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Original Paper

Studies on the Orthoptics for Intermittent Exotropia

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Abstract

Intermittent exotropia [X(T)] has various clinical aspects, such as the occurrence of strabismus despite the presence of underlying binocular single vision and postoperative recurrence. This paper discusses the orthoptics used in treating X(T) in order to reduce deviation.

Typical X(T) recurred four years after strabismus surgery, although the binocular function was still maintained. In recurring cases with a deviation of 20△ X(T) or more, V-type exotropia recurred despite surgical recession of the inferior oblique muscle. In 23 patients that used Uchida color lenses after surgery, it was noted that squinting disappeared in more than 93 % of the cases, and the angle of deviation decreased in 83 % of the patients. Botulinum therapy was administered in cases which showed surplus discharge from the lateral rectus muscle on EMG. As a result, exophoria was normalized in 6 (50 %) of 12 patients. From these results, it was concluded that because X(T) has various clinical aspects, careful planning for orthoptics is required.

Introduction

Intermittent exotropia [X(T)] has some mysterious aspects, such as the occurrence of strabismus despite the preservation of binocular function and postoperative restoration of eye position. It has not yet been concluded whether orthoptic training is effective for

X(T).

Many investigators have studied the etiology and features of X(T)[1)~5)], and their main findings include anatomical abnormalities of the extraocular muscles, abnormal refraction and binocular function, abnormal extraocular proprioception, reduced convergence function, and the presence of active divergence. However, there is no unified opinion due to the various clinical aspects of X(T). In this paper, we focus on therapeutic methods, with preference given to orthoptic training and botulinum injection rather than surgery. The orthoptics discussed here include not only traditional methods, but also all other methods of orthoptic management directed to normalize the eye position and binocular single vision.

Patients and Orthoptic Management

A total of 35 patients with X(T) who were observed for 5 years or longer after strabismus treatment (including surgery) were used as subjects. Ages at surgery ranged from 3 to 13 years (mean 7.2 years). Types of X(T) were: basic (26 patients), convergence insufficiency (3), pure divergence excess (3), and simulated divergence excess (3). All of the patients had underlying binocular single vision. Oculomotor paresis due to a vascular lesion in the midbrain and exotropia due to form vision deprivation amblyopia were studied as pathologic controls. Deviation was measured using the prism alternate cover test and the +3.00 diopters (D) lenses test and the 30-minute occlusion test were performed to classify strabismus types.

Training regimens were decided according to the type of X(T). Thus, antisuppression training and fusion training were carried out for the basic type; diplopia recognized training, convergence training, and fusional amplitude training were selected for the convergence insufficiency type; and antisuppression training, antiabnormal retinal correspondence training, and fusion training were selected for the divergence excess type.

Therapeutic results were evaluated and categorized into the following 3 grades based on residual angles: good for phoria, fair for 18△ X(T) or less, and poor for 20△ X(T) or more.

Results

The therapeutic results of typical X(T) and non-typical X(T), which was used as the pathological control, are described below:

1) Typical X(T)

(1) Therapeutic Results of Orthoptics

The therapeutic results of typical X(T) are shown in Table 1. Good, fair, and poor therapeutic responses were observed in 13, 11,

Table 1 Therapeutic Results of Typical X(T) : 5-Year Follow-Up

X(T) type	cases	good (+ ~ X)	fair (18△X(T)↓)	poor (20△X(T)↑)
Basic	26	7	11	8
Conv. Insuff.	3	1	0	2
Div. Excess true	3	2	0	1
simulate	3	3	0	0
Total	35	13	11	11

Conv. Insuff.: Convergence insufficiency
Div. Excess: Divergence Excess

and 11 patients respectively. The 13 patients with good response included 7 of the basic type, 1 of the convergence insufficiency type, 2 of the pure divergence excess type, and 3 of the simulated divergence excess type. The 11 patients having a deviation of 18△ X(T) or less, classified as a fair response, were all the basic type. Poor responses, determined by a deviation of 20△ X(T) or more, were observed in 11 patients, including 8 of the basic type, 2 of the convergence insufficiency type, and 1 of the pure divergence excess type. A recurrence was observed with all types of strabismus. When recurrence of pathological factors in patients with poor responses (a deviation of 20△ X(T) or more) were analyzed, recurrence occurred in 91 % of V-type X(T), despite recession surgery of the inferior oblique muscle having been performed on all patients. Convergence insufficiency was observed in 45 %.

In comparing long-term therapeutic course, it was found that X(T) recurred 4 years after surgery in more than half of the patients with stereopsis of 40 seconds. On the other hand, in patients with infantile esotropia which is thought to have a poor therapeutic prognosis, the number of patients acquiring stereopsis of 60 seconds increased each year after surgery, which is different than the results from those seen in X(T)[6)~8)] (Table 2).

(2) Therapeutic Effect with Uchida Color Lens

Uchida color lenses are spectral-specific

Table 2 Infantile Esotropia, Acquisition Rate of Binocular Single Vision, and Recurrence Rate of Strabismus by Years of X(T)

Post surg. (year)	Inf. ET Titmus 60 sec. (%)	X(T) Deviation (+~X) (%)
1	23	71
2	27	69
3	40	63
4	43	46
5	53	38

Inf. ET: Infantile Esotropia

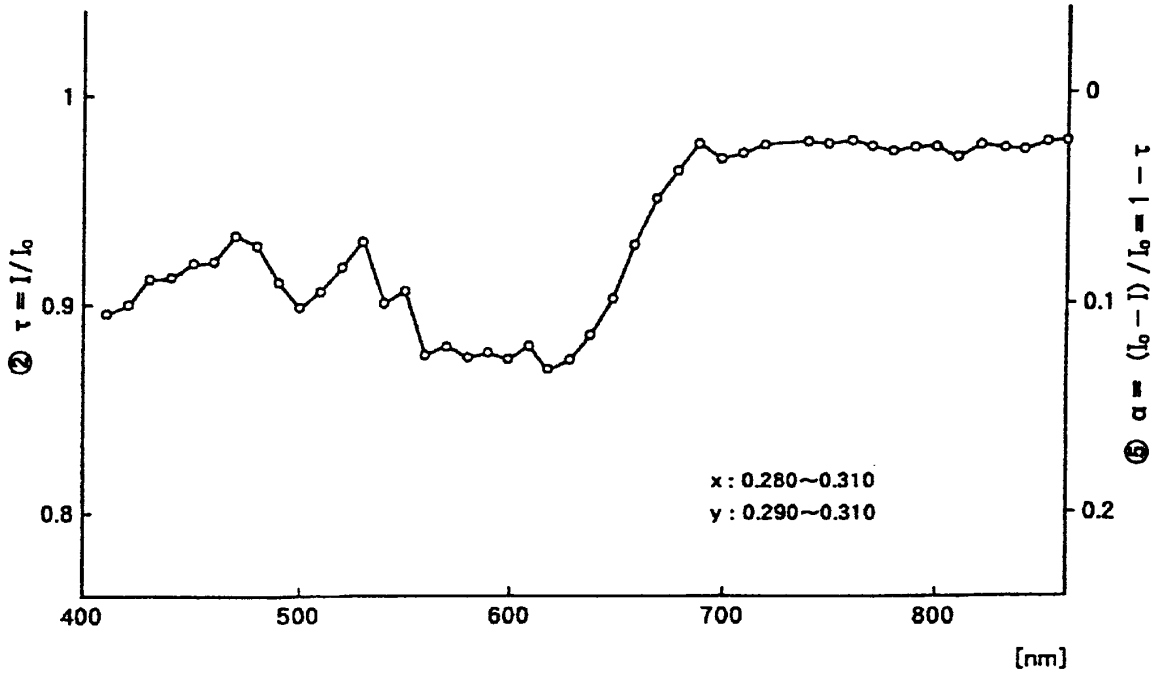

Fig. 1 Curve of Spectral Transmission of Uchida Color Lenses

filters having an absorption region (cut region) of 555-600 (620) nm, x 0.280-0.310, y 0.290-0.310, and color difference 0.3 (Fig. 1). There are 4 types of lenses with different luminous transmittance, 50 %, 75 %, 85 %, and 90 %. An appropriate luminous transmission lens is selected according to the degree of deviation[9].

Uchida color lenses were used in 23 patients with residual exotropia for 1-3 years following strabismus surgery. These patients were divided into group 1 (G1) with a deviation of 18△ X(T) or less (9 patients), and group 2 (G2) with a deviation of 20△ X(T) or more (14 patients). Before application of color lenses, all patients in both G1 and G2 tested positive for squinting. Squinting disappeared in 100 % of G1 and 93 % of G2 within 6 months to 1 year of using Uchida color lenses. Furthermore, 55 % of G1 patients with an angle of deviation of 10△ or less showed a decrease in deviation, whole 58 % of those in G2 at 10△ or more also decreased. Consequently, angles of deviation decreased in 93 % of the subjects in both G1 and G2 (Table 3).

Table 3 Results of Application of Uchida Color Lenses

X(T)	G1 (9cases)	G2 (14cases)
Symptom	18△X(T)↓	20△X(T)↑
no change	3 (33 %)	1 (7 %)
10△↑	1 (12 %)	8 (57 %)
10△↓	5 (55 %)	5 (36 %)
squinting	100 % cure	93 % improved

(3) Results of Treatment with Botulinum Toxin

Botulinum therapy was performed on 12 patients with X(T) who showed surplus discharges from the lateral rectus muscle on EMG. Orthophoria became exophoria in 6 of the 12 patients (50 %). A representative case, showing improvement of eye position using this therapy, is described below.

In this case, we have a 33-year-old man who developed strabismus at the age of about five. Prior to treatment, pseudomyopia

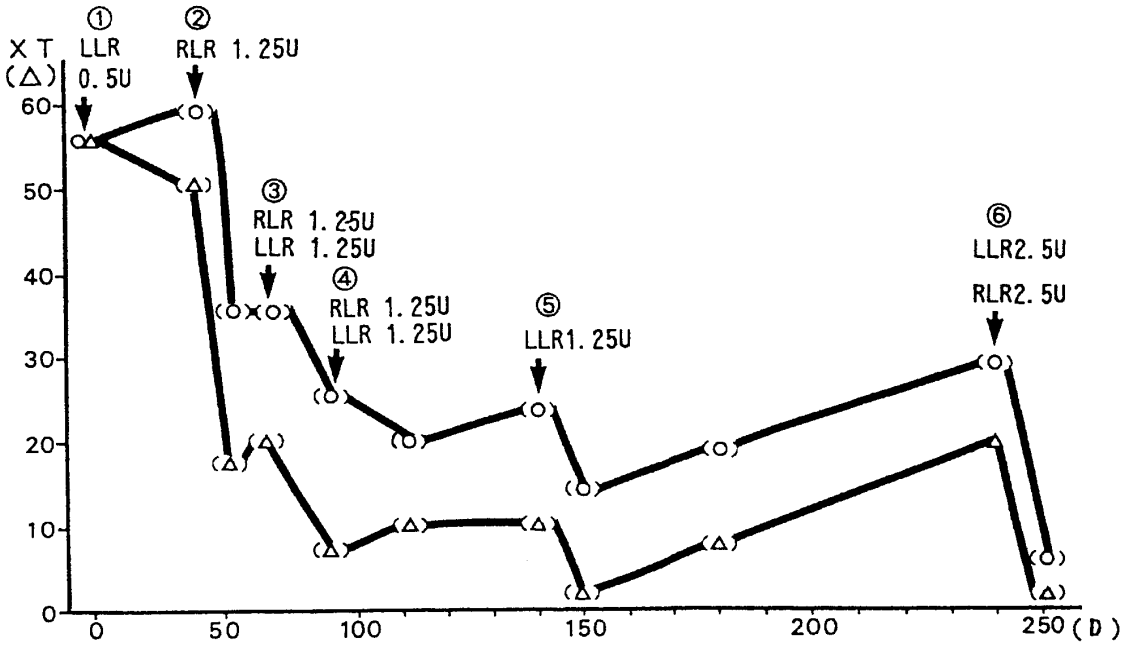

Fig. 2 Changes in Eye Positions of X(T) by Botulinum Therapy

(Seaber, 1966), dual retinal correspondence, and 40 seconds stereopsis were observed. As for eye movement, overaction was noted, particularly in the lateral rectus muscle of left eye. The state of improvement of eye position is shown in Fig. 2. When botulinum at 0.5 U was injected into the causative muscle (lateral rectus muscle of the left eye) for the first time, there were no changes. One month later, 1.25 U of the toxin was injected into lateral rectus muscle of the fixing eye, causing the angle of strabismus to decrease by 25-39△. However, recurred, and the toxin was injected a total of 6 times. At present, the patients near and distant vision are measured at 6△ X(T) and 4△ X(T), respectively.

2) Non-Typical X(T)

(1) Case of Oculomotor Paresis

A case of oculomotor paresis due to a vascular lesion in the midbrain is described here as a pathological control[10]. The patient was a 22-year-old male college student, who noticed diplopia the day after he had drunk 1 or 2 bottles of whiskey (June 7, 1988). After precise neuro-ophthalmological examination a 4-stage strabismus therapy program was initiated for the purposes of training as follows:

Stage 1: Saccadic eye movement and convergence training were performed in order to reduce muscular paresis and to prevent spasms of the antagonist muscles. As a result, horizontal and vertical eye movements showed improvement of 10 to 20 degrees and convergence up to 20 cm was achieved.

Stage 2: Hypertropia was treated with fusion lock training convergence-fusion training using a prism. Although the orthoptic training reduced the deviation by 20-30△, orthophoria could not be achieved.

Stage 3: Recession of the right lateral rectus muscle and resection of the right medial rectus muscle were performed as surgical orthoptics. After this operation, the eye position improved somewhat.

Stage 4: Fusional amplitude training was performed to stabilize the postoperative eye position, and strabismus completely disappeared.

(2) Constant Exotropia Associated with Form Vision Deprivation Amblyopia

Although exotropia following the onset of amblyopia is said to have a poor prognosis, it has been reported that long-term orthoptic management provides satisfactory results with improvement in X(T) shown in some cases[11]. We observed the course of this disease for 5-6 years on average, using 17 patients with X(T) associated with form vision deprivation amblyopia (age 3-17, mean of 7.9 years) as subjects. A good titmus score of 60 seconds or more was observed in 6 patients (35%); 1-8 years of therapy were necessary to achieve this score. Eye positions were determined to be exophoria in 4 patients and X(T) in 2, and their crowded vision was 1.0.

Discussion

We obtained satisfactory therapeutic results through mentioned above strabismus surgery and the orthoptics methods, as well as Uchida color lens training and botulinum therapy. At the 5th International Orthoptic Congress in 1983[12], Uchida reported on the effectiveness of blue gray lenses on a certain type of X(T), which is characterized by the angle of deviation markedly increasing in natural light, but becoming orthophoria in a darkened room. Uchida color lenses are indicated for this type of X(T). Mitsui et al.[5][13] reported that exotropia is induced by contractions of the lateral rectus muscle of the "slave eye" as a result of amplified proprioceptive impulses from the "master eye". As a clinical

phenomenon demonstrating this theory in X(T), the angle of strabismus deviates in a bright room, but this deviation decreases as the light stimulation to the master eye is reduced, and returns to normal in a darkened room.

In recent years, botulinum therapy has attracted our attention as a strabismus therapy[14)15)16)]. This method is reported to be particularly effective for strabismus with excessive contractions of the extraocular muscles[17)]. Fukai reported in 1972 that intravenous injection of amobarbital reduced the angle of strabismus by 10-20△ in some patients with exotropia[18)]. Since exotropia in such patients is often categorized as the divergence excess type, it was assumed that this might induce exotropia. Kimura noted 3 types of exotropia based on EMG findings: surplus discharge of the lateral rectus muscle, balanced discharge of all four rectus muscles, and surplus discharge of both the right and left medial rectus muscles in order to maintain near sight in orthophoria[19)20)]. Exotropia with such lateral rectus dominance should be grouped with contracture strabismus, which suggests the effectiveness of botulinum therapy on this type of exotropia. From the mechanics of botulinum therapy, we can infer that strabismus in X(T) may occur with contracture of the lateral rectus muscle, and that exotropia appears when the strength of contracture exceeds fusion and convergence. Namely, X(T) depends on the fight between active convergence, active divergence, and fusion.

Oculomotor paresis, described as non-typical X(T) in this report, is a constant exotropia of a definite origin—an acquired lesion of the medial rectus part of the oculomotor nucleus. This type of exotropia can be improved to X(T) using orthoptics, and then completely cured with strabismus surgery. This case gives many clues about the mechanics of cure for X(T).

Exotropia associated with form vision deprivation amblyopia, which is also non-typical, has a different etiology from common exotropia. In one case, using the EMG, we observed low amplitudes of discharges from the medial rectus muscle of the exotropic eye (Fig. 3). This case showed not only visual disturbance due to stimulus deprivation of one eye, but also anopsia of convergence action was in the developmental stages, suggesting exotropia occurrence by convergence action deficiency. These cases were non-typical, but served as useful pathological controls because their exotropia started with the disturbance of input, or visual activity.

Conclusion

X(T) is a disease with a strange phenomenon: exotropia occurs while binocular single vision is seemingly preserved. Thus ordinal orthoptics are not always effective, and future orthoptic treatment of X(T) should be conducted with careful consideration to various factors, such as power of convergence, power of divergence, and power of bifoveal fixation. Binocular single vision and eye position are thought to be largely controlled by the balance between cortex, brainstem, and extraocular muscles.

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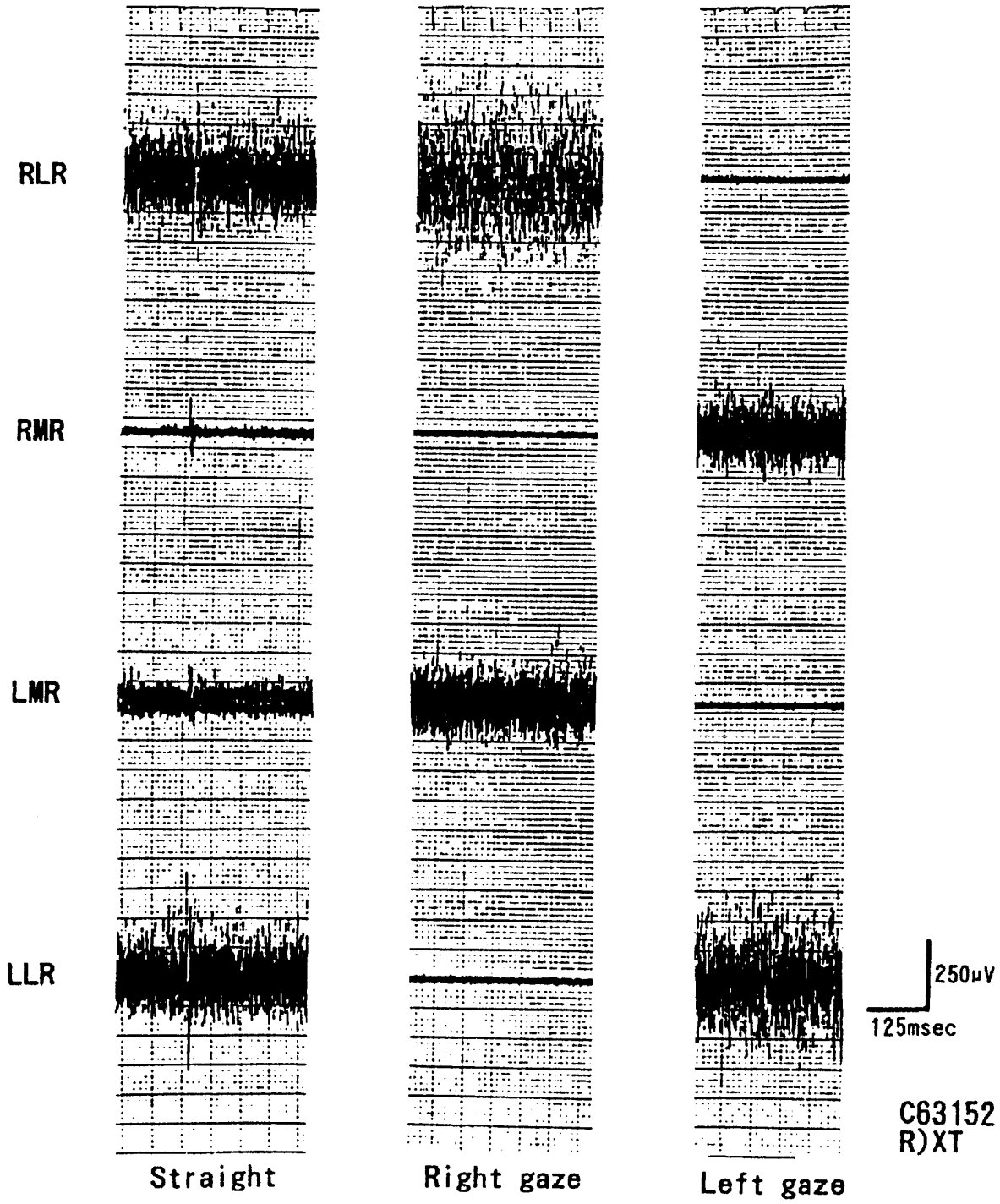

Fig. 3 Electromyogram of Constant Exotropia Associated with Form Vision Deprivation Amblyopia

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