the same group may be comprehended all amauroses following irritation of the fifth pair, chiefly in the dental branches.

The reduction of the amplitude of accommodation coinciding with tooth-ache, a case of which *H. Schmidt* has seen, confirms the possibility of such a phenomenon. That lesions of the supra-orbital nerve may be followed by disturbances of vision, due to contraction of the cicatrix must not be denied, if it is to be granted that compression of the dental nerves can exercise a similar influence. In such cases the possibility of any shock should be carefully eliminated.

Anæsthesia from *disuse* occurs only in cases where functional activity has been in abeyance, during the period of the growth of the eye. Therefore it is almost exclusively confined to young children, in whom a squint exists, or a traumatic cataract, or a congenital cataract which has ripened early. Hence the great importance of not permitting a strabismus to become unilateral. In young children, by closing one of the eyes alternately, during so many hours daily, the vision will of necessity be exercised equally on both sides, and the strabismus made alternating. Hence the advisability of operating on cataracts as early as possible; for if the retina, at the period of its development, ceases to be functionally active for two or three years, that is sufficient to cause permanent injury.

There is no difficulty in recognising whether anæsthesia is due or not to strabismus. It is all the more important to be able to do so as the commonest form of strabismus, namely that arising from hypermetropia, is capable of spontaneous cure as age advances. Whether the disuse depends on deviation outwards or inwards, it will only be the portion of the visual field which is used for binocular vision which will be blunted. In other words, the macula, the temporal side, and a narrow band round the nasal side of the macula, will be variously affected, but the zone of visual field used in single vision, will have preserved its full sensibility, which in well-marked cases of amblyopia from disuse, may even be greater than that of the parts round the posterior pole. The portion of visual field thus endowed with exalted sensibility, will be contracted in cases of convergent strabismus, but enlarged in divergent, as compared with the monolateral portion of an eye with normal vision. This is accounted for by the displacement of the limits of the field of vision, owing to the deviation caused by the strabismus.

Retinal anæsthesia will be both rapid and intense in proportion to the age of the child at the time it first became the subject of monolateral squint. It will be quite sufficient to question a mother carefully to become convinced of the truth of this canon. There is no necessity to presuppose congenital amblyopia as an explanation of high degrees of anæsthesia. Once central fixation is in abeyance, and once the eccentric portions are more sensitive than the central, all hope of effecting a cure must be abandoned. For, if through any cause whatever, even in very early youth, a child should lose his sound eye, and be consequently obliged to depend entirely on the deviated eye, even then the functional activity of the retina will not increase. Hence the inference may be drawn, that all attempts at remedying this loss of power by exercise, by magnifying glasses, and by stimulating injections of strychnine should be reserved exclusively for cases where central fixation has not as yet been lost.

It will be well to consider for a moment the best means by which to detect *simulation,* such as military surgeons are liable to encounter in recruits, who allege they are amblyopic or have unilateral amaurosis. In order to unmask this deception, it will be well to seem at first to credit the statements of the person, and allow him to suppose that you are about to occupy yourself exclusively with his sound eye. Before this a prism should be placed base downwards. If he declares that he sees two images, and if he also declares he has complete amaurosis, you may be sure there is simulation. If he alleges merely a very high degree of amblyopia, you may have recourse to the coloured types of *Stilling,* which will enable you to learn how far such assertions deserve credence. With this object you employ types analogous to *Snellen's,* but which have red or green letters on a dark background. The card is so arranged that the letters shall not reflect any light, and thus betray their presence against the dark ground. If, for example, you use a card with red letters, and place before the eye which is alleged to be sound a green glass, you will make it quite impossible for this eye to see the letters. If nevertheless the patient still can read them, he must do so with the eye which he declares is amblyopic. The finest characters that he can thus decipher will give the exact measure of the visual acuity in the eye he pretended was affected. The impostor will not have the slightest suspicion of the snare you have laid for him, if you have taken the precaution to let him suppose you are about to examine only his sound eye.

The above method has the great advantage not only of exposing deception, but also of showing its extent. In order that the results obtained may be beyond doubt, it will be necessary to satisfy one's self by a preliminary trial that the glass really effaces the letters, and that there is no reflex from them which might make reading possible.

The importance that such a mode of examination may assume is shown by a case which was submitted to me and two other specialists by a very large railway company. One of the employés received, during shunting, a blow on the left superciliary region, resulting in a deep scar. He asserted that he had lost the sight of the left eye in consequence of this accident, and demanded heavy damages. As a matter of fact the ophthalmoscope showed in that eye a slightly marked atrophy of the papilla, that is pallor of the disc, and slight reduction in the size of the vessels, but no well-marked excavation. Examination with the coloured letters showed incontestably that the patient exaggerated the amount of the injury inflicted by the shock. After he had read some of the letters, with a coloured glass before the unaffected eye, I was able, by closing the eye which he asserted was amaurotic, to show him that I was not to be duped by his false statements. At the same time I was able to inform the court how far the accident had really injured vision in the left eye, and thereby to aid in assessing equitable damages.

It is important in the various retinal anæsthesias to discover whether they are complicated or not with hyperæsthesia, and how far smoked glasses or reduced light may improve vision and give relief to the patient. If the simultaneous presence of hyperæsthesia be established, it will be advisable to insist on patients remaining for some days in a dimly lighted room, smoked and curved glasses being used out of doors. All work demanding considerable efforts of accommodation should be given up.

Hysterical anæsthesia is at the present time being treated very successfully by *M. Charcot*, by means of metallotherapy (*Burquisme*). He places bands of metal round the forehead. These it would appear allow the gradual return of sensibility to be measured by the test of colours which reappear in the same order in which they disappeared. You know with what misgiving I accept the statements of hysterical females, for whom the marvellous has so many charms. Still there cannot be any doubt about the efficacy of metallotherapy. I could give you proof of the unquestionable influence of weak continuous currents produced by metal discs, the choice of which, as to the metal, is subordinate to some peculiar idiosyncrasy in the patient.

You see here a woman of forty-two years of age, who has been tormented by perpetual clonic spasms of the left lower lid. The contractions did not cease for an instant, and were a source of extreme annoyance. Thanks to the metal band, her eyelid is now perfectly quiet. She submits willingly enough to the necessity of wearing round her forehead a number of metal discs, in spite of the somewhat strange appearance she thus presents. I also show you another patient who was subject to clonic blepharospasm, which became every instant tonic, and compelled him at last to give up his occupation. You see that with his band of discs he is enabled to resume his usual occupation, and that, save for a few rare clonic movements, both eyes now remain open. From the results in cases like these, where it is easy to check statements, I am disposed to give credence to the assertion of hysterical women regarding the return of sensibility in their retinæ.

Together with the use of metallic discs, lactate, and particularly valerianate of zinc, in doses of from 10 to 25 centigrammes ($1\frac{1}{2}$ to $3\frac{1}{2}$ grains) may be prescribed to hysterical patients of both sexes. Simultaneously with the above, 1 to 3 grammes ($15\frac{1}{2}$ to 47 grains) of bromide of potassium should be given at bed-time. In feeble persons preparations of iron and quinine and change of air to the seaside may be recommended with advantage. The condition of the skin requires attention, and cold douches or sponging with sea water, find in such cases their proper application. All sexual excitement should be carefully avoided.

In the other non-hysterical forms of retinal anæsthesia, subcutaneous injections of strychnine are especially to be recommended, their effect being, even on the sound eye, according to *M. de Hippel*, to slightly extend the field of vision, and augment the central acuity. This influence is especially exerted in cases of anæsthesia from shock. If strychnine can here effect any good, its beneficial action will become evident after the first three or four injections. It is useless to continue it if there is no distinct improvement after some five or six injections. But if fair results have been obtained by the first series, the patient may be allowed to rest for a fortnight, and then the injections be resumed. When strychnine has failed, and the ophthalmoscope shows no changes, nitrate of amyl may be tried in young patients, with all the precautions already insisted on (p. 439). In the intervals of treatment with nitrate of amyl or strychnine, continuous currents may be applied, the number of cells to be proportioned to the age of the patient, and the symptoms of giddiness, &c., they occasion.

In patients of sanguine temperaments and flushed faces, saline purgatives are often beneficial, especially if the anæsthesia is conjoined with much hyperæsthesia. In general, however, in all these cases lowering treatment, and above all, blood-letting, must be avoided.

The various forms of retinal anæsthesia naturally lead me to speak of that torpidity of the retina which is evidenced by a diminution in the power of vision, as soon as the light becomes at all feeble. This torpidity, to which the name *hemeralopia* has been given, is a symptom common to all changes in the retina, when, owing to sclerosis of the vessels, it receives an insufficient supply of arterial blood. It is therefore one of the main symptoms of pigmentary degeneration.

But apart from cases in which some anatomical or opthalmological alteration is present, there are others where the torpidity exists without any accompanying changes. This occurs in cases where, in conjunction with deficient nutrition generally, the eyes have been exposed to the prolonged action of vivid light. What alcohol produces in such a striking manner on the retina of badly fed subjects (dyspeptic) light provokes in a less degree in those whose tone has been lowered from insufficient food or exhausting bodily exercises. The necessity of a combination of the two factors, one of which is deficient nutrition, either actually, or relatively to the work to be performed, is clearly shown by the following facts; when hemeralopia appears in the form of an epidemic among troops, or in Russia at the periods of the great fasts, the officers and priests, who are the better fed, escape it entirely. If it shows itself on board ship, it will be the badly fed passengers or sailors, not the officers, whom it attacks.

A certain analogy also exists between this affection and alcoholic retinitis, as proved by the fact that the size of the field of vision is not reduced, and that around the point of fixation small scotomata exist (*Raymond*), within the limits of which the intensity of the persisting images produces the effect of spots. Moreover, if the portion of visual field corresponding to the macula be examined with feeble light, a scotoma will often be discovered simultaneously with an insensibility to colour. At times, if the light is sufficiently subdued, the same difficulty in appreciating colours will be found to exist over the whole field of vision (*Förster*). Central visual acuity may be excellent with a strong light, but as soon as it is reduced vision falls suddenly in the proportion of 1 to 40, or even 60, as compared with the sound eye.

In many cases the eye will not present any changes either externally or internally. It is only in cases where defective nutrition has long exercised its baneful influence, that a spot of xerosis may be found on the conjunctiva (*Bitot*), which may, according to *Blessig*, also invade the cornea.

Treatment should be directed both to improve the general nutrition and to protect the eyes against excessive light. Prolonged sojourn in a dark room, as *Netter* recommended so strongly, is perfectly logical, on condition, however, that it does not react on the patient mentally, so as to unfavourably influence nutrition. In all cases if the dark room be not at hand, the patient must be protected from light by smoked glasses. Contraction of the pupil by eserine is scarcely a rational mode of treatment, for the narrowing of the vessels which this myotic causes will increase the retinal torpor. The visual field will at the same time become contracted, and increase the patient's embarrassment; for as daylight fades, the power of vision becomes correspondingly reduced.

Cod liver oil, or the liver of the fish given as an article of diet, is a mode of treatment which can only be admissible if intended to aid nutrition. Preparations of iron and quinine are here very valuable. In order to hasten the disappearance of the retinal torpor, a course of hypodermic injections of strychnine may be administered.

Well-nourished persons, living under good hygienic conditions, may, if exposed for a length of time to excessive light, particularly if this be reflected from a white surface, be attacked by retinal hyperæsthesia. This will be shown by photophobia, sufficiently intense to render vision impossible in bright daylight. This nyctalopia has chiefly been met with in travellers who have been obliged to make long journeys over snow-covered plains, and in those who have devoted themselves to hunting under similar circumstances. The same hyperæsthesia of the retina may also supervene when the sun has been too long gazed at, as during partial eclipses. It is also observed in persons who have long been unaccustomed to strong light, such as prisoners or miners, and who suddenly and continuously expose themselves to the full glare of daylight.

These cases, the ætiology of which so easily explains that of acquired hyperæsthesia, scarcely need any notice, as they are both seldom met with, and are transitory. I must, however, mention a form of retinal hyperæsthesia found in nervous subjects (chiefly hysterical females) which can only be diagnosed by, as it were, a process of exclusion. It is evidenced by the fact that these patients cannot use their eyes for any length of time continuously, especially in ordinary conditions of light. In spite of the most accurate correction of any faults of refraction, in spite of the proper convex glasses in hypermetropia, and the decentred concave glasses or prisms in myopia, to aid convergence, the symptoms, which return on the least application of the eyes, necessitate some treatment. Painful spasm of the accommodation might here suggest itself, but cannot be admitted, since the same impossibility of using the eyes continuously is found after paralysis produced artificially, and after the proper glasses have been given to supply the place of the accommodation.

The *retinal asthenopia*, which follows upon this hyperæsthesia, is evidenced by the images of objects looked at disappearing too quickly. There is produced, as it were instantaneously, the same interruption of vision as is noticed if we look continuously at any one object. This manifests itself by a cloud, which commences at the periphery of the field of vision, and covers the point of fixation.

In this retinal hyperæsthesia, collyria of pilocarpine, of a strength of five per cent., have in my hands rendered essential service. One drop should be instilled every morning, and it may be used for a long period without irritating the conjunctiva. But besides this, care must be taken to avoid dazzling of the eyes, and for this end blue or smoked glasses should be used. In some cases coloured glasses (yellow) have produced astonishingly good results, especially if the coloration is combined with convex glasses which prevent accommodation. Santonine, in the form of santonate of soda, which makes objects appear yellow, and which has been recommended by some in alcoholic amaurosis, does not produce any beneficial effects in hyperæsthesia. Besides treatment of the nervous conditions, and attention to general hygienic requirements, each case must be made a study of by itself. It will be necessary to discover how the eyes behave with coloured glass, so as to select a glass of a suitable tint.

Although it would be beyond the scope of these lectures to enter into any account of the researches which have been made on congenital (hereditary) and acquired *daltonism*, I must take this occasion of stating how useful coloured glasses may be to such patients. You are aware of the interesting researches of *MM. Delbœuf* and *Spring*, on the effects that may be obtained in daltonism by placing a solution of fuchsine before the eyes. According to *Javal*, treatment may be attempted with discs of gelatine coloured with fuchsine, and interposed between two glasses. Moreover *Seebeck*, in 1837, insisted on the value of coloured glasses. *Leber* relates that he himself was able to afford considerable relief to a draper by prescribing red glasses, by which means he was enabled to distinguish blue from lilac. It would be impossible to give any exact or general rules as regards the selection of these glasses: each case will require to be studied individually.

AFFECTIONS OF THE MUSCLES.

LECTURE XLI.

STRABISMUS.

When the eyes are in a state of repose and looking into space, the visual lines are parallel. These lines pass through the macula and nodal point, but not through the centre of the cornea. They must not be confused with the corneal axes, by which we judge of the position of the eyes. In emmetropic persons the visual line forms with the axis of the cornea an angle (the angle a) to the inner side of the corneal axis, such that, when the visual lines are parallel, and the eyes adapted for distance, the corneal axes diverge about 10° (*Donders*). This slight divergence passes unnoticed, as from habit we consider the position as equivalent to parallelism.

But in proportion as an eye is flattened (hypermetropic), the angle a increases, until in some cases the corneal may diverge from the visual axes, to almost double the usual amount. The divergence may attain an angle of 18°, and be very apparent; in other words, the patient becomes the subject of divergent strabismus.

On the other hand, in myopic persons, in whom the antero-posterior axis is unusually long, the angle a decreases, and may even, in extreme cases, change its position completely, that is, it may fall on the outer side of the corneal axis. When, therefore, very myopic persons look at distant objects, the slight divergence of the corneal axes, which, in emmetropic persons is equivalent to parallelism, is more or less reduced. The corneal axes, according to the amount of the myopia, tend to take a position during the parallelism of the visual lines, such that they are parallel or even slightly convergent. Therefore, although the visual lines may be strictly parallel, we receive the impression of undue convergence, that is, of an internal strabismus. In such cases, our judgment is based on the position of the corneal axes only, and the squint is in reality merely apparent.

In all other positions of sight, whether we perform associated, or combined, or partly associated and partly combined movements, such as are required for fixing near objects, as for example, reading, the visual lines intercross at the point of fixation; in other words we place the retinal centres opposite that point. The image of the object to which our eyes are directed is, owing to binocular fixation, thrown on the macula of each retina at the same moment. Whenever for distant vision the parallelism of the visual lines is not maintained, or when in near vision the intercrossing does not take place at the point fixed, whereby the image of an object is thrown on some point in one eye (the deviated) other than the macula, we say that *true* squint is present.

The direction in which an eye is deviated, in other words, the displacement that the image has undergone, relatively to the macula, gives the *kind* of strabismus. *Convergent* strabismus is that form in which during fixation of distant objects, one of the visual lines is directed inwards, so that it converges towards the other. If it be a near object which is fixed, the visual line of the deviated eye, forms with that of the other eye, an angle situated *in front of* the object. The image of this in the deviated eye will fall *on the inner side* of the macula. To determine the nature of the strabismus it is necessary that one of the eyes fix some object; consequently, strabismus is always single. By definition the possibility of double strabismus is excluded.

Strabismus is connected with an excess of tension of the muscle which causes the deviation, but except in this particular, the associated and combined movements remain absolutely unaffected. By this excess of tension, the adducting power in convergent strabismus, the abducting in divergent strabismus is alone increased. Consequently the limits of adduction or abduction are slightly enlarged in the direction of the deviated muscle. There is, however, no equivalent and corresponding loss of the power of abduction or adduction respectively; that is to say there is no proportional weakening of the antagonist muscles.

This *integrity of movement*, and of *the limits of the field* of fixation*, are diagnostic points between strabismus and paralytic affections. In these latter there is always loss of motion in the

* *Field of fixation* is the whole extent over which vision can range.—Tr.

direction of the paralysed muscle, and this is often increased still more, owing to contraction (spasmodic) of the antagonist muscle. But in the most aggravated strabismus the contraction of the deviated muscle is never sufficient to destroy the power of its opponent.

The measurement of a strabismus should, strictly speaking, be given in terms of the angle which the visual line of the deviated eye makes, with that of the other eye, when fixed. But inasmuch as no definite idea of the amount of deformity caused by any squint can be quickly conveyed by the mere knowledge of this angle, and as its measurement requires special instruments, it is generally held sufficient, as a general rule, to indicate the amount of deviation in terms of the position of the pupil relatively to the middle of the palpebral aperture. The non-squinting eye is to be directed towards some distant object; you will then have no difficulty in expressing in millimetres the amount of deviation present either outwards or inwards, independently of any specially devised instrument (strabometer).

The deviation which the eye undergoes when directed towards an object distant say five metres, is the *primary* deviation. Whether this be measured by the aid of instruments of precision by means of the angle, or approximately by the amount of displacement the centre of the pupil undergoes, it will be equal to the deviation of the sound eye, the movements of which may be observed behind a piece of ground glass. This displacement of the eye which was first fixed, inasmuch as it is produced when the deviated eye is made to fix, is called *secondary deviation.* If this be equal to the primary deviation, the strabismus is *concomitant.*

It is only possible to judge of the nature of concomitant stra bismus, when vision in the deviated eye is such that in fixation images will fall upon the macula, and not on some peripheral portion of the retina. This latter condition will be present in cases where strabismus has come on very early, and has given rise to amblyopia from disuse, in the affected eye. The most accurate information would be afforded by the distance which separates the double images. But as a general rule a person with strabismus is not conscious of any image apart from that formed on his macula. All artificial means, such as coloured glasses and prisms, of directing his attention towards the existence of such an image, give either absolutely no results, or results difficult to control, for the surgeon is wholly dependent on the somewhat vague statements of the patient.

If a person with equally good vision in both eyes, and able to fix alternately with either eye, squints, the squint will be an *alternating* one. The choice of one eye for fixation is generally determined by some peculiarity of conformation, or by the possession of a greater range of accommodation. It is often also determined by the direction in which the patient desires to look, inasmuch as one eye will necessarily perform a given muscular movement with less difficulty than the other. Hence the squinting person will alternately use one or other eye in fixation.

Strabisums is called *monolateral* when one eye is definitely excluded from fixation. The effect of this is to weaken vision in the eye so excluded, and this in proportion to the earliness of the age at which the strabismus becomes established.

A strabismus is called *permanent* when binocular vision is suppressed definitely, that is, when an eye is excluded from fixation in any direction. On the other hand if under certain conditions binocular vision can be obtained by muscular action, such as by an effort of accommodation, in hypermetropic, or a relaxation of convergence in myopic persons, the strabismus is *periodic*. *Alternation* does not exclude *periodicity*; but a periodic strabismus is generally monolateral.

The term *latent* is applied to a form of strabismus which does not become evident under ordinary conditions, binocular vision in these cases being obtained at the expense of muscular effort. Here as a general rule it is entirely on account of the annoyance of seeing double that the patient consents to undergo the necessary and excessive muscular efforts demanded for single vision. But if from any accidental or artificial cause, binocular vision be suppressed, for example by the interposition of some obstacle between one eye and the object looked at, the muscular effort is at once interrupted, and a squint becomes *manifest* which hitherto had been *latent*. This form of strabismus is met with in myopic patients, whose internal recti muscles are weak. It gives rise to deviation outwards whenever, owing to any object being placed in front of one of the eyes, binocular vision is rendered impossible. It is found also in hypermetropic patients, whose external recti are insufficient. Here, when the hypermetrope looks at any distant object, a ground-glass having been placed before one eye, the eye so covered will perform a movement of adduction. Under normal conditions the interposition of a ground glass, which for the moment prevented binocular vision, ought not to exercise any influence on the position of the visual lines, either if parallel as in distant, or forming an angle by intersection as in near vision.

It is not sufficient in order to deal with strabismus to be acquainted simply with its various forms; you must also understand its causes. I may say that in the vast majority of cases strabismus is the result of ametropia. The convergent form of it being due to hypermetropia, which makes excessive demands on the muscle of accommodation; the divergent to myopia, which makes the same on the muscles of convergence.

It is chiefly persons who are hypermetropic to the extent of from one to three dioptrics, who squint. They do so because the neutralisation of their hypermetropia by any efforts of accommodation, apart from a high degree of convergence, is rendered difficult. In order to obtain distinct images, they are obliged to accommodate so strongly that the visual lines cross in front of the object looked at, because accommodation and convergence are more or less interdependent. To obtain the sum of accommodation necessary for distinct vision, the hypermetrope sacrifices binocular vision, and converges strongly with the deviated eye. He thus gains the desired amount of accommodation, but only on condition that the visual lines converge at a point nearer than the object looked at. It is true, indeed, that as binocular vision has been relinquished in order to gain the necessary accommodative power, vision is confined to one eye. Distinct vision, however, can only be obtained if one eye be suffered to deviate inwards. Hypermetropic patients quickly learn to suppress the image formed on the deviated eye, and they learn it all the more quickly in proportion as the deviation is more considerable; that is, as the image is thrown on a point at a greater or less distance from the macula, and is consequently more or less confused. This suppression of the image is true for all that portion of the retina on which a patient is accustomed to have images projected.

The reasons why all hypermetropic patients do not squint are the following. In the first place, many hypermetropic individuals the degree of whose hypermetropia exceeds 3 dioptrics, do not obtain, even by an excess of convergence, accommodation sufficient to see near objects distinctly. In the second, there are some whose refraction, though slightly or even considerably abnormal, possess a ciliary muscle powerful enough to enable them to dispense with the additional accommodation which a high degree of convergence affords. If by any chance, however, disease should weaken the muscular power of such individuals, they will no longer have sufficient accommodation at command to ensure distinct vision, without resorting to the expedient of convergence. That is to say, they must permit one of their visual lines to cut the other in front of the object fixed. There are also other reasons, such as the greater or less facility with which convergence is brought into play. The relatively great distance between the centres of rotation in early life will cause children to squint more readily when very young. Consequently, as their eyes become closer together, the movements of convergence become easier. With the development of the cranium, and the separation of the centres of rotation, convergence becomes more difficult. It will also be less necessary to exercise it, as the ciliary muscle grows in size and power. This is the explanation of the fact, that, a strabismus appearing in very young children, or in the course of convalescence, may disappear with growth and returning health.

Moreover, as I have shown, convergent strabismus dependent on hypermetropia admits of spontaneous cure. This cure will be probable just in proportion as the progressive reduction in the range of accommodation due to age places moderately hypermetropic individuals in the same conditions as those who are excessively so. The former will therefore abandon all attempts at accommodation, which, even when combined with extreme convergence, does not suffice to give distinct images. They prefer, like those with very high degrees of hypermetropia, to have recourse to optical methods of correction.

Many children are also prevented from squinting by the fact, that even when they converge to the utmost and obtain a high degree of accommodation by intercrossing the visual lines in front of the object, or by allowing one of these lines to deviate by resorting to excessive accommodation in one eye only, they cannot for some time escape diplopia. Therefore, before children have learned to suppress one image, they frequently pass through a period of unpleasant diplopia, which is often sufficient to cure them of squinting; for, they prefer to accommodate insufficiently, and to have indistinct images, rather than to have diplopia. But if, during the course of some affection, a bandage has been placed over one eye, or if an opacity of the cornea has supervened, and so caused diplopia to disappear, they will at once begin to squint.

Very hypermetropic patients squint chiefly owing to true *insufficiency of the external recti.* It must be borne in mind that the angle which in such cases the visual line forms with the corneal axis, is disproportionately great, and that in order to render the visual lines parallel for distance, the corneal axis must at the outset be made to diverge perhaps as much as 18°. Hence there arises a constant strain on the external recti, even when the eye is in a state of rest. Moreover, while an emmetropic individual need not make any call on his accommodation for distance, the strongly hypermetropic must do so more or less in order to see distinctly. Now, I have said that accommodation and convergence are interdependent acts. Therefore, in accommodating to obtain distinct vision, for distance, the external recti ought to be able to counterbalance the internal, the action of which is to destroy the parallelism of the visual lines.

Unless a hypermetropic person has very powerful abductors, they will become exhausted by this incessant effort. For even in near vision, the external recti are obliged to oppose the internal, which necessarily obey the stimulus to excessive convergence transmitted to them from the strong contractions of the ciliary muscle.

It is not difficult to show that latent strabismus is present in numerous cases of hypermetropia. As soon as a piece of ground glass has been placed before one eye, and binocular vision thereby interfered with, the preponderance of adduction over abduction will be revealed by the fact that the eye so covered will deviate inwards. If a prism, base downwards, be substituted for the ground-glass, not only will the retinal image deviate towards the base of the prism, but owing to the abnormal tension of the adductors, the image will be deviated both upwards and somewhat outwards. Any weakness of the muscular system generally may also increase the insufficiency of the external recti, and so contribute to strabismus.

Insufficiency of the external recti causes a periodic and convergent strabismus in myopic patients, whose myopia is not very high in degree (5 to 7 D.), and who are possessed of powerful adductors and are able to converge for a length of time. The result is that their external recti, when obliged to maintain the visual lines parallel, find it difficult to do so in spite of the more favourable position of the visual line with the axis of the cornea; the task is therefore executed at the price of a certain strain on the external recti, which are congenitally weak. The result is, that when the eye is not fixed on some object, these muscles yield to the impulse of convergence which is habitual to the myopic individual. Gradually the external recti become incapable of producing parallelism of the visual lines, as you may have seen in a young patient whom I operated on lately, and who had a myopia of 6 D. When this patient was so placed that you were approximately at his near point, you did not observe any squint; but as soon as ever you withdrew, and his eyes followed you, a very marked internal strabismus became at once apparent.

When convergent strabismus is found in an emmetropic person with normal vision, if it does not date from early childhood, it is probably due to some former muscular paralysis, which, though eventually cured, has lasted sufficiently long to allow the antagonist muscle to become contracted, and a concomitant strabismus to establish itself.

In the much rarer form of *divergent* strabismus, it is the insufficiency of the internal recti muscles, the work thrown on which becomes the more severe in proportion as the myopia is high in degree, which causes the squint. Sometimes this variety disappears periodically, when the myope fixes attentively an object close to him, and converges sufficiently, but it again appears as soon as the eye wanders into space. In proportion as the myopia and the degree of convergence necessary for binocular vision increase, and as the lengthening of the antero-posterior axis of the eye renders convergence more difficult, a moment arrives when the individual grows weary of this excessive muscular exertion, and allows one of his eyes to diverge. Then, after passing through a short stage of diplopia, he contracts a permanent divergent strabismus, with suppression of images formed in the deviating eye.

Before entering on the treatment of strabismus, I must once more lay stress on certain conditions which may greatly aid its *spontaneous cure*. Among the forms of strabismus capable of cure spontaneously, must be excluded the various forms of divergent strabismus. The course of myopia being generally progressive, the increase in the insufficiency of the external recti resulting therefrom (owing to the lengthening of the antero-posterior axis) renders latent and periodic strabismus extremely liable to become permanent. A strabismus once established has a tendency to increase with age, which aggravates the myopia, while at the same time it reduces the muscular power.

It is consequently only in convergent strabismus that we find conditions favourable to a cure. They arise, on the one hand, from the increased difficulty of convergence, arising from the centres of rotation of the eyes becoming further apart, as the cranial bones develop, on the other by the progressive reduction in accommodation with age. Hence, as I have explained (p. 466),

the individual abandons all attempts at convergence. Also there may possibly be some change in the index of refraction with the growth of the eye, by which children may become emmetropic instead of hypermetropic (*Alf. Graefe*).

A cure will be the more probable if sight has continued equally good in both eyes, that is to say, if the strabismus is alternating. Since I have directed my attention to this matter I have noticed the frequency of cases where, without actual cure, that is to say, without re-establishment of binocular vision, there has been a great decrease in the amount of deviation. This holds good even of cases where the amblyopia in the eye which first squinted, was sufficient to prevent fingers being counted beyond a distance of two or three yards.

My first care with children of from two to three years of age, who being hypermetropic are beginning to squint periodically, that is, when they fix any object, is to prevent the strabismus becoming persistent, and especially monolateral. All periodical squints are capable of being cured by optical means, while permanent strabismus holds out but very slender hopes of benefit by mild treatment. However young the child may be, I determine the degree of hypermetropia with the ophthalmoscope, and give glasses which are fastened on with a small elastic band. It is true, indeed, that restless children are liable to injury, if the glasses become broken, but this danger must be met by extra care on the part of the mother.

In the case of a child actually affected with permanent and monolateral squint, every effort should be made to render this alternating. With this object, the child should wear alternately on each eye, say for half a day at a time, a spectacle frame, one side of which is covered over. In this way, the deviated eye, which is very often amblyopic, may be forced to fix objects, during many weeks for half of the entire day. In the case of a child who is just beginning to apply its eyes, I first determine the degree of hypermetropia, and then give glasses for reading the number of which corresponds to the manifest hypermetropia. In other words, I give the child glasses for distant vision. Glasses varying from 1 to $2\frac{1}{2}$ D. are to be worn after the cover has been removed from one eye, in order to allow of both eyes being used as soon as the child can fix his gaze on near objects. The accommodation may also be paralysed, and the hypermetropia entirely corrected. By thus suppressing the efforts of accommodation, which caused monolateral squint, and which, by the use of the spectacle frame, has subsequently become alternating, the attempt is made to change it into a periodical squint. This is then dealt with by the proper convex glasses, which are to be permanently worn.

Every child with periodical strabismus, who squints only when he looks at near objects, may be cured by a steady use of glasses, which correct his manifest hypermetropia, that is, which give him distinct distant vision. The determination of the refraction must be made with the ophthalmoscope. I generally prescribe a glass one third the power of that which the emmetropic eye requires, in order to see the fundus of such an eye distinctly. Should the child still continue to squint, when he looks at near objects, in spite of the glasses, I order a stronger glass to be worn during study, and one which, as a rule, corresponds to about half of the total hypermetropia revealed by the ophthalmoscope.

When parents inform me that a child, while wearing the same glasses both for near and distant vision, no longer squints, I advise them to discontinue the use of spectacles altogether out of doors, and to reserve them exclusively for play, meal-time, or reading. In this way we can tide over the period during which the growth of the cranium and the weakness of the ciliary muscles favour strabismus; but in some cases glasses for work cannot be laid aside before fifteen or sixteen years of age. Nevertheless, mothers will be quite satisfied with this result, especially in the case of daughters.

If it has been found necessary to give glasses of different degrees of strength (the stronger for near vision), while carefully watching the amount of deviation, the stronger glasses should gradually be replaced by weaker ones for close work, confining ourselves as soon as the tendency to squint begins to disappear to those which correct only the manifest hypermetropia. Some times it happens that a child will still suffer his eyes to deviate inwards, even with glasses which correct the total hypermetropia. When such is the case, there is no other course open but that of abolishing, during some weeks, or even months, all action in the ciliary muscle by means of atropine or duboisine. For distance smoked convex glasses should be given, which correct the whole of the hypermetropia; and with these other and stronger glasses which will allow of working with comfort at a distance of from 30 to 40 centimetres.

You will less frequently be called to treat periodic divergent squint. I maintain that periodic convergent strabismus may always be treated by mild measures, but such is not the case with the divergent strabismus of certain myopes, who when they use their eyes for distance without fixing any object attentively suffer them to follow the excessive impulse of the external rectus. In such cases near work is always performed under an effort of the adductor muscles; an effort which, as I have explained elsewhere (p. 213), is from its very nature favourable to increase of the myopia. Tenotomy will therefore be more absolutely necessary here than in cases of latent strabismus.

The convergent strabismus of myopes, when as yet only periodic, may be prevented from becoming permanent by glasses which correct half the myopia. These should be worn for near work in order to reduce the amount of convergence necessary, and to permit reading at a greater distance (35 to 40 centimetres). For distant vision, either these same glasses, or concave ones which correct two-thirds of the myopia, may be given. These latter should be decentred, so that they may have the same effect as weak prisms with bases outwards, or they may even be combined with a very weak abductor prism of one or two degrees. Once this convergent myopic strabismus has become definitive, it necessitates tenotomy.

LECTURE XLII.

TREATMENT OF STRABISMUS.

Before actually resorting to surgical methods, an attempt may be made to treat strabismus by the aid of the stereoscope. Such a method is available in cases in which diplopia readily becomes manifest when the images are distinguished from one another by a coloured glass. The difficulties however experienced in children, as regards the preliminary exercises, has always prevented this treatment becoming general. I only mention it as a method which may occasionally be resorted to when, for instance, parents are unusually nervous. It may also be employed in the periodic spasm of hypermetropes, in whom there is great difficulty in suppressing the tendency to strabismus, even with glasses which correct the total hypermetropia.

In correcting by *tenotomy* a permanent strabismus, we start with this axiom, viz., that the shortening of a muscle has the same effect as the advancement of its insertion in a direction towards the centre of the cornea; and that to place the insertion of a muscle further backwards, is equivalent to neutralising the effects of its shortening. By proportioning the amount by which the insertion of the muscle is set backwards, to the excess of action in the shortened muscle, the deviation may be corrected. The tenotomy required will then be in amount such as will render the effect of the setting back of the muscle proportionate to the deviation which the contraction of the muscle has caused the cornea to undergo.

The traumatic insufficiency which the setting back occasions, should, as much as possible, be annulled by the increased power acquired by the retracted muscle, as adductor in the case of convergent, abductor in divergent strabismus. It will further restore to the antagonist muscle the amount of power it had lost, owing to the contraction of the muscle. In other words, the range of excursive movement of the eye, which though uncurtailed, had been displaced towards the shortened muscle, will resume, by the setting back of the tendon of this, very nearly its normal position.

It must not, however, be concluded that in tenotomy we possess an exact method. The dynamic power of the shortened muscle as regards weakening its antagonist, may vary considerably, according to the shape of the eye, or in other words, according to its refraction. The loss of power, therefore, which a muscle undergoes when its tendon is set back, is not exactly proportional to the degree in which this is done. We must therefore have other means of regulating the effect, and of increasing or diminishing it as required.

Although the result depends a great deal on the skill and experience of the operator, there are two essential rules which must be always borne in mind. The first is, that in reducing the deviation, the least possible injury should be inflicted on the range of muscular movements, so that the movements of association and convergence may be in harmony. The second is, that it is necessary, in convergent strabismus, to allow liberally for the tendency it has to disappear of its own accord. Therefore, all complete corrections, without re-establishment of binocular vision, should be always avoided in such cases.

It was because these practical rules were neglected that the surgical treatment of strabismus was once threatened with complete abandonment. At that time actual myotomy used to be performed, whereby all control was lost over the shortened muscle. The great fault in this proceeding was that it destroyed the harmony of the combined and associated movements. Owing to the labours of *Bonnet* and of *Von Graefe*, the discovery of *Strohmeyer* has been rescued from the fate which for a moment threatened it. But this result has only been obtained by adhering strictly to tenotomy; that is, by respecting the second insertion of the muscle, the one, namely, which maintains the tendon indirectly in contact with the eyeball by the intermediate capsule of Tenon.

Notwithstanding the precept that myotomy should be reduced to tenotomy, the operation was threatened by a fresh danger when, in order to obtain very large corrections, it was recommended to detach freely the second insertion, so as to enable the tendon to be set still more backwards. Great injury was thereby done to the equilibrium of the muscular movements; while there was also a danger that as the influence of spontaneous cure began to make itself felt, the correction of the deviation would become excessive. An intelligent distribution, therefore, of the traumatic insufficiency which every tenotomy must necessarily cause, is imperiously demanded if harmonious action between the muscles is to be re-established.

It is calculated that a setting back of the tendon of the internal rectus muscle, will correct a deviation of 4 or 5 millimetres; that of the rectus externus, one of not more than 2 or 3 millimetres. Correction by partial section of the tendon has been abandoned, because the result was never sufficient at the time, and was almost certain to be lost very soon after the operation. These tenotomies have been given up all the more readily, as in suture of the conjunctiva we possess a means of almost completely annulling the effects of tenotomy. By it we can reduce according to the amount of traction applied to the suture, corrections to three or even two millimetres.

Another very important modification which the operation of strabismus has undergone, is that we now abstain from all attempts to increase the effect of a tenotomy with the view of correcting any deviations greater than 5 millimetres. These large corrections used to be obtained by excessive detachment of the capsule of Tenon, both externally and posteriorly (*Liebreich*), or else by drawing the eye forcibly in a direction away from the divided muscle by means of a conjunctival suture (*Knapp*). A correction beyond 5 millimetres can only be obtained by considerably reducing the adducting power of the rectus internus. As strabotomy is a perfectly harmless operation, the wish to limit it to one eye cannot have any weight, especially when the importance of harmony of movement is considered, and the necessity for every possible guarantee against a strabismus in the direction opposite to the one operated on.

So soon as the deviation exceeds five millimetres, it becomes necessary to divide the correction between the two eyes. If the prospect of a double operation excites alarm, the power of the antagonist muscle may be increased if necessary by being advanced towards the cornea. That we now hesitate much less than formerly about attempting to cure cases by advancement of the weak antagonist muscle, is a step gained in the treatment of strabismus. It is held better practice to thus increase the strength of a muscle directly, rather than indirectly, by setting back, and so weakening its opponent. The dependence we can place on our instruments, the ease with which the muscle may be attached near the corneal border by means of sutures (*Critchett*), the abandonment of all complicated dressings and unreasonable operations, in which the cornea was drawn towards the tendon, instead of the tendon towards the point where it was to be attached, have resulted at length in a thoroughly logical method of procedure.

Cases therefore of diplopia and concomitant strabismus, the result of partial paralysis of one of the muscles, should never be treated by division of the antagonists of the paralysed muscle, for this would to a certainty cause more or less insufficiency in the range of movements. On the contrary, advancement of the paretic muscle is a means of cure which does not leave any traces of the means by which it was obtained; but of course the amount of the advancement must be carefully apportioned.

I must repeat once more, that in convergent monolateral squint where confirmed amblyopia has destroyed any hope of obtaining an absolute cure, with binocular vision, the correction should not be pressed. The deviation should be only partially corrected, and a convergence of some two or three millimetres left, the correction of which should be abandoned to time and to the growth of the individual. This advice will be the more applicable, according to the youth of the subject; on the other hand, if a person above twenty years of age be operated on, a complete correction may be much more boldly made. None of these considerations apply to the correction of a divergent strabismus. In such a case, as soon as the deviation exceeds three millimetres, and that a sufficently good adjustment cannot be obtained by the setting back of the antagonist muscle, I now make a practice of advancing the weakened internal rectus, without at the time taking any further steps to increase the action of the muscle so advanced.

To divide the tendon of the rectus internus muscle, in a case of convergent strabismus, a fold of conjunctiva should be seized near the internal border of the cornea, in the direction of its transverse diameter. The scissors are passed under the conjunctiva, and this is detached over the whole insertion of the muscle, almost as far as the caruncle, should a correction corresponding to 4 or 5 millimetres be required. If a somewhat less effect is desirable, it will be sufficient to make a small button-hole in the conjunctiva, and to advance the scissors only up to the border of the tendon, so as to make a passage just large enough for the hook. It is evident, that by opening more or less widely the conjunctiva, which is united to the capsule of Tenon near the cornea, a greater or less effect as regards retraction can be produced.

The large strabismus hook should then be passed into the wound on the flat, its blunt point being directed towards the border of the muscle, and by a half turn of the instrument the whole tendinous insertion should be taken up. It is important to execute this manœuvre correctly, as we may then, by small snips of the scissors, detach the tendon from the sclerotic without the necessity of any further section. Still, in order to make sure of not having left some portion of tendon uncut, the small hook should be introduced into the wound, and caused to make two half turns above and below the tendinous insertion; these should be commenced about the middle of the already detached tendon, so as not to separate the capsule uselessly from the sclerotic, and so facilitate excessive retraction.

The operation is to be completed by bringing the wound together with very fine silk, which should be well tightened, so as in a few days to cut its way out of the conjunctiva without the necessity of meddling any further with the eye. If it be desired merely to close the conjunctival wound, so as to obviate any unsightly contraction of the caruncle, which, however, is more the result of separation of the subcaruncular tissue than of the size of the wound in the conjunctiva, the suture should be inserted vertically. If, on the other hand, it be desired to reduce the effect of the operation, the suture should be directed horizontally, the conjunctiva being taken up deeply, near the caruncle.

In order to learn whether the tendon has been entirely detached, for if not the effect of the operation will later on be annulled, it is necessary to gauge exactly the amount of adducting power remaining, and with that object to compare before and after the operation the displacement which the muscle is capable of causing on the corneal margin relatively to the inferior lachrymal punctum. As regards estimating the immediate loss of mobility in the external rectus, the distance between the border of the cornea and the external commissure should be taken. The traumatic insufficiency arising from section of the muscle should be at least from 3 to 4 millimetres.

Tenotomy of the rectus externus differs from that of the internus, in that the opening in the conjunctiva should be removed half a centimetre further from the corneal margin. Moreover, care must be taken not to detach the subconjunctival tissue widely, but merely to make a passage along one of the edges of the muscle, so as to execute easily the half turn with the large hook. Having with the small hook made sure that no portion of tendon is still adherent, the conjunctival wound is to be allowed to close, but sutures are not to be applied, except in cases where the wound being large, a portion of the sclerotic has been exposed. Sinking in of the caruncle cannot here occur, and the cicatrix will be much less apparent if the wound has been left without any suture. Where the conjunctiva has been brought together, a thickening resembling a vascularised pinguecula may continue for a long time.

In order to increase the effects of the operation, spectacles may be worn, so covered with black silk as to veil completely the eye not operated on; as regards the other eye, the half of it on the distal side of the section may be left uncovered. The patient is thus obliged to look constantly in a direction opposed to that of the divided muscle. It is useless to continue such treatment more than twenty-four hours, for it is only while the tendon is becoming attached to the sclerotic, that it can have any influence on the results of the operation. It is far more important not to permit the muscle, which has been newly grafted, and has recovered a portion of its former force, to follow the impulse of convergence, which efforts at accommodation will produce. While, therefore, it is absolutely necessary to forbid any close work for some time after the operation, it is also advisable to make the patient wear during some weeks convex glasses, corresponding to his manifest hypermetropia. Later on, when he returns to his avocations, glasses may be laid aside for distant vision, and only used for near work. In this way we may, to a certainty, avoid diminishing the correcting effect of the tenotomy.

I should strongly recommend convex glasses not to be worn in cases where the correction of a strabismus, with amblyopia, has been almost complete. The efforts of accommodation which the patient without glasses will make later on, may be used to reduce the adjustment which is apparently so satisfactory, and to obtain a certain degree of convergence. This, in young subjects, will be a guarantee against the ultimate development of over-correction.

After tenotomy of the rectus internus an amount of muscular insufficiency sometimes remains, such that if an object be brought within 20 or 25 centimetres of the eye, divergent strabismus will ensue. When such is the case there is danger of the correction exceeding the necessary amount. Glasses, therefore, should not be given for work, inasmuch as they would check the natural tendency towards convergence, which accommodation produces.

I have already said that I reject all operative procedures, the object of which is to produce very large corrections. Under this head I include the deviating suture of *Knapp*, which is, moreover, painful in its action. In a very high degree of convergent strabismus, where the adductors are excessively strong, it may be evident beforehand, that the correction will not be sufficient even though divided between the two eyes. When such is the case it would be necessary to detach the conjunctiva and caruncle freely, to open the capsule of Tenon, and so to facilitate retraction of the muscle, without, however, there being any necessity to resort to a deviating suture. In such cases no suture whatever is required. For twenty-four hours deviating spectacles may be worn, and immediately replaced by convex glasses corresponding to the manifest hypermetropia.

It is absolutely imprudent in cases of very marked convergent strabismus to operate on both eyes simultaneously. Not only by so doing would the increased correction obtainable by strongly deviating glasses after each operation be lost, but in some cases there would be great danger of over-correction. It will often happen, with a convergent strabismus of from 7 to 8 millimetres, that after one operation a correction is obtained, such that it is more prudent in young subjects to leave the 2 or 3 millimetres of convergence remaining to be cured spontaneously.

Double strabotomy in an æsthetised patient is an operation which every cautious practitioner will eschew. It is utterly impossible to gauge the effects of the operation immediately, or to decide whether the results of the tenotomy should be diminished or increased.

Where it becomes necessary to diminish the effects of an operation, a compress bandage, together with the horizontal suture, within which the conjunctiva over the muscle should be largely included, must be employed. The patient should also be directed to look as much as possible in the direction of the tenotomised muscle, for example to his left, if the right internal rectus has been divided.

In cases of impaired power in the antagonist muscle from paralysis, I always have recourse to advancement of the weakened muscle. If the deviation be considerable, and complicated with spasmodic contraction, the setting back of one muscle should be combined with the advancement of the other. As far as possible I avoid performing the two operations together, and always commence by advancing the weaker muscle, so as to witness the effect produced, before proceeding to section of the contracted muscle.

It is at this clinique that I have made it my special endeavour to popularise these simple muscular advancements. *Von Graefe* did not consider that advancement would be sufficient, unless the antagonist muscle was at the same time weakened by division of its tendon. Real progress has been made in those sutures which *Critchett* has introduced so generally. They may be modified, so as to do away with all the other difficult and painful methods of muscular advancement. While at one time such operations demanded very complicated after-treatment, you will now see patients leaving for their homes immediately after the operation, with only a compress bandage on. In many cases, in deference to the teachings of physiology and conservative surgery, strabismus ought to be cured by the advancement rather than the retraction of a muscle; but the former operation is much the more painful, and is only really indicated in practice when it is desirable to increase the power of a given muscle.

Our comparatively recently acquired knowledge of grafting, and the fact that we can seize and accurately fix a muscle, gives to the operation of advancement a certainty not inferior to that of tenotomy. If, for instance, we desire to advance an internal rectus, the procedure is as follows:—

The conjunctiva is to be detached from the corneal margin to the extent of from eight to ten millimetres, care being taken that no portion remains attached to the sclerotic. If the conjunctiva has become transformed into cicatricial tissue, as the result of some previous operation, and if this is difficult to detach, I make use of a cataract knife, and clear away the whole portion between the corneal border and the muscle. The conjunctiva is then to be very carefully detached over the insertion of the muscle, to accomplish which the scissors should be made to pass in all directions under the caruncle.

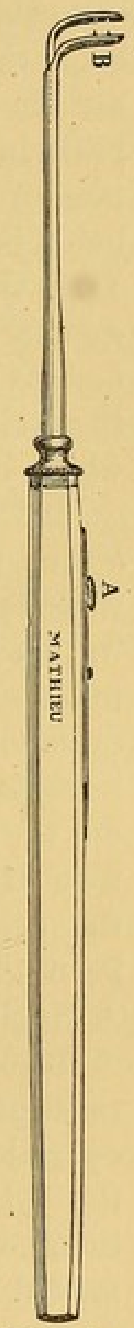

Fig. 31.

The double hook is next introduced opened to its full extent (fig. 31), and is made to describe a half-circle; one branch is thus passed under the tendon of the muscle, which is seized by the instrument. At this stage the second branch is pressed down against the first, so as to form a forceps within which the muscle is grasped. If the thumb be kept on the button of the instrument, and the movable blade well pressed against the one under the muscle, this latter can be securely held while, as in simple tenotomy, the tendon is being divided.

Having made sure, with the small strabismus hook, that no portion has remained included in the double hook, the muscle and subjacent conjunctiva are to be traversed from within outwards by a thread, each end of which is armed with a needle. The muscle and conjunctiva are then taken up at a point further back in proportion, as a more considerable advancement of the tendon is desired. The first needle once passed, the double hook is withdrawn, as the muscle can now no longer escape. With the two other needles the conjunctiva near the border of the cornea is transfixed at two points symmetrically situated, and distant 6 or 8 millimetres from the wound. The two sutures are then closed, and the double thread detached from the needle, which had been previously passed through the muscles.

The sutures may be fastened in two ways, namely, by tying either the corresponding threads, or the reverse, by which the threads first knotted will act as pulleys. To advance the muscle in this latter way, it is necessary that the point of conjunctiva, upon which the first ligature acts, should be very firmly seized, otherwise the suture will fail completely, and a fresh attempt have to be made, which is always disagreeable for the patient. On the other hand, this pulley-like traction has the great advantage of not requiring more than one ligature on the eye-ball, as the other may be laid outside the palpebral fissure and only brought down on the globe at the moment of tying the second. A single snip of the scissors suffices to remove these threads.

According as the conjunctiva shows a greater or less amount of reaction, the sutures may be removed from 24 to 28 hours after operation. If the conjunctiva is discharging but slightly under the compress bandage, I leave the sutures in position for 48 hours. In any case, however, even if the sutures have to be removed early, the bandage may be continued a day longer, so as to ensure firmness of the muscular union.

Many of you have seen me perform advancement in the manner I have described on the internal, external, and superior recti in cases of diplopia, which required most accurate correction. The good results obtained, namely, binocular vision, with disappearance of all diplopia are to me an assurance that these advancements *by the double thread*, cause traction exactly in the direction in which we wish to attach the muscle, and further do not produce any pathological inclination of the meridian.

Mr. Critchett in a former method used to leave a space between the corneal margin and the muscles to be attached, sufficient to insert a suture; to this he added two others, placed laterally, near the edge of the muscle and along the edge of the cornea. By this method it is evident the tendon could not be drawn near enough towards the centre of the cornea, to ensure that correction which old-standing paralyses and injuries at times demand.

Von Graefe employed a single ligature placed diagonally, which, in the absence of a median ligature, permitted strong traction to be made on the muscle towards the corneal margin. By this method traction could not be applied exactly in the axis of the muscle, and therefore a defective inclination of the meridian was inevitable. Slight inclinations are of no importance in merely cosmetical corrections, but in diplopia they vitiate all the results of treatment.

It will be seen that the use of the double hook enables certain steps in the operation, which were difficult and delicate enough, to be done away with completely, such, for example, as the placing a suture in the tendon before dividing it (*Schweigger*). With the double hook a muscle may be easily shortened (*Agnew*) as follows: the needle armed with the double thread is to be passed sufficiently far into the muscle, so that the tendon may be excised and the muscle, as thus shortened, grafted on.

I need scarcely mention the attempts at resection in the body of the muscle itself (*Noyes*). With the object of demonstrating them clinically, I have made such resections, and, I must say, with very satisfactory results. But such methods are too delicate ever to become general. It may be said too that they cannot be apportioned with the same exactness as either simple advancement, or advancement combined with shortening of the tendon.

It will be seen from the foregoing sketch that the treatment of strabismus has undergone important modifications and improvements. In the first place as far as possible excessive corrections, by which the harmony of the muscular movement was destroyed, have been abandoned. In the second, the disposition to spontaneous cure which the commonest form of strabismus, namely, the convergent, possesses, has been more generally recognised. Complete correction is also advisedly abstained from in cases where the influence of binocular vision cannot be brought to bear against over-correction. Finally, whenever the antagonist muscle to the deviated one is perceptibly weakened, advancement is now practised, the operation having been rendered easy and very certain in its results.

These rules have made supplementary operations much less frequent than formerly. The use of sutures and the small size of the conjunctival wound have removed the necessity of cutting off profuse granulations. The sparing of the subcaruncular tissue, together with the insertion of a suture in the conjunctiva, renders it very seldom necessary to advance as it were a sunken caruncula. Finally, in muscular advancement we possess a very precious means of correcting the unsightly appearance resulting from a difference in size of the palpebral apertures. This want of symmetry may have existed before the operation, but have escaped notice, owing to the greater deformity caused by the squint. When, therefore, in a squinting eye, with an excessively large palpebral aperture, the weaker muscle is advanced, instead of its antagonist being moved backwards, a diminution in the size of the fissure is obtained, proportionable to what the enlargement would have been had the opposite plan been followed.

LECTURE XLIII.

MUSCULAR PARALYSES.

To make the indications of treatment afforded by muscular paralysis more easy to comprehend, it will be well briefly to consider the functions of the six muscles of the eye, and the leading symptoms caused by any impairment of one or of a group of them. The action of these muscles is not to displace the eye, but simply to rotate it round a fixed centre. This centre in the emmetropic eye is placed about thirteen and a half millimetres behind the summit of the cornea.

The recti muscles, and the superior oblique have their fixed point near the optic foramen; after piercing the capsule which envelopes the eye, they pass to be inserted by means of curving tendons, the extremities of which are in the same horizontal plane at the centre of the cornea, and equally distant from its margin. The only points of difference between the two curving tendons of these muscles is that the tendon of the internal rectus is two millimetres broader, and nearer to the corneal margin than that of the external. But these two muscles, owing to their common anatomical arrangement and to the existence of the same muscular plane or plane of traction, which passes through their osseous insertion and the summit of their tendinous attachment, namely, the horizontal meridian, have, as their axis of rotation, the vertical diameter perpendicular to this plane. It follows that the movements which these muscles can impose on the eye, can only displace the centre of the cornea, within a great circle, represented by the horizontal meridian, while their axis of rotation which is in the vertical meridian necessarily remains immovable. This latter will, therefore, during the contraction of the abductors or adductors remain perfectly vertical.

The inferior and superior recti arise like the preceding from the optic foramen, and are inserted with less regularity, into the sclerotic. The insertion of their tendons is on the temporal side some two millimetres further from the corneal border than on the nasal, where it is at a distance of five millimetres. Moreover, the summit of the curved line of tendon of the rectus inferior, is not situated in the direction of the vertical meridian, as in the case of the superior, but is placed about one millimetre on the inner side of this meridian, and consequently on the inner side of the centre of the cornea. Strictly speaking, therefore, there does not exist here one single muscular plane, which nevertheless we admit, for this group of muscles. It is clear that this plane cannot pass through the vertical meridian; as a matter of fact it describes an arc of a small circle, which leaves the centre of the eye outside, so that its axis of rotation forms with the horizontal axis of the eye an angle of 20°, and with its antero-posterior axis an angle of 70°.

The contractions of these muscles, which should apparently displace the centre of rotation of the eye, it not being situated in the plane of traction, cause, however, only simple rotations. These muscles, indeed, not only raise and lower the centre of the cornea, but they also draw it slightly inwards, and influence the extremities of the meridian near which they are inserted, that is to say, the rectus superior inclines the meridian inwards, and the rectus inferior outwards. The position of the vertical meridian relatively to the plane of traction of this group, will cause these muscles to act more particularly, as either elevators or depressors or deviators of the meridian. The power they will have of displacing the centre of the cornea, will increase in proportion as the eye is turned outwards, and as the plane of traction and the vertical meridian tend to assimilate. If, however, the eye be turned outwards, and the muscular plane be removed to a distance from the vertical meridian, these muscles will then act more strongly as deviators of their meridian.

The superior oblique has its fixed point near the trochlea, and is inserted into the superior and external quadrant of the eyeball. At the same point is attached likewise the inferior oblique, the fixed point of which is at the orbital edge of the maxillary bone, on the inner side of the lachrymal sac. The tendon of the superior oblique forms a curved line, the convexity of which looks backwards and outwards, while its internal extremity approaches to within seven or eight millimetres of the optic nerve. The very large tendon of the small oblique traces on the same superior and external quadrant of the eye, a curved line, the convexity of which looks upwards and forwards, and the posterior part extends to within four or five millimetres of the optic nerve.

In order to simplify the study of this group, I here suppose the existence of a single muscular plane, which does not correspond with the equatorial plane of the eye, but cuts it, leaving the centre of the eye internal to it, and deviating by its inner extremity anteriorly, and by its external posteriorly, from this same equatorial plane. The axis of rotation of this muscular group forms with the optical axis an angle of from 35° to 40°, and its anterior extremity passes outside the anterior pole. Similarly to the superior and inferior recti, the action of the oblique muscles is threefold. The superior oblique, while lowering the centre of the cornea draws it outwards, and inclines the meridian inwards. The inferior oblique raises the cornea inwards and outwards, and inclines the meridian outwards.

Contrary to what occurs in the case of the superior and inferior recti when the eye is turned inwards, the main action of the oblique muscles is to displace the centre of the cornea, whilst, if the eye be directed outwards, the same muscles act essentially by inclining the meridian. In this case the angle which the axis of revolution of these muscles forms, tends to become one with the antero-posterior axis.

It is easy to recollect that the first group of muscles causes the eye to perform simple movements of abduction and adduction; that the second group, to its action of elevating and depressing, adds also that of drawing the cornea inwards, and of inclining the meridian; and that the same multiple action appertains also to the third group; but that the second group essentially deviates the centre when the eye is directed outwards, and the meridian when inwards, while the exact opposite holds good for the obliques. The rectus superior is then the true antagonist of the inferior oblique, and the rectus inferior of the superior oblique.

As regards the various positions of the eye, it is equally easy to remember that if the eye move strictly in a horizontal or vertical plane, the meridian remains vertical; that in looking *outwards*, the oblique muscles determine the position of the meridian, while, on the contrary, in looking obliquely *inwards*, the superior and inferior recti act upon it.

A loss of power, more or less complete, in the rectus externus, (paralysis of the 6th pair), will cause diminution in abduction of the eye, which will be marked in proportion to the completeness of the paralysis. The cornea, during the effort of abduction, remaining abnormally inwards, the image of an object will fall on the inner side of the macula, and will consequently be projected on the outer side of the point looked at. The result will be homonymous diplopia. The images will become more widely apart, as the paralysed muscle is made to execute a greater abducting movement, in other words, in proportion as the object looked at is moved more in the direction of the paralysed muscle. No marked deviation will be manifest unless the affected eye is made to perform abduction, or unless owing to complete paralysis, the rectus internus has become contracted.

This primary deviation will be very far exceeded (as may be observed through a piece of ground glass) by the secondary deviation due to the contraction of the rectus internus on the sound side, when the affected eye fixes any object. This will be still more evident if the secondary deviation be measured when the eye is abducted. An object will appear to the patient as if placed considerably more outwards than it is in reality, on account of the impulse he believes he has applied to the paretic muscle. Besides, he will turn his head in the direction of the paralysed muscle, in order as much as possible to avoid diplopia by means of this compensatory movement.

In slightly marked cases of paresis; the diplopia will form the only means of diagnosis. This must be studied by distinguishing the images, and rendering them conspicuous, by means of a coloured glass placed before the unaffected eye. The image of this eye will appear the more distinct of the two, because it falls on the macula. The field of the diplopia will be defined, not by a vertical line, but by one inclining outwards, because, all pathological convergence tends to diminish if the eye is turned upwards, and to increase if turned downwards.

The double homonymous images will become more widely apart in proportion as the abduction is increased, but will continue strictly parallel so long as there is no question of any other movement. But if the eye be turned diagonally, then the impairment of the abductor will indirectly affect the position of the meridian, by annulling the controlling action of the oblique muscles. Thus, when the eye is turned upwards and outwards, the inferior oblique exercises a preponderant action, inclining the meridian outwards. But the harmony of position being destroyed, owing to defective abduction, the regulating action of the inferior oblique on the meridian will no longer be felt, and consequently the meridian will be inclined inwards. The images projected on the retina will converge, and will be projected diverging, as regards their upper extremities. The reverse will be the case when the eye is directed downwards and abducted.

All this symptomatology becomes very accurate, when we have an attentive and intelligent patient to deal with, and one who can appreciate a slight inclination of the meridians, and the difference in height of the images caused thereby. The reverse of all the foregoing will hold good when the internal rectus has become contracted, and when consequently the limits of the field of diplopia have become displaced. This contraction of the antagonist will occur all the more rapidly in proportion to the efforts of convergence induced by calls on the accommodation, a paretic muscle not being able to oppose any adequate resistance to convergence combined with accommodation.

When paralysis of the third pair of nerves is complete, all branches being affected, a very characteristic group of symptoms are produced, namely, loss of power of adduction, and of raising or lowering the eyeball, ptosis, dilatation of the pupil, and paralysis of the accommodation. Two muscles only are unimpaired, the rectus externus and the superior oblique. The preservation of the power of abduction may be readily shown; the power of the superior oblique will be manifest when the eye is directed downwards, by a movement of rotation, due to the inclination of the meridian inwards, and by a slight simultaneous lowering of the cornea.

When the paralysis is confined to one or to a few isolated branches, the case demands special study. If paresis is the only symptom present, examination of the diplopia will be necessary, in order to find whether or not other nerves are simultaneously affected.

Paralysis of the rectus internus gives symptoms just the reverse of those of the abductors. There will be crossed diplopia, with slight deviation upwards, arising from the want of parallelism in the meridians. In the diagonal positions of the eye, the regulating action of the superior and inferior rectus cannot play any part. If the eye be turned upwards and inwards the meridian deviates inwards, and this same defective inclination will be imparted to the image formed on the retina; but inasmuch as the image is projected to the inner side of that of the sound eye, its projection will still have, relatively to that of the sound eye, the same inclination; therefore the images will diverge just as the retinal images themselves do. The field of the diplopia is not bounded by a vertical line, but the limit between the portion of visual field within which the patient sees single or double, is formed by a line inclining sensibly to the unaffected side. The abduction of the eye becomes more marked when the patient looks upwards.

Paralysis of the *rectus superior* causes a malposition of the cornea, which becomes evident in proportion as the patient looks upwards. The double images are superimposed and crossed, owing to the slight deviation outwards which the paralysis of the internal rectus causes. The extremities of the crossed images diverge, as do also the retinal images, owing to the faulty inclination of the meridian, the upper extremity of which cannot be drawn inwards by the paralysed muscle. The obliquity of the images becomes peculiarly striking when an object is placed in the direction in which the paralysed muscle should act on the meridian, namely, inwards. If, on the other hand, the eye be directed upwards and outwards, the difference in height but not in obliquity of the images, becomes more marked. Double images do not invade the inferior portion of the visual field, so long as there is not retraction of the rectus inferior.

Paralysis of the *rectus inferior* gives crossed diplopia in the lower portion of the visual field, with convergence of the superior extremities of these images.

Paralysis of the *inferior oblique* causes diplopia in the upper portion of the field of vision, but this, conversely to what obtains in paralysis of the rectus superior, is homonymous; the images being divergent at their upper ends, owing to the defective inclination of the meridian outwards. The contrary is also true as regards increase in the obliquity, and the height, according as the eye is directed inwards or outwards.

Paralysis of the fourth pair affects the superior oblique, and give rises to deviation of the eye upwards and inwards when the patient looks downwards. There is no diplopia except in the inferior portion of the field of vision. The line which separates the portion in which the patient sees double from that in which vision is single, is oblique, and rises towards the healthy side, because the cornea deviates more upwards if the patient looks inwards. The images are homonymous and superimposed; they are also convergent by their upper extremities, for the impairment of the superior oblique causes the meridians, and consequently the retinal images, to diverge. If the patient looks downwards and outwards, the difference in height diminishes. If the deviation of the optical axis becomes equal to 35°, this agreeing with the axis of rotation of the oblique muscles, the height of the two images becomes the same, and there exists only a lateral deviation joined to very marked convergence. On the other hand, the difference in height increases very markedly in proportion as the eye looks downwards and inwards.

The latter symptom distinguishes at once this paralysis from that of the rectus inferior, in which the exact opposite is the case. It will be observed also that the image formed on the paralysed eye seems the nearer of the two, because it is formed in the upper half of the retina,—an object appearing closer to us when it falls above the macula. The same phenomenon is produced equally in the case of paralysis of the inferior rectus. The patient, in order to avoid diplopia, inclines his head downwards, and towards the unaffected side.

It is of the utmost importance, as regards treatment, to determine accurately the nature, extent, and causes of the paralysis. The fact must be recognised that in many of these cases our knowledge is very deficient. However, it is now admitted that these paralyses may be connected with three different influences, namely, (*a*) *cerebral;* (*b*) *spinal;* or (*c*) *peripheral.*

In the group of *cerebral paralyses*, those which acknowledge a central cause, that is to say, which are seated near the roots of the nerve itself, must be distinguished from those determined by affections localised at the base of the brain. There is also another group of paralyses, which result from lesions of the cortical substance, affecting the psycho-motor centres of the motor nerves of the eye. The question of ætiology in any given case of paralysis is very much complicated, even supposing we are certain that the paralysis really depends on some intra-cranial lesion, by the fact that it is not yet certainly known whether the decussation is complete of those nerves, the roots of which lie close to the floor of the aqueduct of Sylvius, and the adjacent parts, constituting the fourth ventricle. For though we are almost in a position to prove positively that the decussation of the fourth pair is complete, and of the sixth partial, nothing has yet been established with regard to that of the third. Thus an embolism or an apoplectic clot on the left side may determine a paralysis of the right superior oblique, a partial paralysis of both external recti, or a paralysis of the third pair on the left side.

A simple consideration of these facts will suffice to show how difficult it is to analyse cases of multiple paralysis. Paralyses determined by apoplexies in the corpora striata, or the optic tract or the hemispheres, are generally crossed like the corresponding hemiplegiæ, a phenomenon which still remains to be explained.

On the other hand, circumscribed centres of degeneration, which are exceptionally developed in the corpora quadrigemina and the pons, are as a rule followed by bilateral paralysis. These facts alone will be sufficient to show that paralytic affections of the muscles are but very imperfect guides in fixing the exact position of a cerebral lesion.

It is true that total paralysis of a nerve is more or less an argument in favour of its having become affected subsequently to its becoming a completely formed nerve trunk. Such therefore points to the existence of some morbid centre near the membranes, and chiefly at the base of the brain (*Von Graefe*), rather than to any disorganisation of the centres, as this must have extended and betrayed itself through other cerebral symptoms. But this hypothesis loses much of its value, when we remember that simple hyperæmias of the brain and membranes may be themselves complicated with states of paralysis. It makes no difference in these cases whether this hyperæmia is active or passive. Thus it may be determined by the pressure exercised by tumours on the abdominal aorta, or on the jugular veins. In other cases the cause must be looked for in a circumscribed hyperæmia due to irritation of the vasomotor nerves, by small tumours in the brain, at a distance from the roots, and expansions of the motor nerves of the eye. Nor should it be forgotten that anæmia of the brain and its membranes readily determines incomplete paralysis of these nerves; or that a similar anæmia, caused by a passing embolism, is the probable explanation of transient paralysis in old persons.

It is also not uncommon for basilar and cerebro-spinal meningitis to propagate itself along the envelopes of the nerves, and determine paralysis (*Schirmer*). I should also mention tubercular and parenchymatous meningitis, which induces as a rule multiple paralysis.

Encephalic meningitis, affecting the psycho-motor centres of the nerves of the eye, gives rise to paralysis and convulsions simultaneously, either isolated or combined with partial facial hemiplegia. This hemiplegia, which extends at times to the limbs, is like the motor disturbances in the eye, crossed; that is to say, it is due to a lesion of the cortical substance of the opposite hemisphere. As regards the third pair, it is never involved as a whole in any single centre in this affection. Moreover, we know as yet absolutely nothing about the exact seat of the motor centres of the muscles of the face and eyebrows. These, from inductions based on experiments performed on animals, and on a few autopsies, have been localised in the second ascending frontal convolution.

(*b.*) It scarcely admits of doubt that ataxy is often preceded by transient paralyses, as regards the origin of which we know nothing for certain. I have shown you lately a patient thirty years of age, and ataxic for the last two, who had severe darting pains, and characteristic myosis, with immobility of the pupil to light, although it contracted strongly under the influence of accommodation. This patient has been seized within the last two months with incomplete paralysis of both right external recti, without a single other cerebral symptom. The optic nerves were absolutely unimpaired, and he came here merely on account of a troublesome diplopia.

I do not speak now of cases where the brain is itself the seat of centres of disseminated sclerosis, and where both the optic and the motor nerves have been found affected by it (the sixth pair, *Lionville*). What is absolutely inexplicable is that, precursory to grey degeneration of the posterior columns, a paretic condition of the nerves appears, leaving one eye to attack the other, and disappearing without any traces, save in the case of the third pair, where a persistent mydriasis continues, though without diminution in the power of accommodation. The anatomical changes in these forms of paralysis, which are met with largely in ataxia, have not as yet been elucidated.

(*c.*) *Peripheral paralyses,* so called because the nerves are attacked in their distribution, may depend on rheumatism. Here a swelling of the periosteum of the orbit may occasionally be seen, which shows itself by a peculiar sensibility when the eyeball is pressed backwards. This form of paralysis may also, though more rarely, be due to circumscribed centres of basilar meningitis, dependent on articular rheumatism. In the course of syphilis, gummy growths, periostitis, and intraorbital exostoses, may induce paralysis. But in these cases the paralysis which affects the majority of the muscles of the eye attacked, is complicated by slight exophthalmos. With these also should be classed the paralyses due to diphtheria. They are met with during convalescence, and very frequently affect the branches of the third pair which supply the ciliary muscle.

I merely refer in passing to those rare forms of *congenital* paralysis of which you have lately seen an example in a young student of twenty-one years of age. The paralysis was especially marked in his right rectus externus, though the rectus internus of the same eye had also suffered, and though there was moreover slight congenital ptosis. Finally, in certain individuals complete and permanent paralysis of all the muscles of both eyes may occur without any apparent cause in the general condition of body to explain it.

Treatment will naturally vary widely according to the nature of the paralysis. An attempt should therefore at the outset be made to discover the exciting cause, which, however, owing to the great number of possible hypotheses, can often only be guessed at. Whatever it be, when diplopia is present, the patient should be relieved by means of a ground glass worn over the affected eye. It is justifiable to exclude the unaffected eye only when its vision is very defective, and when the patient has himself already given a preference to the paretic eye. It is essential in cases of paralysis of the fourth pair to carefully note the position of the images, and the eye which it will be best to exclude from vision, so as not to aggravate the secondary deviation in the sound eye. There can be no objection to a patient laying aside his glasses as the necessity for them becomes less; especially if he is improving; for the efforts that he makes in order to secure binocular vision will necessitate an orthopœdic exercise, analogous to what is obtained with prisms and the stereoscope. By a continuous use of the ground glass, which would render such efforts superfluous, the cure would be delayed.

The principal means at our disposal against peripheral paralysis of rheumatic or syphilitic origin are iodide of potassium and mercurials (syrup of Gibert), and more especially diaphoresis, by means of injection of pilocarpine (p. 123). I can show you more than one patient who had suffered for a length of time from complete paralysis of the third pair, and who, by means of these injections continued from one to three months, is now actually in a fair way of recovery. I have seen patients benefited by ten or twelve injections, in whom the improvement commenced after the third or fourth. Nevertheless, in old-standing paralysis a prolonged series of such injections need not excite alarm, as they apparently never weaken a patient.

Excluding internal remedies, electricity is perhaps the most usually resorted to of any. Its application is purely empirical, and should last from one to three minutes. Six to eight cells, gradually increased to twelve, should be employed if the sensibility of the skin is at all blunted.

The positive pole should be placed, by the intermediary of a disc covered with leather and moistened, on the brow in the region of the supraorbital nerve. The negative pole, in paralysis of the rectus internus, levator palpebrarum, or both obliqui, should be moved over the arch of the brow and bridge of the nose. In paralysis of the superior, inferior, or external recti, the negative pole should remain on the forehead, and the positive be applied over the paralysed muscles. In cases of mydriasis with paralysis of accommodation, two round plates should be used, the negative being laid on the eyelids, the positive on the forehead. In paralysis of the third pair it has also been recommended to place the positive pole, not on the forehead, but on the mucous membrane of the cheek. The rheophore should be short and shaped like a sound (*Schultze*).

These applications, which have the great advantage of being painless if the membrane covering the rheophores is first well moistened, have almost entirely superseded direct irritation of the muscles. The introduction of sounds with rounded ends as rheophores, or of small discs of ivory (*Gillet de Grandmont*), which are passed into the conjunctival cul-de-sac, is always much dreaded by patients. The force of the current requires to be carefully watched, on account of the close proximity of the retina. I should also add, that a very smart conjunctival irritation may sometimes arise from the use of these currents.

The treatment by electricity through reflex action, appears to produce very satisfactory results. Its action will be intensified if, at the moment when mobility is returning in the paretic muscle, a series of strychnine injections be given. However, it is very difficult to speak with any certainty, as regards the efficacy of the various means above mentioned, especially as in a large number of cases we have to do with transient forms of paralysis, which, like those preceding ataxy, disappear spontaneously and sometimes rapidly. In the case of old-standing paralyses with troublesome diplopia, which it has not been possible to correct by prisms, recourse should be had to surgical means.

It must be borne in mind, that when prisms are used, the object in view is by means of the deviation obtained, to bring the image close to the macula, so as to oblige the paretic muscle to contract. In this way we may obtain fusion of the images, and remove a diplopia, which is the more annoying in proportion to the proximity of the images to the macula. If the patient succeed in fusing the images, the strength of the prisms may be progressively diminished, until they are no longer required. This treatment, if the paralysis does not entirely disappear, leaves more or less of a latent strabismus, and is of little practical use, except in the case of very timid patients who shrink from any and all operations.

The advancement of the muscle, if possible without division of its antagonist, is only to be recommended when, from the nature of the paralysis, diplopia can be completely, or at least, in the usual position of the eyes, suppressed. In all cases where paralysis has remained complete, and especially if it has been complicated with spasmodic contraction of the antagonist muscle, no surgical treatment should be attempted. Conversely, if the paralysis has entirely disappeared, and if by contraction of the antagonist muscle strabismus has been produced, analogous in some sort to the concomitant form, then simple tenotomy of the retracted muscle will instantaneously remove this troublesome deformity.

LECTURE XLIV.

SPASM OF THE EXTRINSIC AND INTRINSIC MUSCLES OF THE EYE.

Cases of spasm of single muscles of the eye are so rarely met with, that a clinical description of such a case is almost impossible (*Alfred Graefe*). Combined spasmodic contractions are, however, not uncommon in cerebral affections, involving the motor centres of the eye, where they determine *conjugate deviations* (*Prevost*). These spasms appear first in the form of clonic contractions simulating nystagmus. The contraction next becomes definitive, giving rise to deviation in both eyes, with which displacement of the head in the same direction may be conjoined. According to the observations of *M. Prevost*, if the hemispheres are the seat of the lesion, the eyes are turned in the same direction as the affected hemisphere, and consequently in an opposite direction to the hemiplegia. On the other hand, if the pons, the peduncles of the cerebellum, or the cerebellum itself are involved, the eyes and head are turned to the side opposite the seat of lesion. In cases of a lesion of the cortical substance, or the membranes, the eyes always turn in the direction of the lesion.

These spasmodic affections are interesting enough from a diagnostic point of view, but can never become a matter for any special treatment.

Clonic contractions of the muscles of the eyes, inducing constant and involuntary movements, are known as *nystagmus*.

Nystagmus is often *bilateral*. It is termed *oscillatory*, if the deviation of the eyes is shown in successive movements of abduction and adduction, or what is much more common, by the eye being directed alternately upwards and downwards. When the deviation is *oblique*, the nystagmus is *mixed*. *Rotatory* nystagmus is that form in which the eyes turn on their axes. It is not uncommon to witness a combination of mixed and rotatory nystagmus. As a rule, however, the only pure form of nystagmus is the oscillatory, which is determined by clonic contractions of the abductors and adductors. *Unilateral* nystagmus, though very rare, is found in children in cases where one eye is affected with some malformation near the optic nerve, accompanied by irregular astigmatism.

It is not uncommon to find with oscillatory nystagmus, corresponding movements of the head. In this form, in which the movements of the eyes are due to the abductor and adductor muscles, if the head be inclined, and the eyes be made to converge strongly, the clonic spasms will cease. In the mixed and rotatory forms, where the eyes oscillate vertically, there are also positions into which, if the eye be forcibly moved, more or less perfect repose will be obtained. Even in movements dependent on the adductors and abductors, cases are found in which no rest can be procured, in spite of the strongest convergence, and in spite of the head being held in a position favourable to binocular vision. The manner in which such patients hold their books when reading indicates, as a rule, the direction in which the nystagmus tends to diminish. The direction of the movements of the eyes may be readily studied by the displacement which the image of the retinal vessels passing from the papilla vertically or horizontally undergoes.

As regards ætiology, three forms of nystagmus may be distinguished, namely (*a*), a *congenital*, or one acquired during the period of growth of the eyes, (*b*) a *professional*, and (*c*) a form symptomatic of *cerebral* or *spinal affections*.

Children born with certain malformations, such as microphthalmus, coloboma of the choroid, choroido-retinitis, polar and zonular cataracts, are essentially subject to nystagmus. All causes which reduce the physiological value of retinal images during the period of retinal growth, and which hinder fixation in young children, predispose to nystagmus. Thus the spots on the cornea which succeed ophthalmia neonatorum, are a very common cause of clonic movements of the ocular muscles. In general, therefore, eyes affected with nystagmus are weak as regards visual power, either from congenital or acquired malformations. It is quite the exception to find normal vision in cases where the nystagmus dates from infancy. It must not of course be supposed that every child in whom vision has been defective during the period of retinal growth, must necessarily be the subject of nystagmus. If a large number of young subjects affected with very advanced retinitis pigmentosa be examined it will be seen that given an equal contraction of the field of vision, the eyes will twitch in some, while in others they will be perfectly at rest. Weak sight is therefore at best only a predisposing cause.

In some families nystagmus is hereditary. It is then combined with congenital amblyopia, and more or less achromatopsia. Of this I have shown you a remarkable instance, in the person of a youth nineteen years of age, affected with absolute achromatopsia and nystagmus.

(*b.*) Nystagmus may become acquired (*Schröter*) in persons who, like miners, are obliged to work under conditions of insufficient light, and with their eyes turned in a direction which could not naturally be long maintained, such as convergence of the visual lines when the eyes are directed upwards. As yet this nystagmus has only been observed in persons who work in coal mines. The fact that only miners of a certain age are affected, and those not young and strong, would seem to show that hygienic conditions have some influence on the development of the affection. Professional nystagmus is distinguished from acquired, by the fact that it becomes more marked in proportion as the light grows weaker, and also in that position which is rendered necessary by the patient's daily avocations. Further, while in the preceding forms the patient was unconscious of any displacement of the images on his retina, in this the twitching gives rise to a quivering of the images, and especially of the luminous points, which induce vertigo, and at times even severe nausea.

(*c.*) As already remarked, the symptomatic form precedes the conjugate deviation of *Provost*, but it may be accompanied by cerebral lesions, and may continue without inducing any tonic or conjugate contraction of the muscles. The researches of *M. Gadaud* first called attention to the fact that lesions in the vicinity of the occipital lobes may give rise to nystagmus. It would appear that it is more especially when such lesions are localised in the convolutions in the vicinity of the furrow between the occipital and parietal lobes, that nystagmus results. It has also been stated (*Charcot*) that disseminated sclerosis of the nervous centres, may give rise to it. In such cases it is probably the motor centres of the white substance, that are affected, producing a unilateral and crossed nystagmus. The bilateral nystagmus is also observed as a consequence of sclerosis of the posterior columns of the cord. It has been produced experimentally by lesions of the floor of the fourth ventricle (*Gadaud*).

The treatment of nystagmus would gain much in precision if we understood better the connection existing between the movements of the eye and vision. However, we do know that clonic contractions are extremely rare in cases where the visual function is perfect, and therefore one indication will be to improve, as far as can be done by optical correction, any visual imperfections in the patient's eyes. Unfortunately the existence of irregular and irremediable astigmatism, of permanent opacities in the media, and of congenital torpidity of the retina, are obstacles to any great improvement. At any rate, it is a fact that all augmentation of vision, whether gained by optical correction, or by the establishment of a more direct path for the rays of light, or by stimulation of the retina by injections of strychnine, exercises a beneficial influence, and more or less tends to relieve the symptoms.

The plan of treating *nystagmus* by section of the muscles (*Bœhm*), has been losing ground steadily, except indeed where strabismus, evidently complicated with nystagmus, is present. After tenotomy, I have occasionally seen a transitory nystagmus induced, but have never succeeded in curing it by division of the muscle. However, it is quite justifiable to try the operation, when the patient has, if not actually an apparent, at any rate a latent squint, and if by means of prisms it can be shown that vision is accompanied in certain positions by abnormal muscular efforts. Thus if actual insufficiency of the external recti be present in a case of myopia, in which as soon as the patient looks at distant objects, twitching of the eyes supervenes, and in which the eye wanders inwards as soon as it is covered with a dimmed glass, though it can look steadily at near objects, then such a form of nystagmus may be treated as if it were a latent strabismus, and one of the internal recti be divided.

Tenotomy of the rectus externus would be indicated in cases where the nystagmus became aggravated in movements of convergence, but disappeared when the visual lines tended to parallelism.

It will be seen that I do not advise tenotomy unless the nystagmus be complicated either with an apparent or a latent strabismus. I imagine that such treatment of nystagmus uncomplicated with strabismus only survives in the text-books. There directions are given as to the choice of the muscles to be divided, which is dependent on the position in which the eye can remain fixed. In such cases a pair of associated muscles would have to be cut, an internal rectus on the left side, an external on the right, and *vice versâ*, in order to augment the power of the muscles, the irregularity of whose movements demonstrates their weakness.

These operations are dangerous, in that they may give rise to a diplopia much more annoying than the oscillation which it was sought to remove, and of which the patient is unconscious. They are, therefore, not to be recommended. Besides, it must be borne in mind that nystagmus has a tendency to diminish with age, and in proportion as any optical defects have become corrected. In children, therefore, all surgical interference is to be deprecated.

An attempt has been made to treat nystagmus by means of continuous currents (*M. Ravaud's* thesis) either very weak, or generated by a Trouve's battery of six or eight cells, applied daily for two or three minutes. The positive pole is placed on the back of the neck, or on the mastoid process, the negative on the forehead or temples (*Boucheron*). There cannot be any harm in trying this treatment, care being taken not to prolong it when the nystagmus continues in spite of as accurate an optical correction as possible.

The intrinsic muscles may become the seat of spasm, confined as a rule to the circular portions of the ciliary muscle in hypermetropes, though likewise met with in myopes, where there is hypertrophy of the longitudinal fibres. This spasm is not, generally speaking, joined to any simultaneous contraction of the sphincter of the iris (myosis). It is only in cases where some direct contusion of the eye, and more especially of the cornea, has produced for the moment spasmodic contraction of the internal muscles, that the traumatic spasm is accompanied by myosis.

The action of the ciliary muscle is to make the crystalline lens more convex anteriorly, and so to increase the refractive power of the eye. It will therefore be readily understood that a spasm, especially a tonic spasm, will at once alter and conceal the true refraction of any eye. Thus an emmetrope will become myopic; and if myopia existed before it will now be proportionably increased. A hypermetropia will be more or less concealed, and the refraction may even be so far transformed as to simulate a higher or lower degree of myopia.

Except in traumatic cases, spasm of the ciliary muscle is rarely found in emmetropes. Indeed, the perfect harmony which there exists between the reciprocal movements of convergence and accommodation is not at all favourable to spasmodic attacks. Nevertheless, young subjects who accommodate for minute objects during a length of time may be occasionally attacked by temporary myopia due to spasm of the ciliary muscle. It is otherwise with hypermetropes. With them, especially if the hypermetropia be high in degree, near vision necessitates a contraction of the ciliary muscle out of harmony with the convergence. From this dissociation of two movements, which in emmetropia take place harmoniously, the action of the ciliary muscle becomes exaggerated relatively to the convergence. Consequently, so great an effort on the part of that muscle is required that it interferes with the due functions of near vision. Each movement of the ciliary muscle gives rise to more or less pain, very similar in character to what is felt round the eye, when the ciliary muscle has been overfatigued, and which is characteristic of accommodative asthenopia. This *painful spasm* is more or less confined to hypermetropes.

The diagnosis does not, as a rule, present much difficulty. This spasm is the form met with in youthful hypermetropes, who, although wearing correcting glasses equal to their manifest hypermetropia, experience great tenderness round the eyes as soon as they converge for near objects. Such individuals see distinctly with their glasses only for a short time. In such persons, there is generally considerable disproportion between the manifest and latent hypermetropia. According as the age of the individual increases, a greater proportion of this hypermetropia becomes manifest without the aid of mydriatics. This painful spasm may be diagnosed by attention to the fact, that every effort of convergence is followed by painful sensations round the orbit, while at the same time there is no insufficiency of the internal recti (muscular asthenopia) to account for them.

When once it is established that a patient is suffering from spasm of accommodation, the ciliary muscle ought to be allowed a period of complete rest during some months, all efforts at accommodation being suppressed by the use of mydriatics. Every evening a drop of a collyrium of neutral sulphate of atropine, or, perhaps better, of duboisine (5 centigrammes to 10 grammes) should be applied to the eyes. These mydriatics may be used alternately, if the conjunctiva exhibits any tendency to become irritated by their prolonged use. As soon as complete paralysis of the accommodation has been secured, the total hypermetropia should be corrected, and the patient, in order to prevent dazzling, be allowed to wear out of doors the glasses which correct his hypermetropia, and which should be of a dull neutral tint. For near vision the correcting glasses should be increased in strength, so as to allow of his reading comfortably at the distance of thirty to thirty-five centimetres.

It is absolutely necessary in such cases that the treatment by mydriatics daily instilled, should be continued for two or three months at least, and again recommenced if there be the slightest tendency to relapse.

I have already spoken (p. 216) of similar courses of atropine in myopia, in order to prevent its development owing to the action of efforts of accommodation or spasm, simulating a higher degree of myopia than exists in reality. These courses of atropine must be continued for many months; this may now be done all the more certainly, as atropine can be replaced if necessary by duboisine. The treatment is founded on the fact that the contraction of the ciliary muscle, the longitudinal portion of which becomes in myopes relatively thickened, contributes largely to the formation of staphyloma by direct traction on the choroid.

I certainly have no wish to find fault with treatment by this method, which, together with perfect rest and attention to hygiene, has a very potent action in arresting the progress of myopia in youthful subjects. Nevertheless, I must record what clinical observation has taught me, that spasm of the accommodation very rarely indeed, in myopic cases, simulates a higher degree of myopia than is actually present. Hence the original dictum of *Donders* holds perfectly good, namely, "that the mode in which spasm of the accommodation may be produced in myopes is not very clear," seeing that the same occurs in hypermetropes, and in young emmetropes only when they devote much time to minute work on very close objects.

DISEASES OF THE ORBIT.

LECTURE XLV.

ACUTE PERIORBITAL INFLAMMATION; ACUTE INFLAMMATION OF THE ORBIT; CAPSULITIS; EXOPHTHALMIC GOITRE; TUMOURS OF THE ORBIT; ENUCLEATION.

THE inflammatory affections of the orbit most commonly met with are, orbital periostitis, followed by caries or necrosis of the walls, inflammation of the fatty tissue filling the cavity, and capsulitis, or inflammation of the capsule of Tenon.

Practically it is very difficult to distinguish acute periorbital inflammation from that of the fatty cushion of the orbit, especially as suppurative periostitis will necessarily spread more or less into the orbit itself. Besides, it will be scarcely possible to determine accurately where the periostitis really commenced, or to say how far it was or was not dependent on some earlier lesion of the orbital walls. As a rule, in cases where the cause of the inflammation exists in the bony wall itself, an extensive abscess will be formed, with detachment of the periosteum over a large surface, and necrosis.

It must be borne in mind that in young children the orbital periosteum, owing to the imperfect development of the arch, is almost in contact with the dura mater. This should inspire caution, both on account of the danger of the suppuration spreading directly to the meninges, and of the consequent risk of probing, exploring, or evacuating the contents of the orbit.

If acute periostitis has been developed idiopathically, the tendency to suppuration is less marked. At the commencement the eye is protruded uniformly, and is more or less immovable, though this immovability is not always well marked, and is divided equally among all the muscles. Exophthalmos, more or less well marked, rapidly succeeds attacks of acute pain in the orbit. If the patient be rheumatic or syphilitic, he will attribute these to either a sudden change of temperature, or to a blow or shock. A characteristic symptom of periostitis, especially when localised at the fundus of the orbit, is the extreme tenderness of the eye when pressed backwards. As a general rule, one of the walls is more particularly affected; in which case the exophthalmos will be more marked in the direction opposed to that of the periostitis, but the mobility of the eye will be most impaired on the affected side.

Inasmuch as in most cases the attack will not have been seen at the commencement, it is difficult to diagnose periostitis from inflammation of the fatty tissue of the orbit. In the latter, however, the eye is generally protruded during the whole course of the affection, and is almost wholly immovable, while at the same time the lids are more swollen and red. If the patient be chloroformed, as some recommend, the little finger may be introduced within the cul-de-sac, and any inequalities of surface discovered. These are found mainly when the periostitis is limited to one side of the cavity. But generally it will be scarcely ever possible to distinguish with certainty between periostitis and inflammation of the fatty tissue. The difficulty will be increased if the periostitis has commenced at the fundus of the orbit, and having interrupted the circulation of the optic nerve, has caused papillitis and blindness; this may also occur in inflammation of the fatty tissue.

But although the diagnosis may not be perfectly accurate, no time should be lost in endeavouring, promptly and energetically, to prevent the pus extending and so detaching the periosteum widely. If the attack be seen at the commencement, an attempt may be made to cut it short by frictions of mercurial and belladonna ointment over the brow, and by warm fomentations. Prolonged rest in bed, and abundant salivation, and perspiration induced by injections of pilocarpine, may here do good service.

As soon as ever, from the unequal protrusion of the globe, the length of time the affection has lasted, or from examination of the orbit itself, you are led to suppose that there may be pus under the periosteum, it should at once be evacuated, either by aspiration or the bistoury. In such cases the knife is sometimes obliged to penetrate to a depth of three or four centimetres. It is very important to keep close to the orbital walls, to avoid any sudden movement, and not to approach too near to the eyeball.

Immediately after the abscess has been opened, a narrow drainage-tube should be introduced, and a bandage applied. This latter should be placed over lint or charpie, previously soaked in a one per cent. solution of salicylic acid, which has been prepared by boiling with the addition of biborate of soda. If the patient cannot bear the pressure, the eye may be covered with a piece of linen, kept constantly moist by a solution similar to the above.

Acute phlegmonous inflammation of the orbit, arising from inflammation of the adipose cellular tissue, is generally speaking characterised by much more severe symptoms. While the same protrusion of the eye as in the preceding form is present, the accompanying pain and erysipelatous redness are better marked. The affection runs a more rapid course than does even the most acute periostitis. Fortunately, this affection is very rare. It is only met with in subjects who have long been shattered in health. It is then complicated with erysipelas round the orbit; it may also be induced by wounds or by cauterisations of the lachrymal apparatus.

Considering the weak state in which such patients generally are, it will not do to adopt any antiphlogistic treatment, such as the application of numerous leeches, as in periostitis. Warm aromatic fomentations, quinine, puncture of the abscesses as soon as formed, and dressing with solution of hydrochlorate of quinine (1 part in 150) are the indications of treatment. In order to relieve the pain an exploratory puncture may be made, so as to open as early as possible any abscess which may have formed.

I need not add much as regards those cases in which either from simple periostitis or erysipelatous inflammation, complicated with periostitis or idiopathically, *caries* or *necrosis* of the orbital walls have supervened. These changes in the bones, though they may also be due to direct injury, are generally found in the children of phthisical parents, or as the result of hereditary syphilis. In cases of uncomplicated periostitis, or erysipelas, evacuation of the abscess determines to some extent the end of the attack; here changes take place generally about the edge of the orbit, which produce a fistulous opening, through which ill-conditioned pus continues to flow for months or even years. Exploration with the sound reveals the nature and extent of the disease. This exploration, however, demands the greatest care in children when the upper wall of the orbit is involved.

Together with general treatment by ferruginous preparations, phosphate of lime, and cod-liver oil, the disease should, if possible, be cut short by the removal of sequestra of bone. It will be necessary to enlarge the wound, in order to employ antiseptic injections and a drainage-tube. Besides this, an effort should be made to prevent the fistulous tract, as it heals, inducing angular ectropium. I am therefore generally in the habit of temporarily uniting the external third, or even half of the palpebral aperture by means of a tarsoraphia. I do not separate the lids (p. 36) until some months after cicatrisation of the fistula, when there can be no longer any fear of the wound either reopening or contracting.

Capsulitis, or the inflammation of the layer of cellular tissue next to the eyeball, is a very rare disease, and might at first be mistaken for an early stage of one of the preceding. The slight protrusion of the eye, the deep injection (possibly concealed by a chemosis), which does not depend on any changes in the iris, cornea, or conjunctiva, together with the slight but symmetrically distributed loss of mobility, constitute the most characteristic symptoms of the disease. It may, at times, be produced by direct injuries to the capsule (strabotomy), and may accompany corneal suppuration and suppurative choroiditis. It is very rarely found in company with facial erysipelas, and seldom breaks out suddenly, except as a result of suppression of the menses.

I have been able lately to show you an instance of *gummy capsulitis* of the rarest. It occurred in the case of a lady, fifty-six years of age, in the periphery of whose orbit I made two incisions, and thereby exposed a very characteristic gummatous tissue. Thanks to energetic mercurial treatment, the patient made a good recovery, with fair vision, but there remained a slaty hue around the sclerotic, extending to within half a centimetre of the cornea.

You should be able to recognise capsulitis, which, as a rule, runs a mild course, in order not to treat it in the same energetic manner as you would either of the preceding affections. For it the proper treatment will be mercurial frictions, warm fomentations, a moderately tight compress bandage, mild purgatives, and some injections of pilocarpine. The disease is more alarming than dangerous.

Before I speak of the various forms of exophthalmos due to morbid changes within the cavity of the orbit, I must delay a moment over a peculiar neurosis, which is in most cases connected with dilatation of the thyroid gland, and is known as *exophthalmic goître*. The group of clinical symptoms which characterise the disease, to which *Basedow* and *Graves* have attached their names, is made up as follows. The action of the heart becomes tumultuous, the systole more frequent and intense, and causes a throbbing sensation which is felt over the whole body. The heart itself, as a rule, is healthy, except for an hypertrophy which to some extent is physiological. To the above symptoms, the following are also joined, either singly or together.

1. Spasm of the levator palpebrarum, or rather of the portion of smooth muscular fibres attached to the lid, and known as the superior palpebral muscle. This sympathetic spasm (p. 26), which, when the eye is directed downwards, exposes more or less of the sclerotic, and prevents the lid following the globe as it turns downwards, is a very characteristic sign. It is not correlated with the degree of exophthalmos, and may even exist, with the cardiac neurosis, without the slightest protrusion of the eye.

2. A second symptom, and one which has attracted the most attention, is the protrusion. This is due to dilatation of the vessels of the adipose tissue and to serous transudation. The exophthalmos generally attacks both eyes, commencing in the right. It is marked by considerable daily and even hourly alterations in amount. Care must be taken as regards this fact, not to be led into error by the retraction of the eyelid, which may likewise at times become increased.

3. Together with the two foregoing symptoms there is generally a third present, namely, goître. The origin of this, which never attains any great size, must be looked for in dilatation of the vessels.

There is a general consensus of opinion that this vasomotor neurosis (*Rosenthal*), the brunt of which more especially falls on the vaso-dilators, is due to morbid changes in the cervical portion of the sympathetic. These may have been induced by moral causes, or by privations which have brought about excessive anæmia. While this affection is comparatively unimportant, so long as the anæmia continues slight, or has existed for a number of years, it becomes a most formidable disease when the anæmia assumes a malignant character. When this takes place the eyelids can no longer be closed. The innervation of the cornea becomes reduced, and the sphacelus, against which tarsoraphia is powerless, ensues. Some time ago, I had under my care a man fifty years of age, who was attacked after the war with exophthalmic goître. This became so aggravated that the metallic sutures which were used to keep the eyelids closed, cut their way through the tissues in less than twenty-four hours. In spite of every effort necrosis of both corneæ ensued.

The reflex nervous action transmitted from the cardiac sympathetic in such cases, overpowers the influence of the branches of the fifth pair. Two hypotheses have been suggested to explain this. According to one, the origin of the affection is to be looked for in anæmia of the pons, producing a failure in sensibility of the vagi, or regulating nerves. According to the other, in an increased cardio-motor stimulus (or vaso-dilator), furnished by the branches of the sympathetic. There would in all probability in these cases, be some alteration in the spinal marrow, if we admit, with *M. Vulpian*, that the "decrease in the number of the globules seems to stimulate rather than depress reflex irritability of the cord." This anæmia of the pons, or hyperæsthesia of the cord and sympathetic system, should be met by a treatment calculated to improve nutrition and combat the premonitory anæmia. This indication will in a great measure be fulfilled by hydropathy and change of air.

All weakening measures must be carefully avoided (Iodine). Careful attention to hygiene both of mind and body will naturally play a considerable part. It should be recollected that the exophthalmos and goître are not congestive phenomena, but that the increase in size depends on hypertrophy of the vessels, the functions of which have been exalted by the stimulus applied to the sympathetic ganglia. Vascular hypertrophy becomes visible in these cases in two portions of the body, more or less superficial, and in which the peculiar distribution of the vessels favours distension. It cannot, however, be doubted but that other organs not quite so readily examined would also present the same hyperæmia.

Among the best plans of treatment I would mention preparations of iron and arsenic in very small doses, administered at considerable intervals. The tincture of *veratrum viride* (3 to 5 drops four times a day) may also be used with advantage (*G. Sée*), but it is especially in water-treatment that our chief hopes must centre. This should be commenced with wet-packing lasting from ten to fifteen minutes, to be followed by shampooing (kneading) with a moist and warm sheet. Later on, after packing, friction with a cold towel should be practised, and after a certain time dry-packing alone, the sheet being sprinkled with water at a temperature of 6° to 8° C. (= Fahr. 44°—46°). All douches and immersions in cold water are to be avoided. Against very marked palpitation, a *Priesnitz* bandage applied round the chest or neck may occasionally be useful. In cases where goître shows a tendency to become suffocative, local douches of very fine spray at a very low temperature, and continued for a considerable time, have been tried.

I look on the direct application of ice or water-bags over the cervical or cardiac region, owing to the annoyance they cause the patient, as likely to do more harm than good. The chief difficulty is to accustom nervous patients to the various remedies employed; the first applications may, therefore, be of short duration, and the water used at not too low a temperature. It is for this reason advisable not to leave patients entirely in the hands of the somewhat enthusiastic persons who direct hydropathic establishments, without some precise directions as to the details of the treatment to be carried out.

Tincture of digitalis, prescribed when the heart is unusually disturbed, will give great relief. The same may be said of continuous currents, which should be directed over the cervical sympathetic. One electrode is to be placed either directly over the cervical region, or a metal disc is to be worn at the back of the neck during sleep. This empirical treatment must of course be carefully watched, and modified according to the results obtained on the first application.

To obviate in women the unsightly appearance caused by the sympathetic spasm, or the exophthalmos itself, partial tarsoraphia may be performed, especially in chronic cases. No hesitation need be felt about performing this, if the necessary precautions already mentioned (p. 36) are taken.

If the protrusion be such as to actually imperil the cornea, the palpebral aperture should be united throughout its whole length. In order to ensure reunion, metallic sutures should be used. The pressure which the tarsoraphia exerts on the adipose cushion of the orbit, very often produces most salutary effects. If the patient objects to all surgical treatment, eserine may be instilled, and a piece of lint soaked in borax kept to the eye (p. 333). This lint should be from time to time moistened with a saturated cold solution of boracic acid, or, until the violence of the attack has somewhat subsided, the eye may be kept covered with linen soaked in a solution of salicylic acid, of a strength of 1 part in 500.

Attempts to stimulate the vessels to contract by continuous currents—one electrode being placed on the cervical region, and one on the eyeball—do not seem to me to have given any very brilliant results. If, however, it be thought worth while to make the attempt, a compress bandage may be used, with a very thin plate of metal adapted to it, and resting on the eye. The other plate should be fastened by a bandage to the neck, so that a weak current, combined with pressure, may act during the whole night.

A suggestion has been made to protect the eye and remove the unsightly retraction of the upper lid by an incomplete section of the levator palpebrarum near its tarsal insertion. By this a partial ptosis could be obtained, which *Graefe* considered would be only transient. But this suggestion has fallen into complete oblivion.

Cases of exophthalmos from *tumours* of the orbit are interesting, owing to the difficulty which attends their diagnosis. I shall touch but lightly on them here, as they require in most cases treatment by complicated surgical methods. I content myself, therefore, with naming to you such growths as *ivory exostosis, fibroma, lipoma, sarcoma, enchondroma*, and *carcinoma*. *Effusions, cysts*, and *vascular tumours*, are far more important, for they may at times become objects of simpler and less direct treatment, and of one consequently within the reach of the general practitioner.

Emphysema may be ranked as an effusion into the orbit, and it has already been considered under emphysema of the eyelids (p. 2), by which it is always accompanied. It is very rare to find a sudden extravasation of blood in the fundus of the orbit apart from some injury. When such actually takes place it is in leucæmic subjects, or in those affected by pernicious anæmia. The fact of the sudden appearance of exophthalmos and the absence of all tenderness when the eyeball is pressed backwards, will assist the diagnosis. This is especially the case if these symptoms can be connected with some passing cause, such as exposure to great heat, suppression of the menses, etc. Any attempt at evacuation is to be avoided; regular pressure, mercurial frictions, repeated saline purgatives, and injections of pilocarpine, are the best means of hastening absorption.

When exophthalmos comes on more or less rapidly in a person who by age and appearance is not likely to be the subject of a morbid growth, the possibility of a *hydatid cyst* should always occur to your mind. Puncture with the needle of an aspirator will here give useful information. This puncture should be made along the wall of the orbit, with the same precautions as required in the opening of abscesses generally. The point of the needle should penetrate at the side opposite to the deviation of the eye.

I have lately seen a remarkable case of this kind in a young lad sixteen years of age. An exophthalmos attained, within the space of some six months, and without pain, such a size that the eyelids could scarcely close over the eyeball, which was forced downwards and inwards. You saw me draw off a perfectly clear liquid by aspiration, with a Pravaz syringe. Three several aspirations, at intervals of some days, were made. On each occasion after the first, considerable œdema of the eyelids came on, into which and the tissues of the orbit, a certain quantity of fluid escaped, when the canula was removed. After the third evacuation, the eyelids remained very much inflamed, and the eye strongly protruded. Fearing that the effused fluid had now produced an orbital abscess, I made near the superior and external border of the orbit, an incision of one centimetre and a half in length, and kept it open by a drainage-tube. A copious flow of pus at once relieved the patient, who had experienced intense pain since the puncture of two days previously. Next day I was able to extract two hydatids which presented in the wound; the sac of one of these measured not less than four centimetres. The case then went rapidly on to recovery, and the lad was soon able to return home.

Follicular cysts are generally congenital, and may spread into the orbit. They usually spring from its superior and external border, which they do not altogether quit, though they may penetrate considerably backwards. An important point in such tumours is to remove their orbital attachment, and, if necessary, sacrifice a portion of the periosteum in order to avoid a fistulous wound. If this be once established, it cannot be cured by either injections or cauterisations, and will necessitate a further ablation of the cyst. Very exact coaptation of the wound, antiseptic treatment, and the compress bandage will be the best guarantee against the dangers that these apparently harmless operations sometimes present.

Among *vascular tumours* must be mentioned those of the cavernous tissue, which are enclosed in a capsule, and are really only spongy and very vascular fibromata. Owing to their being circumscribed, they can be removed from the fundus of the orbit without injury to the eyeball. Excluding the *erectile* tumours, which, in almost every case, will be found to have spread from the eyelids to the orbit, we have three varieties of exophthalmos, produced by vascular dilatations, as follows:—

The commonest of the three is the result of a simple cirsoïd dilatation of the veins of the orbit, chiefly of the ophthalmic vein, as I was once enabled to see at an autopsy performed by *M. Cornil.* Generally speaking, the veins of the upper eyelid, and especially those which ramify towards the superior and internal border of the orbit over the forehead, share in the dilatation. The exophthalmus is considerable, and the mobility of the eye is reduced in all directions. On auscultating over the orbital region, an intermittent and loud *bruit de souffle* will be audible, which the patient may hear with a distinctness sufficient to deprive him of sleep.

The second variety, which is always connected with some actual wound or violent shock, consists in communication between the internal carotid and the cavernous sinus. This *false aneurism*, or arterio-venous aneurism, grows more quickly, causes a greater protrusion, and has more evident intermissions than the preceding variety. The sound heard on auscultation is continuous, with, however, an increase of the *souffle* which accompanies it at intervals; this increase being isochronous with the contraction of the carotids. In cases of simple venous dilatation, the *bruit de souffle* entirely intermits.

The third variety is due to aneurism of the ophthalmic artery itself. We possess so very few recorded cases of aneurism of this small artery, that it may be asked whether it ever really occurs. It would seem probable that some confusion must have been made in the recorded cases with one of the preceding forms, perhaps with the simple venous dilatation.

As regards exophthalmos combined with the *bruit de souffle*, it should be borne in mind that all such cases, almost without exception, are due to simple venous dilatation, and that rest, and ergot of rye, or *veratrum viride* in large doses, together with cold, may effect a cure in the earlier stages. The patient should be kept in bed, and should have continually over his eye a bag of pounded ice, the weight of which should be apportioned to the sensibility of the parts; while at the same time it should exert a sensible pressure. Generally speaking, any attempts to force the eye back by means of a bandage cannot be borne.

Simultaneously with the above treatment, digital compression may be applied daily to the carotid of the affected side (*Vanzetti*), or pressure by means of *Henry's* instrument, if the conformation of the neck permit. The applications of digital compression should be repeated, according as they are well borne or otherwise, on four or six occasions, and should last from twenty to thirty minutes. This treatment, followed out during some weeks, and renewed on the slightest tendency to relapse, may give very good results. Except the syncope which it sometimes causes, compression can produce no dangerous symptoms. This, however, is not the case with another method of treatment by means of coagulating injections, even where the precaution is taken of carefully compressing the carotid at the moment of administering them. Injections of perchloride of iron, given by means of an ordinary Pravaz syringe, will afford, as I have been satisfied myself, excellent results. The injection should consist of 4 or 5 drops at intervals, and the canula should be inserted at various points. By allowing a little blood to flow through it, we should make sure that it has actually penetrated a dilated vessel.

It is only as a last resort that the most dangerous treatment of all, namely, ligature of the carotid, should be attempted. This operation, owing to the peculiar nature of the affection, offers but small chances of success. Out of every three patients, two only will recover, while the third will run an equal chance of keeping his disease, or succumbing to the effects of the operation.

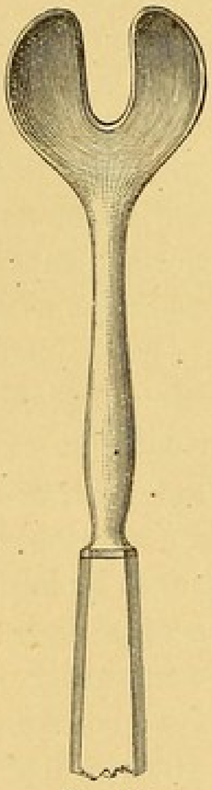

Fig. 32.

I will close this account of affections of the orbit by speaking of an operation which has more frequently to be performed than any other within the territory of the orbit. I refer to enucleation. Complete emptying of the contents of the orbit has been mentioned already (see *glioma*, p. 407). The simplest method of performing enucleation is to introduce a spring speculum, and seize the conjunctiva with forceps, passing beneath it one of the blades of a pair of curved scissors and cutting carefully all round the cornea. The four recti muscles are then divided as in the ordinary operation for strabismus. The next step is to direct along the external portion of the globe, a small *De Weltz spoon* (fig. 32), which I pass over the optic nerve, and which enables me to raise and luxate the eyeball very readily. Moreover, this spoon acts as a director to the scissors, with which the optic nerve is now to be cut. The section of the nerve is to be followed by rapid detachment of the oblique muscles, and of the cellular tissue which still retains the eyeball.

As you have seen, I am accustomed to terminate the operation by passing a needle armed with a thread of waxed silk, and held in a *porte aiguille* (p. 92), through the various folds of conjunctiva which cling round the wound. I gather up the pericorneal conjunctiva on the needle, and when these folds have been threaded like a purse, I simply draw on the two ends of the waxed thread and cut, but do not knot it. This enables me, two or three days later, to remove the suture with great facility, by simply drawing on one end of the thread.

You have often seen me perform enucleation without anæsthetics. I send the patient home with a common bandage on, which covers a dressing of lint soaked in solution of boracic acid. *Tillaux's* modification, which consists in first opening the conjunctiva at a distance from the cornea, and, after dividing the rectus internus, proceeding at once to cut the nerve, and then the other muscles, does not appear to me to be any improvement; on the contrary, it has the disadvantage of rendering the operation less neat. The spoons of *M. Weltz* and of *M. Welat* do away with all necessity for traction by means of threads or hooks, and render the division of the nerve much more easy and certain.

DISEASES OF THE LACHRYMAL APPARATUS.

LECTURE XLVI.

ANATOMY; EPIPHORA.

In order to satisfactorily carry out the treatment of affections of the lachrymal apparatus, which is essentially mechanical, it is necessary to have clear notions of the anatomy of the parts. I shall, therefore, briefly recapitulate the main anatomical facts which should always be borne in mind.

The lachrymal gland is divided into a large superior, and a small inferior, portion; the former occupying the lachrymal fossa. It lies immediately behind the external and superior border, while its longitudinal axis runs almost parallel to the edge of the orbit. The gland in its upper portion is surrounded by a fibrous capsule; its inner edge is close to the levator palpebrarum, its external to the junction of the frontal bone with the zygoma. This juncture may be easily felt under the skin, and if taken as the starting point of an incision along the orbital border, the knife will fall upon the most important portion of the gland. It may then be detached in its capsule, some prolongations of which are inserted into the periosteum. In proportion as we pass backwards, this capsule becomes more and more imaginary, while small gland masses are scattered here and there among the adipose tissue of the orbit.

The principal portion of the gland measures two centimetres in length by one in breadth, and half a centimetre in thickness; it rests on a second lobe, representing its inferior portion. The lobules are destitute of any capsular envelope, and are in direct continuity with the conjunctival cul-de-sac; this small inferior portion of the gland descends as low as the superior border of the orbit.

The tears, after bathing the eye, are taken up by the puncta, traverse the *canaliculi* and *lachrymal sac*, and are conducted through an osseous canal into the nasal cavity.

The *puncta lacrymalia* are placed on papillæ, formed of dense, felt-like, cellular tissue, not unlike that of the tarsus. They occupy the inner extremities of the tarsi, at the junction of the external and internal surfaces of the lids. The lower lachrymal punctum, and also the more important, is larger than the upper, and has a flatter and shorter papilla. When the lids are open, the superior punctum looks downwards, and being at the same time in contact with the eyeball, lies at the junction of the globe and the lachrymal sac, and moves up and down over the semilunar fold with the movements of the lid, as if in a groove (*Merkel*). The inferior punctum, on the contrary, quits the semilunar fold during the movements of the lower lid; it becomes again applied, however, and meets the superior, when the lids are completely closed. The puncta, though patent, because placed in the dense tissue of the lachrymal papillæ, should normally not be visible, unless the eyelids are drawn apart. The puncta become very conspicuous in aged persons.

The *canaliculi* run at first almost vertically, but at the distance of somewhat more than a millimetre from the puncta, change their direction and follow the folds of skin which surround the eye. This direction is at first inwards, but subsequently they converge like the folds of skin within which they are contained. The lower canaliculus is slightly convex inferiorly, the upper one superiorly.

Near the lachrymal punctum the duct is not more than half a millimetre in width, but its diameter increases to double this immediately behind the small sphincter, which some of the fibres of the orbicularis supply it with. Immediately behind this diverticulum, as it were, its canal becomes uniform in size, and resembles a vertical fissure, some 0.6 millimetre in breadth. The walls of the canaliculi are extremely thin, and are formed of pavement epithelium, and of a basement membrane reposing on a membrane proper. This last is separated from the skin only by the fibres of the orbicularis muscle; and thus these narrow canals admit of dilatation to more than double their ordinary size.

Shortly before reaching the lachrymal sac, the canaliculi either unite to form a single duct, or pass separately into the sac. It is probable that in some cases the difference in the mode of termination of the canaliculi has an important bearing on obliterations following the introduction of probes. A canal which passes singly into the sac is much more likely to become occluded than if the two unite, and form a larger canal. The single (or double) openings of the canaliculi repose on a sort of papilla, formed by a circular fold of mucous membrane.

The lachrymal sac occupies the lachrymal fossa, and is bounded internally by bone, but externally by skin only. From the point where this latter ceases, and the sac is entirely enclosed by bone, it has received the name of the "nasal duct," or "*ductus lacrymalis.*" The posterior wall of the sac rests on the periosteum of the orbit. Its anterior wall is also furnished with an analogous fibrous covering, the orbital periosteum being stretched from one lachrymal crest to the other over the sac. The mucous membrane of the sac is lined with cylindrical and ciliary epithelium, which is continued unchanged through the nasal duct. It is not till towards the end of this, in the nose, that it assumes gradually the characters of pavement epithelium.

The lachrymal sac exhibits on section a certain flattening from before backwards; it is oval in form, its larger diameter measuring half a centimetre, and its smaller four millimetres. Where the sac approaches nearest to the skin of the face, it is protected by an internal palpebral ligament, which covers it so that under ordinary conditions of development, the apex of the sae scarcely ever rises above it.

The ducts enter the sac at a point corresponding pretty nearly to the line of demarcation, between the sac and its apex. This latter does not rise higher than two millimetres, and therefore the sac, which is not yet protected by bone, rises but very slightly above the palpebral ligament.

The lachrymal sac becomes continually smaller, until, at the point where it is completely surrounded by bony walls, and forms the nasal duct, its calibre has dwindled down to 3 or 4 millimetres. The mucous membrane reduces this still further.

The *nasal duct* has, as a rule, the same oval form as the sac; at times, however, it is more circular. The length of the duct is from 1 to 1½ centimetres, and varies with that of the nose, presenting, according to the individual, a difference of as much as one centimetre. From the point where it enters the orbit, the duct becomes slightly narrowed, so that its major axis measures four millimetres, and its minor barely three. Near the opening of the duct into the nose its walls are lined with mucous membrane, while its mouth, which may vary considerably in size, becomes narrower and flatter.

If we except the papilla, which the mucous membrane of the sac forms at the point where the lachrymal ducts meet, and the slight swelling of the periosteum, where the sac becomes the duct, and lastly, the flattening of the mucous extremity of this as it enters the nose, there is no apparatus of valves. The greater or less obliquity with which the nasal duct passes down, might lead to the supposition that valves existed at the point of junction of the canaliculi with the sac, or of the sac with the duct, or of the duct with the nose. No such, however, do exist, as is shown by the facility with which an educated hand can pass a probe from the canaliculi through the ducts into the nose.

The positions of the various parts of the lachrymal apparatus are well defined by the ducts, the puncta, and the folds of skin round the great angle. An instrument passing through the skin, between the internal palpebral ligament (which may easily be brought into view by drawing on the external commissure), and the edge of the orbit, will of necessity fall upon the lachrymal sac. The direction of the duct alone will vary with the conformation of the face. This canal, which opens from 3 to $3\frac{1}{2}$ centimetres from the posterior extremity of the nostril, will be closer to it if the nose is turned up, further off if flattened.

The direction of the canal, as regards its temporal inclination from within outwards, is very accurately shown by a line drawn from the centre of the internal palpebral ligament, to the junction of the naso-labial line with the ala of the nose, or if a fixed point be desired, between the interstice of the second incisor and canine teeth. The duct inclines slightly backwards, but its direction is liable to considerable alteration according to the conformation of the face. From a practical point of view, this is not of importance, for once an instrument has reached the bony wall of the lachrymal sac, it will glide along it in the proper direction from before backwards. In order, therefore, to direct an instrument with certainty, it is only necessary to know the lateral direction; this will be given by the two landmarks I have just mentioned, one of which is movable, the other fixed.

As regards the various morbid changes which the lachrymal apparatus is subject to, I need say but little about *inflammation* of the gland, which is so rare that you are never likely to be called on to treat it. It is, perhaps, impossible to distinguish between it and phlegmonous inflammation of the cellular tissue of the gland. The treatment will be the same in both cases. If fluctuation shows that in spite of mercurial frictions, Vigo plaster, or iodide of lead, and pressure, pus has formed, it must be evacuated without delay. *Tumours* in the gland, such as simple hypertrophy, hydatid cysts, fibromata, fibrosarcomata, colloid cancer, myxoma, etc., are extremely rare, and can only be treated by removal.

The most important affection is undoubtedly *epiphora*, or "watering" of the eye. This may arise from some irregularity either in the *lachrymal puncta*, the *canaliculi*, the *sac*, or the *nasal duct*, all of which I shall consider in turn.

Displacement of the *puncta* is one of the most frequent causes of watering of the eye. It affects especially persons somewhat advanced in years, in whom the looseness of the skin, and the readiness with which on the slightest fatigue the lower lid becomes œdematous, readily predispose to it. The margin of the lid easily becomes the seat of congestion, of slight excoriations, of eczemas, which cause the skin to contract, and the puncta to separate from the globe. Hence results continuous watering, all the more aggravated as the congested state of the lids causes an increased flow of tears, which is quite beyond the power of the upper canaliculus to carry off. This condition must be remedied by opening up the punctum, so that it can lie against the globe. The best instrument with which to do this is *Weber's* (fig. 33) probe-pointed knife. It should be introduced either directly into the punctum, or if this be too narrow, then, after dilatation with a small conical sound (fig. 34). The knife is to be pushed along the external wall of the canal into the sac, its edge being directed towards the eyeball. Without raising or lowering the knife in the least, but simply passing it along the canaliculus to the sac, the punctum is enlarged sufficiently to enable it to receive the tears. The grooved knives, which have been recommended for the operation, are quite unnecessary, and indeed not so convenient.

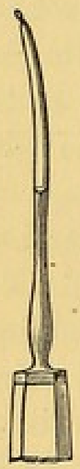

Fig. 33.

I must here say how important I consider it is, in the treatment of affections of the lachrymal passages, to disturb as little as possible the hydraulic apparatus by which the tears are carried off. This aspirator will only work well when its delicate mechanism is uninjured. When, as used at one time to be recommended in cases of displacement of the punctum, the canaliculus has been transformed into a groove (*Bowman*), extending to the caruncle, the course of the tears is necessarily obstructed, and regurgitation takes place, which in its effect is quite as bad as deficient aspiration. A mere incision of from one to two millimetres is sufficient to remove all the symptoms due to simple deviation of the punctum.

It will be necessary either on the day of operation or the following, to pass a probe through the punctum into the sac; for it may probably happen that the sides of the canaliculus which has been excluded from its proper functions have become glued together. This condition will yield without difficulty to the probe. It is advisable during the first few days to separate occasionally the edges of the wound at the entrance of the canaliculus, in order to prevent too speedy union.

Constriction or *obliteration* of the *puncta*, is often the result of displacement and impairment of function continued over a considerable time. Obliteration takes place in consequence of skin eruptions and excoriations, of small-pox, ophthalmic herpes, and diphtheria, involving the punctum. Generally speaking, the occlusion is very superficial, and consists only in the presence of a thin layer of epithelium. The great difficulty in all such cases is to find the inferior punctum. To do so the lower lid should be well drawn down, and the portion between the conjunctiva and skin carefully examined by reflected light. It will generally be found then, that the papilla no longer exists owing to the punctum having been obliterated by the skin affection. As soon as the small facet, which occupies the position of the obliterated punctum, has been discovered, it will be sufficient to reopen it with a small conical probe, and then enlarge it definitely to the extent of one or two millimetres in the way just described.

All dilating instruments except the probe (fig. 34), are unnecessary, expensive, and difficult to keep in order. Moreover, all excessive dilatation of the canaliculus is to be avoided, for if the mucous membrane be torn in this its narrowest portion, permanent obliteration may easily ensue. It is much better to incise the entrance of the canaliculus to the extent of one to two millimetres rather than to dilate it forcibly, in order to make a passage for thick probes.


Fig. 34.

If the puncta be carefully searched for by the aid of reflected light they will almost always be found. The recommendation to remove a portion of skin near the papilla, in order to find the opening of the canaliculus in the wound, is absolutely absurd. As *Velpeau* pointed out long ago, this is really the best way to ensure artificial obliteration. The proposal to remedy simple displacement by opening the lachrymal sac, and passing a sound from within outwards, shows how little alive some surgeons have been to the necessity of leaving the lachrymal passages in a normal state after their treatment shall have been finished. It may also be asserted that those who suggested such a practice must have had but little experience of the difficulties to be encountered in passing a probe from the sac through the inferior canaliculus without injuring it. They also apparently forgot how often a traumatic lesion of the anterior portion of the sac leaves bridles, diverticula, and constrictions, which militate very much against the regular removal of the tears.

I shall merely mention in passing those rare cases of *supplementary lachrymal* puncta, and of *congenital fistulous openings* extending the whole length of the canaliculus, or congenital transformation of one of the puncta into a narrow slit, causing the same appearance as if the canaliculus has been opened up. These anomalies are of no importance from the point of view of treatment.

Obstruction and *obliteration* of the *inferior* canaliculus is often the sole cause of epiphora. The obstruction may depend on the presence of foreign bodies, the growth of fungi, such as the leptothrix, or the formation of small calcareous concretions. When the canaliculus is thus obstructed, there is as a rule a morbid discharge; it is generally dilated, and when the angle of the eye is pressed upon, a certain amount of mucopurulent matter escapes from the punctum. I showed you some time ago a patient fifty years of age, in whom the inferior lachrymal punctum was traversed by a small polypus, about the size of a grain of millet, the pedicle of which was, on section, seen to be situated close to the punctum.

Such obstacles are easily diagnosed by the distension and presence of morbid secretions within the canaliculus. A cure may readily be effected by slitting up the entrance of the canaliculus, and evacuating the contents. It is somewhat more difficult to say whether the canaliculus be constricted or temporarily obliterated near its commencement. On this point, information will be gathered from the passage of a No. 2 or 3 *Bowman's* probe. The recommendation of *O. Becker* to pass the sound into the nose, through the upper canaliculus without slitting it, is, as I have shown you, easily enough put in practice, if the superior punctum has first of all been slightly dilated.

I have, however, very grave doubts as to the general utility of this proceeding. For, as a rule, the obstacles arising from agglutination of the mucous membrane, are not seated either in the nasal duct, or lachrymal sac, or the junction of the canaliculi, but in the inferior canaliculus, either close to the curve it makes near the papilla, or else before it joins the upper. If, as is asserted, this agglutination were mostly situated just where the duct enters the sac, inasmuch as the union of the two ducts takes place generally at a distance of from one to two millimetres from the sac, the upper canaliculus could be left intact, and the probe passed by preference through it. In spite of certain doubts which hang over its efficacy, this passage of the probe by simple dilatation of the superior punctum, is to be recommended in the case of patients who have a dread of cutting instruments. But, as a rule, it is better to proceed directly to pass a probe, without waiting to explain your plan of treatment, or calling the patient's attention to it.

When epiphora has become established in consequence of some laceration of the lower canaliculus, I think, if the original wound is healed up, that it is hopeless to search for the duct, or attempt to restore permeability, quite as hopeless in fact as it would be after obliteration of a punctum as the result of deep ulceration of the skin. In these cases attempts have been made to establish a communication between the lachrymal and the conjunctival sacs, and to slit up the superior lachrymal duct as far as the caruncle, to enable it to carry off more tears than in the normal condition.

Too much, however, must not be looked for from such operations, inasmuch as they always necessarily injure the physiological action of the lachrymal apparatus. The great point under such circumstances is to avoid any irritation of the eye which might increase the flow of tears; we should endeavour to reduce this to a minimum, so as to render it as little annoying to the patient as possible.

LECTURE XLVII.

DACRYOCYSTITIS; LACHRYMAL TUMOUR AND FISTULA.

Dacryocystitis is one of the most important affections which you can be called upon to treat. It occupies the *lachrymal sac*, and its direct continuation the *nasal* duct, and is in the nature of a catarrhal inflammation. The amount of secretion from the lachrymal passages and the sac is in normal conditions very small. It is liable, however, to become increased under the influence of any irritation, propagated from the nasal or conjunctival mucous membranes, and may acquire a variety of characters according to the different forms of catarrh. It is met with in various stages of transition, from a simple transparent fluid, mingled with some mucous filaments, to a thoroughly purulent secretion. Occasionally the discharge has the appearance of perfectly clear mucous, like white of egg. The immediate result of this inflammation is a more or less marked swelling of the mucous membrane, followed by distension of the elastic portions of the lachrymal apparatus. Portions which were mere passages, the sides of which were kept apart by a continuous but very thin layer of tears, become of considerable size. The contents, too, no longer consist of tears only, but of an excess of inflammatory products, poured forth by the mucous membrane, both secretions mingling together.

This progressive distension of the sac gives rise to what is commonly known as a *lachrymal tumour*. This may acquire in time considerable proportions, and become an actual *dropsy* of the sac. It is accompanied by thinning of the walls, and may grow to the size of a pigeon's egg, eventually causing erosion of the bone. Here a deep excavation is formed which may be easily felt with the finger after the sac has been emptied.

The presence of dacryocystitis is no proof of obstruction or stricture, either of the lachrymal puncta or the nasal duct. The overflow of tears is due to the distension of the sac interfering with the performance of its regular functions, and also to the swelling of the mucous membrane, and the excessive secretion of tears. This excess arises from the presence in the conjunctival cul-de-sac, of the catarrhal and strongly alkaline fluid, which comes from the lachrymal sac. If the fact that the patient can empty the contents of the sac, either into the conjunctival cul-de-sac or nose, was not sufficient to demonstrate that the lachrymal passages were unobstructed, it could be so demonstrated by passing, as *Otto Becker* has suggested, a Bowman's probe (No. 2 or 3) through the superior canaliculus, the punctum having first of all been slightly dilated.

The large number of patients, the majority of whom are women, treated in this clinique, has enabled me to demonstrate to you that simple dacryocystitis, that form, namely, in which the mucous membrane is the starting point of the inflammation, and in which it spreads from the nose, is not complicated with stenosis.

The conditions of cranial conformation which favour the development of dacryocystitis, are flattening of the bridge of the nose and approximation of the nasal and maxillary processes. A predisposition to it is therefore found in persons with a large space between their eyes (children), as also in those where this space is particularly narrow, and where, as in the Jewish type of nose, the bridge is high and the nasal duct flattened laterally. The differences in distribution of the mucous membrane of the nasal canal and the greater or less facility with which any inflammation of it can destroy communication with the nasal duct, and thus prevent extension from below upwards of any irritating secretions, explains how it is that inflammation does not more often spread from the nose to the lachrymal passages, and, moreover, how this inflammation, as a rule, affects only one side, which is often the left.

Treatment should aim at removal of the catarrhal condition of the mucous membrane. This may, in numerous cases of simple dacryocystitis, be accomplished readily by re-establishing the continuity of the column of fluid which is normally interposed between the nasal cavity and the conjunctival cul-de-sac. There are two points of capital importance here on which much of the success of treatment will depend. One is, to realise that we are not called on to remove any obstacles which oppose a definite amount of resistance, such as occlusion or constrictions. All methods, therefore, in any way rough or coarse are to be deprecated. The second is, to realise that any treatment adopted should disturb the physiological functions of the tear passages as little as possible. A consideration of these two points explains why, in cases of dacryocystitis, I always prefer to commence with the superior canaliculus, which plays an important part physiologically. For the same reason, also, I incise it very slightly indeed, and, unless there be some erysipelatous complication present, do not incise the mucous membrane of the sac. The only alterations I actually make in the very excellent rules laid down by *Otto Becker*, is, that I prefer slightly incising the upper canaliculus, to forcibly dilating it with a conical probe, and that I reject all large probes, never using any in excess of Bowman's No. 3.

The probe should be passed as follows: the superior punctum should first be dilated, if it does not readily afford a passage, and a small Weber's knife passed into it. The eyelid should be drawn upwards and outwards, whereby the canaliculus will be put on the stretch, and made to form, as nearly as may be, a straight line with the sac and the nasal duct. The probe-pointed end of the knife is to be passed along the posterior portion of the duct, until the resistance of the bony wall of the lachrymal sac can be felt. This simple introduction of the knife without any other movement is sufficient to open up the entrance to the canal and allow the sound to be introduced. In order that the patient shall not, by any sudden movement of his head, enlarge this narrow section, he should be steadied by an assistant, or made to lean against the back of a chair.

A No. 2 or 3 Bowman's probe should then be passed, it having been previously somewhat curved, so as not to meet with any check from the supraorbital ridge. The canal is to be raised and put upon the stretch, by steady traction on the upper lid, upwards and outwards, and the probe is then to be introduced. It must be kept always against the posterior wall, and passed on until the resisting wall of the sac is felt. Having reached this point, the end of the sound should be maintained in exact contact against this wall, *which henceforth must be its guide.* The other hand still keeping firm hold of the eyelid, the sound is raised and pressed back towards the brow exactly over the middle of the internal palpebral ligament. If the sound be now carefully guided along the bony wall of the sac and canal, in a course directed from the middle of the palpebral ligament to the naso-labial fold, it will pass easily down without the application of any considerable force.

This introduction, if carefully performed, should not cause much pain. When I chide patients who make wry faces as the probe passes, it is not merely to remind them that the amount of pain they shrink from is what can be very easily borne, indeed, but more because I do not want to lose an important landmark, by the displacement of the nasolabial line. It is true, of course, that the interval between the canine and second incisor teeth offers an equally good guide. But it will be granted that in private practice it is scarcely seemly to raise a lady's upper lip in order to examine teeth which may be false, while on the other hand, in hospital practice, it may not be altogether pleasant to have to do so.

The introduction of the sound, which should not penetrate quite so far as the floor of the nasal fossæ, where it would give rise to unpleasant sensations in the teeth and nose, must be repeated daily during from one week to a fortnight, the probe being left in position for twenty or thirty minutes at a time. Care must be taken when removing it to place, by suitable traction on the eyelid, the canaliculus as much as possible in a straight line with the sac and the nasal duct, and to withdraw the sound very gently in the same direction.

The number of introductions of the sound I have given above is sufficient to combat ordinary dacryocystitis, where there is no phlegmonous tendency, or great dilatation of the sac, especially if supplemented by compresses soaked in a one per cent. solution of acetate of lead or sulphate of zinc. If the affection has lasted for a considerable time, and if a lachrymal tumour of some size has been formed, No. 2 or 3 of the hollow probes which I have had made, should be passed. This probe (fig. 35) should likewise be left for some twenty or thirty minutes in the lachrymal passages; the plug (added by *M. Fieuzal*) should then be withdrawn, and a small india-rubber syringe attached, with which, as the probe is being removed, an astringent solution can be applied to every portion of the affected mucous membrane.

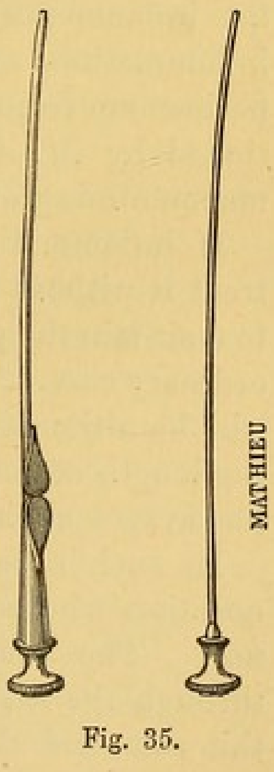

Fig. 35.

I use, as the material for these injections, sulphate of zinc solutions (1 per cent.) in preference to any others. Equally useful, perhaps, are solutions of carbolic acid, or of equal amounts of salicylic acid and biborate of soda, namely, 1 part of each to 300 of water. Among the numerous astringent preparations that may be suggested, care must be taken to avoid all those which, like tincture of iodine, either pure or diluted, can cause very marked contractions of the mucous membrane. Apart from this, all injections administered by means of special instruments, and with a certain amount of force, are bad, inasmuch as they are liable to produce laceration of the mucous membrane.

By the use of this mild treatment, the surgeon who passes the sound each time with equal patience and skill, will cure the patient perfectly in a comparatively short space of time, of his dacryocystitis. Besides, it is very easy indeed to teach women to pass the instrument themselves before a looking-glass. They should be advised every week, or at least every month, to pass the probe, especially if they experience a certain amount of discomfort about the eyes, or if any remains of epiphora still linger behind.

In cases of *inflamed lachrymal tumour*, or of *fistula lacrymalis*, the treatment may require to be somewhat modified. Phlegmonous inflammation will often be the result solely of dacryocystitis. This may have caused retention of a discharge which grows constantly more alkaline, and which, becoming decomposed, excoriates the mucous membrane and leads to catarrhal ulcerations. These will afford an excellent field for the corrosive and septic action of the inflammatory products, and will determine an acute form of inflammation. This may also be induced by irritation of the periosteum from decayed teeth (see a case of dental caries mentioned by *M. Abadie*), the inflammation having spread to the mucous lining of the sac.

If inflammation of the sac be complicated with ulceration, I treat it without any special regard to the latter, and am as careful to maintain the perfect integrity of the lachrymal apparatus as in an ordinary case. It must be remembered that the regular functions will be ultimately impaired by the inflammation, in proportion to the length of time the dacryocystitis has been allowed to continue its ravages unchecked.

In such a case we need not preoccupy ourselves as to the question whether the abscess has already resulted in a fistula or not. The tumour or the fistula should always be attacked through the superior canaliculus. There is but one exception to this rule, and that is when the swelling has been so great as to invade the upper lid, which, perhaps, is the size of a pigeon's egg, so that the superior punctum cannot be reached. In such a case, even if you succeed in reaching the disease from the duct, you will not escape perforating the skin, which has been thinned by the inflammation. Under these circumstances, I prefer to make an incision above the internal palpebral ligament and the border of the orbit, and evacuate the pus by pressure. Poulticing for several days gives time for the inflammation to subside, and renders the ordinary internal incision possible.

For this incision I make use exclusively of the small Weber's knife, introduced through the superior lachrymal punctum. The extremity of the knife having reached the bony wall of the sac, I lower the handle and so open up the canaliculus throughout its whole length. Having thus opened it as far as the caruncula, I pass the knife along the posterior wall into the nasal duct. As soon as my knife has reached the floor of the nose I withdraw it, incising at the same time any bands which may exist in the duct or sac, and also the constriction caused by the internal palpebral ligament. To make this latter incision, the moment the knife is withdrawn the external commissure should be put on the stretch.

This internal incision has received the incorrect name of "*stricturotomy*;" in numerous cases no stricture exists, and the knife divides merely that portion of the sac which was constricted by the palpebral ligament. It has been installed as a special operation by *Stilling*, who, however, saw it practised at this clinique, as he states in his pamphlet. What he saw there suggested to his mind the idea of a special knife. The same incision can be just as well made with the small Weber knife, which has the advantage of making a smaller wound.

Immediately after the incision, I apply warm compresses imbued with a solution of acetate of lead (4 parts in 300), or poultices, and do not pass probes. If the incision has been a free one, compresses will suffice during several days, no probing being required. But in cases where there is danger of perforation, and more especially where this has already taken place, I commence the day after, or the next but one, to pass No. 2 or 3 of Bowman's probes. When the discharge does not rapidly cease, I use hollow ones.

In the treatment of simple dacryocystitis I have already given it as my opinion that no probes larger than No. 2 or 3 should be passed, and that *Bowman's* original idea of dilating the lachrymal passages progressively was essentially a wrong one. The only indication to be fulfilled in such cases is to re-establish the continuity of the capillary layer, between the conjunctival sac and the nose. I hold the same views as regards acute inflammation; at the same time I do not wholly abandon the prolonged use of probes, but reserve them exclusively against the cicatricial contraction which follows the inflammation. What I am strongly opposed to is, the violence done to the lachrymal apparatus by forced dilatation, and by the passage of probes which, as *Ad. Weber* allows, are designed to fit the dry bones. Nor do I approve of constantly wearing a stylet, which can only be maintained in position by means which in the long run are injurious. It is much better, if necessary, to teach patients to pass the probe themselves. The coarse dilatations obtained by laminaria, have fallen into the same discredit as the large probes. They are both violent and rough remedies, which, by the laceration of the mucous and submucous tissues, only aggravate the injuries which the ulceration has already inflicted on the sac, and which require the very gentlest treatment.

I never use any probe larger than a No. 2 or 3. Experience has in fact taught me that the method by dilatation with very large probes gives much less satisfactory results, and even if they pass through the duct, does not prevent the constant overflow of tears. Doubtless I may be told that the passage of sounds No. 2 or 3 does not succeed a whit better in many cases. It is true so far that every case of epiphora does not admit of cure by catheterisation, but I do not think that this should be attributed to the inefficacy of the method. It is owing rather to the permanent injury which the inflammation has inflicted on the delicate structure of the lachrymal apparatus, and partly, also, to the measures necessarily taken to check the progress of the ulceration.

It will be quite possible to reduce the watering to a minimum by injections, and by treatment directed especially to the eyelids. If the patient be taught to pass a probe at gradually increasing intervals, a result may be obtained, which though not actually a cure, will at least be highly satisfactory.

The point I wish to establish is that obstinate attempts to check the watering by forcible dilatation should never be persisted in when this condition is due not to any obstruction, but to the effects of inflammation, and, to a less extent, of the treatment it has necessitated.

Extirpation of the lachrymal gland is an operation which in certain extreme cases seems to me quite justifiable. In my opinion this lead deserves to be followed, more especially after the successful attempts of *Z. Laurence* and *Abadie.* In some cases, in fact, the disturbance in the flow of tears, and the resulting inconveniences are so great, that patients are prevented following their ordinary avocations or gaining their livelihood. Under such circumstances, the indication is clearly to remove the cause of the disease, by excising the greater portion of the lachrymal gland.

In cases where treatment with probes has been practised after suppuration of the sac, or where dacryocystitis has unduly dilated it, although all discharge may have ceased, and even large-sized probes have been passed, the flow of tears will continue so abundant as to trickle more or less unceasingly from the eye. Before undertaking so radical a course as that of removal of the gland, it will be necessary to make sure first of all that the catheterisation through the upper has not determined the occlusion of the lower canaliculus at its juncture with the superior; and secondly, should such an obstacle not exist, or have been removed, it will be advisable to try how far compression by means of a bandage worn for some time may, by rendering the eyelids immovable, reduce the hypersecretion.

If, in spite of all these measures the watering continues, or if the patient has become weary of waiting, and refuses to submit to any further palliative treatment, the gland should be removed. The best method of performing the operation is, after shaving the brow, so as to hide the scar (*Halpin, Laurence*), to make an incision along the edge of the orbit, extending from the junction of the frontal with the zygomatic arch up to the middle third of the edge. The tarso-orbital fascia is to be divided, and the little finger at once passed down to the edge of the orbit; it is to be guided very gently round this, so as not to detach the gland from the floor of the orbit, but merely to isolate it below. A double hook should then be fastened in the gland, which is to be drawn towards the operator, and by a free use of the scissors loosened from the periosteum and fatty tissue. A tolerably free hæmorrhage follows, which may be checked by sponges soaked in ice-water; the skin should not be brought together till the flow of blood has been completely stanched. Ice compresses may be applied for a day or so, or the compress bandage, which latter I have generally found sufficient.

The dangers of the operation consist first of all in including the temporal artery in the incision; this, however, may be easily avoided. A second is detaching the tarso-orbital fascia too freely, from which ptosis may result later on; this may be avoided by keeping the edge of the knife very close to the brim of the orbit. Lastly, there is a danger of removing instead of the gland a pellet of fat, an error which is not likely to be made if the orbital margin be closely followed, and if the gland be not forced back either by instruments or the fingers. However, it will always be well to make sure that the portion excised presents on section the brown, lobulated, firm structure of the true gland.

The removal of the gland, necessarily causes the flow of tears to cease, even although a few of the posterior and inferior lobules, not comprised within the capsule, be left. The operation relieves the patient completely, does not cause excessive dryness of the eye, and is less dangerous than the various methods of obstruction and obliteration of the lachrymal passages. Even when such are successful, they have the serious drawback of permitting a very copious flow of tears whenever the patient is exposed to any irritation such as wind, dust, or smoke. Moreover, obstruction can only relieve a patient from the inconvenience of a morbid discharge from the sac, and this very often at the price of an unsightly cicatrix, a sinking in of the internal palpebral ligament, and a displacement of the greater angle of the eye.

It should be remembered that in order to thoroughly *obliterate* the lachrymal passages, it would be necessary to lay bare the ducts, and the sac, and apply a destructive agent over the whole extent of the mucous membrane, or even to remove this totally. Caustics, such as butter of antimony, and pâte de Canquoin, only destroy it partially, so that the mouths of the ducts may possibly escape cauterisation, in which case the operation will be null and void. It may even be possible, as I demonstrated to you on a patient, who had undergone such a cauterisation four weeks previously, to introduce a No. 3 sound quite easily through the upper canaliculus, in spite of the so-called obliteration of the sac.

If the mucous lining of the ducts and sac be laid bare, and the galvano- or thermo-cautery applied, a most unsightly sinking in and contraction of the greater angle of the eye will be produced. The result will be much worse than if the gland had been removed. It should be known that, up to the present, no accident has happened after extirpation of the gland, whereas I have seen cases in which the actual cautery determined suppuration, followed by shrinking of the eyeball, and erysipelas, with complete atrophy of the optic nerve. I think, then, I may venture to predict that all methods devised for obstructing the lachrymal passages will share the same fate as couching of the lens; in other words, that a place will be reserved for them in the history of ophthalmology.

Suppuration of the lachrymal sac may leave permanent fistulæ, which require no other treatment than incision, as already described (p. 527). A fistula that has become *capillary* is the only one which may possibly prove rebellious to such treatment. This form of fistula is met with in cases where, owing to excessive thinning of the external wall of the sac, and the skin over it, a very minute opening has been formed, which allows the escape of a tear each time the lids are closed. A capillary fistula is often a source of very little annoyance to a patient, seeing that it seldom becomes established until all morbid secretion from the sac, and consequently all excessive watering, has ceased.

Under such circumstances it is better to abstain from treatment. But if in spite of the formation of a capillary opening the eye waters abundantly, it will be better to remove the gland, as such a fistula is very difficult to close even by the severest operations. In one case of this nature I endeavoured in vain to freshen and unite the edges of the opening, or cover it by displacement of a flap (*Chassaignac*). Finally, I enlarged the fistula, and introduced into it a small plug of pâte de Canquoin. By this means I succeeded in closing it and a portion of sac simultaneously, but without relieving the patient from the flow of tears. If you have at hand a galvano-caustic apparatus, or a thermocautery, the cauterisation of these capillary fistulæ can be more readily effected.

I believe I was one of the first to point out that all fistulæ, except the capillary, even if they have existed a length of time, may be cured by incision internally, and that it is never necessary to touch the integument over the sac.

I have only a few words to say relative to obstruction of the nasal duct, resulting from fractures of the nose, from bony tumours, or from caries, which latter is accompanied in most cases by very marked ozœna. What is the best course to follow under such circumstances when there is practically no hope of reestablishing the normal course of the tears? Is the destruction of the sac here more especially indicated? I believe that in such cases, by opening a wide communication with the conjunctival cul-de-sac, by laying open the duct up to the ligament, and by cleansing the sac with daily injections, the patient may be spared a painful operation, and the profuse discharge greatly diminished. In cases where this continues and excites watering, I should prefer to extirpate the gland, rather than the sac, which is only a palliative, and effects merely a partial diminution in the flow of tears.

The bare suggestion of perforating the os unguis, and of thus drawing off the tears through an artificial communication with the nose, is proof how little care has sometimes been taken to protect the delicate mechanism of the lachrymal apparatus. It is astonishing that any surgeon should have imagined that a huge canal would be capable of performing such nicely balanced functions; but, besides, it must have been perfectly evident that such a canal was very unlikely to remain permanently open.

Before leaving this subject I will, with your permission, draw a parallel between treatment of the lachrymal and of the urinary passages. A patient who had suffered from stricture, and undergone the operation of division of it, would not be at all surprised if the surgeon advised him to carefully look after the condition of his urethra, and pass a bougie from time to time. He would not consider himself any the less cured, because he was obliged to pass an instrument occasionally, and to abstain from certain excesses. Why not then teach patients, who have had serious affections of the lachrymal passages, such as abscesses or fistulæ, to consider themselves similarly situated, and to be careful to pass a probe at intervals, and not exert their eyes unduly? Great benefit may likewise be experienced from carefully selected glasses, which correct any form of ametropia that may be present.

Both the surgeon and patient should realize the fact that when a destructive malady, such as phlegmonous inflammation, has invaded an organization of such extreme delicacy as the lachrymal, there can be no hope of obtaining a cure so perfect that it will obliterate the very recollection of the disease which once existed.

LECTURE XLVIII.

SOME PRACTICAL CONSIDERATIONS ON REFRACTION AND ACCOMMODATION; EMMETROPIA; HYPERMETROPIA; MYOPIA; ASTIGMATISM; PRESBYOPIA.

In studying an eye, with reference to its refraction, three conditions may be met with. It may be *emmetropic*, *myopic*, or *hypermetropic*, according as it is adapted when its accommodation is relaxed, to parallel, to divergent, or to convergent rays. There is no other possible refraction. Astigmatism is only a combination in one and the same eye of two different states, or of two different degrees of the same form of ametropia.

Before proceeding to speak of the rules which govern the choice of glasses, inasmuch as these depend on the state of the refraction, I shall first treat of the methods by which the three conditions above mentioned may be recognised. With this object convex and concave glasses are used, and in order to measure the effect produced on vision by them, the same card as we use for measuring the visual acuity is employed. The finest type on this card has the No. 5, that is to say, that a person whose eyes are adapted to parallel rays, and whose vision is not in any way defective, can read it at a distance of five metres. The larger types placed above, have also a number, with the same meaning, but referring to greater distances. If the patient be placed at a distance of five metres from the card, we shall be able to tell whether his vision is improved or otherwise by the use of any given glass.

In practice we do not generally make use of mydriatics, which paralyse the accommodation, in determining refraction. Therefore we must make allowances for this. An eye will be emmetropic if its vision be disturbed by a glass in the slightest degree convex, while it is not improved by one that is concave. When sight is improved by a concave glass, myopia is present. Finally, an eye is hypermetropic if convex glasses can be placed before it without in any way interfering with vision. If vision indeed be actually improved, this will be all the more a proof of the existence of hypermetropia.

When the presence of ametropia, be it myopia or hypermetropia, has been established, its degree must be ascertained. If the patient, placed at a distance of five metres from the card, can only read it by means of concave glasses, we have herein a proof that he is myopic. The *weakest* concave glass with which he can read at this distance the finest type, namely, No. 5, gives the degree of his myopia. In a case where vision was defective, it would still be the weakest glass, with which vision was best, which would measure the myopia. This rule must be strictly kept in mind, as a concave glass of a number of dioptrics superior to the myopia, may also furnish equally good vision, for the eye instinctively makes an effort of accommodation which neutralises the divergent action of a too powerful glass. This explains how it is that an eye perfectly emmetropic, or even hypermetropic, may be capable of seeing very well with a weak concave glass.

In a case of hypermetropia, it may be that the patient, if the degree of hypermetropia is not too great, will read No. 5 fluently at a distance of five metres from the board. The reason is that he makes an effort of accommodation exactly sufficient to adapt his eyes to parallel rays, or, in other words, to correct his hypermetropia. In this case we must look for the strongest convex glass which does not prevent his reading No. 5 easily. Hence, as regards hypermetropia, we measure it by finding the strongest convex glass that permits of distinct vision.

When an eye accommodates, we do not as a rule discover the whole of the hypermetropia. We get only the *manifest* hypermetropia, for convex glasses are refused, as interfering with vision, before we have arrived at the true measure of the hypermetropia. The proof of this is, that if we try the glasses over again, after an interval during which a mydriatic has been employed, we shall find eventually a stronger glass, and this it is which corresponds to the *total* hypermetropia. The difference between the manifest and the total represents the *latent hypermetropia*, which will be more marked in proportion as the patient can dispose of a greater amount of accommodation; in other words, as he is younger. So far is this the case, that in children, hypermetropia, if not too high in degree, may pass altogether unnoticed; in other words, the manifest hypermetropia amounts to nothing, although there is a certain amount of total. On the other hand, these two forms of hypermetropia tend more and more to merge into each other, in proportion as the accommodation decreases and the individual advances in age. You will perceive further on, that in practice the most important thing is the manifest hypermetropia.

While thus proving the existence of emmetropia, or correcting the myopia or hypermetropia, we obtain likewise the measure of the visual acuity. If at five metres from the card the patient can read No. 5, his vision is looked on as normal. But if at this distance, and for various reasons, he can only read No. 20, which he should be able to read at 20 metres, his vision is impaired in the proportion of 5 to 20,—in other words, his visual acuity is only $\frac{5}{20}$ or $\frac{1}{4}$. Hence the following rule: after correction of the myopia or the hypermetropia, the visual acuity is expressed by a fraction, the numerator of which represents the distance he has been placed at from the board, the denominator the number of the finest type which he can read at that distance.

The refraction and the visual acuity should always be thus determined for distance; and in practice five metres represents infinity sufficiently correctly. If it be wished to determine visual acuity from the book, which is a step beyond the card, as it were, and in which the numbers accompanying each type have always the same significance, an inaccurate result might be obtained, and defective vision diagnosed, whereas it was really normal. To see well, close at hand, two conditions are absolutely necessary. Not only must the visual acuity be normal, but the accommodation must be capable of adapting the eye to the distance at which the book is held. In cases of deficient power of accommodation, one source of error is thus removed by making the examination at a distance, that is to say, under conditions in which the accommodation has no part to play, a correction having of course been made first of all in cases of hypermetropia.

The glasses that we order may be for two distinct purposes: namely, either for distant or for near vision.

As regards the former, it should be noted that in the case of an emmetropic eye, there can never be any question of glasses for distance, seeing that such an eye, when the accommodation does not come into play, is adapted for parallel rays. In cases of low degrees of hypermetropia, glasses will not as a rule be required, since the employment of a certain amount of accommodation will suffice to correct the hypermetropia. When, however, this is not the case, as in aged persons, and when vision is improved by convex glasses, the glass which gives the best and most agreeable vision should be ordered for distance, as it corresponds to the manifest hypermetropia, or is possibly somewhat less.

As to myopic persons, they always require concave glasses for distance. But there is a rule that they should not be allowed those which correct their myopia completely, unless indeed this be very low in degree.

I shall now speak of the glasses which should be given for near vision. I first take the case of young persons, who have not as yet attained the age for presbyopia. Inasmuch as emmetropic individuals only require convex glasses when they have by age become presbyopic, no rules are necessary except for myopic and hypermetropic cases. The following are what experience has shown to be the best.

When hypermetropes require glasses for near vision, which is shown by their feeling fatigued whenever they direct their eyes for a length of time to near objects (*accommodative asthenopia*), they should be given such as correct their manifest hypermetropia. This rule might be slightly modified in the case of a young subject, presenting a very high degree of hypermetropia, or if with a moderate degree of hypermetropia, he was approaching the age when presbyopia should show itself, namely, about forty. In the first case it would be better to order a glass a little weaker than the manifest hypermetropia; in the second, one a little stronger. Inasmuch as the manifest hypermetropia is represented by a number of dioptrics which varies according to the age of the individual, while the total hypermetropia remains the same, it is plain that the glasses must be changed from time to time for stronger ones, in proportion as the manifest tends gradually with the progress of age, to equal the total hypermetropia.

As regards the proper concave glasses for myopic patients for near work, experience teaches that not more than half of their myopia should be corrected. Thus for a myopia of six dioptrics (6″·5) a glass of — 3 D. (— 13″) should be prescribed. There are, however, two exceptions to this; one is, where the individual presents a high degree, the other where he presents a very low degree of myopia. In the former he will be sometimes better satisfied with a glass weaker than one half his myopia; in the latter he will prefer to use no glass at all for near vision.

A certain class of myopic patients may thus do without concave glasses for near work, but when such is the case they nearly all require other glasses, namely prismatic ones. These are intended to remedy a relative weakness of the internal recti, which nearly always accompanies myopia. This *insufficiency of the internal recti* (latent divergent strabismus) may be explained as follows: convergence and accommodation are two acts which take place simultaneously, one provoking the other; therefore, in a typical or emmetropic eye, convergence and accommodation are exactly balanced, and when the eyes are adapted for any given distance, there ensues at once a corresponding movement of convergence, such that the two visual lines intercross at the point fixed. But in the case of a myopic eye, which can see near objects with a slight effort of accommodation, or perhaps without any, convergence will not take place; and this, which is necessary for binocular vision, will only be accomplished by an excessive effort, to be made by the internal recti. Hence that fatigue which the myope experiences so frequently when he applies his eyes for any length of time to near objects. This muscular asthenopia can be overcome by the use of prisms, with their bases directed inwards, which will allow the visual lines to intercross at the object fixed, with less convergence of the eyes.

Insufficiency of the internal recti may easily be shown to exist by the following experiment: the myopic person is made to look steadily at a point upon a sheet of paper, and by the aid of a prism, with its base downwards, held before the eye, this image is moved vertically upwards. If the intercrossing of the visual lines on the point fixed was not obtained by an excessive effort of convergence, the two points would be superimposed on the same vertical line; if not, the dot seen through the prism would undergo lateral displacement, on the side opposite to the prism, in proportion to the amount of the insufficiency of the internal recti. The insufficiency being thus recognised, that prism will give the measure of it which serves to bring back the displaced dot immediately over the other.

For this measurement either the double prism of *Creté's*, or the simple prism of *Berlin* may be used. If, as found by this method of examination, a prism of four degrees be necessary, this should be divided between the two eyes, and a prismatic glass of two degrees, with its base inwards, prescribed for each. These glasses may be worn alone for near vision in low degrees of myopia, or united with a concave glass, of a number which corresponds to half of the myopia.

This method of treating insufficiency of the internal recti, can only be useful when the insufficiency is slight. When it exceeds ten degrees, and the symptoms of asthenopia are not relieved by prisms (which should never exceed 3 or 4 degrees in each eye), tenotomy of one of the external recti should be performed, so as to increase the power of its antagonist muscle.

It may happen that after you have carefully studied the refraction of an eye, and corrected all the ametropia you can find, vision still continues imperfect. On the other hand you have been able to find no changes either in the anterior or deep portions of the eye to account for this. Further, this impairment you are satisfied, can not be due to functional disuse, as is the case in strabismus, either when actually existing or after it has spontaneously disappeared. In such a case as the above you will naturally be led to suspect the existence of *astigmatism*, the correction of which will restore normal vision.

In order to recognise that astigmatism is actually present, that is to say, that all the meridians of the eye have not an equal power of refraction, a circle is employed on which radii at intervals of fifteen degrees are drawn. This circle is marked like the dial of a clock, and thus furnishes easy points of guidance. In this clinique I have substituted for the half dial of *Snellen* an entire circle, which is so far an advantage that the patient's answers on one half of the circle can be checked by those on the other. Besides, as the various rays, though of equal thickness, appear to be more distinct as they converge to the centre, I have taken the precaution to make them somewhat thinner at their inner ends. Lastly, seeing that in practice we constantly require to know the direction which is at right angles to any given meridian, I have indicated round the dial at each radius, the position which is exactly at right angles to it. This circle forms part of my "Metrical Test-types."

In the great majority of cases, astigmatism will not have been suspected. You will have probably gone to work as usual, and having placed the patient at the distance of five metres from the table, have tried in succession convex and concave glasses. It is just because perfect vision has not thus been obtained, that by a process of exhaustion, you have been led to diagnose astigmatism.

As soon as this first portion of the examination has been concluded, the convex or concave glass will remain in the frame before the eye, according as the individual has appeared to be hypermetropic or myopic; no glass whatever will have been employed if he appeared emmetropic. His attention is then directed to the circle, and you enquire whether he sees one radius, or better, one diameter, more distinctly than any of the others. If he says he does, the presence of astigmatism is established.

The next point is to make him, with as much accuracy as possible, point out the line which appears to be the blackest. He will be readily able to name it by the hour notation inscribed on the card. Having thus learned that one line is blacker than the others, and that it has a certain inclination, we know thereby that not only astigmatism is present, but also that any *cylindrical* correcting glass must henceforth maintain a certain position. It must be always perpendicular to the line which appears the blackest. As regards this there is not the slightest practical difficulty, as the lines traced on the dial give all the necessary information. The spectacle frame has a second groove marked off into degrees, corresponding to those of the circle; the axis of the cylinder is indicated by a small mark on the glass.

I have been speaking of cylindrical glasses, and in practice it is with them that we correct regular astigmatism. These glasses are plane in one direction, but in another are cut on a cylindrical surface, either concave or convex. In all boxes of lenses, there exist convex and concave cylinders. In a direction parallel to their axes, the surfaces of these glasses are parallel, and their refracting power nil. But in proportion to the obliquity of direction the refractive power becomes greater, until finally the maximum is reached perpendicular to the axis. These glasses have a number upon them, which represents their refractive power in dioptrics for the latter direction.

Such glasses reproduce in fact exactly the conditions of refraction in an eye with regular astigmatism. For all lines which pass through the centre of the glass, the refraction is the same; but for each change of direction there is a different refractive power. However, for inclinations at regular distances from each other, the refraction increases or decreases with perfect regularity, so that there exist two exactly opposite positions, one of which is that of greatest refraction, while the other is that of no refraction whatever. Now this is a condition of refraction precisely analogous to that of the astigmatic eye. It will be seen, therefore, that a glass which reproduces the anomaly of refraction in the opposite direction will correct the astigmatism.

If you wish to form some idea of the vision which an astigmatic person enjoys, you have only to place before one eye a cylindrical glass. If with this the circle be examined, only one diameter can be seen with distinctness, namely, the one corresponding to a direction at right angles to the axis of the glass. All the other diameters will appear blurred, in proportion as they are more nearly parallel to the axis of the cylinder.

The patient then having been placed at five metres distance from the card, and having stated that he perceives one line more clearly than the others, and the direction of the line exactly opposite to this being known, we have only to place in the frame at the right inclination a cylindrical glass which shall make *all* the lines appear equally black. When this has been done, the anomaly will have disappeared, and the astigmatism have been corrected. The question arises how to find the required cylinder. A choice must first be made between the concave and convex cylinders. This should not be a matter of any difficulty, for it is only necessary to try a weak cylinder of each kind, in order to perceive that while one increases the existing astigmatism, and makes vision worse, the other reduces the ametropia more or less. It will be to the series to which this latter glass belongs that you must have recourse. In succession, glasses from it must be tried of increasing strength, and the one which makes all the lines on the board equally distinct will be the proper one to select.

When a spherical glass has first been given, and a cylindrical subsequently added, the union of the two will form the correcting glass in the particular instance. If the patient at first appeared emmetropic, a cylindrical glass alone will suffice for the correction. In many cases the results furnished by this mode of procedure will admit of being simplified, for it may possibly happen that you have been led to place a concave cylindrical over a convex spherical, or *vice versâ;* but a simple calculation will soon rectify this.

As regards the notation by which astigmatism is expressed, it is as follows: first of all, the cylindrical glass with the inclination of its axis, its sign, and its strength, should be indicated; next, the spherical glass, if one has been ordered. For example, $90° + 2 + 3{\cdot}50$ expresses that the eye in question has an astigmatism which is corrected by a convex cylinder, of 2 dioptrics, placed vertically, and united to a convex spherical glass of 3·50 dioptrics.

Astigmatism is *hypermetropic* when corrected with a convex cylinder; *myopic*, with a concave. *Mixed* astigmatism is a form requiring for its correction two cylinders, one of which is concave the other convex. It is this latter form of astigmatism which is present when, after a spherical glass has been placed before the eye, a cylinder stronger and of a different sign is still required to correct the ametropia.

No particular rules can be laid down as regards the glasses to be given to astigmatic patients. The same rules which applied to emmetropes, hypermetropes and myopes will also apply here. One thing however is to be noted, namely, that of all spectacles, however intended to be worn, the cylindrical glass should form an integral part.

Before I speak of *presbyopia,* I will say a few words as to what is understood by punctum remotum, punctum proximum, and amplitude of accommodation.

The *punctum remotum* is the furthest point for which the eye can adapt itself, when the accommodation is completely relaxed. In the emmetrope the punctum remotum is situated at an infinite distance. In the myopic eye it lies between the eye and infinity, at a distance from the former, which diminishes in proportion as the myopia increases in degree. The degree of myopia always gives the position of the punctum remotum, for it corresponds to the focus of the lens which corrects the myopia. Thus if we take for example a myopia of two dioptrics, the punctum remotum will be situated fifty centimetres in front of the eye. In a hypermetropic eye, that is in one adapted when its accommodation is relaxed to convergent rays, the punctum remotum lies behind it, and is therefore situated under conditions which render vision impossible. The distance which separates it from the eye is also given by the focal length of the glass which measures the hypermetropia.

The *punctum proximum* which represents the shortest distance for which an eye can be adapted, is discovered as soon as the individual has brought into play his entire accommodation. It will be situated at a variable distance, according to the greater or less power of the accommodation, and the conformation of the eye. Thus, with an equal effort of accommodation, the punctum remotum, relatively to an emmetropic eye, will be closer in a myopic, and further off in a hypermetropic eye. The punctum proximum is directly determined by actual measurement of the shortest distance at which fine type can be read distinctly.

If we know on one hand the refraction of an eye, and on the other its punctum proximum, we can always find the *amplitude of accommodation,* which is nothing more than the sum of the accommodative power, of which the eye disposes. In an emmetropic eye the amplitude of accommodation will be equivalent to the refracting power of a lens, having for its focal distance the space separating the eye from the punctum proximum. In an hypermetropic eye, inasmuch as this, in order to be in the same condition as an emmetropic eye, that is to say, to adapt itself to parallel rays, is obliged to make an effort of accommodation equal to its hypermetropia; the hypermetropia must be added to the figure furnished by the previous calculation. In the myopic eye, on the other hand, which is assisted in near vision by a power of refraction equal to its myopia, the myopia should be subtracted from this value. Thus, suppose that in a certain case of emmetropia, the punctum proximum is situated at 20 centimetres distance, the amplitude of accommodation will be equivalent to 5 dioptrics. But if a person has a hypermetropia of say 2 dioptrics, the amplitude of accommodation will become 7; whereas, in a case of myopia of the same amount it would be reduced to 3.

In cases where, from insufficiency of accommodation, some difficulty is experienced in finding the exact position of the punctum remotum, and consequently of the amplitude of accommodation, a convex glass of known power should be used, and the same method be adopted. But the calculations once made, a number of dioptrics equivalent to the number of the glass used must be subtracted.

The determination of the amplitude of accommodation on an eye may acquire great importance. This will be at once evident when it is remembered that the reduction in the amplitude of accommodation is a symptom which appears at the commencement of certain affections, such for instance, as glaucoma, and sympathetic ophthalmia, where it is very necessary that an early diagnosis be made. But to do this it is necessary to know what the amplitude should be in a normal eye, and with this object the table of *Donders*, giving the amplitude of accommodation at different ages, may be consulted; thus:

At 10 years of age	14	dioptrics.
15 ,,	12	,,
20 ,,	10	,,
25 ,,	8·50	,,
30 ,,	7	,,
35 ,,	5·50	,,
40 ,,	4·50	,,
45 ,,	3·50	,,
50 ,,	2·50	,,
55 ,,	1·75	,,
60 ,,	1	,,
65 ,,	0·75	,,
70 ,,	0·25	,,
75 ,,	0·	,,

When in consequence of the gradual failure of the accommodation, as age advances, the punctum proximum is removed to a distance greater than 30 centimetres, the individual becomes presbyopic. Reading small print then becomes impossible, except at a distance greater than 30 centimetres, and then only by using the whole accommodative power he can command. Such an effort cannot be long sustained, without a certain amount of fatigue, and this fatigue marks the commencement of presbyopia. Later still, the book would require to be removed to a point so distant as to render reading utterly impossible.

By reference to the table of the amplitude of accommodation at different ages, it will be seen that the emmetrope has passed 45 years of age before the punctum proximum lies beyond 30 centimetres. In such an eye, therefore, 45 is approximately the age at which presbyopia commences. It is to be corrected by the use of convex glasses, such as will bring back the punctum remotum to within 30 centimetres. Just as the amplitude of accommodation has been calculated for all ages, so also the correcting glass can be calculated for any age beyond 45. The table which gives the number of the glasses required by emmetropic eyes which have become presbyopic, has been reduced to simple figures, easy to remember, and quite sufficient for all practical purposes; they are as follows:—

At 45 years of age	0·5	dioptric.
50 ,,	1	,,
55 ,,	1·50	,,
60 ,,	2	,,

And so on, adding half a dioptric for each period of five years.

If a person be hypermetropic, it will be evident that the signs of presbyopia will show themselves earlier than in the emmetrope. In myopia, on the contrary, their advent will be postponed, and this to such a degree, that if the myopia is such that the punctum remotum lies nearer than 30 centimetres, the individual will never become presbyopic. Thus a person with a myopia of 4 dioptrics, and whose punctum remotum lies consequently at 25 centimetres, will never require a convex glass for close vision, no matter what decrease may have taken place in his accommodation.

To recapitulate: an emmetropic person will only require convex glasses for close vision, and that not until he shall have reached the age of 45 years. From this age onwards, the glasses that should be given can easily be found from the preceding table.

In a case of hypermetropia I have already said that the glass which corrects the manifest hypermetropia should be given for near vision. When, however, a hypermetropic person has passed the age at which presbyopia appears in the emmetrope, glasses should be given correcting not only the manifest hypermetropia, which is now much the same as the total, but also the presbyopia proper to his age. Thus if a hypermetrope be 60 years of age, and present a manifest hypermetropia of three dioptrics, convex glasses of 5 D. should be given.

When a myopic person shows signs of presbyopia, the proper convex glass to correct this condition is furnished by a reverse calculation, inasmuch as a portion of the presbyopia as it exists in the emmetropic eye, is annulled by the myopia. Take a myopia of two dioptrics. If the individual be 70 years of age, for example, a convex glass of 1 D. will suffice to correct the presbyopia instead of one of 3 D., which would have been necessary, if the individual had been emmetropic. For a given degree of myopia it is always easy therefore to calculate at what age presbyopia will appear. It will show itself the moment the myopia is counterbalanced by the glass required for presbyopia. Thus a person myopic to the extent of two dioptrics, will become presbyopic after 60 years of age.

APPENDIX.

I.—THE METRICAL SYSTEM IN OPHTHALMOLOGY.

THE unit of length in the metric system is the metre, equivalent to 100 centimetres, 1000 millimetres, or 39·37 British inch. The unit of measurement in refraction is a lens with a focal distance of one metre. This is called a *Dioptric* (*D*). No. 2 is a lens which has double the refracting power of No. 1. No. 20 is *twenty* times stronger than No. 1, and is therefore $= 20\,D$.

The numbers by which the glasses of the old system are designated indicate *in inches the radius of curvature of the lens.* If the index of refraction ($n = 1·5$) be taken as 1·5, then their radii of curvature will coincide with their foci, and consequently the numbers of the lenses will indicate their *focal distances.*

The following Table shows the equivalents in English and French inches, and in millimetres, of each dioptric, or fraction of a dioptric ($n = 1·5$).

No. in Metrical Dioptrics.	French Inches.	English Inches.	Millimetres.
·50	73·8816	78·7416	2,000
·75	49·2544	52·4944	1,340
1·	36·9408	39·3708	1,000
1·25	29·5526	31·4966	800
1·50	24·6272	26·2472	667
1·75	21·1090	22·4976	571
2·	18·4704	19·6854	500
2·25	16·4181	17·4981	444
2·50	14·7763	15·7483	400
2·75	13·4330	14·3166	363
3·	12·3136	13·1236	333
3·25	11·3664	12·1141	307
3·50	10·5545	11·2488	285
3·75	9·8509	10·4988	266
4·	9·2352	9·8427	250
4·25	8·6919	9·2637	235
4·50	8·2090	8·75	222
4·75	7·7978	8·2886	210
5·	7·3881	7·8741	200
5·50	6·7165	7·1583	181
6·	6·1568	6·5618	166
7·	5·2772	5·6243	143
8·	4·6176	4·9213	125
9·	4·1045	4·3745	111
10·	3·6940	3·937	100
11·	3·3582	3·5791	90
12·	3·0784	3·2809	83
13·	2·8416	3·0285	77
14·	2·6386	2·8122	71
15·	2·4627	2·6250	66
16·	2·3088	2·4606	62
18·	2·0522	2·1872	55
20·	1·8470	1·9685	50

Where, however, as is more generally the case, the index of refraction is not 1·5 but 1·53, the following table, constructed by Dr. Landolt, is more correct, and should be used in preference :—

OLD SYSTEM.				NEW SYSTEM.			
I. Number of the Old System.	II. Focal Distance in Paris inches where $n=1·53$.	III. Focal Distance in Millimetres.	IV. Equivalent in Dioptrics.	V. Number of the New System.	VI. Focal Distance in Millimetres.	VII. Focal Distance in Paris inches.	VIII. Number corresponding to the Old System where $n=1·53$.
72	67·9	1837	0·54	0·25	4000	148·	156·
60	56·6	1523	0·65	0·5	2000	74·	78·
48	45·3	1225	0·81	0·75	1333	49·	52·
42	39·6	1072	0·93	1·	1000	37·	39·2
36	34·	920	1·08	1·25	800	29·6	31·2
30	28·3	766	1·30	1·5	666	24·6	26·1
24	22·6	612	1·63	1·75	571	21·	22·3
20	18·8	509	1·96	2·	500	18·5	19·5
18	17·	460	2·17	2·25	444	16·4	17·4
16	15·	406	2·46	2·5	400	14·8	15·6
15	14·1	383	2·61	3·	333	12·3	13·0
14	13·2	357	2·8	3·5	286	10·5	11·1
13	12·3	332	3·0	4·	250	9·23	9·78
12	11·3	306	3·26	4·5	222	8·22	8·7
11	10·3	280	3·56	5·	200	7·4	7·8
10	9·4	254	3·9	5·5	182	6·71	7·1
9	8·5	230	4·35	6·	166	6·15	6·5
8	7·5	203	4·9	7·	143	5·29	5·59
7	6·6	178	5·6	8·	125	4·6	4·89
6½	6·13	166	6·02	9·	111	4·1	4·35
6	5·6	152	6·52	10·	100	3·7	3·91
5½	5·2	140	7·12	11·	91	3·37	3·56
5	4·7	127	7·83	12·	83	3·07	3·26
4½	4·2	115	8·70	13·	77	2·84	3·01
4	3·8	102	9·72	14·	71	2·63	2·8
3½	3·3	89	11·2	15·	67	2·47	2·60
3¼	3·1	83	12·0	16·	62	2·3	2·44
3	2·8	76	13·0	17·	59	2·18	2·30
2¾	2·6	70	14·4	18·	55	2·03	2·17
2½	2·36	64	15·7	20·	50	1·85	1·95
2¼	2·1	57	17·4				
2	1·88	51	19·6				

1 Paris inch = 27·07 millimetres.
1 English ,, = 25·40 ,,
1 Austrian ,, = 26·34 ,,
1 Prussian ,, = 26·15 ,,

II.—The following table shows the

METRIC EQUIVALENTS OF BRITISH WEIGHTS.

$\frac{1}{20}$ grain	= 0·003 gram., or	3 milligram.	8 grains	= 0·5	gram., or	5 decigram.
$\frac{1}{15}$,,	= 0·004 ,,	4 ,,	9 ,,	= 0·58	,,	58 centigram.
$\frac{1}{12}$,,	= 0·005 ,,	5 ,,	10 ,,	= 0·65	,,	65 ,,
$\frac{1}{10}$,,	= 0·006 ,,	6 ,,	11 ,,	= 0·7	,,	7 decigram.
$\frac{1}{8}$,,	= 0·008 ,,	8 ,,	12 ,,	= 0·77	,,	77 centigram.
$\frac{1}{6}$,,	= 0·01 ,,	1 centigram.	13 ,,	= 0·85	,,	85 ,,
$\frac{1}{5}$,,	= 0·013 ,,	13 milligram.	14 ,,	= 0·9	,,	9 decigram.
$\frac{1}{4}$,,	= 0·016 ,,	16 ,,	15 ,,	= 0·95	,,	95 centigram.
$\frac{1}{3}$,,	= 0·02 ,,	2 centigram.	20 ,,	= 1·3	,,	
$\frac{1}{2}$,,	= 0·03 ,,	3 ,,	25 ,,	= 1·6	,,	
1 ,,	= 0·06 ,,	6 ,,	30 ,,	= 2·0	,,	
2 grains	= 0·13 ,,	13 ,,	35 ,,	= 2·25	,,	
3 ,,	= 0·20 ,,	·2 decigram.	40 ,,	= 2·5	,,	
4 ,,	= 0·26 ,,	26 centigram.	45 ,,	= 3·0	,,	
5 ,,	= 0·32 ,,	32 ,,	50 ,,	= 3·25	,,	
6 ,,	= 0·4 ,,	4 decigram.	55 ,,	= 3·5	,,	
7 ,,	= 0·45 ,,	45 ,,	60 ,,	= 4·0 nearly.		

1 Avoirdupois ounce = 437·5 grains = 28·35 grammes.
1 Apothecaries' ounce = 480· grains = 31· grammes.

The figures in the above table are not in all cases absolutely accurate beyond the first place of decimals, but are sufficiently so to lead to no error of importance. In the smaller quantities the metric equivalents are slightly less than the British weights.

The minim of the British Pharmacopœia being equal to 0·91 grain, a reduction of about one-tenth must be made in each case in order to find the metric equivalent of any number of minims. Thus, 5 minims = 0·32 – 0·03 gramme = 0·29 gramme ; and 12 minims = 0·77 – 0·07 gramme = 0·7 gramme nearly.

Table showing British Equivalents of Metric Weights.

Grammes.		Grains.	Grammes.		Grains.
0·001	=	$\frac{2}{200}$	0·6	=	9
0·01	=	$\frac{3}{20}$	0·7	=	$10\frac{1}{2}$
0·02	=	$\frac{1}{3}$	0·8	=	12
0·03	=	$\frac{9}{20}$	0·9	=	$13\frac{1}{2}$
0·04	=	$\frac{3}{5}$	1·	=	$15\frac{1}{2}$
0·05	=	$\frac{3}{4}$	2·0	=	31
0·1	=	$1\frac{1}{2}$	3·0	=	47
0·2	=	3	4·0	=	62
0·3	=	$4\frac{1}{2}$	5·0	=	77
0·4	=	6	10·0	=	154
0·5	=	$7\frac{1}{2}$.			

For minims an addition of one-ninth must be made to the figures representing grains : thus, 0·9 gramme = $13\frac{1}{2} + 1\frac{1}{2}$ = 15 minims.

III.—METRIC NOTATION OF THE THERMOMETER.

The ratio existing between the Fahrenheit, Centigrade, and Réaumur thermometers is as 9 : 5 : 4. But inasmuch as the freezing point of F. = 32°, while of C. and R. it = 0°, 32° must be added or subtracted in expressing C. as F., or *vice versâ*, *e.g.*, required the value of 100° C. in terms of F. *i.e.* $100 \times 9 \div 5 + 32 = 212°$.

ALPHABETICAL INDEX.

BRADBURY, AGNEW, & CO., PRINTERS, WHITEFRIARS.