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Skew Transposition of Vertical Rectus Muscles for Excyclovertical Deviation

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Purpose: The authors established a surgical treatment for excyclovertical strabismus in which either the inferior rectus muscle or the superior rectus muscle was transposed diagonally. The effects and the safety of the procedure, called skew transposition, were studied.

Methods: Eighteen operations using local anesthesia with eye drops were performed on 17 cases, including 10 with superior oblique palsy. Diplopia was checked during the operation with the cooperation of each patient. Both the clinical findings and eye deviation were examined during observation periods.

Results: After the first operation, the diplopia in the primary position had disappeared in 10 cases and had improved in the other 7. The average effect of all operations on excyclodeviation was a correction of 6.2 degrees in the primary position. In the 7 cases of superior oblique palsy that received nasal recession of the inferior rectus muscle, the average correction of excyclodeviation was 6.4°, and vertical deviation improved 1.8° per 1 mm of recession. In no case did the diplopia worsen, nor were there any complications.

Conclusions: This safe procedure facilitates the simultaneous improvement of both excyclo- and vertical deviations. It may become the treatment of choice for excyclovertical strabismus. **Jpn J Ophthalmol 2000;44:428–432**

Key Words: Cataract surgery, cyclovertical strabismus, orbital trauma, strabismus surgery, superior oblique palsy.

Introduction

Excyclodeviation is caused by an imbalance between the muscle pair producing intorsion (superior oblique muscle and superior rectus muscle) and the muscle pair affecting extorsion of the globe (inferior oblique muscle and inferior rectus muscle). To manage excyclodeviation in patients without a significant associated vertical deviation, either the Harada-Ito procedure[1–3] or horizontal transposition of the vertical rectus muscles[4–7] is an acceptable procedure. Although treatment for cases showing vertical deviations has not been established, some trials of the combined procedures (both resection/recession and horizontal transposition of vertical rectus muscles) have been reported in a few cases.[5,7] However, it was pointed out that there is a risk of inaccurate results and/or occurrence of postoperative complications.

We investigated the effect and safety of the combined procedures for correction of excyclovertical strabismus in which either the inferior rectus or superior rectus muscle was transposed diagonally (Figure 1).

The simultaneous improvement of both excyclo- and vertical deviations was achieved without any complications. Therefore, we report the combined procedures, designated as skew transposition of the vertical rectus muscles, as a useful treatment for excyclovertical strabismus.

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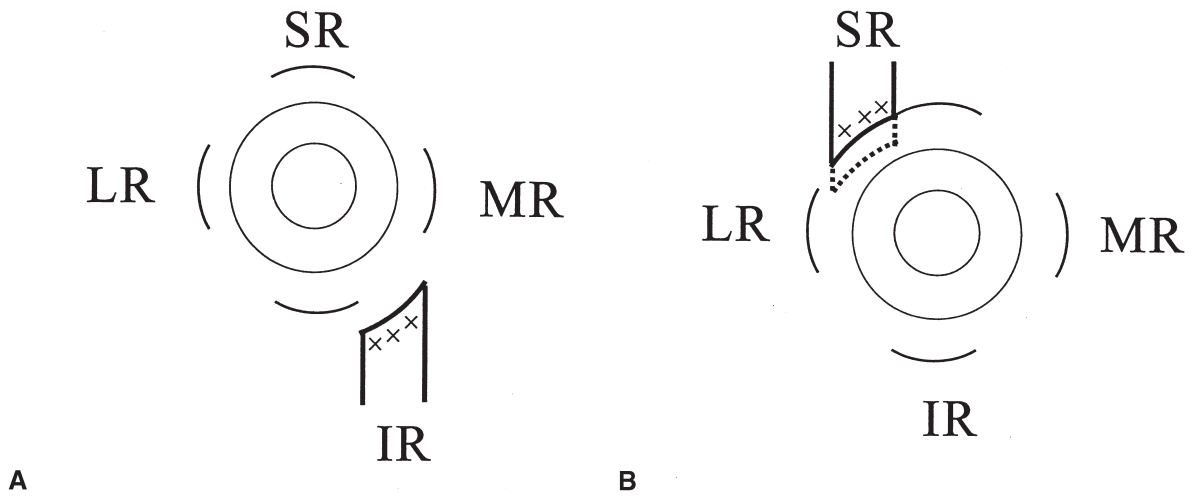

Figure 1. Skew transposition procedures. (**A**) nasal transposition and recession. (**B**) temporal transposition and resection. SR: superior rectus muscle, IR: inferior rectus muscle, MR: medial rectus muscle, LR: lateral rectus muscle.

Materials and Methods

The 17 subjects were adult cases with excyclovertical strabismus who underwent skew transposition procedures since April 1998 in Teikyo University Hospital (Table 1). Causes of the conditions included superior oblique muscle palsy in 10 cases, orbital trauma in 3 cases, and one case each with skew deviation, strabismus after cataract surgery (no. 12), dysthyroid ophthalmopathy (no. 15), and misdirection syndrome after oculomotor nerve palsy (treated surgically three times previously, no. 17). All except one were unilateral cases. Six patients, nos. 12–17, showed some degree of restricted eye movement: many of the cases had been treated with other procedures previously. However, diplopia had not been corrected by the procedures. Nine cases with superior oblique muscle palsy and one case with oculomotor nerve palsy (no. 17) underwent surgery on the unaffected side; in the others, on the affected side. The inferior rectus muscle was usually selected for the operation; however, the superior rectus was chosen either in the cases where the excyclodeviation when looking upward was dominant or in cases where the inferior rectus had been operated on previously.

Table 1. Patient Data

Case No.	Age	Sex	Side*	Causes†	Previous Surgery (Side)*
1	64	F	R	SO palsy	+(R)
2	52	F	R	SO palsy	—
3	67	F	L	SO palsy	—
4	26	M	L	SO palsy	—
5	65	M	L	SO palsy	—
6	78	M	L	SO palsy	—
7	24	M	R	SO palsy	—
8	39	M	L	SO palsy	—
9	35	M	R	SO palsy	—
10	21	F	L	SO palsy	—
11	59	M	L	Skew deviation	—
12	73	F	R	Cataract surgery	—
13	69	M	L	Trauma	+(L)
14	36	M	R	Trauma	+(R)
15	65	F	B	Dysthyroid	+(L)
16	37	M	L	Trauma	+(L)
17	36	M	L	Oculomotor palsy	+(B)

*R: right, L: left, B: both.
†SO: superior oblique muscle.

All the operations were performed under local anesthesia with eye drops so that the changes in both diplopia and eye position could be confirmed by the patient during surgery. The muscles, with three absorptive sutures, were transposed at the point that was planned before surgery (Figure 1). The extent of transposition was modified during the intraoperative examinations in case of diplopia and/or eye deviation.

All the cases were treated by the same surgeon, with the exception of case no. 15. As shown in Table 2, the total number of operations was 18 on 17 cases because a severe case (no. 12) required an additional operation 3 months after the initial treatment.

The degree of deviation was measured with the synoptophore: the fixing eye was on the unaffected side in the unilateral cases and on the right side in no. 15. All the cases were examined on several occa-

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Table 2. Surgical Procedures and Results in Primary Position*

Case No.	Side	Procedures	Amounts		Pre-op	Early (4 Weeks)	Post-op Late (Months)	Effects (4 Weeks)		
			Rc/Rs (mm)	NT/TT (Muscle Width)				Vertical	Intorsional	Diplopia
1	L	IR−NT−Rc	2	1	−2 R/L 5 ex 8	+2 L/R 1 0	+2 L/R 4 (4) 0	6	8	Improvement
2	L	IR−NT−Rc	2	1	+3 R/L 2 ex 8	+2 0 ex 2		2	6	Disappearance
3	R	IR−NT−Rc	3	1	−2 L/R 7 ex 15	+1 0 ex 5	+1 R/L 1 (5) ex7	7	10	Disappearance
4	R	IR−NT−Rc	4	1	+5 L/R 5 ex 11	+3 L/R 4 ex 6	+4 L/R 4 (5) ex 5	1	5	Improvement
5	R	IR−NT−Rc	4	1	0 L/R 8 ex 27	+2 0 ex 21		8	6	Improvement
6	R	IR−NT−Rc	5	1	+7 L/R 7 ex 9	+9 L/R 1 ex 5		6	4	Disappearance
7	L	IR−NT−Rc	5	1	−1 R/L 16 ex 7	+4 R/L 1 ex 1		15	6	Disappearance
8	R	IR−NT−Rc	0.5	half	+5 L/R 4 ex 4	+5 0 ex 1		4	3	Disappearance
9	L	IR−NT−Rc	2	half	+4 R/L 4 ex 4	+2 R/L 1 ex 1		3	3	Disappearance
10	L	SR−TT−Rc	3	1	−1 L/R 7 ex 14	+1 L/R 2 ex 1	+1 L/R 1 (6) ex 1	5	13	Disappearance
11	R	IR−NT−Rc	5.5	1	−5 L/R 10 ex 8	−1 L/R 1 ex 7		9	1	Improvement
12	R	IR−NT−Rc	3	1	+10 L/R 6 ex 26	+8 L/R 7 ex 15	+8 L/R 7 (3) ex 16	−1	11	Improvement
	R	SR−TT−Rs	4	1	+8 L/R 7 ex 16	+7 R/L 1 ex 8		6	8	Disappearance
13	L	IR−NT−Rc	5	1	+1 R/L 8 ex 10	+1 R/L 2 ex 1	+1 R/L 1 (4) ex 2	6	9	Disappearance
14	R	IR−NT−Rc	3	1	+3 L/R 8 ex 5	+4 L/R 2 ex 3	+5 L/R 2 (3) ex 2	6	2	Disappearance
15	R	IR−NT−Rc	4	1	−10 L/R 12 ex 11	−7 L/R 4 0	−7 L/R 1 (3) 0	8	11	Improvement
16	L	IR−NT−Rs	4	1	−4 L/R 8 ex 6	+4 0 0		8	6	Disappearance
17	R	IR−NT−Rs	5	1	+4 R/L 8 ex 9	+2 R/L 3 ex 10	+4 R/L 4 (3) ex 9	5	−1	Improvement

*R: right, L: left, IR: inferior rectus muscle, SR: superior rectus muscle, NT: nasal transposition, TT: temporal transposition, Rc: recession, Rs: resection, ex: extorsion.

sions before surgery, up to the postoperative period. To clarify the quantitative effects of the skew transposition procedures in peripheral directions, results of pre- and postoperative examinations were analyzed for a 4-week period in 7 cases with superior oblique muscle palsy (nos. 1 to 7) that received the nasal transposition (one full muscle width) and recession of inferior rectus muscle on unaffected side.

Results

All patients were able to inform us about the changes in diplopia during the intraoperative examinations. On the basis of this information, 2 cases with orbital trauma received modifications to the amount of transposition that was planned before surgery. It took 8–40 (average; 17) minutes in total for the surgical procedures and the examinations. No case showed worsening of the diplopia outside the primary position, nor were there occurrences of any complications.

Results are shown in Table 2. After the first operation, the diplopia in the primary position disappeared in 10 cases, improved in the other 7: one of the 7, the one that received the second operation, was finally released from the diplopia.

The changes in both the vertical and excyclodeviations in the primary position were also demonstrated in Table 2. The vertical and excyclodeviations improved simultaneously in 16 of 18 operations. Of the other 2 cases, the first operation on no. 12 showed improvement in excyclodeviation only, whereas no. 17 improved in vertical deviation. The average correction in all 18 operations was 6.2°. The total extent of correction in the two operations on no. 12 was 18° of excyclodeviation and 7° of vertical deviation.

The stability of the effects in the 9 cases that were observed over 3 months after the operations is shown in Table 2. The observation period after the operations has been short; the longest observation being for only 6 months. No case showed aggravation of any of the deviations during this period.

The quantitative results for the horizontal, vertical, and torsional effects after the nasal transposition and recession of inferior rectus muscle are shown in Table 3.

The procedure showed a mild limitation horizontally in the supra-abductive position, but no effect in either the infraductive or the adductive position. This procedure has weakened two of the major functions of the inferior rectus muscle; infraduction in the abductive position and excycloduction in the adductive position.

Table 3. Effect of Nasal Transposition and Recession of Inferior Rectus Muscle on Unaffected Eye*

Direction and Degrees†	20° Adduction	0°	20° Abduction
Upper 20°			
Horizontal	0.0 ± 2.6	2.8 ± 2.9	3.9 ± 3.4
Vertical‡	0.8 ± 0.8	1.0 ± 0.9	1.3 ± 1.1
Torsional	4.3 ± 2.2	5.3 ± 2.1	4.0 ± 3.7
0°			
Horizontal	1.1 ± 1.7	3.1 ± 2.5	3.3 ± 2.6
Vertical‡	1.2 ± 1.0	1.8 ± 1.0	2.1 ± 1.6
Torsional	6.1 ± 2.4	6.4 ± 2.0	3.9 ± 1.9
Down 20°			
Horizontal	0.0 ± 1.8	1.6 ± 2.3	1.9 ± 2.3
Vertical‡	1.6 ± 1.1	1.9 ± 1.1	1.9 ± 1.6
Torsional	6.6 ± 1.5	4.9 ± 3.2	4.9 ± 3.2

*Average and standard deviation in each eye position. n = 7.
†Horizontal: Esodeviative, vertical: hyperdeviative, torsional: intorsional.
‡Per 1 mm of recession.

Discussion

The study demonstrates that the skew transposition procedures of vertical rectus muscles improved both excyclodeviation and vertical deviation simultaneously in most cases. Moreover, the quantitative results of the nasal transposition and recession of the inferior rectus muscle showed weakening of both infraduction and excycloduction. As shown in Figure 1, the skew transposition procedures are a combination of the resection/recession and the horizontal transposition of vertical rectus muscles. There has been no report on the quantitative analysis of both torsional and vertical effects of the combined procedure. Therefore, in this study we made a comparison between the skew transposition and the previous for the correction of either vertical or excyclodeviation.

The recession of the inferior rectus muscle on the unaffected side is an acceptable procedure to treat superior oblique muscle palsy.[3] Our previous study of the quantitative effects of the conventional recession on the inferior rectus muscle demonstrated that the amount of correction from the primary position of excyclodeviation was 3.7° and the vertical deviation was 1.3° per 1 mm of recession.[8] The nasal transposition and recession of the inferior rectus muscle in this study corrected exocyclodeviation (6.4° from the primary position) more effectively than the conventional recession.

In previous studies, the average correction for excyclodeviation was described as follows: 8.3° or 8.5° after the Harada-Ito procedure[2,3], 5.7° after nasal transposition of the inferior rectus muscle[5], and 8°

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after a combined transposition procedure of the inferior rectus muscle nasally and the superior rectus muscle temporally.[6] The average correction for excyclodeviations of all 18 operations in this study was 6.2°. This result for one-muscle surgery was similar to the horizontal transposition of one muscle. However, this may be less effective than the Harada-Ito procedure. The limitation of the effect might be one of the reasons that diplopia remained after the surgery in several cases. The two-step treatment of the skew transposition procedures showed a larger amount of correction of excyclodeviation than either the Harada-Ito procedure or the combination of horizontal transpositions of two muscles in the previous reports. Consequently, even in severe cases of excyclodeviation, the combination of skew transposition procedures may become a viable treatment.

In this study, diplopia in all 6 cases with restricted eye movement was improved after the skew transposition procedures: in 2 of the 6 cases modifications were made to the amount of transposition after intraoperative examinations. In cases with mechanical restriction, it is difficult to treat on the basis of quantitative experience, because each of the situations is different. Therefore, the intraoperative examination is important to obtain a result that is more satisfactory.

Parks and Hamtil[9] advocated principles of treatment for cyclovertical strabismus: the surgeon's objective must be simultaneous improvement of the cyclo- and vertical deviations. They stressed that surgery should be performed on only one muscle at a time to prevent overcorrecting. We believe that the skew transposition procedures are ideal for implementing these principles from the standpoint of their effectiveness and safety. In the future, we will present a further study on the stability of the effects of the procedures over a longer period.

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