The absence of binocular vision is a disadvantage, but I doubt if this is so great as that involved in a reduction of the sense of light difference which cuts down the shadow effects.

The ultimate requirement in the perception of solid form is that the retinal stimuli must present a certain minimal amount of the characteristics of solidity to which the individual is accustomed, such as perspective, shadow effects, graded definition, and, in the case of those with two eyes, the two differing images. Where these stimuli are provided by photographs or other projection representations, it is necessary also that they do not contain inconsistencies greater than will, in the particular circumstances, be overcome by the accommodative elasticity of whatever sense factors may be concerned.

THE MONTGOMERY LECTURE. 1917-1918*

A survey of cases of concomitant squint in the practice of the late Mr. P. W. Maxwell.

BY

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(Concluded from page 349.)

V. *Operative technique and results.*—Mr. Maxwell's operative technique may be thus briefly outlined:

(1) His tenotomies were always "complete," the tendon being severed as far forward as possible; the conjunctival wound was invariably sutured. The introduction of an "emergency suture" was a later development. This consisted of a double-threaded suture passed from behind forwards through the divided tendon and anterior lip of the conjunctival wound. It was left ready to tie over a bead, within a few hours to a few days after the operation, if an over effect was noted.

(2) His shortenings were performed with a "tucker" of his own design (Fig. 1).

Screw "a" regulates the height to which the control hook can raise the muscle. In the figure it stands about 8 mm. above the lateral hooks, in which position a shortening of 16 mm. could be accomplished.

Fig. 2 illustrates the tucker in position.

The double suture seen held in the forceps, was first passed through the posterior lip of the conjunctival wound, then through

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FIG. 1.

FIG. 2.

the muscle and finally through the anterior lip of the conjunctival wound where it was tied over beads. In this way the closure of the wound was effected without a second suture.

In the original description of the operation it was recommended to insert a suture through the upper portion of the muscle loop which could be brought backwards through the posterior lip of the conjunctival wound, and there tied. This procedure was intended to prevent any unsightly protrusion of the loop. As, however, such a protrusion, when it did exist, was very temporary, the procedure was abandoned as unnecessary.

FIG. 3.

A slipping of the suture through the muscle fibres, thus lessening the intended size of the tuck, could only occur to a slight extent, as the tough connective tissue covering was as little disturbed as possible.

About 1911, anchor sutures were introduced. These were two double-threaded sutures passed through the superior and inferior recti respectively, and then, in the case of convergent squints, through the external canthus where they were tied together over rubber tubing.

Fig. 3 illustrates a "tucking" suture tied over beads, and two anchor sutures held away from the globe by forceps.

Fig. 4 illustrates these same anchor sutures tied over rubber tubing at their exit from the lid.

Anchor suturing in divergent squints met with but slight success. One method was recorded by which sutures through the superior

and inferior recti were secured with adhesive plaster to the nose; another by which a double threaded suture, introduced from without through the inner part of the upper lid, passed under the four recti muscles in succession to its exit through the inner part of the lower lid; the ends being then tied together over rubber tubing.

It is of interest to record that chemosis with the anchor sutures (not very infrequent with sterile vaseline) almost disappeared with the substitution of xeroform powder dressings.

In the shortening operations No. 3 curved needles for the muscle suture, and No. 3 half curved for the anchor sutures, were employed. The sutures were composed of No. 3 black and white silk respectively.

FIG. 4.

Where a shortening had been performed both eyes were bandaged for ten days to a fortnight. The anchor sutures were removed on the seventh day, the muscle sutures on the tenth. On the removal of the bandage, glasses, where indicated, were at once resumed. Their omission for a day or two, where operation was found to have over-corrected a convergence, was recorded as effecting the necessary change in several instances.

Most of the operations were performed under general anaesthesia. Changes in the deviation occurring as the result of the anaesthesia, were not allowed to interfere with the original plan.

The notes showed that for convergent squint the operation of tenotomy by itself lost in favour as time progressed, but as an adjunct to the shortening operation, was never abandoned.

The average results of *tenotomy* in ninety-four cases of *convergent squint* are here recorded :

The individual reductions were noted to vary considerably amongst themselves.

"Immediate reduction" implies the result as noted two to three days after the operation; "secondary" as noted about six months later. Only the reduction "longe" is recorded in this and the subsequent tables, the reduction "prox" being a still more variable quantity.

Where not otherwise notified the results in this and the subsequent tables were those recorded without glasses.

General immediate reduction	With glasses	Operation on "fixing" eye	In angles over 30°	"Emergency" sutures inserted, but not tied
16.5°	14.5°	18.75°	19.5°	15.5°
General secondary reduction 19°				

The figures in the first two columns are very similar to the averages published by other authors.^{4 11}

The greater reduction noted in the cases of the larger angles was presumably the result of the cessation of the secondary adducting actions of the superior and inferior recti, on the lessening of the convergence.

No appreciable diminution in the reduction from the mere insertion of the "emergency" suture, was recorded.

The results, according to age, were as follows :

	Immediate reduction.	Perfect cure.
Up to 14 years of age	.. 17.5° ...	30 per cent.
Over 14 years of age	... 15.0° ...	40 per cent.

The percentages of perfect cures were compiled from a survey of cases seen, one to several years after the tenotomy, no other operation having been performed in the interval. "Perfect cure" in this and the subsequent tables includes cases which, after operation became straight with glasses, but still showed some convergence without.

Out of six cases, seen some years later and noted as divergent, four had been operated on before puberty and two after.

3.5 per cent. of the cases were recorded as showing an upward deviation after the operation.

Two out of fifteen cases seen some years later were noted as having exophthalmos.

I was able to examine the mobility of the tenotomised muscle years after the operation in a few instances, and found an average

reduction in the rotation arc of about 6° . None of these cases complained of any discomfort in ordinary convergence.

A greater reduction was recorded in the few cases where a simultaneous double tenotomy was performed than in the cases where a short interval was allowed to elapse between the operations.

Only one partial tenotomy was noted; this caused no appreciable reduction in the squint.

The average results of *single shortenings* in 58 cases of *convergent squint* are here recorded:

Individual reductions were again noted to vary considerably amongst themselves.

"Immediate" reduction, wherever the result of a shortening is being recorded, implies the correction as noted two or three weeks after the operation: "secondary" as noted about six months later.

General immediate reduction		With glasses		Operation on "fixing" eye		"Anchor" sutures employed
9.75°	...	4.75°	...	9.75°	...	13°
General secondary reduction						
9.75°						

The markedly lessened reduction noted in cases tested with glasses before and after the operation was presumably due to the fact that shortenings, single or double, were mainly performed in cases already much improved with glasses, a slight further improvement causing straightness. One or two cases where sepsis ensued, allowing of the sloughing away of the sutures, showed a temporary increase in the squint after operation; these were omitted from above list.

The results according to age were as follows:—

	Immediate reduction.		Perfect cures.	
Up to 14 years of age	...	8°	...	58 per cent.
Over 14 years of age	...	12°	...	40 per cent.

The percentages of "perfect cures" were compiled from a survey of cases seen one to several years after the shortening, no other operation having been performed in the interval.

The immediate results according to the number of mm. of shortening were:—

6-8mm.	...	9-11 mm.	...	12-14 mm.	...	15-18 mm.
5°	...	9°	...	10°	...	15°

These figures average roughly a reduction of 1° for every mm. of shortening; an average reduction of 2° for every mm. of shortening would appear to be the usual estimate of other observers^{2, 3, 8, 9}. This is suggestive of slipping of the sutures in the above cases, yet

all the same the general results effected by this "tucker" compare well with the general results of advancements and tendon tuckings as estimated by Jackson¹.

Two cases were noted as showing an upward displacement just after operation.

Two cases were recorded where a rupture of the muscle occurred during the operation. In one of them a shortening of 18 mm. was being attempted, in the other feeble development of the muscle was noted. These two instances represent about 0.4 per cent. of all the shortening operations performed.

I found an average increase in the rotation arc of about 5° in the few cases where I was able to examine the mobility of the shortened muscle, years after the operation.

The average results of *double shortenings* in 47 cases of *convergent squint* are here recorded:—

Individual results in these cases did not appear to differ so considerably amongst themselves.

General immediate reduction.	With glasses.	Anchor sutures employed.	Restricted mobility outwards noted before operation	Double bandaging for over a week.
21°	10°	21°	26°	25°
General secondary reduction.				
21°				

It will be noted that the average reduction in cases where anchor sutures were employed showed no increase over the general reduction as in the case of single shortenings. This may be due to the fact that the majority of these cases were performed with anchor sutures. It might also be the result of less movement on the part of the patient, both his external recti being painful.

The results according to age were:—

	Immediate reduction.	Perfect cures.
Up to 14 years or age ...	17.5°	60 per cent.
Over 14 years of age ...	25°	35 per cent.

The percentages of perfect cures were compiled from a survey of cases seen one to several years after the shortening, no other operation having been performed in the interval.

Three cases seen some months later and noted as divergent, were all operated on, after puberty.

The immediate results according to the number of mm. of shortening in each eye were:—

9-11 mm.	12-14 mm.	15-18 mm.
10°	21.5°	28°

One case was noted as showing a downward displacement just after operation.

The average reduction effected by double shortenings in cases where a brief interval was allowed to elapse between the operations was 16.5° , as compared with the average 21° effected in the case of simultaneous double shortenings.

The average results of *tenotomy* combined with *shortening* in 52 cases of *convergent squint* are here recorded.

Individual results in these cases showed remarkable constancy.

General immediate reduction.	With glasses.	"Emergency" sutures inserted but not tied.
26.5°	25°	29°
General secondary reduction.		
27°		

The results according to age were as follows :

	Immediate reduction.
Up to 14 years of age	26°
Over 14 years of age	26°

No difference in the relative number of perfect cures or divergences was noted in respect to age.

The immediate results according to the number of mm. of shortening were :

6-8 mm.	9-11 mm.	12.14 mm.
21°	24°	30°

Five cases were noted as showing altitudinal displacements just after operation.

Two out of twenty cases seen years after operation were recorded as having developed an exophthalmos.

One case was noted in which a mild tenonitis developed in the shortened muscle, just after operation.

In the few instances where mobility was examined, an average reduction inwards in the rotation arc of about 8° and increase outwards of about 6° was found.

The average reduction effected, where a brief interval was allowed to elapse between the tenotomy and the shortening was 20.5° , as compared with the average 26° effected in the case where the operations were combined.

The following tables show some interesting points in connection with those *convergent squints* which became *divergent* after operation. Cases which showed divergence with glasses after operation, but were straight or still convergent without, were omitted from the percentages.

Divergence following tenotomy.	Tenotomy and shortening.	Double shortening.	Single shortening.
40 per cent.	25 per cent.	35 per cent.	0 per cent.

Two of the cases which diverged after shortening had restricted outward mobility noted before operation.

Squint amblyopia present.	Bad fixation.	Sense of perspective.	Temporary diplopia developing after operation.
55 per cent.	20 per cent.	0 per cent.	25 per cent.

The majority of these cases did not diverge immediately after operation but on an average about $2\frac{1}{2}$ years later.

These "late" secondary divergences occurred, according to the age at which the operation was performed, as here shown:—

Operated on—		
Under 6 years of age.	6-14 years of age.	Over 14 years of age.
40 per cent.	60 per cent.	0 per cent.

All the cases of "late" secondary divergence noted, occurred after tenotomy or tenotomy and shortening.

The average results of *tenotomy* in sixteen cases of *divergent concomitant squint* are here recorded:

General immediate reduction,	General secondary reduction.
16.5°	7.5°

Both the immediate and secondary reductions were greater in the cases associated with divergence excess, than in those associated with convergence insufficiency.

The immediate reduction according to age showed:

Up to 14 years of age	...	...	16°
Over 14 years of age	...	...	17°

One case of downward squint occurring after operation was noted.

The cases of *divergence* treated by means of *shortening* operations were not sufficiently well recorded for tabulation. Two or three instances of a latent divergence associated with convergence insufficiency cured by this operation, were noted. In three cases of divergence following tenotomy for convergence, the average immediate reduction effected by a single shortening was 4°.

The average results of *tenotomy and shortening* in 26 cases of *divergent squint* are here recorded:

General immediate reduction.	General secondary reduction.
25°	18°.

This average secondary reduction corresponds with Jackson's estimate.⁴

The immediate reduction was greater in the cases associated with convergence insufficiency, than in those associated with divergence excess.

The immediate reduction according to age was:

Up to 14 years of age...	...	27.0°
Over 14 years of age ...	...	23.5°

The immediate results according to the numbers of mm. of shortening were:—

5-12 mm., 23.5° ; 14 mm., 26.5° .

Two cases of upward, and one of downward squint, occurring after operation, were noted.

In three cases, where the mobility was tested, years after the operation, an average decrease of roughly 15° in outward rotation was noted, the internal rotation arc being about 44° in both eyes, in these instances.

The cases in which an interval was allowed to elapse between the operations showed an average reduction of 17.5° as compared with the average 25° effected by a simultaneous tenotomy and shortening.

Three cases of *convergence* were noted following operation for *divergence*. The cases were all associated with convergence insufficiency, were myopic, had good fixation, and corrected vision.

They were all noted as developing a temporary homonymous diplopia after operation. The operation in one case was a tenotomy, in the other two tenotomy combined with shortening.

As regards the results of operations on the *vertical muscles* only two cases were satisfactorily recorded:

(1) An upward squint of 20° , reduced to 5° by a tenotomy of the internal rectus, was corrected vertically by a tenotomy of the superior rectus.

(2) An upward squint of 10° , accompanied by slight convergence, was corrected vertically by a tenotomy of the superior rectus. A slight divergence, and a widening of the palpebral fissure on the inner side, was noted after the operation.

These results roughly correspond with Landolt's estimate of the average reduction effected by tenotomy of the superior rectus.⁶

My own experience of the treatment of squint is too limited to allow of an opinion based on personal results; certain points, however, emphasised themselves in my mind during the preparation of this paper, which are here enumerated.

I.—*Early operation and fusion training in concomitant convergent squint:*

That, as the best training for the eye is to put it straight, early operation in convergent squint is strongly indicated. The correction before operation, of any deviation from the normal, such as enlarged tonsils and adenoids, should not be forgotten. In the very young, between two and four years, an improvement with glasses and occlusion of the fixing eye may be expected to continue up to within one and a half years after the commencement of treatment; in older patients no very marked further improvement after three months would appear to take place.

Fusion training in the very young appeals to me in theory, but it

would seem to necessitate qualities on the part of the ophthalmic surgeon more difficult to acquire than operative dexterity. Rather do post-operative orthoptic measures, at a time when the child can co-operate, commend themselves to my mind. Where suppression can be artificially overcome, these would appear to be of value up to puberty or later.

As so few squinters would appear ultimately to attain binocular vision, its practical importance in everyday life becomes, in discussing this subject, a matter of interest.

I venture to think that as few forms of work are impossible without it, its value may be greatly over-estimated by those who especially interest themselves in its development.

II.—*The choice of operation in concomitant convergent squint :*

That the choice of operation in c.c. squint must be determined by the age of the patient, as well as by the size of his angle. During the period of rapid growth, say up to twelve years of age, when the possibility of the development of a secondary divergence is greatest, only advancements or shortenings would appear to be indicated. After this age tenotomy is surely a most valuable method of treatment. As the retraction of the capsule of Tenon, which may follow this operation is thought by some observers to be a more potent factor in the development of a subsequent exophthalmos than the division of the muscle, might not its inclusion in the conjunctival suture lessen the occurrence of this disfigurement ?

III.—*The classification and treatment of concomitant divergent squint :*

That the two main types of concomitant divergent squint, with their essential treatments, are :—

(1) Squints the result of "convergence insufficiency."

This condition is apparently most often associated with bilateral myopia and, in such cases, would be a consequence of the poor development of the function of convergence.

Where operation is indicated, a shortening or advancing, would appear to offer the best chance of success.

(2) Squints, the result of "divergence excess."

This condition is apparently most often associated with emmetropia or low degrees of hypermetropia. The refractive error obviously plays no part in the causation.

The excess in divergence may conceivably, in many instances be the result of an instability of the convergence centre. The "neuropathic divergent squints" described by Worth seem to me to correspond in the main with the cases of "divergence excess" described by Wooton.^{10,11}

Attention to the general health, combined with convergence exercises, would appear to be the treatment indicated. Where operation is necessary, tenotomy seems to offer the best chance of success. The external rectus being less liable to retraction than the internal, and full external mobility being of less importance than internal, it can be performed at an early age with less risk than in the case of convergence.

IV.—*An estimation of the result of operation for concomitant squint:*

That as the results of any individual operation cannot be mathematically estimated beforehand, the exact size of the angle is of less importance than a knowledge of the fixation and vision of the eye, together with existing muscular anomalies or complicating factors. A knowledge of the existence of diplopia beforehand may be of some help in an estimation of the value of post-operative orthoptic exercises, its temporary development after operation is apparently of no prognostic value.

At the same time, despite individual differences in operations, it is noteworthy how closely the various averages tally. Some scheme, therefore, of measurement would appear to be of value even to the most experienced of operators.

In young children with c.c. squint, straightness with glasses would appear to be the ideal result. In older persons complete corrections of squint without glasses may be attempted.

V.—*Shortening versus advancement:*

That, in an estimation of the respective merits of the shortening or tucking as compared with the advancing operations, the following points would appear to be in favour of the former:

- (1) Great ease in the performance of the operation.
- (2) Rarity in the accidental production of altitudinal displacements.
- (3) The impossibility of a slip backwards on the part of the tendon.
- (4) The almost negligible interference with the health of the muscle.
- (5) The great ease with which a reshortening can be performed.

Against this method is the fact that on an average less reduction is effected than by advancement:

On the average estimation that an advancement of 1 mm. will effect a reduction of 2° , the greatest result that may be expected without resection in cc. squint is 15° , as the insertion of the external rectus is normally 6.7 mm. from the cornea.⁴ We may take, therefore, a reduction of 12° to 15° as the average effect of a single advancement in cc. squint, as compared with a reduction of 9° - 12° , the average effect of a single shortening.

A similar relative comparison can presumably be made when dealing with the internal rectus in divergence.

If the muscle insertion is unusually far back an advancement may be expected to produce a still greater effect. In such cases, therefore, if a big reduction be necessary, I would suggest that advancement be the operation of choice. Again, where at the time of operation the muscle is found to be very poorly developed, an advancement would appear to offer a better chance of success.

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ANNOTATIONS

The Qualifications of Ophthalmic Surgeons

In the columns of this Journal (March, 1918) we published an appeal that some degree or diploma should be open to ophthalmic surgeons commensurate with the position occupied by them in the medical profession. We then suggested that it would be useful in bridging the hiatus if ophthalmology were in part substituted for the final examination for the M.S. (Lond.) and the F.R.C.S. (Eng.). This would have far-reaching consequences, into which we need not enter at the moment. It is with satisfaction that we now learn that the Senate of London University has sanctioned the granting of the M.S. degree in two additional branches, one of which is ophthalmology. The regulations have been modified in accordance with the foregoing decision.

The Need of a New Eye Hospital in Calcutta

In our issue of May, 1919, we commented at some length on the apathy which has been displayed by the Government of Bengal