CHAPTER XIV.

PARALYSIS OF THE MUSCLES OF THE EYE—STRABISMUS.

Preliminary remarks.

Preliminary Considerations.—It will be advisable, before entering on the subject of this chapter, to make a few preliminary remarks on the innervation and action of the muscles of the eye, and to explain the mechanism of diplopia or double vision, that we may the better appreciate the symptoms complained of by patients suffering from paralysis of one or more of the muscles of the eye.

Distribution of nerves.

Innervation and Action of the Muscles.—The third pair of nerves divides into two branches in the orbit, the upper one supplies the levator palpebræ and superior rectus, and the lower branch sends nerves to the rectus internus, rectus inferior, obliquus inferior, and the sphincter pupillæ.

The fourth nerve supplies the superior oblique.

The sixth nerve the external rectus.

Combined actions of muscles.

1st. The cornea is inverted and everted in the horizontal meridian plane, by the action of the internal and external recti respectively.

2nd. The cornea is directed upwards by the combined action of the superior rectus and the inferior oblique.

3rd. The eye is turned downwards by the combined action of the inferior rectus and superior oblique.

4th. In moving the eye diagonally upwards and inwards, the rectus superior acts in combination with the rectus internus, being further controlled by the action of the inferior oblique.

5th. In moving the eye upwards and outwards, the rectus superior acts in conjunction with the rectus externus, the inferior oblique limiting the action of the rectus superior.

6th. The eye is turned inwards and downwards by the action of the rectus inferior and rectus internus, the superior oblique also controlling the action of the rectus inferior.

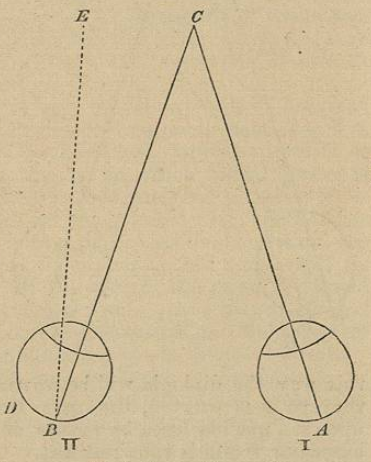
7th. The movement downwards and outwards is accomplished by the rectus inferior associated with the rectus externus, the superior oblique controlling the action of the inferior rectus.

Diplopia.

Harmony of two eyes impaired.

Diplopia.—In order to insure correct vision the two eyes must work in unison; for if the rays of light do not fall upon exactly corresponding portions of the two retinæ, double vision or *diplopia* is the result. There are two forms of diplopia, the *direct* and the *crossed;* the former may be best understood by referring to Fig. 46. The left eye, B, in this case is supposed to be inverted, the right eye, A, is normal, and directed towards the object C, the rays from which fall on the macula lutea at A; but in consequence of the left eye being inverted, the rays from C will fall on the point B, internal to the macula lutea D, and the image formed will be mentally projected, in a line perpendicular to this spot, in the direction of E; and thus two images of the figure C will be visible, one in its real position, and the other to the left of C at E. The reverse of this would, of course, hold good, if the right eye were inverted; the second image would then be to the right instead of the left of C.

Fig. 46.



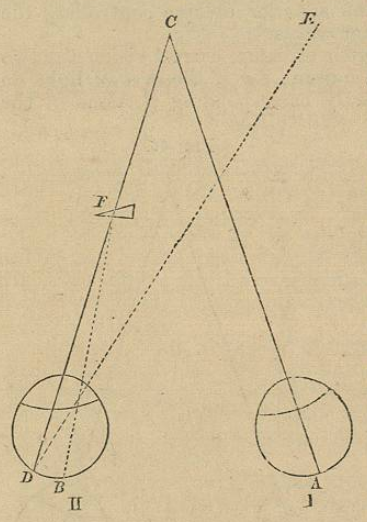
Direct diplopia.

In the second form of diplopia, as its name implies, the images cross one another, as shown in Fig. 47.

Crossed diplopia.

The left eye, B, is supposed to be everted, and the right eye A, is in its normal position, the rays of light from the luminous point C falling upon the macula lutea at A; but as B is everted, the rays from C do not impinge upon its macula lutea at B, but on a point external to it at D, and are projected in a line perpendicular to this point in the direction of E, so that they cross those proceeding from C to A, and hence the crossed diplopia.

Fig. 47.



Prisms to correct diplopia.

I may here remark, that the course of the rays C D may be changed by means of a prism, as at F, by which they are bent towards the base of the prism, and so fall on the macula lutea at B; in this way the diplopia will be corrected; for although the eye B is everted, the rays from C are directed upon its macula lutea by means of the prism F, and binocular vision is thus restored.

To test binocular vision.

Prisms of this kind are now in constant use, not only for rectifying slight diplopia, but also as a test of the presence of binocular vision in cases of *strabismus*. It is most important that we should be accurately informed on this point; for, unless binocular vision exists, we cannot operate for the cure of strabismus with any hope of success. It does not follow, that because a patient squints, he must suffer from diplopia; in fact, in the majority of cases of long-standing strabismus, the functions of the whole or a portion of the retina in the affected eye are destroyed or suppressed,

and it is then useless to interfere, unless for appearance sake.

Principle and method of using them.

The existence of binocular vision is ascertained in this way. If a prism be held with its base inwards, before either eye, rays passing through it will be defracted towards its base, and falling on the retina, will form an image internal to the macula lutea, which being projected, as in Fig. 46, in the direction E, direct diplopia will be the result. But the other eye will immediately and unconsciously endeavour to correct this, and by an involuntary motion, it will turn inwards (become inverted), so that the rays of light from the object under observation may fall upon a corresponding portion of its retina, internal to the macula lutea, and thus correct the diplopia. Consequently, if under any circumstances the prism has this effect, we may be sure that binocular vision exists, and the reverse, if no such changes are induced.

The prism test is very useful in cases of assumed blindness, for as Professor Longmore remarks, if a prism of 12° or so, be held with its base upwards or downwards before the eye in which visual power is acknowledged to be retained, and the person who is subjected to the test on being asked what effect it has on his sight, states that it causes double vision, the simulation is proved, for diplopia could only result by both eyes seeing. If the base of the prism is turned inwards, and the other eye squints, evidently an effort is being made to prevent double vision, and the assertion of blindness in the squinting eye is therefore absurd.

Primary and secondary angles of squinting.

Primary and Secondary Angles of Squinting.—In the diagnosis of cases of paralysis of the muscles of the eye, as distinguished from strabismus, it is very necessary to notice if the secondary angle of squinting is greater than the primary angle; the former invariably forms the greater angle in all cases of paralysis. By the primary angle of squinting, we mean the angle of deviation of the optic axis of the diseased eye, from an object upon which the other eye is fixed. Upon covering the sound eye, the other makes a movement in order to fix its optic axis on the object, causing the covered eye to move in association with it; this deviation of the sound eye is called the secondary angle of squinting, and will be found greater than the primary angle through which the weakened eye has moved.

Illustration.

For instance, suppose the external rectus of the left eye is paralysed, the patient is therefore unable to evert this eye; but if a candle be held in front of his face, and the right eye closed, on moving the candle to the left of the patient, the left eye makes an effort to follow it, and may be moved perhaps one line outwards; the right eye, we shall find, has made an associated movement inwards of two lines. In this case, therefore, the secondary angle is evidently greater than the primary one.

Why the secondary exceeds the primary angle in paralysis.

Von Graefe explains this phenomenon as follows. The nervous apparatus of the left external rectus being defective, it requires an increased effort of the will to evert the left eye; but this increase of force cannot be confined to one eye, it is equally propagated to the sound one; and as the healthy muscle responds normally to the increased nerve force, the right eye is inverted considerably more than the left one is everted. As a consequence of the want of action in the external rectus, after a time, secondary changes occur in the antagonistic muscle, leading to alterations in its contractile power, and the diplopia becomes complicated with strabismus, as I shall more fully explain by-and-by.

PARALYSIS.

Paralysis of External Rectus.

Paralysis of the External Rectus.—Let us suppose the left external rectus is affected. On holding a lighted candle, or some such object, at a distance of five feet from the patient's face, we find both eyes are fixed on it, and it is only when the candle is moved to the left of the patient that the want of action in the muscle becomes apparent; the optic axes then no longer work in unison, and diplopia is the result. This is particularly noticeable if the candle is held a little below as well as to the left side. On closing the right eye the secondary angle of squinting will be found greater than the primary angle.

How detected.

Nature of the diplopia.

The diplopia which exists in a case of this kind will be readily understood by reference to Fig. 46, for as the object is moved to the left of the patient, the rays of light must fall upon a part of the retina internal to the macula lutea, and being projected forwards the diplopia will be direct. In order to overcome this diplopia the patient is apt habitually to turn his head to the left, and also in striking at an object is likely to hit too far to the left, especially if the right eye is closed and the blow is a rapid one. In the form of paralysis we are now considering, the action of the muscles of the eye, with the exception of the rectus externus, may be perfect.

Paralysis of Third Nerve.

Paralysis of the Third Nerve may be complete or partial; in the former case, all the muscles supplied by this nerve are paralysed, and in the latter, one or more only may be affected.

Ptosis.

Supposing complete paralysis of the third nerve of the left eye exists, the first symptom we shall notice will be loss of power of the levator palpebræ, the patient being unable to raise his upper eyelid. On opening the lids, we shall find that our patient can only direct the eye outwards; in other directions it is unable to follow an object placed before it, so that if the latter be held above, below, or to the right of the affected eye, diplopia is produced. In consequence of the illusion thus created in the mind, when the patient attempts to walk across a room to reach an object in front of him, he is apt to stagger much as a drunken man would do.

Eye can only move outwards.

Diplopia and vertigo.

Exophthalmos.

In some cases exophthalmos results from the loss of power in the recti muscles, and their inability to resist the natural tendency of the elastic contents of the orbit to thrust the eye forwards. The pupil acts very slowly under the stimulus of light, and is more or less dilated.

Slow pupil.

In instances of complete paralysis of the muscles supplied by the third pair, we have only to bear in mind their combined action, in order that we may understand the nature of the diplopia that must occur.

Paralysis of Internal Rectus.

Paralysis of the Internal Rectus.—The eye cannot be moved inwards, and a crossed diplopia results if an object is held to the right of the patient (supposing the left eye affected), the squint being divergent. The diplopia is most apparent if the object is held to the right, and above the level of the patient's eye. The secondary angle of squinting is greater than the primary angle, and the patient habitually turns his head towards the right, in order that he may overcome the diplopia as far as possible.

Divergent squint.

Characters of the diplopia.

The double images are parallel and equally high; except in the diagonal positions to the right and upwards, and to the right and downwards, where there is

an obliquity and a difference in height—the image of the left eye, on looking towards the right and upwards, being inclined to the right and lower—whilst on looking towards the right and downwards, it is inclined obliquely to the left and higher.*

Paralysis of Rectus Superior.

Paralysis of the Rectus Superior (left eye).—The movements of the eye before the horizontal meridian plane are normal; but if an object is moved from below upwards above this level, the patient's left eye cannot follow it. The cornea is seen to be directed forwards and slightly outwards, on account of the action of the inferior oblique muscle being unopposed.

Eye cannot be raised.

Is slightly everted.

If the right eye is covered, and an object is held above the patient's eyes, the paralysed eye being directed upwards as far as the paralysis will allow, the right cornea is turned upwards and outwards to a greater extent than the left one. The chances are, if the patient strikes quickly at an object, that he will hit too high. In order to correct the diplopia as far as possible, he carries his head directed backwards and upwards.

Diplopia on looking up.

If the object be held above the horizontal meridian plane of the eye there will be diplopia, and one image appear above the other. The rays of light under these circumstances fall upon the inferior part of the retina of the affected eye below the macula lutea, and the image is therefore projected above that of the other eye; but in consequence of the slight eversion of the cornea which takes place in paralysis of the superior rectus, the images do not appear precisely one above the other, the false image being to the right of the true one as well as above it; in fact, the diplopia is crossed, in consequence of the divergence of the optic axes.

False image above and to the right.

Of Rectus Inferior.

Paralysis of the Rectus Inferior.—The symptoms characteristic of this affection are precisely the reverse of those above enumerated in the instance of paralysis of the superior rectus.

Of the Inferior Oblique.

Paralysis of the Inferior Oblique very rarely if ever occurs without some of the other muscles of the eye being involved.

Paralysis of the Superior Oblique (left eye).—The

* "Principles and Practice of Ophthalmic Medicine and Surgery," by T. W. Jones, F.R.S.; 3rd edit., p. 582.

Of the Superior Oblique.

patient complains that objects below the horizontal meridian of the eye appear as if double and unsteady; this fault is corrected to some extent by the head being thrown forwards and to the right.

Diplopia on looking down.

On examining the affected eye we find that objects are correctly seen above the horizontal plane, but that below it, in consequence of the cornea being directed upwards and inwards, while the right eye is directed downwards, the false image will be below and to the outer side of the real one, the deviation of the two figures being greater as the object is placed further beneath the horizontal plane. The secondary angle of squinting is greater than the primary angle. It is a remarkable fact, that in this form of paralysis the false image appears to be nearer to the patient than it really is.

False image below and to the left;

appears nearer.

I have already considered the circumstances of paralysis of the sphincter pupillæ under the head of mydriasis, and may therefore proceed to make a few remarks on the causes, prognosis, and treatment of the various paralytic affections of the muscles of the eye.

Causes.

The Causes of Paralysis of the Muscles of the Eye may be divided into two classes—1st, those affecting the nerve; and 2nd, disease involving the nervous centre.

1. In the nerves.

1. Among the first of these causes syphilis holds a prominent place. I need hardly remark that the nerve may be affected with neuroma of a syphilitic origin in any part of its course; but fatty degeneration of the nerve as a result of syphilis, is probably a more frequent though less palpable source of paralysis of the muscles of the eye. Lastly, syphilitic nodes or a thickening of the sheath of the nerve may, by pressing on its true nervous elements, induce paralysis.*

Syphilis.

Rheumatism.

Rheumatism, again, appears to be a common source of paralytic affection of the muscles of the eyeball. The attack usually comes on after exposure to cold, and is generally accompanied with violent pain in the head and supra-orbital region.

Malaria.

Malarious influences have evidently a direct relation to the class of diseases we are now considering; hemi-

* Cases of Paralysis of the Oculomotorius, by Professor von Graefe: *Ophthalmic Review*, vol. i. p. 216.

crania, apparently depending upon miasmatic influences, being occasionally followed by paralysis of the orbital branch of the third nerve of the corresponding side of the head.

Mechanical compression.

Effusions of blood into the orbit, or tumours in this locality may, by pressure upon the nerve, impair its functions, and cause paralysis of the muscles of the eye. Abscess in the cellular tissue, or disease of the bones of the orbit may act in the same way. Lastly, Mackenzie has drawn attention to the fact, that the third nerve may be injuriously compressed by the posterior artery of the cerebrum, and the superior artery of the cerebellum, should these vessels happen to be much congested, the nerve passing between them as it emerges from the brain.

2. Disease of the brain.

2. Of the second class of causes which produce paralysis of the muscles of the eye—viz., those originating in the nervous centre, we may reasonably expect to meet with symptoms indicating the seat of the lesion, and in all probability the patient's intellectual faculties will be impaired, or paralysis of other parts of the body will exist; but, as I before remarked when speaking of ptosis, the consideration of these forms of disease would involve us in that most difficult and obscure study—the pathology of the brain, which certainly does not fall within my province.

Diagnosis.

I may however observe that the diplopia accompanying paralysis of the third pair, and depending on lesions of the brain, has a marked peculiarity, in that "the double images in these cases show a very great disinclination to be united. Even with the most carefully selected prism it is found difficult, or even impossible, to unite them; and even if we have effected this, the diplopia generally awakens again, as soon as a very slight alteration is made in the strength of the prism, or in the position of the object. If we find that several muscles, which are supplied by different nerves, are paralysed, together with one or more muscles supplied by the oculomotorius, particularly if both eyes are affected (and we can find no cause within the orbit), we may suspect some cerebral lesion. The same may be said with regard to a succession of paralyses in different muscles. If several of the muscles, furnished with nerves of the third pair, are *successively* affected, and then perhaps the trochlearis

Diplopia obstinate.

or abducens also, and after this, one or more muscles of the other eye, we are justified in thinking of a cerebral cause."*

Prognosis uncertain in brain cases.

The Prognosis in cases of paralysis dependent upon causes situated at the base of the brain, or within the brain itself, must be more or less dubious, but will evidently depend very much upon the nature of the cerebral lesion; we may hope for amendment in the diplopia if the cerebral symptoms disappear, but hardly otherwise.

Favourable in syphilis or rheumatism.

In cases of paralysis of the nerve depending on syphilitic or rheumatic influences, we may fairly hope that with proper treatment the paralysis will gradually disappear. The same remark applies to instances of paralysis depending on malarious influences.

Must vary with cause of pressure.

The prognosis to be given in cases of affections of the muscles of the eye, caused by pressure upon the nerve from effusion of blood, or from morbid growths within the orbit, will evidently very much depend upon the possibility of the removal of the compressing force. If there is no likelihood of this, it is hardly possible that the affection of the muscles of the eye will be overcome. On the other hand, effused blood, or even an abscess, may be got rid of, and if so, we may fairly hope for a favourable result as regards the muscular apparatus of the eye.

Treatment.

Treatment.—In instances of paralytic affections of the muscles of the eye depending upon syphilitic or rheumatic influences, we shall have to enforce a plan of treatment such as I have before recommended in cases of the kind. The tendency of these paralytic affections is to recovery, especially if nature is judiciously assisted in her efforts to cure.

Tendency to recovery.

Open an abscess.

In the case of paralysis depending on causes situated within the orbit, should this be an effusion of blood, it is well to allow it to become absorbed; abscesses should be opened as soon as possible, but I would refer to Chapter III., on diseases of the orbit, for an account of the treatment to be followed in these affections.

I before remarked that *prisms* are employed in

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* Mr. Wells on Paralysis of the Muscles of the Eye: *Ophthalmic Hospital Reports*, p. 29, July, 1860.

Exercising weak muscle by prisms.

some cases of diplopia with advantage. Supposing the diplopia has to some extent been overcome either by the efforts of nature or medical treatment, and if no contraction of the opposing muscle has taken place, we may hope by the use of prisms to strengthen the paralysed muscle, giving it gentle exercise in the following way for some three or four hours every day.

Mode of using them.

I have already explained the action of the prism (Fig. 47): light being defracted by it towards its base, we may in this way bend the rays of light into such a position, that they will fall upon the retina near the macula lutea of the diseased eye. In consequence of the great confusion of vision which is thus caused (the rays of light falling on the yellow spot in the sound eye, and very near it in the weak one), the paralysed muscle contracts, in order that it may correct the diplopia, by turning the axis of the diseased eye so that the two images may coincide; and by the daily exercise of this contraction, it gradually gains strength, and in time may work without the prism.* Glasses of this kind are especially useful during the progress of recovery from palsy of the sixth, or partial paralysis of the third nerve, in which the internal rectus is the only muscle, or the one principally affected.

Illustration.

Supposing the external rectus to be paralysed, the base of the prism should be directed towards the temple, so as to defract the rays of light on a spot internal to the macula lutea; the external rectus, to correct the diplopia thus caused, would contract and slightly evert the eye, and being gently exercised in this way, day by day, would gain strength, and perhaps ultimately recover its former power. In cases of paralysis of the other muscles of the eye, the base of the prism should be placed in such a position as to call the affected muscle into play, upon precisely the same principle as above explained.

Electricity.

Faradization is often most useful in cases of paralysis of the muscles of the eye, one pole being applied over the closed lid, and the other behind the corresponding ear. The remarks I have already made upon this method of treatment, when discussing the subject of paralysis of the orbicularis and levator palpebræ, are

* E. Meyer on Treatment of Strabismus by Prisms: *Brit. and For. Med.-Chir. Rev.*, vol. xxxiv. p. 392.

applicable to instances of paralysis of the muscles of the eye.

Operation of Tenotomy.—We have another means at our command for overcoming the diplopia produced by paralysis of the muscles of the eye, particularly if the antagonistic muscle is not affected by secondary changes; it consists in the operation of tenotomy, modified according to the circumstances of the case. Tenotomy.

Let us again suppose that the external rectus of the left eye is paralysed, and that other means have failed to cure the disease; we may then divide the internal rectus, and fix its attachment to the sclerotic further backwards than its normal position. By this means we weaken the action of the internal rectus, so that in all probability the external rectus may be able to neutralize it, and thus overcome the diplopia. Opposing muscle displaced backwards.

This operation, however, would only answer if the power of the external rectus were but slightly diminished; if much enfeebled, Von Graefe proposed that in addition to tenotomy of the internal rectus, we should divide the external rectus, and fix its attachment to the sclerotic close to the cornea. In this way, by increasing its power over the eyeball, and at the same time diminishing that of the internal rectus, we should correct the diplopia. Weak one brought forward.

One of the drawbacks to this operation is, that the paralysed muscle, after long disuse, often undergoes fatty degeneration, and it is then of little use endeavouring to force it to increased action by an operation such as I have above indicated. But if the muscle has undergone fatty degeneration it is most probable that the internal rectus will have inverted the eye, so that we shall have a case of diplopia plus strabismus to deal with; we may nevertheless, if electricity combined with the prolonged employment of the iodide of potassium, has failed to restore power to the external rectus, endeavour to overcome this condition by an operation; the result, however, of any such proceeding is very doubtful, because, however much we may shorten the paralysed muscle, we cannot restore its functions by this means.

Should we think it advisable to operate, the internal rectus must be divided as described in cases of strabismus, but the subconjunctival cellular tissue should be disturbed as little as possible, so that the divided end