

prism of 14° (with its base upwards) is then to be placed in front of one eye. This will at once produce diplopia, and the image of the eye before which the prism is held will be beneath that of the other eye. If the eyes are normal, the double images will only show a difference in height, but not any lateral difference, they will lie straight above one another. But if the internal rectus is insufficient, the eye moves outwards, and consequently the double images will not only show a difference in height, but also a lateral difference, and they will be crossed. We next try what prism (with its base inwards) is required to neutralize the effect of this deviation, and bring the images straight above each other. In order to ascertain whether the images are crossed or homonymous, we place a slip of red glass before the other eye, and this will enable us at once to distinguish which image belongs to the left and which to the right eye. After the presence and degree of insufficiency have been thus determined, we should proceed to test the relative strength of the internal and external rectus of each eye, by ascertaining the strongest prism which they are able to overcome.

Fig. 21.



Although insufficiency of the internal recti muscles occurs chiefly together with myopia, it is occasionally also met with in emmetropic and hypermetropic eyes. Indeed it is far more common than is generally supposed. It will be self-evident that a short-sighted person will have to approximate small objects more closely to the eye than an emmetropic individual, and that the internal recti muscles will, therefore, have to maintain a greater degree of convergence; if the myopia is very considerable, they may be unable to do so for any length of time without becoming over fatigued and symptoms of asthenopia arising. This constant fatigue will soon weaken them and lead to still greater insufficiency. Diseases which greatly weaken the general system, such as severe fevers, diphtheria, &c., may also produce a temporary insufficiency, which disappears, however, when the patient has regained his strength.

Cases of insufficiency of the internal recti muscles may be treated in different ways, according to whether our purpose is merely to alleviate, or to cure the affection. We may alleviate this muscular asthenopia in two ways:

1st. By permitting the use of concave glasses (if the patient is myopic) for reading and working at near objects. For if we give a patient, suffering

from myopia = $\frac{1}{6}$, a pair of spectacles which enable him to read at a distance of from 12" to 14", the amount of convergence of the optic axes (and the consequent action of the internal recti) will be proportionately diminished, and he will now be able to read with more ease and comfort. But the spectacles act only as a palliative; indeed the internal recti muscles become weaker instead of stronger, for they will now have much less than their accustomed work. We must remember also the danger in using concave glasses for near objects, viz., that the patients are apt after a time, when their eyes get somewhat fatigued, to approach the object too near the eye, and thus to strain their power of accommodation. These spectacles should be slightly blue, as such eyes often suffer from photophobia.

2. The asthenopia may be alleviated by the use of prisms with their base turned inwards. Let us presume, for instance, that the tendency of the eye is to deviate outwards to about 1" during work at near objects; now, if we place a prism with its base inwards, of sufficient strength to exactly neutralize this deviation (by bringing back the retinal image to the macula lutea), we should enable the person to read with comfort, for we thus diminish the action of the internal recti and remove the

symptoms of asthenopia. It is not always necessary to neutralize the whole of the deviation, for weaker prisms will often suffice. It is always better to divide the prism between the two eyes, more particularly if it be stronger than 8°. If a prism of 10°, is required, we should order one of 5° for each eye. In myopia it should be combined with the requisite concave lens, whereas in hypermetropia, or in emmetropia if the range of accommodation is diminished, it is advisable to combine it with a convex lens, as the diminution in the convergence of its optic axes is accompanied by a diminution of the power of accommodation.

These prismatic glasses are particularly indicated in slight cases of insufficiency, or in those in which there is but a very limited power of abduction for distance, and hence the fear that a convergent squint might arise after division of the external rectus.

It has been thought that this affection may be cured by strengthening the internal recti muscles through constant exercises with prismatic glasses held with their base outwards before one eye, so that the rays from the light (to be placed at a distance of about 8') will impinge upon a portion of the retina slightly to the outer side of the macula lutea. In order to avoid the diplopia

arising from this, the eye will then move inwards, so as to bring the rays again upon the yellow spot.* By gradually increasing the power of the prism we exercise the internal rectus more and more, and it will soon acquire greater strength.

But this treatment requires great patience and accuracy, both on the part of the medical man and of the patient, and the latter generally soon gets wearied of these exercises, which, in order to secure anything like success, would have to be continued for a length of time. If the prism is chosen at all too strong, it will rather tend to weaken the muscle by over-exertion, than to strengthen it.

The best plan of treatment is division of the external rectus muscle. Our object in doing this is to strengthen the abnormally weak internal rectus by a division of its opponent muscle, so that the former will have a less resistance to overcome. Our primary object must always be to enable the patient to read, write, and work at near objects without any difficulty, and we must, of course, be chiefly guided in this by the state of refraction. If he is myopic, he will have to hold

* Short-sighted persons must be furnished with concave spectacles during these exercises, so that they may see the object distinctly.

the object much closer to the eye than if he is emmetropic or hypermetropic. If, for instance, he suffers from myopia = $\frac{1}{7}$, he will require to read at about $5\frac{1}{2}$ " and should be able to converge his optic axes steadily, and for some time, upon an object at 4". We must, above all things, endeavour to obtain this result, and it will not matter much if there should be a slight tendency to convergent squint when he is looking at distant objects; for in order to escape the diplopia consequent upon this, the external rectus will contract, and, by moving the eye slightly outwards, correct the squint, and once more bring both optic axes to bear upon the object. Of course the amount of convergence which may be safely permitted for distance, must depend upon the relative strength of the internal and external recti, and more particularly upon the power of abduction. If in a myopia of $\frac{1}{7}$, the internal rectus could, before the operation, only overcome a prism of 4° or 5° , but the external rectus one of 14° or 16° , it would be perfectly safe to permit a convergence of $\frac{1}{2}$ " or 1" for distance, more particularly if the excluded eye had, before the operation, deviated outwards $\frac{3}{4}$ " or 1" when covered. In such a case, even after its division, the external rectus would remain sufficiently strong to rectify the convergent squint.

The following considerations must guide us as to the extent of the tenotomy :—

1. The degree of the myopia, and the consequent distance for which the optic axes must converge in reading, etc.

2. The strength of the prisms which can be overcome by the internal and external rectus. The strength of the prism which can be overcome for distance by the external rectus gives us a clue as to the extent of the tenotomy, for we may correct with safety the deviation outwards which corresponds to the strength of this prism. Von Graefe has found that the primary effect of the operation may even exceed this by $\frac{2}{3}$ or $\frac{3}{4}$ ''', so that, at a distance, homonymous double images arise in the middle line, which require a prism of 10° to unite them. As long as this is not exceeded, we need not fear that the homonymous diplopia will remain permanently. In order not to be misled by the temporary insufficiency of the external rectus, it is better not to hold the object in the median line, but 15° or 20° to the nasal side of the operated eye (Von Graefe).

3. The degree of deviation outwards (in looking at distant objects), which occurs when the affected eye is covered. The less this power of abduction is, the more careful must we be with

the tenotomy. If the degree of insufficiency exceeds the prism which the eye can overcome at a distance by abduction, we must only partially correct the insufficiency, and limit the effect of the operation by a conjunctival suture. We may also assist the effect of the operation by using prismatic glasses, with the base inwards, for reading, etc. Where the power of abduction is extremely slight, and the insufficiency at a distance almost nil, tenotomy is contra-indicated, for it would be sure to be followed by a convergent squint, and consequent diplopia for distance. In such cases, the asthenopia must be alleviated by prismatic glasses.

4. The mode of deviation when the object is approximated to the eye. This test is, however, less accurate than the preceding ones. Von Graefe thinks that a considerable correction is indicated, if the eye moves suddenly and spasmodically outwards at the moment when the insufficiency of the internal recti shows itself; whereas we must be more guarded in the extent of the operation, if, as the object is brought gradually nearer to the eyes, the one moves outwards in about the same ratio as the other moves inwards, making an associated movement with this. Still more cautious must we be, if the affected eye

remains stationary at a certain point, without apparently deviating any further outwards.

If both internal recti are much weaker than normal, and if the deviation under the covered hand exceeds $1\frac{1}{2}''$ — $2''$, a double operation will be necessary. This, however, should never be done at one sitting. We should first divide the external rectus of the eye most affected, and then, after a few days, when the final result of the operation is apparent, the other eye must be carefully and accurately examined, in order to ascertain to what extent the insufficiency still remains, and to what extent the operation is indicated. It is always safest at the second operation to divide the abductor very carefully and very close to its insertion, and then to test the accommodative movements of the eyes, the amount of convergence at a distance, and the prism required to overcome the homonymous diplopia, and if the convergence at all exceeds our wishes, to insert a conjunctival suture.

As these cases of insufficiency frequently demand great nicety in the performance of the tenotomy, and as it is of the greatest importance that it should be efficiently executed, and all minutiae carefully attended to, I give the following extract from my work on the Diseases

of the Eye, p. 588, to which I would also refer the reader for further information upon the subject of strabismus.

“As the operation is sometimes very painful, the patient should be placed under the influence of chloroform. The eyelids are to be kept apart by the spring speculum, or, if this proves not sufficiently strong, by the broad silver elevators. An assistant should evert the eye with a pair of forceps (I am supposing that the internal rectus of the right eye is to be operated on), taking care to do so in the horizontal direction, without rotating the eyeball on its axis; otherwise, the horizontal position of the internal rectus will be changed. The operator should then seize, with a pair of finely-pointed forceps, a small, but deep fold of the conjunctiva and subconjunctival tissue, close to the edge of the cornea, and about midway between the centre and lower edge of the insertion of the internal rectus. He next snips this fold with the scissors (which should be bent on the flat, and blunt pointed), and burrowing beneath the subconjunctival tissue in a downward and inward direction, makes a funnel-shaped opening beneath the subconjunctival tissue, this being, however, done very carefully, so as not to divide it to too great an extent. If the subconjunctival tissue is