Acquired Superior Oblique Palsy

Diagnosis and Management

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In 40 cases of acquired superior oblique palsy, head trauma was the most frequent cause. The pattern of the resulting vertical, horizontal, and torsional defects is discussed. Data are presented, indicating that the habitual head tilt is a compensation to reduce the vertical deviation, and thus aid fusion. In surgical treatment, weakening of the antagonist inferior oblique muscle will often be required. Vertical rectus muscle surgery in addition to inferior oblique muscle surgery is required if the vertical deviation exceeds 15 to 20 prism diopters in the primary position. Horizontal muscle surgery is required if inferior oblique weakening is to be done in cases with esodeviation over 4 to 5 △ in the primary position. Tucking of the paretic superior oblique is found to be of less value than inferior oblique and vertical rectus muscle surgery.

SUPERIOR oblique muscle palsy is the most frequently encountered acquired extraocular muscle palsy in our experience. It is the purpose of this paper to discuss findings in acquired superior oblique palsy, to point out that different patterns of ocular motility occur with superior oblique palsy, and to discuss methods of management corresponding to the several patterns of disturbed motility.

Methods

The records of 3,000 consecutive strabismus cases were reviewed for the presence of superior oblique palsy. The diagnosis was considered positive on the basis of the presence of all or of a combination of some of the following characteristic signs: (1) vertical diplopia and strabismus, (2) torsional diplopia and strabismus, (3) esotropia or a "V" pattern, (4) habitual head turn or tilt, or both, and (5) positive Bielschowsky's sign (forced head tilt test).

Eliminated from consideration were cases of congenital origin, those which had undergone strabismus surgery, and those associated with other extraocular muscle palsies. Forty cases of acquired superior oblique palsy meeting these criteria were found. Of these, seven were bilateral.

Measurements.—Measurements of vertical and horizontal strabismus are in prism diopters. In unilateral cases, these data were gathered by prism and cover techniques with fixation at distance by the normal eye. In bilateral cases, fixation was by the dominant eye. Torsion was measured by Maddox wing and is recorded in degrees of torsional deviation. Overactions and underactions of muscles are recorded on a scale of 0 (normal) to +4 (overaction), and 0 (normal) to −4 (underaction). For example, a −4 underaction of the superior oblique represents a lack of depression of the involved eye below the horizontal while fixing with the fellow eye in extreme depression and abduction. Underactions between this total paralysis (−4) and total normalcy (0) are graded by observation. An overaction of +4 of the superior oblique represents an excessive depression of 25 △ or more, while fixing with the fellow eye in extreme depression and abduction. Lesser overactions are graded by observation. Other vertically acting muscles are similarly graded by observation in their fields of maximum vertical action. A forced head tilt test was considered positive when the vertical deviation with the head tilted far to the right was different from the vertical deviation with the head tilted far to the left by an amount of 5 △ or more. A "V" pattern is considered to exist if there is at least 5 △ more exodeviation or less esodeviation in far upgaze, as compared to the horizontal deviation in far downgaze.

Clinical Findings

Origin.—Closed head trauma[27] was found to be the most common cause of acquired superior oblique palsy in 40 cases. Other

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Table 1.—*Variation of Vertical Deviation With Position of Gaze*

Unilateral Superior Oblique palsy (33 Cases) (Position of Gaze)	Vertical Deviation · 2 △ or More (No. of Cases)	Position of Gaze With Greatest Vertical Deviation (No. of Cases)
Primary position	33 (Average—9.75 △)	0
Upgaze	16	3
Downgaze	25	14
Adduction of paretic eye	32 (One case not recorded)	20 (4 cases have same deviation in downgaze)
Abduction of paretic eye	11	0
Bilateral Superior Oblique palsy (7 cases)		
Primary position	6 (Average—7.2 △)	2
Upgaze	0	0
Downgaze	5	3

Table 2.—*Head Tilt Findings*

	Positive Forced Head Tilt Test (Bielschowsky) (No. of Cases)	Habitual Head Tilt (No. of Cases)
Unilateral superior oblique palsy (33 cases)	31 (2 cases not recorded)	17
Bilateral superior oblique palsy (7 cases)	6 (1 case not recorded)	5 (Tilt to side of lesser palsy in all cases)

causes are cerebral vascular accident (1), diabetes (1), ethmoidectomy (1), brain tumor (1), acute mastoiditis (1), and uncertain (8). This is true both in unilateral and in bilateral cases. Of the 27 cases of head trauma, only two lost consciousness for over 30 minutes. The apparent insignificance of the head injury was a striking feature in many of these cases. No area (frontal, occipital, etc) could be identified as the one where injury particularly occurred.

Vertical Deviations.—In unilateral cases, a vertical deviation of 2 △ or more was seen in the primary position in each instance (Table 1). In one bilateral case there was no vertical deviation in the primary position. The vertical deviation increased with gaze in the adducted position of the involved eye in over half of the cases, both unilateral and bilateral. In the majority of cases, a vertical deviation was present in straight downgaze. Of interest are those cases where the vertical deviation was greater in upgaze. These are further discussed below.

Torsional Deviation.—Half of the patients with unilateral superior oblique palsy, and over 70% of the patients with bilateral superior oblique palsy show an habitual head turn or tilt (Table 2). Over 90% of all patients show a positive forced head tilt test with greater vertical deviation with the head tilted toward the side of the paretic muscle. In bilateral cases, the greater vertical deviation occurred with tilt to the more paretic side. Comparative data on the vertical and torsional alterations with forced head tilting are available in eight cases (Table 3).

Horizontal Deviation.—An esodeviation greater than 3 △ was present in downgaze in half of the unilateral cases, and in six of the seven bilateral cases. Correspondingly, a "V" pattern was seen in 55% of the unilateral cases, and in each of the seven bilateral cases (Table 4).

Findings on Rotations.—Weakness of vertical action of the superior oblique muscle in the adducted position is seen in 75% of cases of unilateral superior oblique palsy, and in 100% of the bilateral cases (Table 5). This weakness on rotations was minimal in many cases, however, so that normalcy or minimal weakness (−1 underaction) was seen in over half of the cases, both unilateral and bilateral. Overaction of the direct antagonist inferior oblique muscle was seen in 70% of unilateral cases and in 57% of bilateral cases.

Comment

The superior oblique has depressing, ab ducting, and intorting action from the primary position. Its paralysis, therefore, re-

Table 3.—*Vertical and Torsional Alterations With Head Tilting*

Patient	Diagnosis	Vertical Deviation (Prism Diopters)				Excyclodeviation (Degrees)			
		Head Tilted Right	Primary Position	Head Tilted Left	Difference—Head Tilted Right and Head Tilted Left (Average—16.3 △)	Head Tilted Right	Primary Position	Head Tilted Left	Difference—Head Tilted Right and Head Tilted Left (Average—2.3°)
1	R SO* palsy	30 RH*	6 RH	5 RH	25	2	1	0	2
2	R SO palsy	45 RH	30 RH	25 RH	20	12	12	12	0
3	R SO palsy	12 RH	2 RH	0	12	12	12	8	4
4	R SO palsy	10 RH	5 RH	0	10	12	12	10	2
5	L SO palsy	12 LH*	15 LH	30 LH	18	0	0	0	0
6	L SO palsy	0	2 LH	12 LH	12	10	10	12	2
7	L SO palsy	0	3 LH	10 LH	10	3	5	7	4
8	Bilateral SO palsy	4 RH	6 LH	20 LH	24	25	25	20	5

* R indicates right; SO, superior oblique; H, hyperdeviation; and L, left.

Table 4.—*Horizontal Deviation*

	"V" Exo-deviation	"V" Exo-deviation	"A" Pat-tern	No "A-V" Pat-terns	% of Cases With "V" Pattern
Unilateral SO palsy (33 cases)	12	6	0	15	55
Bilateral SO palsy (7 cases)	4	3	0	0	100

Table 5.—*Findings on Rotations*

	Weakness of SO Muscle (No. of Cases and %)	Overacting of Inferior Oblique Muscle (No. of Cases and %)
Unilateral SO palsy (33 cases)	25 (75)	23 (70)
Bilateral SO palsy (7 cases, 14 eyes)	7 cases, 14 eyes (100)	4 cases, 8 eyes (57)

sults in (1) elevation, (2) esodeviation, and (3) extortion of the involved eye.

Vertical Deviation.—In unilateral cases, depending on recovery of the superior oblique paralysis, and upon the occurrence of overaction-contractures of other muscles, the vertical deviation may take several patterns. (1) The vertical deviation may be greatest in downgaze, acting in this instance like 'pure' superior oblique paralysis. This is seen in 14 of the present cases. Moderate to marked weakness of the vertical action of the superior oblique is seen on rotation in these cases. (2) The vertical deviation may become especially pronounced in adduction and in elevation, associated in such instances with overaction-contracture of the inferior oblique muscle on the involved side. This pattern is seen in eight of our present cases. This overaction of the inferior oblique on the involved side is usually not associated with gross weakness of the superior oblique muscle on rotations. For this reason the proper diagnosis of such cases can be missed if the other characteristic signs are not specifically sought. (3) The vertical deviation may become reasonably comitant. This is seen in 11 of the present cases where vertical deviation is present even in full abduction of the paretic eye.

In bilateral cases, the vertical deviation tends to be smaller since loss of depressing function in one eye tends to balance that same loss in the fellow eye. In two of these seven cases, the balance between the eyes was so nearly equal that there was less than 2 △ of vertical deviation in the primary position. Elevation in the adducted position was seen both to right and to left gaze in these two cases.

Horizontal Deviation.—The normal abducting effect of the superior oblique is greatest in downgaze. Its paralysis, therefore, results in greater esodeviation in downgaze. As indicated above, this is most marked in bilateral cases where a "V" pattern was seen in each instance. Indeed, esodeviation is sometimes the most prominent finding and complaint in bilateral superior oblique palsy.

Torsional Defects and Head Tilt.—The habitual head tilt has been considered both as a compensatory posture to decrease the extorsional defect, and as a compensatory posture to decrease the vertical deviation produced by superior oblique paralysis. Marked difference of the vertical deviation (16.3 △) with head tilt to one side as opposed to the other side, and a very modest difference (2.3 degrees) in torsional deviation accruing from head tilt from one side to the opposite side, lead us to believe that an habitual head tilt is usually a compensation to reduce the vertical deviation and thus gain fusion (Table 5). This is not to deny that head tilting can occur even in monocular individuals with torsional deviation of the fixing eye, and as an aid to fusion in binocular individuals where cyclodeviation is the sole or major defect. A head turn is occasionally seen placing the eyes in the field of lesser vertical deviation, usually abduction of the paretic eye. One also occasionally sees a depression of the chin, placing the eyes in upgaze to avoid the vertical or the esodeviation in downgaze. A difference in vertical and torsional deviation is seen with forced head tilting in persons with vertical strabismus from causes other than superior oblique palsy, eg, orbital floor fracture. Therefore, a difference on forced head tilting is most characteristic of superior oblique palsy, but not pathognomic.

Nonsurgical Management

Several superior oblique palsies caused by head trauma, and also by presumed vascular thrombosis of the brain stem were seen to heal spontaneously and fully over a period of three months to two years. An additional number of patients will heal to a point where minimal deviation in the primary position is overcome with moderate head tilting or the development of large vertical fusional amplitudes. While diplopia may be present in other fields of gaze, the more phlegmatic of these patients will learn to ignore such diplopia and will require no treatment of any kind. During the healing phase, when diplopia is a troublesome complaint, resort to occulsion of one eye to avoid the diplopia is often indicated. The procedure of occluding the good eye, along with prisms so placed to enforce fixation with the paretic eye into the field of action of the paretic muscle and thus prevent contracture of its antagonist muscle, is an appealing one. The practical matter of interference by this scheme in daily activities makes it unsatisfactory for many individuals. Patching of the paretic eye when the palsy is unilateral becomes the means of handling diplopia for such individuals.

Long-term treatment with prisms is useful primarily in patients who have (1) deviations of small amount, or (2) deviations which are not greatly incomitant, or (3) when a patient refuses surgery or where there is a contraindication to surgery. Slab-off prisms are useful where the vertical deviation is significantly incomitant from the primary position to downgaze.

Surgical Management

As an arbitrary rule, we have not undertaken surgical management until stability of the deviation has been documented over at least a three-month period, and in any case, not before six months following onset. As in any strabismus surgery, the primary goal is elimination of the deviation in the primary position with a secondary goal of restoration of as large a field as possible of single binocular vision surrounding the primary position.

In planning surgery, the following general principles serve as a useful clinical working guide. (1) Oblique muscle surgery results in substantially greater vertical effect in the adducted position of the operated eye, whereas the vertical effect of vertical rectus muscle surgery is more nearly equal in the abducted and adducted positions. (2) Strengthening procedures on paretic muscles, especially with overaction-contracture of the direct antagonist, are relatively in-

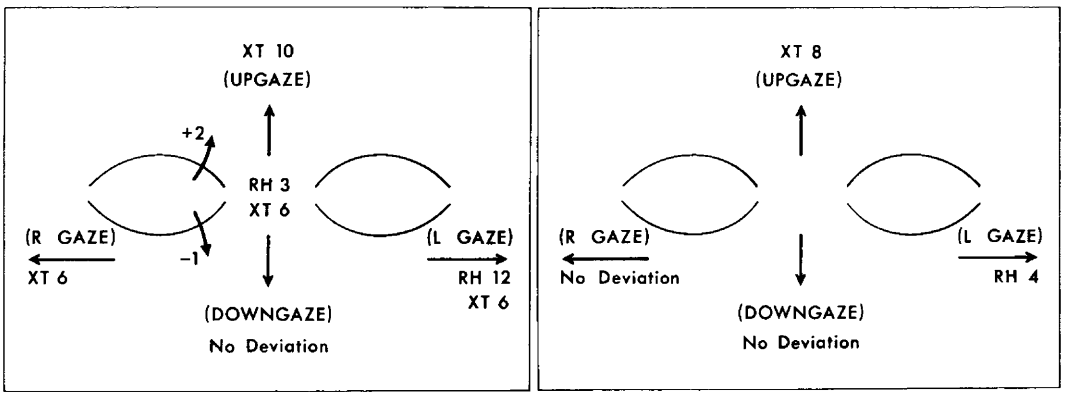

Fig 1.—Preoperatively (left), and postoperatively (right) (case 1). R indicates right eye; L, left eye; H, hyperdeviation; E, esodeviation; X, exodeviation, and T, tropia.

effective. Conversely, weakening procedures on overacting or contracted muscles are highly effective, roughly in proportion to the degree of overaction or contracture. For this reason, superior oblique muscle surgery is infrequently indicated in superior oblique palsy, and inferior oblique weakening is commonly indicated.

Report of Cases

CASE 1.—The diagnosis was vertical deviation due to right superior oblique palsy with right inferior oblique overaction-contracture. A 20-year-old man presented with vertical diplopia, especially in left gaze, 17 months following an auto accident. Vision was 20/20 in each eye. A 6 △ exodeviation was present in the horizontal plane. No vertical deviation was present in right gaze, 3 △ of right hypertropia was present in the primary position, increasing to 12 △ of right hypertropia in left gaze. In direct upgaze there were 10 △ of exodeviation. In straight downgaze there was no vertical or horizontal deviation. A forced head tilt test was positive, and rotation showed a −1 underaction of the right superior oblique and a +2 overaction of its antagonist right inferior oblique (Fig 1, *left*). Three months following myectomy of the right inferior oblique muscle, there was no vertical deviation in right gaze, no vertical deviation in the primary position, and a residual 4 △ of right hyperphoria in extreme left gaze. In upgaze there were 8 △ of exodeviation and no vertical deviation (Fig 1, *right*). In downgaze, there was no vertical or horizontal deviation.

COMMENT.—Weakening of an overacting inferior oblique is indicated when the vertical deviation is minimal or absent in downgaze and in the position of abduction of the paretic eye, and when there is marked increase in the vertical deviation with adduction and elevation.

CASE 2.—The diagnosis was left superior oblique palsy requiring vertical rectus muscle surgery in addition to inferior oblique muscle

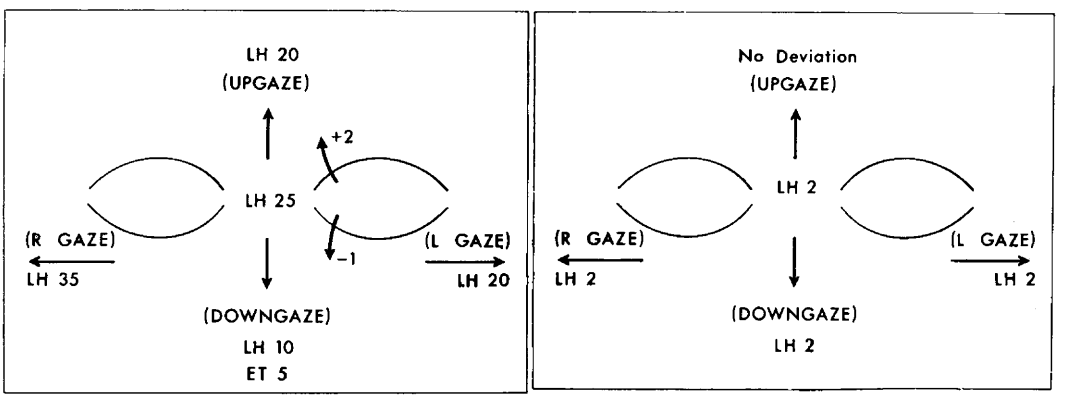

Fig 2.—Preoperatively (left), and postoperatively (right) (case 2).

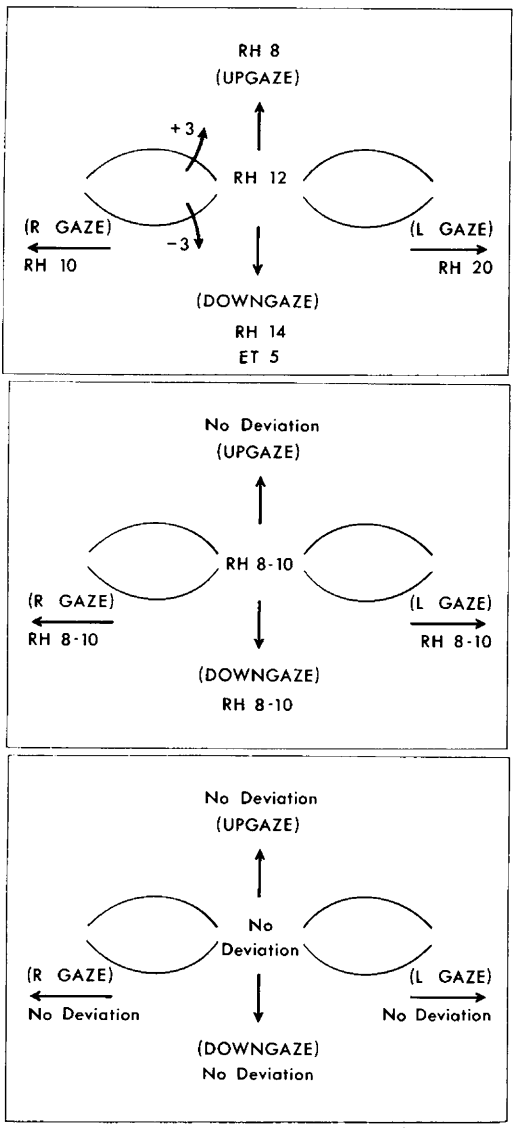

Fig 3.—Preoperatively (top), after first operation (center), and after second operation (bottom) (case 3).

weakening. A 36-year-old truck driver complained of diplopia since age 13. In left gaze there was a 20 △ left hypertropia increasing to 25 △ of left hypertropia in the primary position, and 35 △ of the left hypertropia in far right gaze. In straight upgaze there were 20 △ of left hypertropia and in straight downgaze there were 10 △ of left hypertropia and 5 △ of esotropia. A forced head tilt test was markedly positive, and rotations showed a −1 underaction of the left superior oblique muscle and a +2 overaction of the left inferior oblique muscle (Fig 2, *left*). Four months following a myectomy of the left inferior oblique and a 4 mm recession of the left superior rectus, there were 2 △ of left hyperphoria in the primary, right, left, and downgaze positions, and no deviation in upward gaze (Fig 2, *right*).

COMMENT.—When the vertical deviation in the primary position is of a larger amount than 15 △, vertical rectus muscle surgery is indicated in addition to inferior oblique weakening. This should take the form of ipsilateral superior rectus weakening as in the present case where there is 5 △ or more of vertical deviation in the abducted position, and where the vertical deviation is greater in straight upgaze than in straight downgaze.

CASE 3.—The diagnosis was right superior oblique palsy requiring vertical rectus surgery in addition to inferior oblique weakening. A six-year-old boy complained of diplopia four months following an injury with scissors to the area of the right upper lid. There were 10 △ of right hypertropia in right gaze, increasing to 12 △ in the primary position, and to 20 △ of right hypertropia in left gaze. In straight upgaze there were 8 △ of right hypertropia, and in straight downgaze, 14 △ of right hypertropia with 5 △ of esotropia. On rotations there was an underaction of the right superior oblique of −3, and an overaction of the right inferior oblique of +3 (Fig 3, *top*). Four months following a right inferior oblique myectomy and a 4 mm right superior rectus recession, there was no deviation present in upgaze. However, 8 to 10 △ of right hypertropia was present in the primary, right, left, and downgaze positions (Fig 3, *center*). Five months following a 5 mm recession of the left inferior rectus no vertical or horizontal deviation was present (Fig 3, *bottom*).

COMMENT.—As an addition to inferior oblique myectomy when there is over 15 △ of vertical deviation in the primary position, recession of the yoke muscle (left inferior rectus in the above case) should be done when the vertical deviation is greater in downgaze than in upgaze. The following circumstance is an exception to this dictum. A contracture of the ipsilateral superior rectus, limiting infraduction, and producing greater vertical deviation in downgaze, can occur in superior oblique palsy. Such a contracture then shows as a marked resistance on forced duction tests, and indicates need for recession of the ipsilateral superior rectus. In case 3, however, forced infraduction was

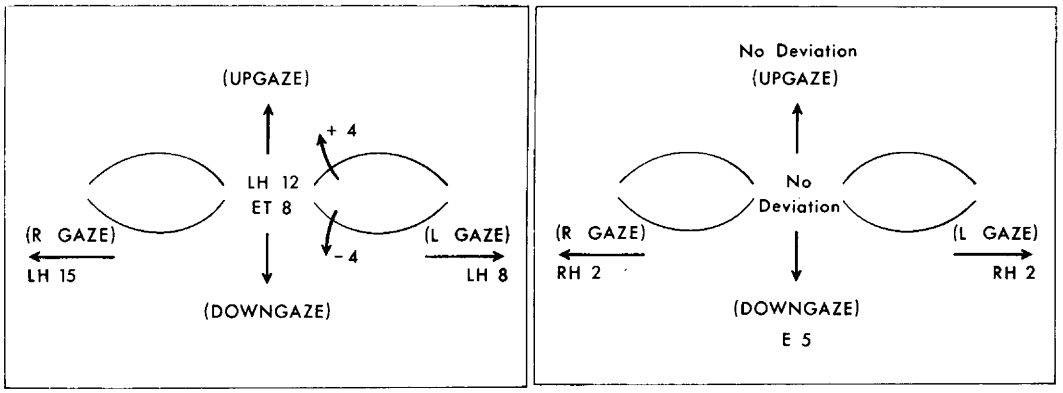

Fig 4.—Preoperatively **(left)**, and postoperatively **(right)** (case 4).

only questionably abnormal. Superior rectus recession, therefore, was ineffective, and inferior rectus weakening was required later.

CASE 4.—The diagnosis was left superior oblique palsy requiring horizontal muscle surgery. A 15-year-old boy was seen because of vertical diplopia. Vision was 20/20 in each eye. There were 8 △ of esotropia in the horizontal plane. Eight prism diopters of left hypertropia were present in left gaze, 12 △ in the primary position, and 15 △ of left hypertropia in far right gaze. On rotations, there was a +4 overaction of the left inferior oblique (Fig 4, *left*). Four months following a myectomy of the left inferior oblique and a 4 mm recession of the left medial rectus there was no deviation in the primary position or in upgaze. Two prism diopters of right hyperphoria was present in right gaze. In downward gaze, there was a residual 5 △ of esodeviation (Fig 4, *right*).

COMMENT.—Weakening of an overacting inferior oblique muscle reduces its abducting function as well as its vertical and torsional activity. If more than 4 to 5 △ of eso deviation exists in the primary position, and if oblique muscle weakening is contemplated, then appropriate horizontal muscle surgery should be done in addition.

CASE 5.—The diagnosis was left superior oblique palsy illustrating complications of superior oblique tuck. A 44-year-old woman complained of diplopia following a fall on the stairway four months previously. Vision was 20/20 in each eye. In left gaze there was no deviation. A left hypertropia of 10 △ was present in the primary and in the right gaze position. In upgaze there was no vertical or horizontal deviation. In downgaze there were 15 △ of left hypertropia and 12 △ of esodeviation. The head tilt test was positive. On rotations, the left superior oblique showed −1 underaction and the left inferior oblique +1 overaction (Fig 5, *left*). A left inferior oblique myectomy and a 4 mm tuck of the left superior oblique was done. Two months following surgery there were 2 △ of left hyperphoria in primary position. In downgaze

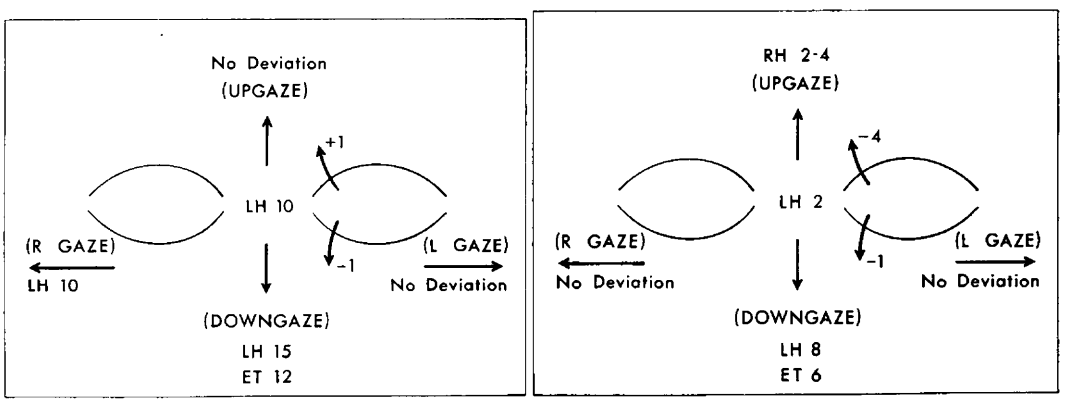

Fig 5.—Preoperatively **(left)**, and postoperatively **(right)** (case 5).

there were 8 △ of left hypertropia with 6 △ of esodeviation. In upgaze there was a right hyperphoria of 4 △. Marked limitation of elevation of the operated left eye in the adducted position was seen postoperatively (Fig 5, *right*).

COMMENT.—In this case, as in each of six instances where superior oblique tuck was done either alone or opposite an inferior oblique weakening procedure, there was a limitation of elevation in adduction. It is noteworthy that tucking a paretic superior oblique did not change the vertical or esodeviation, preferentially in downgaze. In cases such as this, a recession of the yoke (inferior rectus of the fellow eye) rather than tucking the paretic superior oblique is indicated to influence the greater vertical deviation in downgaze.

Summary and Conclusion

Acquired superior oblique palsy is most commonly a sequel to closed head injury. Weakness of vertical action of the paretic superior oblique muscle on rotations is absent or minimal in over half of cases. Loss of the abducting power of the superior oblique, especially when palsy is bilateral, will frequently result in esodeviation or a "V" pattern. The positive forced head tilt test is characteristic, but not pathognomic, of superior oblique palsy. When an habitual head tilt is to aid fusion in superior oblique palsy, it is usually a compensation to reduce the vertical rather than the torsional deviation. Many cases of superior oblique palsy will recover adequately so that only short-term occlusion, or treatment with prism glasses, is required.

In surgical treatment of unilateral superior oblique palsy, primary attention should be directed to correction of the vertical defect. This will frequently require weakening of the inferior oblique on the involved side because of its overaction-contracture. In addition to weakening the ipsilateral inferior oblique, rectus muscle surgery is indicated when the vertical deviation is greater than 15 prism diopters in the primary position. This will take the form of weakening the superior rectus of the involved eye when the vertical deviation is greater in upgaze than in downgaze. It will mean weakening the yoke muscle (the inferior rectus of the fellow eye) when the vertical deviation is greater in downgaze than in upgaze. Yoke muscle surgery alone (weakening the inferior rectus of the fellow eye) is indicated when the vertical deviation is minimal in upgaze, greatest in downgaze, and when the inferior oblique on the involved side is not overacting on rotations.

Horizontal muscle surgery should be considered when surgical weakening of the inferior oblique muscles is proposed, if any esodeviation exists in the primary position. Tucking the superior oblique tendon did not affect the vertical or esodeviation in the downgaze position preferentially. Such tucks usually cause a limitation of elevation in the adducted position.

In this series, torsional defects did not occur except in conjunction with vertical or horizontal strabismus. Appropriate procedures to correct the vertical and horizontal strabismus made it unnecessary to direct specific measures to the torsional component.

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