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Treatment for "A" and "V" Exotropia by Slanting Muscle Insertions

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Purpose: The purpose of the present study is to evaluate the therapeutic effects of slanting muscle insertions for "A" and "V" exotropia.

Methods: We performed slanting recession and resection of medial or lateral rectus muscles. A slanting surgical incision creating a 3–4 mm difference between the upper and lower margins of the muscles was performed in 28 patients with "A" or "V" exotropia ("V" exotropia, 16 patients; "A" exotropia, 12 patients). Cases of "V" exotropia with moderate or marked overaction of the inferior oblique muscle were excluded.

Results: "V" exotropia: The average "V" pattern was 17.9 prism diopters (Δ) before and 7.6 δ after the operation. Slanting surgery reduced the "V" pattern in 15 of the 16 "V" patients. The mean reduction was 10.3 Δ in the "V" pattern and 29.8 Δ in the upward gaze deviation. "A" exotropia: The average "A" pattern was 26.6 Δ before and 6.3 Δ after the operation. Slanting surgery reduced the "A" pattern in 8 of the 12 "A" patients. The mean reduction was 20.3 Δ in the "A" pattern and 36.4 Δ in the downward gaze deviation.

Conclusion: We conclude that the surgical technique of slanting muscle insertions for correcting exotropia of "A" pattern with superior oblique muscle overaction and "V" pattern without moderate or marked inferior oblique muscle overaction is suitable for reducing "A" and "V" patterns. **Jpn J Ophthalmol 2000;44:433–438**

Key Words: "A" and "V" exotropia, inferior oblique muscle overaction, slanting muscle insertion, superior oblique muscle overaction, "trick" operation.

Introduction

The surgical technique of slanting muscle insertions (slanting surgery) for correcting "A" and "V" patterns was first reported by Bietti[1] in 1970 and since his report only 3 other studies[2–4] have been reported. This procedure is based on Scott's principle[5] that horizontal muscle tensions are different between the upper and lower margins of the muscle with variant amounts of gaze, ie, horizontal muscle tension at the upper margin is stronger than that at the lower margin in upward gaze. Therefore, in the slanting surgery, the upper margins of the lateral rectus muscles are recessed more than the lower margins to gain a greater effect on horizontal deviation in upward gaze in patients with "V" exotropia. In accordance with the same principle, in patients with "A" exotropia, more recession is required at the lower margins of the lateral rectus muscles and similarly, in those with "A" esotropia, more recession of the upper margins of the medial rectus muscles is necessary. In our previous study[6] on 3 patients with "A"and "V" exotropia, we found that slanting surgery was effective for the correction of "A" and "V" patterns.

In the present study, we evaluated the therapeutic effects of slanting surgery on "A" and "V" exotropia in 28 patients.

Subjects and Methods

In the present study, 28 patients (12 men, 16 women) with "A" or "V" exotropia ("V" exotropia, 16 patients; "A" exotropia, 12 patients) were treated

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by slanting surgery. The average age of the patients was 16 years (range, 3–77 years). The patients were diagnosed as having "A" or "V" patterns according to Knapp's criteria,[7] that is, a deviation of greater than 15 prism diopters (Δ) between upward and downward gaze for the "V" pattern and a deviation of greater than 10 Δ between upward and downward gaze for the "A" pattern. None of the patients had any significant vertical muscle imbalance. In all cases, pre- and postoperative measurements of the horizontal deviation were performed by the alternate prism cover test at 25° of upward gaze (UP), at the primary position (PP), and at 25° of downward gaze (DOWN), while the patients were fixating on a target at far distance. None of the patients had undergone previous extraocular surgery.

Inferior oblique muscle overaction (IOOA) was graded according to the degree of overelevation of the eye in adduction using a scale ranging from 0 (normal) to 4+ (overaction), and superior oblique muscle overaction (SOOA) was graded according to the degree of overdepression of the eye in reading position using a scale ranging from 0 (normal) to +4 (overaction). In maximal lateral version, a vertical deviation of approximately 10° was 1+ (mild); 10°–20° was 2+ (moderate); 20°–30° was 3+ (marked); and over 30° was 4+ (severe). The cases of "V" exotropia with moderate or marked IOOA were excluded. Stereo-acuity was evaluated by the Titmus Stereo Test for stereoscopic vision. The amounts of recession and resection of the recti were determined by the surgical dosage schedules of Parks.[8] Slanting recessions or resections were performed with a surgical incision creating a 3–4 mm difference between the upper and lower margins of the muscles as a standardized procedure. The duration of postoperative follow-up ranged between 12 and 27 months (average, 15.8 months). Informed consent was obtained from all patients.

Results

Preoperative Data in "V" Exotropia Patients

The preoperative deviations (mean ± SD) were 42.8 ± 8.6 Δ at UP, 33.4 ± 9.4 Δ at PP, and 24.8 ± 9.4 Δ at DOWN. The mean "V" pattern (UP-DOWN) was 17.9 ± 4.2 Δ. Ten of the 16 patients had mild IOOA, while the other 6 had none. In 7 of the 16 "V" patients (43.7%), the preoperative stereo-acuity threshold was less than 80 seconds on the Titmus Stereo Test. Most of the patients (n = 13) underwent bilateral recession of the lateral rectus muscles with bilateral slanting surgery, but some adult patients (cases 12, 14, and 15) underwent the recess-resect procedure with bilateral slanting surgery on only 1 eye. None of the patients had any congenital anomaly or abnormal insertions of the horizontal muscles (Table 1).

Postoperative Data in "V" Exotropia Patients

The postoperative deviations (mean ± SD) were 13.0 ± 8.6 Δ at UP, 6.9 ± 7.2 Δ at PP, and 5.4 ± 6.7 Δ at DOWN. The postoperative mean "V" pattern was 7.6 ± 4.7 Δ. It was found that slanting surgery reduced the "V" pattern in 15 of the 16 patients (94%); the reduction of deviation (mean ± SD) was 29.8 ± 11.0 Δ at UP, 26.5 ± 12.2 Δ at PP, and 19.4 ± 11.6 Δ at DOWN, and the mean reduction of the "V" pattern was 10.3 ± 5.4 Δ.

No significant difference was observed in reduction of the "V"pattern between the group with mild IOOA (10 patients) and the group of 6 patients with no IOOA. Futhermore, among the latter, 3 exhibited excyclo-deviations at PP as shown by examination with a synoptophore. In 11 of 16 patients (68.7%), the stereo-acuity threshold was less than 80 seconds on the Titmus Stereo Test (Table 2). Figure 1shows case 15, an example of one of the patients with "V" exotropia.

Preoperative Data in "A" Exotropia Patients

The preoperative deviations (mean ± SD) were 24.7 ± 11.5 Δ at UP, 33.9 ± 13.4 Δ at PP, and 51.3 ± 25.7 Δ at DOWN. The mean "A" pattern (DOWN-UP) was 26.6 ± 16.3 Δ. All patients had marked or severe overaction of superior oblique muscle in the version test. Preoperative stereo-acuity threshold was less than 80 seconds on the Titmus Stereo Test in only one of the 12 "A" patients (8.3%). Most of the patients, 8 cases, underwent bilateral recession of the lateral rectus muscles with bilateral slanting surgery, but some adult patients underwent the recess-resect procedure combined with bilateral slanting surgery on only one eye. Patient 3 underwent slanting surgery (resection of 4 mm of only the lower margins of the medial rectus muscles without whole muscle resection). None of the patients had any congenital anomaly or abnormal insertions of the horizontal muscles (Table 3).

Postoperative Data in "A" Exotropia Patients

The postoperative deviations (mean ± SD) were 8.5 ± 11.9 Δ at UP, 8.1 ± 11.1 Δ at PP, and 14.8 ± 11.3 Δ at DOWN. The postoperative mean "A" pattern was 6.3 ± 8.2 Δ. It was found that the slanting surgery reduced the "A" pattern in 8 of the 12 patients (66.6%); the reduction of deviation (mean ± SD) was 16.2 ± 8.1 Δ at UP, 25.8 ± 12.3 Δ at PP, and 36.4 ± 19.1 Δ at DOWN, and the mean reduction of

Table 1. Preoperative Data on "V" Exotropia Patients

Case	Sex	Age (y)	UP (Δ)	PP (Δ)	Down (Δ)	"V" pattern (Δ)	IOOA	TST (s)	Surgery
1	F	4	40	35	25	15	1+	40	BLR recess (LM 7 mm, UM 11 mm)
2	M	11	50	40	35	15	1+	140	BLR recess (LM 8 mm, UM 12 mm)
3	F	11	45	40	30	15	1+	100	BLR recess (LM 7 mm, UM 11 mm)
4	M	4	45	40	30	15	1+	80	BLR recess (LM 7.5 mm, UM 11.5 mm)
5	F	15	50	45	35	15	1+	100	BLR recess (LM 7.5 mm, UM 10.5 mm)
6	F	3	55	45	40	15	0	Supression	BLR recess (LM 7 mm, UM 11 mm)
7	M	8	35	22	20	15	0	800	BLR recess (LM 5 mm, UM 8 mm)
8	M	6	32	25	16	16	1+	140	BLR recess (LM 6 mm, UM 10 mm)
9	F	8	30	20	14	16	1+	40	BLR recess (LM 5 mm, UM 8 mm)
10	F	8	30	20	12	18	1+	50	BLR recess (LM 5 mm, UM 8 mm)
11	M	5	45	35	27	18	0	40	BLR recess (LM 7.5 mm, UM 11.5 mm)
12	M	77	40	30	20	20	0	50	LLR recess (LM 6 mm, UM 10 mm) and LMR resect (LM 6 mm, UM 10 mm)
13	M	8	60	50	40	20	0	40	BLR recess (LM 6 mm, UM 10 mm) and LMR resect 3.5 mm
14	M	50	40	30	20	20	0	Supression	RLR recess (LM 7 mm, UM 10 mm) and RMR resect 6 mm)
15	F	32	45	32	21	24	1+	Supression	RLR recess 8 mm and RMR resect (LM 6 mm, UM 4 mm)
16	M	5	42	25	12	30	1+	100	BLR recess (LM 6 mm, UM 10 mm)
Average		15.9	42.8	33.4	24.8	17.9			

UP: 25° of upward gaze; PP: primary position; Down: 25° of downward gaze; IOOA: inferior oblique muscle overaction; LM: lower margin of muscle; UM: upper margin of muscle; BLR: bilateral lateral rectus muscle; RLR: right lateral rectus muscle; LLR: left lateral rectus muscle; RMR: right medial rectus muscle; LMR: left medial rectus muscle; IOOA: inferior oblique muscle overaction, Scale : 0 (normal) to 4+ (overaction); TST: Titmus Stereo Test.

the "A" pattern was 20.3 ± 18.5 Δ. Following the treatment, weakened SOOA was noted in 6 patients, including 3 with severe weakening, and 3 with moderate weakening. The other 6 patients exhibited no change in SOOA. In 3 of the 12 patients (25%), stereo-acuity threshold was less than 80 seconds on the Titmus Stereo Test (Table 4). Figure 2. shows Case 1, an example of a patient with "A" exotropia.

Table 2. Postoperative Data on "V" Extropia Patients

Case	Follow-Up (M)	UP (Δ)	PP (Δ)	Down (Δ)	"V" pattern (Δ)	Reduction of "V" (Δ)	TST (s)
1	15	0	0	0	0	15	40
2	15	25	20	14	11	4	40
3	25	18	10	10	8	7	40
4	12	25	18	18	7	8	40
5	12	8	0	0	8	7	50
6	17	0	0	0	0	15	200
7	15	9	7	3	6	9	100
8	19	20	14	16	4	12	140
9	13	8	2	0	8	8	40
10	13	10	3	3	7	11	40
11	12	25	15	12	13	5	40
12	27	6	4	0	6	14	40
13	12	20	0	0	20	0	40
14	14	6	0	0	6	14	Supression
15	14	10	3	0	10	14	Supression
16	24	18	14	10	8	22	40
Average	16.2	13.0	6.9	5.4	7.6	10.3	

UP: 25° of upward gaze; PP: primary position; Down: 25° of downward gaze; TST: Titmus Stereo Test; M: month.

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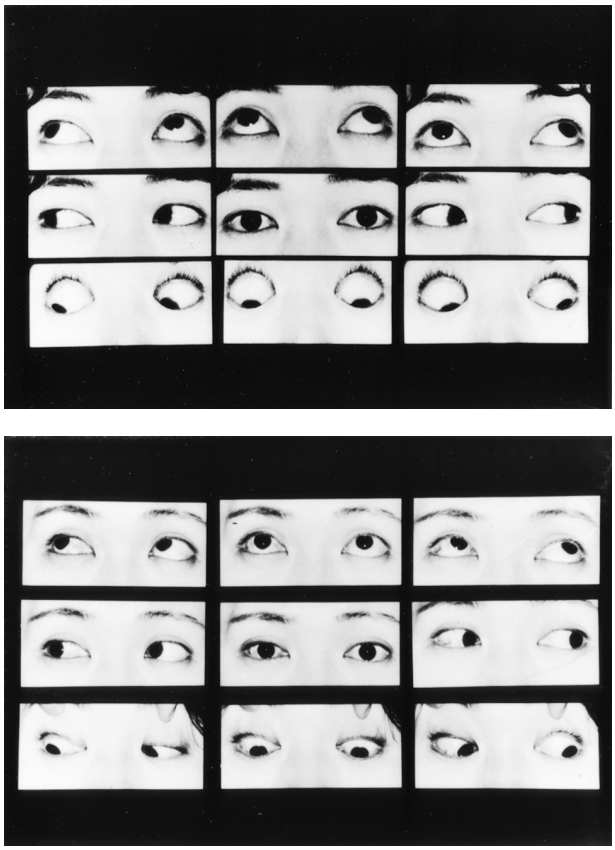

Figure 1. (**A**) Preoperative photo (case 15, 32-year-old) shows "V" exotropia with slight inferior oblique muscle overaction. (**B**) Postoperative photo (same patient) shows normalization of "V" exotropia.

Discussion

"V" Exotropia

The generally accepted surgical technique for "V" exotropia with marked IOOA is horizontal muscle surgery combined with weakening of the inferior oblique muscle. However, in cases of "V" exotropia with mild or no IOOA, the "trick" operation involving transposition of the horizontal muscles is usually used. Boyd[2] argued that the disadvantages of the "trick" procedure were that it could induce torsional deviation and that the measurement of the degree of "trick" may be difficult, because points of reference such as the breadth of the muscle, the breadth of the muscle insertion and the location of the muscle insertion are not the same in all patients. Urist[9] has shown that bilateral recession of medial rectus muscles combined with the "trick" operation in cases of "A" esotropia results in a "V" pattern of consecutive divergence in the majority of cases as shown by long-term follow-up. On the other hand, von Noorden[10] pointed out that the cyclo-deviation caused by the "trick" operation was not a problem. Although simple comparison between the results of the "trick" operation and the slanting surgery is difficult because of differences in the amounts of "V" preoperatively and the extent of upward and downward gaze, comparison of postoperative results between the "trick" operation and slanting surgery in the literature are as follows: (1) The mean "V" pattern reduction in "trick" operations, 7.8–16.5 Δ[11–13]; in slanting surgery, 6–11.1 Δ.[1,2,4]

Table 3. Preoperative Data on "A" Exotropia Patients

Case	Sex	Age (y)	Up (Δ)	PP (Δ)	Down (Δ)	"A" Pattern (Δ)	SOOA	TST (s)	Surgery
1	F	6	25	25	35	10	4+	Supression	BLR recess (UM 6 mm, LM 10 mm)
2	M	5	15	25	25	10	3+	140	BLR recess 6 mm (Rt.UM 6 mm, Rt. LM 10 mm)
3	F	16	7	8	18	11	4+	800	RMR resect (UM 0 mm, LM 4 mm)
4	F	12	35	40	50	15	4+	Supression	BLR recess (UM 8 mm, LM 12 mm)
5	F	36	10	16	26	16	4+	Supression	BLR recess (UM 5 mm, LM 9 mm)
6	M	6	30	38	50	20	4+	140	BLR recess (UM 8 mm, LM 12 mm)
7	M	13	18	35	40	22	3+	60	BLR recess (UM 7 mm, LM 11 mm)
8	F	10	16	30	41	25	3+	800	RMR resect (UM 6 mm, LM 10 mm) & RLR recess 8 mm
9	F	36	25	45	65	40	4+	Supression	BLR recess (UM 7 mm, LM 11 mm)
10	F	12	40	50	90	50	4+	Supression	BLR recess (UM 7 mm, LM 11 mm) & LMR resect (UM 5 mm, LM 9 mm)
11	F	25	35	50	85	50	4+	Supression	RLR recess (UM 8 mm, LM 12 mm) & RMR resect (UM 6 mm, LM 10 mm)
12	F	17	40	45	90	50	4+	Supression	RMR resect (UM 6mm, LM 10 mm) & RLR recess (UM 8 mm, LM 12 mm)
Average		16.2	24.7	33.9	51.3	26.6			

UP: 25° of upward gaze; PP: primary position; Down: 25° of downward gaze; LM: lower margin of muscle; UM: upper margin of muscle; BLR: bilateral lateral rectus muscle; RLR: right lateral rectus muscle; RMR: right medial rectus muscle; LMR: left medial rectus muscle; SOOA: superior oblique muscle overaction; Scale: 0 (normal) to 4+ (overaction); TST: Titmus Stereo Test.

Table 4. Postoperative Data on "A" Extropia Patients

Case	Follow-Up (M)	UP(Δ)	PP(Δ)	Down (Δ)	"A" pattern (Δ)	Reduction of "A" (Δ)	TST (s)
1	12	12	10	0	−12	22	800
2	15	8	12	14	6	4	50
3	12	0	8	11	11	0	800
4	12	0	0	8	8	7	Supression
5	14	−14	−16	0	14	2	Supression
6	26	12	12	20	8	12	40
7	21	0	0	18	18	4	40
8	14	0	0	0	0	25	200
9	12	16	20	30	14	26	Supression
10	19	30	14	30	0	50	Supression
11	12	20	10	20	0	50	Supression
12	13	18	27	27	9	41	Supression
Average	15.2	8.5	8.1	14.8	6.3	20.3	

UP: 25° of upward gaze; PP: primary position; Down: 25° of downward gaze; TST: Titmus Stereo Test; M: month

(2) The mean reduction in upward gaze deviation in "trick" operations, 15 Δ[11] or more than 15 Δ[14]; in slanting surgery, 22.2 Δ.[2,4] In our series, the "V" pattern averaged 17.9 Δ before and 7.6 Δ after surgery, the mean reduction of the "V" pattern was 10.3 Δ, and slanting surgery reduced the "V" pattern in 15 of 16 patients (94%). The mean reduction in upward gaze deviation was 29.8 Δ. Although simple comparison between our series and previous reports of slanting surgery is difficult because of differences in the extent of "V" deviation preoperatively, and the possibility that Bietti's[1] report included patients with moderate IOOA, slanting surgery seems likely to be very useful for treating "V" patterns.

Among the 6 patients without IOOA, 3 exhibited excyclo-deviations at PP as shown by examination with synoptophore. This indicated that the mild IOOA of these patients may have been masked preoperatively. The postoperative results of stereo-acuity were satisfactory as expected.

Figure 2. (**A**) Preoperative photo (case 1, 6-year-old) shows "A" exotropia with superior oblique muscle overaction (SOOA). (**B**) Postoperative (same patient) shows normalization of "A" exotropia and weakened SOOA.

"A" Exotropia

Since "A" exotropia is usually combined with SOOA, weakening of the superior oblique (SO) muscles has been the preferred procedure, but "trick" operations have not been performed as often as corrective surgery. It was reported that the mean reductions in downward gaze following bilateral weakening of SO muscles for "A" exotropia were 30 to 50 Δ (Jampolsky[15] 45 Δ, Parks[16] 40–50 Δ, Helveston[17] 32 Δ, and von Noorden[10] about 30 Δ). For slanting surgery, Boyd[2] reported that the average "A" pattern was 22.5 Δ before and 13.5 Δ after surgery, and that the mean reduction of "A" pattern was 9 Δ, but the number of patients studied by that author was only two. In our series (12 cases), the average "A" pattern was 26.6 Δ before and 6.3 Δ after surgery, and the mean reduction of the "A" pattern was 20.3 Δ. Slanting surgery reduced the "A" pattern in 8 of 12 patients (66.6%), and the mean reduction in downward gaze was 36.4 Δ. In

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"trick" operations, Knapp[12] showed that the mean reduction of the "A"pattern was 15 Δ in 4 patients with "A" exotropia and without SOOA.

Urist[9] reported that the increased divergence in downward gaze in "A" exotropia was caused by underactive medial rectus muscles. Miki[18] advocated that the effect of resection of the medial rectus muscles for correction of "A" extropia was related to the activity of the horizontal muscles. On the other hand, von Noorden indicated that SOOA is an important factor contributing to "A" exotropia. In terms of the relationship between SOOA and slanting surgery, SOOA was reduced in 6 (75%) of the patients with reduced "A" pattern (8 patients), but 2 patients had persistent SOOA in spite of the reduction in the "A" pattern. Although the etiology of "A" exotropia may be explained by a multiplicity of factors, our present results suggest that weakened SOOA may be caused by simulated SOOA due to the previously existing horizontal muscle imbalance. In the "A" exotropia cases, it seems that SOOA is divided into true and simulated types, and it is impossible to distinguish between them preoperatively.

In our series, either moderate or severe oblique muscle overactions were associated with "A" exotropia but not with "V" exotropia. In the case of true SOOA, it seems likely that this condition will persist following slanting surgery, but simulated SOOA seems to be diminished by the same operation. Therefore, the results of our present study showing less correction in the exotropia of the "A" pattern (66.6%) as compared with that of the "V" pattern (94%) may be due to the existence of marked or severe SOOA.

von Noorden[10] reported that the etiology of the "A" and the "V" patterns involved many factors: horizontal, vertical, and oblique muscle dysfunctions, facial characteristics, and abnormal muscle insertions. There is no unanimity concerning the pathophysiology of the "A" and "V" patterns. This is a fertile field for future investigation using advanced imaging techniques to determine the pathophysiology and therapy for "A" and "V" patterns.

In conclusion, the surgical technique of slanting muscle insertion for correcting exotropia of "A" pattern with SOOA, and of "V" pattern without moderate or marked IOOA is suitable for reducing "A" and "V" patterns.

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