

of the muscle may not retract very far back, and then form its new attachment to the sclerotic; in fact we do not require to weaken the power of the internal rectus too much. Having completed the tenotomy of the internal rectus, we may proceed to shorten the paralysed muscle; the opening in the conjunctiva will have to be rather more extensive than in an ordinary case of strabismus; it is better in fact to expose the tendon of the external rectus, and insert a strabismus hook beneath it; a curved needle with a silk thread is passed through the tendon close to its insertion into the sclerotic, the suture is then to be tied. The muscle is subsequently to be cut through about three-fourths of a line from the suture, towards the angle of the eye, and another suture is to be passed through the retracted end of the muscle: the two sutures are to be tied together, and in this way the muscle is shortened. In fact all we have to do is to cut a small piece out of the tendon of the rectus and bring the divided ends of the muscle into apposition, so that they will unite, and thus shorten the muscle to the extent of the piece we have cut out of it. When writing the last edition of this work I had operated on several cases of this kind, and was disposed to think well of the proceeding, but subsequent experience has convinced me, that in my hands, the above described proceeding should seldom if ever be resorted to with the view of improving the sight in cases of external strabismus depending on paralysis of the internal muscle, but it may be useful to overcome the unsightly appearance of an eye affected with an external squint.

STRABISMUS.

STRABIS-
MUS.

DEFINITION.—Formerly all cases in which there was a want of correspondence between the optic axes of the two eyes were classed as Strabismus, however different the character and cause of the disorder; now, however, that we have learnt to discriminate the various paralytic affections of the eye, we may restrict the term strabismus to those cases in which there is inability to bring both visual lines to bear simultaneously upon the same point, depending on some change in the muscles themselves and not in their nervous supply.

There is, therefore, a marked difference between cases

of strabismus and of paralysis. In the latter the move-
ment of one or more of the muscles is impaired from a
faulty state of its innervation, but in strabismus the
muscles are in working order, so that the eye can
move in all directions, the degree of tension of the
affected muscle being alone at fault; the muscle is
practically shortened, and the axis of the squinting eye
is never in its proper place.

Difference
between it
and para-
lysis.

But, as I have before remarked, after long-continued
paralysis of one of the muscles of the eye, the opposing
muscle, though healthy, may in the course of time
contract, so that in instances of this description we have
diplopia complicated with strabismus. On the other
hand, in a confirmed squint, the opposing muscle from
want of use becomes atrophied, so that ultimately the
strabismus again becomes complicated with paralysis
in the opposing muscle.

Paralysis
complicat-
ed with
strabismus.

A strabismus may be either convergent, divergent,
sursumvergent, or deorsumvergent, but the two latter
are very rare forms of strabismus; an internal squint is
the most common.

STRABISMUS CONVERGENS.—We may suppose that one
eye only is affected. If an object be held before the
patient's face, and he is directed to look at it, the
working eye is fixed on the object, but the squinting one
is instantly inverted. If the working eye is closed, the
squinting one turns slowly outwards, and is fixed on
the object, but if the other eye is opened the squinting
one again rolls inwards.

CONVER-
GENT
STRABIS-
MUS.

I have before explained the meaning of the term
secondary angle of squinting, and laid it down as a rule
that the secondary angle is always greater than the
primary one in instances of paralysis; but that is not
the case in strabismus, for if the working eye is closed,
it will be inverted to exactly the same extent as the
squinting eye is everted, when directed towards an ob-
ject held before the patient's face.

Primary
and se-
condary
angles
equal.

In consequence of the inability of the two eyes to fix
their optic axes on the same object, double vision exists;
and in cases of internal strabismus the diplopia is
direct, the image observed with the squinting eye being
projected towards the corresponding temple (Fig. 46).

Diplopia
direct.

The double vision may after a time disappear, the
sight in the squinting eye becoming suppressed; this is
particularly the case if the strabismus is very marked;

Sight of
affected eye
may be
suppressed.

the rays of light from an object fall on the outer and less sensitive portions of the retina, and the impression is therefore ignored by the patient. Whereas, if the squint be only slight, the image falls upon the retina near the macula lutea, and this part of the retina being very sensitive the confusion of vision becomes very great indeed.

In the above remarks we have supposed only one eye to be affected, but this is by no means always the case. The squint may be alternating, and appear first in one eye and then in the other, so that if the apparently working eye is closed, the squinting eye assumes its normal position; but in place of becoming again inverted when the former is opened, it retains its natural position, and the other eye remains inverted. In fact, first one and then the other squints; it appears to be a matter of indifference to the patient which eye he uses, but he is unable to concentrate both his optic axes simultaneously on the same object. In these cases the sight of both eyes is usually equally good.

Alternating
strabismus.

Causes of
strabismus.

Causes.—The remote causes usually assigned for strabismus are very numerous: among these I may mention, convulsions, worms, exanthematous diseases, injuries to the head, and the habit of imitating a person affected with strabismus. The more direct and immediate causes of strabismus we may group as follows:—I. Impaired vision of one or both eyes. II. Primary affections of the muscles of the eye. III. Anomalies of refraction of the eye.

Impaired
vision.

I. Impaired vision of one or both eyes. If the sight of one eye is impaired from an opacity of the cornea, or of the deeper structures of the eye, the patient is likely to be troubled by the presence of the faulty image, and the eye involuntarily squints, in order that the image may fall upon the peripheral and less sensitive part of the retina; in time the diseased eye may cease to recognise the impaired image, but the strabismus remains.

Paralysis.

II. Primary affections of the muscles, paralysis. In speaking of diplopia arising from paralysis of the muscles, I mentioned that the opposing muscle to the paralysed one might, in the course of time, become contracted, inducing strabismus.

Wounds.

In this way also wounds, or injuries of one of the muscles of the eye, may, by impairing its contractile

power, prevent its effectually resisting the opposing muscle, and a strabismus occurs in consequence. We occasionally notice this form of squint following an operation for the cure of strabismus; the tenotomy having been carelessly performed, the opposing muscle is unresisted, and contracting, draws the eye outwards or inwards as the case may be.

III. Anomalies of refraction of the eye. Of these hypermetropia is by far the most common cause of internal strabismus, the defective accommodation of the eye being partially overcome by an increased convergence of the optic axes (*see* Chapter XV.). At first the squint is periodic, the effort by which the internal rectus is called upon to act being only occasional, when near or minute objects are under observation; but if the defective accommodation is not overcome by the habitual use of convex glasses, the strabismus is almost certain to grow permanent.

Myopia may, though rarely, induce an internal strabismus, from the fact of the internal rectus being overworked, in the constant straining efforts at convergence which the patient makes in looking at objects placed close to his eye, in order that they may be clearly seen.

STRABISMUS DIVERGENS.—An external squint is a rare affection as compared with the number of cases of internal strabismus we meet with. In external strabismus the diplopia is crossed: the image, falling on a part of the retina external to the macula lutea, is projected inwards (Fig. 47). The phenomena of external strabismus, in fact, are precisely the reverse of those of an internal squint, the affected eye being everted, and moving from without inwards when an object is held in front of it, and the sound eye is closed. The secondary angle of squinting is equal to the primary angle.

DIVERGENT
STRA-
BISMUS.

Diplopia
crossed.

Eye
everted.

Causes.—Some of the circumstances already mentioned as giving rise to convergent squint may also produce divergence. The most common cause of external strabismus is myopia. I have above remarked that this affection of the accommodation of the eye may induce an internal squint, from contraction of the internal recti due to overwork; this, however, is a very rare sequence of myopia; far more commonly an external strabismus is induced by the insufficiency of the internal recti with which it is associated.

Causes.

Myopia.

Myopia in very many cases depends on posterior staphyloma, the eyeball being elongated from before backward. Under these circumstances it requires a greater effort on the part of the internal recti to maintain the necessary convergence of the optic axes for distinct vision, and consequently the muscles become fatigued: the maculae luteae of both eyes are no longer kept steadily fixed on the object under observation, diplopia results, and to remedy the confusion one eye flies outwards, so that the rays may fall upon the least sensitive parts of the retina (its periphery) and the images be widely separated; and thus in the course of time an external strabismus occurs. I have already explained, when discussing the subject of posterior staphyloma, Dr. Giraud-Teulon's theory regarding the connexion of this affection with insufficiency of the internal rectus; he considers that the muscular defect is the cause of the myopia and posterior staphyloma, leading also to external strabismus, rather than that the myopia induces the divergent squint.

Weakness
of internal
rectus.

Wounds.

Wounds of the internal rectus may cause an external strabismus.

Rare forms
of squint.

Strabismus *sursumvergens* and *deorsumvergens* are rare forms of disease, and seldom occur unless in connexion with paralysis.

Prognosis.

Prognosis.—Before recommending any particular line of treatment in cases of strabismus, we must ascertain if the patient possesses binocular vision, p. 535: if this is not the case, our prognosis should be guarded as to the probability of a cure being effected. In ninety per cent. of the cases of strabismus operated on by Von Graefe, binocular vision was absent: but of these some fifty per cent. recovered it to a greater or less extent, after an operation. Not only, however, is binocular vision often wanting in these cases of strabismus, but in time the patient's vision in the squinting eye becomes completely destroyed. It is consequently always advisable to operate in cases of strabismus as soon as practicable, so as to anticipate these changes in the visual powers of the squinting eye.

Good if
vision
binocular.

and opera-
tion early.

In old cases
must vary
with state
of vision.

Subsequently, the strabismus having existed for some time, our prognosis, as to the effects of an operation upon the visual powers of the affected eye will depend upon the degree of impairment of vision. If the sight is pretty good, and the squinting eye can be

steadily fixed on an object in front of it, while the working eye is closed, we may expect much benefit from an operation. But if the sight is already much injured, and the patient cannot fix the squinting eye on an object, although the other eye is closed, we can hope to gain but very slight advantage from an operation.

and power
of fixing
the eye.

Treatment of Strabismus.—The methods which have from time to time been advocated for the cure of strabismus have been very numerous, but for all practical purposes we may confine our attention to tenotomy of the affected muscle, our object being to weaken the power of the muscle, and thus overcome the strabismus.

Treatment.

No doubt much may be done, and must be done, by means of convex glasses in the case of hypermetropia, and of concave ones in myopia, to overcome the abnormalities in the refractive media which induce a squint; but strabismus having been once acquired, division of the muscle which causes the squint is the treatment upon which we must rely.

Glasses.

Tenotomy.

Children are frequently brought to us, in which hypermetropia and a fixed internal strabismus exist; parents naturally object to an operation, and tell us of instances in which so-and-so's child squinted and recovered without an operation: our course in such cases is clear, we can only advise the proper and rational mode of overcoming the defect, which is by an operation, and the earlier it is undertaken the better for the patient, provided the squint is a fixed one. If an alternating squint, the operation may be postponed.

It is almost always necessary to divide the muscle not only of the squinting, but of the working eye also, even in cases of monolateral strabismus, because the parallelism of the eyes is affected through means of a common motor influence; but if the internal rectus of only one eye is divided, its tendon retracts and forms an attachment to the sclerotic further back than that of its normal position: the muscle in the eye which has not been operated on is therefore anterior to the insertion of the internal rectus of the other eye, and the former muscle is longer (stronger), and has an advantage over the divided muscle when the eyes are made to converge on a near point. We should conse-

Often ne-
cessary in
both eyes.

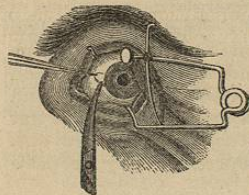
quently divide the internal rectus in both eyes, and by putting back the attachment of both muscles equally, obtain parallelism of the eyes at rest, and also when converging.

The relations of the tendons of the recti muscles to the capsule of Tenon have already been considered (Chap. I.), and it is only necessary for me to add that in dividing the tendons of the muscles for the cure of strabismus, we must cut through them at their insertion into the sclerotic, so as not to divide their connexions with the capsule of Tenon more than we can help. Further, it is far easier to increase the effect of an operation by subsequently dividing more of the tendon, than it is to overcome the defect produced by a too free tenotomy in the first instance.

Operation. The patient having been placed under the influence of chloroform, and the lids separated with a stop speculum (the internal rectus being the muscle to be divided), an assistant seizes a fold of the conjunctiva with a pair of forceps and everts the eyeball. The surgeon then nips up a fold of the conjunctiva with a

Division of conjunctiva.

FIG. 48.

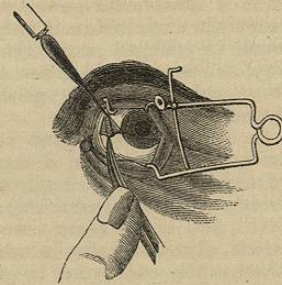


Passing the hook.

pair of fine forceps at a line corresponding with the lower border of the muscle to be divided. The scissors should then cut through the fold of conjunctiva below the forceps (Fig. 48), dividing all the structures right down to the sclerotic. It is very important to expose the sclerotic clearly. The surgeon then takes a Cowell's strabismus hook, and placing its point on the sclerotic, runs it a little downwards, so as to get below the muscle, and then well backwards, so as to get behind it; the point of the instrument being still kept on the sclerotic, is then moved upwards and forwards, so that the extremity of the hook protrudes under the conjunctiva above the upper border of the muscle. The internal rectus is now to be put on the stretch, by drawing the hook towards the outer angle of the eye, and while it is kept tense in this way the points of the scissors are to be introduced into the wound (Fig. 49), the lower blade passing beneath the tendon of the

muscle in contact with the sclerotic, and the upper blade between the tendon and the conjunctiva. In this way the tendon of the muscle is to be cut through. The strabismus hook is then to be passed upwards and downwards against the sclerotic, so as to determine if any of the lateral offsets of the muscle have been left undivided; if so, they must be carefully cut through.

FIG. 49.



The after-treatment consists in keeping the eye at rest for a few days; a cold compress may be employed for the first twenty-four hours after the operation.

As soon as the patient has recovered from the effects of the chloroform, we must examine the eye operated on, in order that we may ascertain the condition of the internal rectus. It is evident that, if the operation has been successfully performed, the patient will still have some power of inverting the eyes through the attachments of the muscles to the capsule of Tenon, so that both eyes will converge upon an object held some six inches in front of the patient's nose; but when more closely approximated to the face, should not have sufficient power to turn the eyes any further inwards.

Test the power of divided muscle.

In the course of three or four days the divided ends of the muscles reunite with the sclerotic, at a point slightly further back than their original place of insertion, and then the action of the internal recti becomes more powerful, the eyes act in unison, and the squint in fact is cured.

Action of muscle partly restored.

Should it be necessary to divide either of the other recti muscles the operation may be performed after the method above described.

We not unfrequently meet with cases of strabismus in grown-up people, in which the sight of one eye is very defective, from want of use. In cases of this kind the squinting eye should be exercised in reading with a

strong magnifier for three or four hours, the working eye being closed. Subsequently we may divide the muscle of the squinting eye with considerable advantage, but harmony of movement can rarely be obtained, from want of sensational guidance; and we should consequently in such instances only operate on one eye. Of course in younger people the sight of one eye may be very defective, and under these circumstances the above rule still holds good; only operate on the squinting eye.

In cases of convergent strabismus depending on paralysis or weakness of the external rectus muscle, we must treat the case upon the principles I have already described (page 543) of dividing the internal rectus, and at the same time shortening the external muscle, always bearing in mind the fact that we must subsequently endeavour to give tone to the weakened (external) muscle by means of a well and long continued course of local faradization.

Divergent strabismus, as I have before explained, is commonly due to insufficiency of the internal rectus and myopia; it may be produced from a defective operation for the cure of a convergent squint. In cases where the vision of one eye is very defective the eye often diverges: under these circumstances, for the sake of appearances, we may be called on to correct the squint, and shorten the internal rectus by means of the operation already described (p. 543), and at the same time the external rectus should be divided subconjunctivally, so that its insertion may be placed backwards. In fact for the relief of all cases of divergent strabismus, our object must be to shorten the internal rectus or bring its point of insertion into the sclerotic forwards, while we lengthen (so as to lessen the power) of the external muscle by dividing it and allowing the retracted extremity to unite to the sclerotic behind the point of its normal insertion.

Downward squint.—This affection of the eye is of rare occurrence, but the following case given by Surgeon Partridge, of Bombay, is a remarkably good illustration not only of the symptoms, but also of the successful treatment of a case of the kind:—Captain E., aged about 45, came under my care in September, 1869, complaining of defective

Downward
squint.

Case.

vision and strabismus. On examination, I found that he only, as a rule, used the right eye, and had acquired a habit of half-closing the lids of the left eye, to avoid confusion of images. If the right eye was covered, he could see, though not clearly, with the left. When directed to look at an object distant about twelve inches, with both eyes open, the left eye turned directly downwards, or downwards and very slightly inwards. The right eye being covered, the left immediately came into position, showing a primary deviation of about two lines. The right eye being observed while the left was coming into position, the secondary deviation was seen to be equal to the primary, thus excluding the idea of any paralysis of the opposing muscle.

Testing the
deviation.

Both eyes being uncovered, and he being told to look with the left eye only, the right eye was turned somewhat upwards.

On testing his vision, I found that with the right eye he could read No. 23 Snellen, only at ten feet, and that no spherical glass corrected vision, $V = \frac{1}{5}$. With the left eye he could read No. 20 only at five feet, $V = \frac{1}{4}$; and no spherical glass corrected vision. By means of the stenopaic apparatus, however, I found that in the right eye he had "simple astigmatism," being "myopic" in the vertical meridian ($\frac{1}{30}$), and "emmetropic" in the horizontal meridian; and that a concave cylindrical glass, with its axis horizontal, enabled him to read perfectly at 20 feet. In the left eye he had mixed "astigmatism," being myopic $\frac{1}{60}$ in a direction midway between the vertical and horizontal meridians, while he was "hypermetropic" $\frac{1}{40}$ in a direction at right angles to this. A combination of two cylindrical glasses (-50) in the semi-horizontal direction, and ($+40$) in the semi-vertical direction, corrected vision up to fourteen feet—a certain amount of amblyopia from forty-five years of disease preventing his reading fluently at twenty feet.

Testing the
condition of
vision.

Taking into consideration that there was no paralysis, that diplopia could be produced by a prism, that vision could be corrected by suitable glasses, I saw no reason why an operation for the cure of the strabismus should not succeed, although it had existed for forty-five years! Accordingly, I placed him under

Treatment
by operation.

chloroform, and divided the inferior rectus by the subconjunctival operation. There were no lateral expansions of the muscle, and the eye immediately righted itself, turning at first a little outwards; this, however, corrected itself after the first day. The eye is now quite straight, and all deformity is removed. When I last saw him, he had not received his astigmatic glasses, but I have no doubt that, when he gets them, he will not only be greatly improved in appearance, but will enjoy good vision.*

* *Medical Times and Gazette*, vol. i. 1871, p. 243.

CHAPTER XV.

DISORDERS OF REFRACTION AND ACCOMMODATION
OF THE EYE.

Myopia—Hypermetropia—Presbyopia—Astigmatism—Asthenopia: motor, and accommodatory.

It is remarkable how few cases of impaired vision, due to anomalies in the refraction or accommodation of the eye, are met with among the lower classes in India. In fact, whole races of people appear to be actually strangers to these diseases. For instance, some years ago I was among the Sonthals, the aborigines of Bengal, dwelling in the Rajahmahal hills, and I took every opportunity of examining the eyes of the people I was brought in contact with, for the purpose of discovering if myopia and such like diseases existed among them; but I never yet saw a young Sonthal whose eyes were not emmetropic; the same remarks apply to nearly the whole of the lower classes in Bengal, with the exception of those living in Calcutta and other large towns, where overwork, sensual indulgence, and a polluted atmosphere have done a vast deal of harm to the physical as well as the moral eyes of the inhabitants.

It is an established fact that, for correct vision, rays of light which enter the eye from every point of an object under observation, must be brought to a focus upon the bacillar layer of the retina; it follows, therefore, that the healthy eye possesses an inherent power by means of which both finite and infinite rays are brought to a focus on the retina—that is, both divergent and parallel rays are made to converge to a

Disorders of refraction and accommodation,

rarely met with among some classes.

Focal adjustment of eye necessary.