

Postoperative outcomes of patients initially overcorrected for intermittent exotropia

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BACKGROUND

Esotropic overcorrection on postoperative day 1 after surgery for intermittent exotropia is generally thought to increase the likelihood of long-term satisfactory alignment; however, it is unclear why some patients who are initially overcorrected demonstrate recurrent intermittent exotropia whereas others maintain esotropic to orthotropic alignment.

METHODS

The records of all patients who underwent primary surgical correction of intermittent exotropia were reviewed; those with any degree of esotropia on postoperative day 1 were included. The status at the last visit was categorized as orthotropic to $<8^{\Delta}$ exotropia or having recurrent exotropia $>8^{\Delta}$, monofixational esotropia $<10^{\Delta}$, or esotropia $>10^{\Delta}$.

RESULTS

A total of 63 patients met the inclusion criteria. The mean postoperative day 1 alignment was $6^{\Delta} \pm 3^{\Delta}$ esotropia at distance and $5^{\Delta} \pm 3^{\Delta}$ esotropia at near. At the last visit, 31 (49%) were orthotropic to $<8^{\Delta}$ exotropia, 26 (41%) had recurrence of exotropia $>8^{\Delta}$, and 6 (10%) had monofixational esotropia $<10^{\Delta}$. There was no significant difference between outcome groups in onset age, age at surgery, stereopsis, deviation (preoperatively or on postoperative day 1), or follow-up length. Risk factor analysis revealed no association between exotropia type, surgical approach, or postoperative day 1 alignment and risk of recurrent intermittent exotropia or monofixational esotropia, although there was a trend toward recurrent intermittent exotropia in those least overcorrected.

CONCLUSIONS

Recommended overcorrection on postoperative day 1 for intermittent exotropia can result in esotropia, intermittent exotropia, or orthotropia. The results of overcorrection for exotropia are variable and unpredictable. We were unable to determine associations with the recurrence of exotropia or secondary esotropia. (J AAPOS 2011;15:527-531)

Opinions on the optimal indications, timing, and general approach to the surgical management of intermittent exotropia vary widely; however, most clinicians agree that the initial postoperative alignment should be targeted to an esotropic overcorrection.¹ Although the advantage to early overcorrection has been ascribed either to the induction of diplopia and stimulation of fusional vergences^{2,3} or to moving patients out of their previously induced temporal suppression scotoma,⁴ neither of these explanations necessarily implicate an amount of esotropia required to stimulate these changes. Initial overcorrection has been shown to provide the best long-term results, but it is still not clear whether the amount of initial overcorrection has a role in determining surgical success.^{5,6} Raab and Parks⁶ found good outcomes for bilateral lateral rectus muscle recession with overcorrection of

0^{Δ} to 10^{Δ} but even better outcomes with overcorrection of 10^{Δ} to 20^{Δ} . Scott and colleagues⁷ suggested 4^{Δ} to 14^{Δ} of overcorrection in bilateral lateral rectus muscle recession, and McNeer⁸ recommended overcorrecting 0^{Δ} to 10^{Δ} . When the approach is a unilateral recession-resection procedure, Parks⁹ suggested only a few prism diopters of overcorrection, while Souza-Dias and Uesugui¹⁰ suggested 5^{Δ} to 10^{Δ} of esotropia. In this study we evaluated surgical outcomes in a large population of patients with intermittent exotropia who were initially overcorrected with any amount of esotropia on postoperative day 1. Our goal was to determine whether the amount of esotropia on postoperative day 1 played a role in long-term stability of the intermittent exotropia or in the development of a permanent and potentially stereopsis-threatening esotropia.

Methods

This study was approved by the University of California Los Angeles Institutional Review Board and conformed to the requirements of the United States Health Insurance Portability and Accountability Act. The clinical records of all patients who underwent surgical correction of intermittent exotropia by a single surgeon (Arthur L. Rosenbaum, MD) between the years of 1996 and 2008 were retrospectively reviewed. Those subjects who had at least 6 months of postoperative follow-up and demonstrated any amount of esotropia on postoperative day 1 (after

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suture adjustment when applicable) were included in the analysis. For patients with adjustable sutures, the postoperative day 1 alignment goal was an esotropia between 5^{Δ} to 10^{Δ} . Patients were excluded if there was any history of previous strabismus surgery, coexistent surgery for a vertical deviation, neurological deficit, or coexistent restrictive or parietic strabismus. All subjects who were orthotropic or exotropic on postoperative day 1 were excluded from the analysis.

The following preoperative characteristics were recorded from the patients' record: age at onset, age at surgery, best-corrected visual acuity, preoperative motor alignment at distance and near, stereoacuity at distance and near, and postoperative motor alignment on postoperative day 1. In addition, all subsequent surgical procedures and complications were noted. In general, visual acuity was assessed by use of projected age-appropriate optotypes after a manifest or cycloplegic refraction. Near stereopsis was assessed with the Titmus test. Distance stereopsis was tested with the Mentor BVAT System (Mentor Ophthalmics, Inc, Norwell, MA). Ocular alignment was assessed with cover-uncover and alternate prism cover testing at distance (20 feet) in the cardinal gaze positions. Motor alignment at near was assessed at 14 inches. All motor evaluations were performed with the use of spectacle correction.

Patients were classified as having a basic intermittent exotropia if the distance deviation was within 10^{Δ} of that at near. Divergence excess exotropia or pseudodivergence excess exotropia were defined as a distance deviation at least 10^{Δ} greater than that at near. Convergence insufficiency was defined as an exotropia at near at least 10^{Δ} greater than that at distance. Patients were considered to have lateral incomitance if the exotropia was at least 10^{Δ} different between central and lateral gazes.

Patients were divided into a final outcome group on the basis of their final postoperative examination or their final examination before any subsequent surgical procedures. The final outcome groups were as follows: (1) orthotropic $<8^{\Delta}$ exotropia, (2) recurrent exotropia $>8^{\Delta}$, (3) monofixational esotropia $<10^{\Delta}$, and (4) esotropia $>10^{\Delta}$.

Statistical analyses were performed with the statistical software STATA version 10.0 (StataCorp, College Station, TX) and Microsoft Excel (Microsoft Corporation, Redmond, WA). Preoperative characteristics were compared among outcome groups by the use of a Kruskal-Wallis test for continuous variables and the Fisher exact test for categorical variables. In addition, postoperative day 1 alignment was analyzed by grouping patients by postoperative day 1 alignment ($<5^{\Delta}$ esotropia, 5^{Δ} to 10^{Δ} esotropia, or $>10^{\Delta}$ esotropia) and comparing final outcome with the Fisher exact test.

Results

A total of 63 patients met the inclusion criteria. Of these, 31 (49%) were orthotropic to $<8^{\Delta}$ of exotropia, 26 (41%) had recurrent exotropia $>8^{\Delta}$, and 6 (10%) had a monofixation range esotropia at the last visit. No patients had an esotropia $>8^{\Delta}$. The mean age of the subjects at the time of exotropia onset was 4.9 ± 10.0 years, and the mean age at surgery was 12.5 ± 17.4 . The mean follow-up

was 39 ± 38 months; the mean follow-up was 49 ± 47 for the recurrent orthotropic $<8^{\Delta}$ exotropia group, 33 ± 31 for the recurrent exotropia $>8^{\Delta}$ group, and 17 ± 17 months for the esotropia group. There was no significant difference among outcome groups in age of onset or age at surgery (Table 1), although there was a trend toward worse outcomes in subjects with a younger age of onset (2.4 ± 2.1 years for secondary esotropia and 2.6 ± 4.5 for recurrent exotropia groups vs 4.9 ± 10.0 years for the orthotropic to <8 exotropia group).

At the preoperative examination, diplopia was present in 10 of the 63 patients. Amblyopia was present in 7 patients and attempts had been made to treat the amblyopia before we resorted to surgery in all cases. The visual acuity of the amblyopic eye at the time of surgery ranged from 20/25 to 20/40. Lateral incomitance was present in 7 patients. There was no significant difference in the percent of subjects with preoperative diplopia, amblyopia, or lateral incomitance among outcome groups. The mean preoperative deviation at distance and near was not significantly different among groups (Table 1).

There was no significant association among outcome groups with respect to surgical procedure (Table 2). Likewise, the deviation on postoperative day 1 at distance and near was not significantly different among groups. There was a trend ($P = 0.2$) toward an increased risk of recurrent exotropia among patients who were the least overcorrected on postoperative day 1 (Table 3). The percentage of patients experiencing postoperative diplopia was lowest among patients with recurrent exotropia (7.7% vs 22.6% and 16.7%), yet this trend did not reach statistical significance. Prisms were used in the immediate postoperative period in 9 subjects (29%) in the orthotropic <8 exotropia group, 3 subjects (11.5%) in the recurrent exotropia group, and 1 subject (16.7%) in esotropic group. There was no significant difference in the immediate postoperative stereoacuity in the orthotropic to <8 exotropia, and recurrent exotropia, and esotropic groups (283 ± 228 vs 134 ± 138 vs 183 ± 171 arcsec, respectively, $P = 0.62$).

Discussion

Although overcorrection for intermittent exotropia is widely accepted as the optimal postoperative day 1 outcome, evidence has been brought forth suggesting that initial overcorrection may not be indicated. In a retrospective review of 89 patients undergoing surgery for divergence excess type exotropia, Koklanis and Georgievski¹¹ found that no single factor, including postoperative alignment, significantly influenced the final outcome in their patients. Hardesty¹² found a one-third "cure rate" for undercorrected patients in whom base-in prisms were used. Schlossman and colleagues¹³ found a high success rate in adults with undercorrections up to 14^{Δ} . Leow and colleagues¹⁴ found that in patients undergoing bilateral lateral rectus muscle recessions, initial postoperative alignment was not a good indicator of long-term success¹⁴; they observing

Table 1. Demographics and preoperative factors in patients undergoing surgery for intermittent exotropia: analysis for associations with different postoperative results

Factors (mean \pm SD)	Orthotropia $<8^{\Delta}$ XT (n = 31)	Recurrent XT $>8^{\Delta}$ (n = 26)	Monofixation range ET $<10^{\Delta}$ (n = 6)	P value ^a
Age of onset, years	4.9 \pm 10.0	2.6 \pm 4.5	2.4 \pm 2.1	0.24
Age at surgery, years	12.5 \pm 17.4	7.1 \pm 12.5	12.8 \pm 19.9	0.19
Pre-op diplopia, n (%)	5 (16.1%)	3 (11.5%)	2 (33.3%)	0.35
Pre-op near stereopsis, arcsec	261 \pm 657	88 \pm 59	60 \pm 40	0.56
Amblyopia, n (%)	4 (12.9%)	2 (7.7%)	1 (16.7%)	0.60
Pre-op distance deviation, PD	26.6 \pm 9.0	27.5 \pm 8.9	23.8 \pm 5.8	0.74
Pre-op near deviation, PD	22.4 \pm 13.5	20.0 \pm 14.3	12.2 \pm 11.1	0.23
Lateral incomitance, n (%)	3 (9.7%)	2 (7.7%)	2 (33.3%)	0.21
Exotropia type, n (%)				0.4
Basic	23 (74)	14 (54)	3 (50)	
Divergence insufficiency	7 (23)	11 (42)	3 (50)	
Convergence insufficiency	1 (3)	1 (4)	0	

ET, esotropia; PD, prism diopters; Pre-op, preoperative; SD, standard deviation; XT, exotropia.

^aKruskal-Wallis test for continuous variables and the Fisher exact test for categorical variables.

Table 2. Postoperative factors in patients undergoing surgery for intermittent exotropia: analysis for associations with different postoperative results

Factors (Mean \pm SD)	Orthotropia $<8^{\Delta}$ XT (n = 1)	Recurrent XT $>8^{\Delta}$ (n = 26)	Monofixation range ET (n = 6)	P value ^a
Surgical procedure, n (%)				0.33
LR recession	13 (42)	14 (54)	3 (50)	
Recession-resection	17 (55)	12 (46)	2 (33)	
MR resection	1 (3)	0	1 (17)	
Adjustable suture, n (%)	8 (27)	3 (12)	1 (17)	0.46
Post-op day 1 distance deviation, $^{\Delta}$ ET	5.9 \pm 4.0	4.5 \pm 3.6	6.3 \pm 5.6	0.28
Postoperative day 1 near deviation, $^{\Delta}$ ET	2.7 \pm 6.0	3.8 \pm 4.5	5.2 \pm 5.9	0.73
Post-op prism, n (%)	9 (29.0)	3 (11.5)	1 (16.7)	0.34
Post-op diplopia	7 (22.6)	2 (7.7)	1 (16.7)	0.25

ET, esotropia; LR, lateral rectus muscle; MR, medial rectus muscle; Post-op, postoperative; SD, standard deviation; XT, exotropia.

^aKruskal-Wallis test for continuous variables and the Fisher exact test for categorical variables.

Table 3. Comparison of final outcome by separate postoperative day one deviation groups

Post-op day 1 esotropia, n (%)	Orthotropia $<8^{\Delta}$ XT (n = 31)	Recurrent XT $>8^{\Delta}$ (n = 26)	Monofixation range ET (n = 6)	P value ^a
>10 ET (n = 7)	4 (57)	2 (29)	1 (14)	0.20
5-10 ET (n = 27)	17 (63)	8 (30)	2 (7)	
<5 ET (n = 29)	10 (35)	16 (55)	3 (10)	

ET, esotropia; Post-op, postoperative; XT, exotropia.

^athe Fisher exact test.

a larger exotropic drift occurring in patients who were initially esotropic or orthotropic rather than exotropic. Similarly, several other groups found no significant relationship between initial and final postoperative alignment.¹⁵⁻¹⁷ In contrast, there have also been groups that have found good correlation between immediate postoperative and final ocular alignments.^{3,14,18,19}

In our study population of patients who had any amount of esotropia on postoperative day 1, 26 patients (41%) had an intermittent exotropia of $\geq 8^{\Delta}$ at the last follow-up visit, whereas 6 (10%) had a monofixation range esotropia. There was no significant difference between the outcome groups in any parameter assessed, including initial distance or near deviation. In addition, risk factor analysis demonstrated no statistically significant association between postoperative day 1 alignment and the risk of monofixation

esotropia or recurrent exotropia. There was, however, a trend toward an increased risk of recurrent exotropia with postoperative day 1 alignment of 1^{Δ} to 5^{Δ} esotropia. We agree with Ruttum¹⁵ in his conclusion that that initial postoperative overcorrection is desirable in most cases but does not ensure a good outcome. We further assert that the amount of esotropia on postoperative day 1 does not necessarily predict long-term stability or the presence of a consecutive esotropia.

Although most surgeons agree that early overcorrection is a desirable outcome, there is concern about the danger of overcorrection in visually immature individuals or those who are still at risk of developing amblyopia and binocular suppression. Most investigators believe that intentional overcorrection should be avoided in children with immature systems because of the risk of developing a suppression

scotoma and an irreversible monofixation esotropia, which can lead to loss of stereopsis and amblyopia.^{1,2,20}

Recently, Morrison and colleagues²¹ found that a persistent small-angle esotropia at 2 months postoperatively was significantly associated with loss of near stereopsis. Of their study group, all patients who maintained or immediately improved their stereoacuity were either orthotropic or exotropic postoperatively.²¹ Ruttum¹⁵ noted that patients with long-term overcorrection all required at least one additional surgery despite the use of patching and prisms postoperatively. In a study of 68 patients with constant or intermittent exotropia initially overcorrected by 20^Δ or more, Kim and colleagues²² found that 5.9% needed a second operation, none had complete loss of stereoacuity, and only 2 developed amblyopia, both of whom responded to occlusion therapy. Taken together with our data, these studies may provide counterevidence to the widespread belief that overcorrection is recommended in all patient populations; however, visually immature and mature patients should not necessarily be considered equivalent in clinical practice, and we continue to believe that overcorrection is reasonable in visually mature patients given the findings of previous large studies and the lack of amblyopia and suppression risk.^{2,3}

Aside from postoperative alignment, many authors have attempted to characterize preoperative and postoperative predictors of surgical success. As pointed out by our group in the past, these studies are hindered by a lack of a standard length for follow-up and definition of surgical success.² In various studies, these factors have included age of onset,²³ amblyopia,²³ age at time of surgery,²³ refractive error,^{23,24} anisometropia,^{2,23} stereopsis,^{23,26} preoperative deviation,^{24,27} and type of surgery²³ as other important factors in the successful management of intermittent exotropia. Most of these findings, however, have not been corroborated by other studies. Long-term studies have revealed that follow-up length may be the most important factor in determining recurrence of exotropia.^{2,28}

The results of our study must be understood within the context of its limitations. First, this study was retrospective and is therefore subject to inherent bias, including selection bias and changes in surgical techniques and patient management over time. In addition, we did not quantify the effect of postoperative maneuvers often used to overcome undesirable outcomes such as patching or prism use because this was not the primary goal of the study. In addition, we did not differentiate true divergence excess from pseudodivergence excess patterns of exotropia as this was not consistently done in our clinical practice, especially in light of evidence that simulated divergence excess patients demonstrate good outcomes with bilateral lateral rectus muscle recessions.²⁹

Despite its limitations, this study provides evidence that the amount of initial postoperative esotropia may not predict surgical stability or undesirable outcomes such as esotropia and associated loss of stereopsis. Although we will continue to recommend postoperative

overcorrection, we do not anticipate that the amount of overcorrection will necessarily predict long-term outcome. We expect that future randomized, controlled trials for the treatment of intermittent exotropia will provide evidence to support specific treatments and postoperative alignment goals.

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