

# Consecutive Esotropia in Intermittent Exotropia Patients with Immediate Postoperative Overcorrection More Than 17 Prism Diopters

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**Purpose:** To report the incidence and the factors of consecutive esotropia (ET) in patients with immediate postoperative overcorrection of at least 17 prism diopters (PD) after surgery for intermittent exotropia (X(T)).

**Methods:** Four-hundred-five patients under the age of 18 were included in this study. They underwent bilateral lateral rectus recession (LROU-rec) or unilateral recession-resection (R&R) for X(T). On postoperative day one, the patients with at least 17 PD overcorrection were classified as group 1 and those with less than 17 PD as group 2. Age, refractive error, type of surgery, lateral incomitancy, and the incidence of consecutive ET were analyzed for each group.

**Results:** Group 1 consisted of 116 patients (28.6%) and group 2 consisted of 289 (71.4%). At the six-month follow-up visit, consecutive ET had developed in 16 patients (13.8%) in group 1, and in five patients (1.7%) in group 2 ( $p < 0.001$ ). The occurrence of consecutive ET was not related to age at the time of surgery ( $p = 0.46$  in group 1 ;  $p = 0.54$  in group 2), refractive error ( $p = 0.18$  in group 1 ;  $p = 0.08$  in group 2), or the type of surgery ( $p = 0.69$  in group 1 ;  $p = 1.00$  in group 2). The incidence in group 1 was 23.8% in patients with lateral incomitancy and 8.1% in patients without lateral incomitancy ( $p < 0.05$ ). In group 2, the incidence was 4.4% in patients with lateral incomitancy and 0.5% in patients without lateral incomitancy ( $p = 0.04$ ).

**Conclusions:** Consecutive ET developed in 13.8% of patients with immediate overcorrection of at least 17 PD. Lateral incomitancy was the most important risk factor.

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**Key Words:** Consecutive esotropia, Intermittent exotropia, Lateral incomitancy, Overcorrection

While intermittent exotropia (X(T)) recurs in 20~30% of patients after surgery,<sup>1-11</sup> consecutive esotropia (ET) arises in 2~20% because of overcorrection.<sup>12-16</sup> Once consecutive ET has occurred, the patient can suffer from cosmetic problems and diplopia. Moreover, suppression, amblyopia, and deterioration of stereovision may occur later.<sup>17</sup>

Lateral incomitancy, medial rectus muscle contracture, and overcorrection of at least 20 prism diopters (PD) immediately after surgery have been reported as risk factors for consecutive ET.<sup>9,11,15,18,19</sup> Many studies reported that

overcorrection of 11~20 PD immediately after surgery was optimal for the prevention of consecutive ET.<sup>6,9,11,16</sup> Raab and Parks<sup>4</sup> suggested that in cases of overcorrection that exceeds 17 PD, the occurrence of consecutive ET increased. Kim and Hwang<sup>20</sup> reported that 6% of patients who have had overcorrection over 20 PD developed consecutive ET.

The purpose of this study was to investigate the incidence and factors in the development of consecutive ET in patients with immediate postoperative overcorrection of at least 17 PD after surgery for X(T).

## Materials and Methods

Medical records were reviewed for 405 X(T) patients who underwent LROU-rec or R&R performed by one surgeon at Anam Hospital at Korea University between January 1998 and December 2004. Patients who met the following criteria were excluded in the study: those with previous strabismus surgery, a combination of vertical or oblique muscle surgery,

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postoperative follow-up less than six months, and no overcorrection (undercorrection or orthotropia) immediately after surgery.

Preoperative examination involved assessing visual acuity, the amount of exodeviation, version and duction, stereovision, and fundus examination. The amount of surgery performed was based on the degree of exotropic deviation at distant gaze and, was measured using the prism cover test. In cases involving uncooperative children, the Krimsky method with angle kappa correction was used.

Patients were grouped into two categories: group 1 contained those with an overcorrection of at least 17 PD immediately after surgery, while group 2 contained those with an overcorrection, less than 17 PD. Consecutive ET was defined as esodeviation over 10 PD at six months or more post-operatively. Alternate patching therapy or a Fresnel lens was used for consecutive ET. If ET could not be controlled by these therapies, patients underwent reoperation.

To determine the risk factors for consecutive ET, the patient's age, refractive error, type of surgery, deviation angle, and lateral incomitancy were analyzed for each group. Lateral incomitancy was defined as a condition in which the angle of exotropia for lateral gaze was 20% or less than the angle for primary gaze.

Pearson's chi-square test was used for statistical analysis.

**Results**

The results of 405 patients were analyzed for this study.

Two-hundred forty-eight (61.2%) patients were female, and 157 (38.8%) patients were male. Fifty-seven (14.1%) patients were under four years of age, 223 (55.0%) patients were between 5 and 8 years of age, 117 (28.9%) patients were between 9 and 12 years of age, and 8 (2.0%) patients were between 13 and 17 years of age. The mean follow-up duration for all patients was 3.3±2.7 years (range, six months to six years).

Group 1 consisted of 116 patients (28.6%) and group 2 consisted of 289 (71.4%). The mean angle of ET at postoperative day one was 21.8±4.5 PD in group 1, and 10.7 ±4.3 PD in group 2 (Table 1). Consecutive ET developed in 16 patients (13.8%) in group 1, and five patients (1.7%) in group 2 at the six month follow-up (p<0.001) (Table 2).

Overcorrection of at least 17PD developed in 16 patients (28.1%) under four years of age (n=57) and in 100 patients (28.7%) 5 to 17 years of age (n=348). The incidence of consecutive ET in group 1 was 18.8% in those under four years of age and 13.0% in those 5 to 17 years of age. The incidence of consecutive ET in group 2 was 2.4% in patients under four years of age and 1.6% in those 5 to 17 years of age (Table 3).

According to refractive errors, the following patients were classified into group 1: 31 (30.0%) myopic patients (n=107) with refractive values at more than -1.00 diopters (D), 62 (30.0%) emmetropic patients (n=209) with refractive values between -1.00 D and +1.00 D, and 23 (25.8%) hyperopic patients (n=89) with refractive values more than +1.00 D. Consecutive ET developed, in group 1, in 22.6% of myopic

**Table 1.** Immediate postoperative esotropia in intermittent exotropia

Esoangle at POD <sup>†</sup> 1	No. of patients (%)	Mean±SD* PD (Range)	
		Postoperative esoangle	Preoperative exoangle
≥ 17 PD	116 (28.6)	21.8±4.5 (17-35)	28.6±5.6 (20-55)
< 17 PD	289 (71.4)	10.7±4.3 (1-16)	29.0±4.9 (16-43)

\* SD: standard deviation.

† POD: postoperative day.

**Table 2.** Incidence of consecutive esotropia according to immediate postoperative esotropia

Esoangle at POD 1	No. of patients		Incidence (%)
	Consecutive esotropia	Total	
≥ 17 PD	16	116	13.8
< 17 PD	5	289	1.7
Total	21	405	5.2

p<0.001

**Table 3.** Incidence of consecutive esotropia according to age at surgery

Esodeviation at POD 1	Age at surgery (years)	No. of patients		Incidence (%)	p-value
		Consecutive esotropia	Total		
≥ 17 PD	≤ 4	3	16	18.8	0.46
	> 4	13	100	13.0	
< 17 PD	≤ 4	1	41	2.4	0.54
	> 4	4	248	1.6	

patients with refractive values at more than -1.00 D, as well as in 11.3% of emmetropic patients with refractive values between -1.00 D and +1.00 D, and in 8.7% of hyperopic patients with refractive values greater than +1.00 D. In group 2, consecutive ET developed in 5.3% of myopic patients with refractive values at more than -1.00 D, in 0.0% of emmetropic patients with refractive values between -1.00 D and +1.00 D, and in 1.5% of hyperopic patients with refractive values more than +1.00 D (Table 4).

Fourteen patients (24.1%) who underwent unilateral recession-resection (R&R) (n=58), and 102 patients (29.4%) who underwent bilateral lateral rectus recession (LROU-rec) comprised group 1 (n=347). Consecutive ET occurred in group 1 in 7.1% of patients who underwent R&R and in 14.7% who underwent LROU-rec. In group 2, no patients who underwent R&R developed consecutive ET, but 2.0% who underwent LROU-rec did (Table 5).

With regards to lateral incomitancy, overcorrection of at least 17PD occurred in 42 patients (31.8%) in the lateral incomitancy group (n=132), and in 74 patients (27.1%) in the other group (n=273). The incidence of consecutive ET was 23.8% in patients with lateral incomitancy and 8.1% in patients without lateral incomitancy in group 1 (p<0.05). In group 2, the incidence was 4.4% in patients with lateral incomitancy and 0.5% in patients without lateral incomitancy (p=0.04) (Table 6).

## Discussion

In prior studies, the incidences of consecutive ET after surgery for X(T) varied. Cho and Yoo<sup>13</sup> reported that the incidence was 2.6%; in the Richard and Parks<sup>11</sup> study, the incidence was 6%; in the von Noorden study,<sup>3</sup> 11%; Pratt-Johnson et al.<sup>14</sup> 15%; and in Park et al.<sup>15</sup> 25%. In this study, consecutive ET developed in 21 (5.2%) of 405 patients who underwent X(T) surgery, with a minimum of six months of follow-up. Strict postoperative patching therapy may explain this relatively low rate of developing consecutive ET.

Parks<sup>4</sup> said that the overcorrection of at least 17 PD immediately after surgery was a risk factor for consecutive ET. Overcorrection inhibits the recurrence of exotropia and makes long-term maintenance of orthotropia possible. The optimal amount of overcorrection differs from investigator to investigator, but it is known that the overcorrection must not generally exceed 20 PD.<sup>4,6,9,11,21</sup> Kim and Hwang<sup>22</sup> reported that consecutive ET arose in 16% of the overcorrected patients with over 20 PD. In this study, 21.1% of the overcorrected patients with over 20 PD developed consecutive ET.

We chose 17 PD as a criterion for this study according to Park's suggestion. The incidence of consecutive ET in 17 PD or more in the overcorrected group was significantly higher than that of overcorrection less than 17 PD.

**Table 4.** Incidence of consecutive esotropia according to the refractive error

Esodeviation at POD 1	Refractive error	No. of patients		Incidence (%)	p-value
		Consecutive esotropia	Total		
≥ 17 PD	< -1.00D	7	31	22.6	0.18
	-1.00~+1.00D	7	62	11.3	
	> +1.00D	2	23	8.7	
< 17 PD	< -1.00D	4	76	5.3	0.08
	-1.00~+1.00D	0	147	0.0	
	> +1.00D	1	66	1.5	

**Table 5.** Incidence of consecutive esotropia according to the type of surgery

Esodeviation at POD 1	Type of surgery	No. of patients		Incidence (%)	p-value
		Consecutive esotropia	Total		
≥ 17 PD	R & R*	1	14	7.1	0.69
	LROU recession	15	102	14.7	
< 17 PD	R & R	0	44	0	1.00
	LROU recession	5	245	2.0	

\* R&R: recession and resection.

**Table 6.** Incidence of consecutive esotropia according to lateral incomitancy

Esodeviation at POD 1	Lateral incomitancy	No. of patients		Incidence (%)	p-value
		Consecutive esotropia	Total		
≥ 17 PD	+	10	42	23.8	0.05
	-	6	74	8.1	
< 17 PD	+	4	90	4.4	0.04
	-	1	199	0.5	

Pratt-Johnson et al.<sup>14</sup> and Knapp<sup>21</sup> obtained higher success rates when surgery was performed in those under four years of age. Early surgery may inhibit amblyopia and reinforce the tendency to deviate. On the other hand, Jampolsky<sup>2</sup> and von Noorden<sup>3</sup> preferred late surgery (after seven years of age) for a better follow-up, precise measurement of deviation, and decreased incidence of amblyopia and suppression when an overcorrection occurred. Cho and Lee<sup>23</sup> reported that the incidence of consecutive ET was 10.8% in those under four years of age, and that this was higher than that of patients whose age was over five years. Richard and Parks<sup>11</sup> and Dunlop<sup>24</sup> found that age at the time of surgery was independent of the development of consecutive ET, as was demonstrated in this study. However, in our study the age distribution was not equal, so a larger study will be needed.

Some investigators believed that amblyopia or a high refractive error could be a risk factor for consecutive ET.<sup>15,25</sup> In this study, myopic patients over -1.00D had an increased tendency to develop consecutive ET, but it was not statistically significant.

While Keech and Stewart<sup>26</sup> concluded that the incidence of consecutive ET was not related to the type of surgery, Park et al.<sup>15</sup> reported that the incidence was higher in the LROU-rec group than in the R&R group. In this study, there was no relation between the incidence of consecutive ET and the type of surgery.

Moore<sup>27</sup> reported that consecutive ET rate eight times higher in the lateral incomitancy group than the other group, and Parks<sup>28</sup> reduced the amount of recession or resection in cases with lateral incomitancy. In our study, the incidence of consecutive ET in group 1 was 23.8% in patients with lateral incomitancy and 8.1% in patients without lateral incomitancy. The incidence in group 2 was 4.4% in patients with lateral incomitancy and 0.5% in patients without lateral incomitancy. These results were both statistically significant.

In conclusion, consecutive ET developed in 13.8% of patients with immediate overcorrection of at least 17PD after X(T) surgery. Lateral incomitancy was the most significant risk factor.

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