THE SURGICAL TREATMENT OF COMITANT AND PARALYTIC STRABISMUS.

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This paper describes its author's methods of operating for each of these forms of strabismus. It was read before the Sioux Valley Eye and Ear Academy at Sioux City, January 19th, 1921.

As the title indicates, this paper will be limited to a practical discussion of the operative treatment of squint, both comitant and noncomitant, or paralytic.

In all considerations of the treatment of squint, a sharp distinction must be made between the methods of surgical procedure in the cases of comitant and paralytic deviations respectively. In comitant squint the angle of deviation remains definite and fixed in whatever direction the eyes are carried with the object of fixation at any given distance; while in noncomitant or paralytic strabismus the deviation increases or diminishes, increasing as the object looked at is carried in the direction of the action of the paretic muscle and diminishing when carried in the opposite direction.

Comitant strabismus is limited to the two forms, internal and external squint, while in paralytic strabismus the deviation depends upon what muscle, or muscles, may be paralyzed. In constant comitant strabismus of long standing, the deviating eye is in the great majority of cases defective in vision, which is the result of the mental suppression of the visual image (amblyopia ex anopsia), or is due to congenital defects, or postnatal pathology.

In paralytic strabismus there is a very definite pathology involving the nerve of supply in its nucleus, along its trunk, or in certain of its branches of distribution. This pathology must be taken into very serious consideration when planning a method of treatment.

The views advanced in this paper relative to the operative treatment of strabismus are founded upon the writer's experience as an ophthalmic surgeon, extending thru many years, and will no doubt be found to be at variance in certain regards with the opin-

ions of writers generally considered to be authorities on the subject.

1. THE SURGICAL TREATMENT OF COMITANT STRABISMUS.

As before stated, comitant strabismus is limited to the two forms, internal or convergent squint and the external or divergent variety. While the scope of this paper will require an omission of the discussion of the various theories relative to the causation of comitant squint, it must, nevertheless, be noted that as a necessary preliminary to radical surgical treatment, the static refraction must be accurately determined under cycloplegia.

The refractive correction, constantly worn, may, in certain cases, secure a satisfactory cosmetic result, especially in young subjects with a marked error of the hyperopic type; and such correction by glasses should invariably be tried before operative measures are attempted. Of course it goes without saying that along with the use of the correcting lenses the usual orthoptic methods should be made use of in advance of operation, and this applies with especial force to the treatment of the young.

In cases, however, in which all of the usual preliminary measures have been tried, and the squint still continues, operative interference is definitely indicated in patients over five years of age.

(a). The surgical treatment of internal or *convergent strabismus*.

Before operating one should determine approximately the degree of deviation with a view to establishing some estimate of the extent of the operative procedure to be undertaken. The words "some estimate" are used advisedly, for it is absurd to hold that by determining mechanically, or subjec-

tively, the supposed degree of deviation of a squinting eye, the data so obtained will enable the operator accurately to gauge the amount of operative interference required, and to judge as to the exact number of millimeters a given tendon should be advanced or set back.

In the case of the functions of the ocular muscles, we are dealing with highly complex physiologic processes, which in strabismus have become disarranged to some extent it is true, but which, nevertheless, are to be taken into careful consideration.

Thus, while in the case of one patient with an inward deviation of seemingly 20° (about 40 mm. linear measure), a careful complete tenotomy of the internal rectus muscle may secure a perfect cosmetic result; in another individual under exactly similar conditions, as far as can be determined, only a comparatively moderate change in the angle of convergence may result from the same operative attempt. The ophthalmic surgeon, in fact, cannot operate upon hard and fast lines in his strabismus cases, but must consider every patient a law unto himself and must be prepared to meet unexpected conditions as they may arise. Given a case of convergent strabismus, upon which operation is indicated, the following method of operating is advised:

Under local anesthesia, which is indicated in all patients over fifteen or sixteen years of age, a very careful complete tenotomy of the internal rectus muscle of the squinting eye, close to the sclerotic insertion, is performed. The separation of the tendon from the globe at this point must be complete, all strands of muscular tissue being divided with as little interference with the relations of the muscle to Tenon's capsule as possible. Any such interference as clipping the connections of the muscle to the capsule is to be condemned.

If, after such a carefully performed tenotomy, the cosmetic effect desired has been obtained and the internal rectus muscle is found to have preserved its control over the globe, the opera-

tion may be considered satisfactorily performed, and there only remains the closing of the conjunctival wound with silk sutures. If, however, a manifest degree of squint still remains, the correction of the remaining deviation should be secured by an immediate advancement, or tendon shortening operation, upon the external rectus muscle of the same eye. Under no condition should an increased effect be sought by separation of the belly of the muscle from Tenon's capsule during the performance of the tenotomy. The use of the usually recommended stitch to increase the effect is not advised.

The method of operating recommended may be criticised as being at variance with the views of certain authorities², but the writer has been in the habit of performing this double operation at one sitting on the same eye for the last twenty two years with most satisfactory results.

If, however, the primary division of the tendon of the internal rectus results in an over effect, this must be controlled by the immediate use of a correcting suture. The form of suture, which the writer can thoroly endorse, is the following: A ten day chromicized catgut mattress suture, size OO, is so introduced that the base of the suture is located in the belly of the muscle close to the cut end and in the overlying Tenon's capsule, and the two free ends are passed deeply thru the remnant of the attachment to the sclera left in consequence of the division of the tendon. This suture will enable the cut end of the tendon to be drawn towards its former attachment to the proper degree, and, when the free ends are tied, the entire suture will remain unabsorbed for a sufficient time to permit of a firm attachment of the tendon to the globe in its new position.

Since this is a practical surgical paper, it would seem appropriate to describe here the tendon shortening, or "tuck" operation referred to, which the writer has habitually performed since 1898. The "tuck operation," which in the writer's hands has proved eminently satisfactory, is the operation brought forward by Dr Francis Valk

of New York in 1897 with certain modifications. In this operation, the tuck is made with a single mattress suture of "O" or "OO" chromicized catgut and left buried, the flap of Tenon's capsule and conjunctiva being united over it by silk sutures, of which two are generally sufficient.

In performing this operation, I have found attention to the following points essential: (a) The careful freeing of the tendon from Tenon's capsule and separation of the belly of the muscle from the globe back to a point beyond the base of the mattress suture in order that the tendon may be permitted to slide forward when the suture is drawn taut to make the "tuck." (b) The passage of the ends of the suture thru the upper and lower thirds respectively of the attachment of the tendon to the sclerotic, embracing the dense episcleral tissue just at the tendon insertion, and the securing of a strong hold upon the belly of the muscle at the situation of the base of the mattress suture, by weaving the suture in and out as it is passed thru the muscle. These steps are necessary in order that the muscle, included in the base of the suture, may be brought sharply against the attachment to the sclerotic, and held there without slipping. In my experience in a great many cases, a tuck so placed has invariably held. These are modifications of the original operation suggested by practical experience at the operating table.

Another modification, which has been utilized by my colleague, Dr. H. B. Lemere, and myself, is the following, which we have found very useful. If after drawing taut and tying the mattress suture, an insufficient effect has been obtained, an additional effect may be secured by rethreading the needle upon one end of the suture, which has been left uncut, passing the needle farther back thru the belly of the muscle, and then tying to the other end of the suture left in situ. This makes a supplemental tuck, which, in our experience, has always held firmly. The "hump" in the muscle resulting from the tuck atrophies in a very

short while and the tendon remains shortened in proportion to the amount of the muscle embraced in the mattress suture. This method has decided advantages over the usual technical advancement with a separation of the muscle from its attachment to the globe and with a reattachment by silk sutures at a point nearer the cornea. In the first place there are no sutures that can possibly cut thru the ocular tissues with a resulting slipping back of the tendon and loss of effect; in the second, the effect can be more accurately gauged and if not sufficient the accessory tuck can be utilized; and thirdly, since an absorbable material is used to make the tuck, there are no deep sutures to be removed afterwards³.

In the case of intermittent strabismus of the convergent form, it may be easily possible to secure a permanent curative effect by the performance of this tendon shortening operation alone upon the external rectus of one or both eyes, combined with the use of the correcting lenses when required by a refractive error. It is in such cases that the tendon shortening operation performed on the antagonist without tenotomy of the internal rectus, is especially indicated. In young children the operation for strabismus of whatever degree must be performed under general anesthesia, which is a great disadvantage as the results at the table cannot then be accurately judged.

(b) The surgical treatment of *external strabismus*.

In the effort to correct an external strabismus, a tenotomy of the external rectus muscle may possibly be successful but in the great majority of cases it is not. We cannot expect as much effect on the direction of the eye to follow a tenotomy of the external as in the case of the separation of the tendon of the internal rectus muscle. The insertion of the tendon of the former muscle is farther from the cornea than is that of the latter, and the effect of an operation, in the nature of a setting back of the tendon insertion, is in direct proportion to the nearness to the cornea of the normal muscular attach-

ment to the globe.⁴ Such being the case, in the great majority of cases of external comitant strabismus, the double operation on the squinting eye will be required, that is a tenotomy of the external rectus and a tendon shortening of the internus by the "tuck" method as described.

By the double operation on the squinting eye, as advised both in internal comitant squint when required and in external squint of the comitant type, in the majority of cases, the full effect is secured at one time, by one operation, on one eye, which is a most decided advantage.

2. THE SURGICAL TREATMENT OF PARALYTIC STRABISMUS.

In paralytic squint we are brought face to face with a positive pathologic state in each case. In considering the surgical treatment of such conditions, therefore, we must be careful to exhaust all therapeutic methods and to allow a sufficient time to elapse to prove that such means are hopeless before proceeding to surgical operation. A case of this type should not be operated upon in a shorter time than six months.

It may be stated as a general proposition that syphilis is responsible for the muscular palsy in fifty per cent of the cases. Other general diseases may stand in a causal relation; and focal infections may also play a definite part in causing such palsies, especially those resulting from infective disease of the accessory sinuses of the nose, and from apical infections of the teeth.

It goes without saying that an exact diagnosis of the type of the paralysis, and of the muscle, or muscles, involved must precede any operative attempt. Third nerve palsies are far more common than the other varieties, and in such cases we may find paralysis either of all the extrinsic muscles supplied by this nerve, including the levator palpebrae superioris, or of individual muscles supplied by certain branches. Paralysis may affect the superior oblique or external rectus muscles alone, due to a lesion involving the 4th or 6th nerve respectively.

Given a permanent palsy of the muscles supplied by the 3rd nerve with an external strabismus accompanied by ptosis, the writer would advise the following method of procedure: The ptosis should be corrected at least to the extent of uncovering the pupil. The Eversbusch or the Gruening operation will as a rule serve to meet this indication. It must be noted, however, that the Eversbusch operation is contraindicated where there is complete paralysis of the levator muscle.⁵

The correction of the external squint may be performed as a later operation, if a choice in this regard may be exercised; or the entire corrective measures, both as regards the paralytic deviation and the ptosis, may be done at one time either under general anesthesia or under local anesthesia with nerve blocking, which latter is to be preferred.

In performing this operation to correct paralytic squint, the writer first tenotomizes the external rectus and then secures the effect of an advancement of the internus thru the "tuck" operation before described. By this double operation the deviating eye can be directed straight forward and the distressing heteronymous diplopia, existing in the half of the visual field corresponding to the sphere of action of the external rectus muscle, can thus be relieved. If the internal rectus muscle is completely paralyzed, this is all that can be expected; but in some cases in which there is not absolute paralysis of this muscle, a surprising degree of converging power may be secured. This occurred in a recent case in the writer's practice, in which single vision resulted when looking outward, forward, and a little inward in relation to the affected eye.

In cases of this type, it is highly probable that the secondary contraction of the externus may still further compromise the action of the internus, thus causing this paretic muscle to lose all power of turning the globe inward even tho not absolutely paralyzed. When in such a case the secondarily contracted externus is tenotomized and the paretic internus ad-

vanced or shortened, the remnant of power remaining in the latter may be enabled to function to some extent.

The same method of procedure is advocated and practised by the writer in the case of internal squint due to paralysis of the external rectus, i. e. a tenotomy of the internus and a simultaneous advancement by the "tuck" operation of the externus to the extent of directing the eye straight forward.

In the case of vertical squint, hypertropia, or hypotropia, which forms can occur independently from involvement of the respective supplying branch of the 3rd nerve in each instance, or where deviations occur from paresis of the superior and inferior oblique muscles, the surgical indications are as follows: In vertical squint the paretic muscle should be shortened (advanced) by the "tuck" method. This may be sufficient to relieve the deformity and secure single vision. If not, we shall have to increase the effect. The writer would advise for this purpose a very careful tenotomy of the antagonist of the same eye, barely separating the tendon at its attachment and treating its connections with Tenon's capsule with great reverence.

If too much effect should be secured in this way, which will be more likely in the case of tenotomy of the inferior rectus after advancement or tendon shortening of the superior rectus, it will be easy to correct this over effect and to secure parallelism of the visual axis in the horizontal plane and below by applying the same catgut correcting suture advocated in the case of over-effect discussed under the surgical treatment of comitant strabismus of the convergent type. The effect desired can be accurately secured in this way, as I know from practical experience, and this effect may be expected to be permanent. Before dividing the muscular attachment to the sclera in tenotomizing either the superior or inferior rectus, it is advisable to pass the correcting mattress suture thru the belly of the muscle and thru the overlying Tenon's capsule, as one will thus have control of the tendon. In case an over effect should result from the tenotomy, the two ends of the suture

can be passed thru the remnant of the attachment to the sclera, and the muscle drawn toward its former attachment to the exact extent required. The ends of the suture are tied and cut short, and require no further attention.

The writer is well aware of the fact that very different methods from those advised in the case of squint due to palsies of the superior and inferior recti muscles⁶, have been advocated by men whom we consider authorities in ophthalmic surgery; and that he may be suspected of being the subject of a dangerous originality in the proposed advancement by "tuck" of the paretic muscle combined if necessary with tenotomy of the direct antagonist of the same eye supplemented by a controlling absorbable suture when required. Be this as it may, the fact remains that the result desired can be obtained most satisfactorily in this way with the operative measures confined to the strabismic eye and without interference with the sound organ in the way of curtailing its motility in certain directions to secure a compensating deviation tending to relieve the diplopia caused by the muscular palsy affecting its fellow. Thus for example in states of marked paresis of the superior rectus in either eye, Duane has advised a tenotomy of the inferior oblique of the other or sound eye, and this procedure has been quite generally endorsed.⁷ The writer is opposed to crippling the motility of a perfectly sound eye to secure relief from diplopia resulting from a paretic affection of the fellow organ, when a perfectly satisfactory result can be secured by limiting the surgical interference to the affected side as recommended.

In paralysis of either the superior or inferior oblique, however, this limiting of the operation to the affected eye is impracticable. In the case, therefore, of paralysis of the superior oblique, the inferior rectus of the sound eye should be tenotomized; and likewise, where a palsy affects the inferior oblique of one eye, the *superior rectus* of the other should be set back by a tenotomy. The purpose of the operator in both operations will be to create

in the sound eye in each instance a deviation which will correspond to that induced by the paralysis affecting the other eye, with a relief of the diplopia as the result.

In order, therefore, to relieve the diplopia, in case of paresis of the right superior oblique, the tendon of the left inferior rectus is set back causing the image in that eye (Fig. 1, L) to cor-

Fig. 1
Left.

Paralysis of left inferior rectus.

Fig. 2.
Right.

Paralysis of right superior oblique.

In Fig. 1 and Fig. 2 the positions of the double images are represented in cases of paresis of the left inferior rectus and of the right superior oblique respectively, while in Fig. 3 and Fig. 4

respond with that of the right or paretic eye (Fig. 2, R.)

When the right inferior oblique is paralyzed, the effect of a tenotomy of the left superior rectus will be to

Fig. 3
Left.

Paralysis of left superior rectus.

Fig. 4.
Right.

Paralysis of right inferior oblique.

the positions are shown in instances of similar involvement of the left superior rectus and right inferior oblique.

It should be noted that the diplopia in the case of paralysis of the two oblique muscles is homonymous, while in involvement of the superior and inferior recti it is heteronymous.

cause the image, L, in the left eye (Fig. 3) to correspond with the image, R, in the right, or paretic, eye (Fig. 4), thus relieving the diplopia.

The same relationship would exist, of course, between the superior and inferior oblique muscles of the left eye, and the contralateral inferior and superior recti respectively.

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