Long-term Surgical Outcomes of Augmented Bilateral Lateral Rectus Recession in Children with Intermittent Exotropia

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Abstract

**Purpose:** To compare the long-term surgical outcomes of augmented bilateral lateral rectus (BLR) recession with conventional surgery.

**Design:** Retrospective, non-randomized clinical study.

**Methods:** 447 children ≤ 35 prism diopters (PD) of basic and divergence excess-type intermittent exotropia, who underwent conventional BLR recession based on the largest angle measured at distance and near, or augmentation surgery with the surgical dosage augmented by 1.0 to 1.5 mm more than the conventional formula were included. Patients were observed for at least 2 years. Success rates, cumulative probabilities of success, factors related to recurrence and overcorrection were evaluated.

**Results:** At a mean follow up of 4.0 years, 48 (48%) of 101 patients undergoing conventional surgery maintained successful alignment within 10 PD of exophoria/tropia and 5 PD of esophoria/tropia; 49 (49%) had recurrence, and 3 (4%) had overcorrection. After augmented surgery, 203 (59%) of 346 patients were successfully aligned, 129 (38%) had recurrence, and 19 (4%) had overcorrection. Augmented surgery showed higher long-term successful alignment rates and lower recurrence rates compared to conventional surgery \((P = .047)\) and the overcorrection rate was similar between two groups \((P = .774)\). Patients with divergence excess-type showed higher cumulative success rates compared to that of the basic-type \((P = .010)\) after augmented surgery.

**Conclusion:** Augmented BLR recession resulted in more successful alignment and lower recurrence without higher overcorrection compared to the conventional surgery for the children with intermittent exotropia. Augmentation of the conventional table should be considered when planning BLR recession, especially in patients with
divergence excess-type.
Long-term Surgical Outcomes of Augmented Bilateral Lateral Rectus Recession in Children with Intermittent Exotropia

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Short title: Surgical outcomes of augmented bilateral rectus recession
Introduction
Exotropic drift is common after surgery for exotropia resulting in recurrence over time in many patients.\(^1-^6\) Reported success rates after bilateral lateral rectus (LR) recession in intermittent exotropia is highly variable ranging from 41% to 83%.\(^4-^14\) This variability comes from the various lengths of follow-up periods among the studies that was reflected by the increasing rate of recurrence as time passes.\(^5\)

Kushner\(^1^1\) suggested that increasing the amount of bilateral LR recession might be beneficial for patients with basic-type intermittent exotropia. Mims and Wood\(^1^5\) reported that they routinely added up to 1.0 mm as the near deviation approached the distance deviation in size. Since Lee et al\(^2\) first reported better surgical success rates with the augmented bilateral LR recession in exotropia, there have been two more studies. However, these studies included a small number of patients and the follow-up duration was short.\(^2,^1^6,^1^7\) Furthermore, the previous studies only included basic-type exotropia and no study compared surgical outcomes of augmented surgery according to type of exotropia.\(^2,^1^6,^1^7\)

In this study, we evaluated the long-term outcomes of augmented bilateral LR recession in a large number of subjects with intermittent exotropia who were followed-up for more than 2 years. Our goal was to determine whether augmented amounts of the recessed muscle could play a role in the long-term stability of exotropia by reducing the rate of late recurrence. In addition, surgical outcomes of original and augmented surgery were compared between different types of exotropia.
Methods
A retrospective review of medical records was performed on 447 consecutive patients who underwent surgery for intermittent exotropia ≤35 prism diopters (PD) by 1 surgeon (J-MH) between 1997 and 2013. The minimum required follow-up period after surgery was 24 months, except for patients who required reoperation within 24 months after the primary surgery. Patients younger than 3 years of age at the time of surgery or patients who had convergence insufficiency-type exotropia, histories of strabismus surgery, moderate to severe amblyopia, paralytic or restrictive strabismus, ocular disease other than strabismus, congenital anomalies, or neurologic disorders were excluded from our study. Patients with A or V patterns, dissociated vertical deviation, or oblique muscle overactions that did not require surgery were included. This study adhered to the Declaration of Helsinki, and the protocol was approved by the Institutional Review Board of Seoul National University Bundang Hospital.

Preoperative Ophthalmologic Examination
A prism and alternate cover testing with accommodative targets for fixation at 1/3 and 6 m was performed. An additional near measurement was obtained after 1 hour of monocular occlusion of the habitually deviating eye, and another post-occlusion near measurement was obtained with an additional +3.00 diopters (D) sphere over each eye prior to allow the patient to regain binocular fusion. In patients with hyperopia, glasses of approximately 1.00 to 1.50 D less than the full cycloplegic hyperopic refraction were given. We noted preoperative patient characteristics, including gender, age at surgery, deviation at distance and near, fixation dominance, presence of lateral incomitance, stereopsis, refractive errors, presence of amblyopia, anisometropia, A or V pattern, dissociated vertical deviation, vertical deviation, and superior oblique or inferior oblique overaction. The presence of fixation dominance was determined with repeated examinations of the cover-uncover test. Lateral incomitance was defined as ≥5 PD change in right or left gaze from the primary position. Refractive errors were determined using cycloplegic refraction with cyclopentolate hydrochloride 1% and analyzed as spherical equivalent values. Anisometropia was defined as a spherical or cylindrical difference of >1.50 D between the 2 eyes. Amblyopia was defined as a difference of 2 lines or more between monocular visual acuities and only mild amblyopia with a difference of 2 lines but the best corrected visual acuity of the worse eye was >20/40 were included. An A pattern was defined as an increase of ≥10 PD of exodeviation at down gaze compared with up gaze, and V pattern was defined as an increase of ≥15 PD of exodeviation at up gaze compared with down gaze. Stereaoacity of ≤100 seconds or arc (arcsec) with the Randot stereoaucity test was defined as good.

Intraoperative procedures
All surgeries were performed under general anesthesia by 1 surgeon (J-MH). Original bilateral LR recession was performed according to the Wright formula based on the largest angle of deviation measured during distance and near fixation. Augmentation surgery was performed in patients with the surgical dosage augmented by 1.0 mm to 1.5 mm than the original formula. The surgical table is presented in Table 1.

Postoperative measurements
Postoperative alignment at distance in the primary position was measured at 1, 6, 12 and 24 months postoperatively and afterward. Patients with diplopia associated with
postoperative esotropia were managed with alternating full-time patching for 1 to 4 weeks until diplopia resolved. If the esotropia did not reduce with alternate patching for 4 weeks, cycloplegic refraction was performed again, and hyperopia >+1.00 D was corrected. Patients without hyperopia of +1.00 D were prescribed base-out Fresnel press-on prisms (3M Health Care, St. Paul, Minnesota) to facilitate constant fusion. When it became evident that prisms would have to be worn for a number of months, prisms incorporated into regular spectacles are prescribed. An outcome as considered satisfactory if the distant deviation in the primary position was between ≤10 PD of exophoria/tropia and ≤5 PD of esophoria/tropia. Recurrence was defined as an alignment of >10 PD of esotropia, and overcorrection was defined as >5 PD of esotropia. Reoperation for overcorrected patients was performed if esotropia of >20 PD persisted or increased for 6 months after surgery. Reoperation for recurrent or residual esotropia was recommended for constant esotropia ≥14 PD at distance, despite treatment by nonsurgical means, such as part-time occlusion or minus-lens therapy in most patients.

**Main outcome measures**

Primary outcome measures included cumulative probabilities of success at 2 years after surgery and long-term surgical success rates based on postoperative alignment at distance, improvement in stereopsis, rates of recurrence and overcorrection. Subgroup analysis was performed according to the type of esotropia.

**Statistical Analysis**

Statistical analyses were performed using SPSS for Windows v 22.0 (SPSS, Chicago, Illinois). The independent t test, chi-square test and Fisher exact test were used to compare the patient’s characteristics and the surgical outcomes. Cumulative probabilities of success were assessed according to the Kaplan-Meier life-table analysis. Correlations between outcomes at each follow-up period were examined with McNemar-Bowker test and generalized estimating equation. The risk factors associated with recurrence and overcorrection after operation including age of onset, age of surgery, type of esotropia, sex, amount of preoperative exodeviation, refractive errors, type of surgery, surgical results at 1 month after surgery and existence of hypertropia over 5 PD, DVD, A or V pattern, oblique muscle dysfunction, lateral incomitance, fixation preference and preoperative stereoscopic status were estimated using univariate and multivariate analyses. P < 0.05 was considered statistically significant.
Results

Patient demographics
Among the 447 patients, 101 patients underwent original surgery and 346 patients received augmented surgery. The preoperative patient characteristics were not significantly different in the 2 groups except for the type of exodeviation and dissociated vertical deviation (DVD) (Table 2).

Surgical outcomes
At the final examination after a mean follow-up of 4.0 years, 48 of 101 (48%) patients in the original group had ocular alignment meeting the defined criteria of success, 49 (49%) patients had recurrence, and 3 (4%) patients had overcorrection (Table 3). In the augmented group, 203 of 346 patients (59%) had successful alignment, 129 patients (37%) had recurrence, and 14 patients (4%) were overcorrected.

Augmented surgery showed higher success rates compared to original surgery at 6 months ($P = .003$) after operation, and this was maintained until after 2 years ($P = .037$) and the final examination ($P = .047$). The recurrence rates were lower after augmented surgery at all follow-up periods up to 2 years ($P = .004$) and at the final examination ($P = .042$). The overcorrection rates were higher at 1 month after augmented surgery, however, it became comparable in both groups after 6 months. According to the amount of augmentation, 292 patients underwent augmentation by 1.0mm per muscle and 54 patients by 1.5mm per muscle, and there was no significant difference in successful alignment rates between 1.0mm and 1.5mm augmentation ($P = .604$).

The cumulative probabilities of success at 2 years after surgery were 52% in the original surgery group and 69% in the augmented surgery group, according to Kaplan-Meier life-table analysis (Figure 1). The estimated mean times to recurrence were 60.8±5.8 months in the original group and 72.9±3.0 months in the augmented group. The rates of recurrence per person-year were 19% and 13%, respectively.

Surgical outcomes according to the type of exotropia
In subgroup analysis regarding the type of exotropia, cumulative success rates after 2 years in basic-type exotropia were 52% after original surgery and 67% after augmented surgery ($P = .032$, log rank test). Cumulative success rates after 2 years in divergence excess-type exotropia were 59% after original surgery and 84% after augmented surgery ($P = .049$, log rank test). At 2 years after surgery, augmented bilateral LR recession was significantly more successful than the original bilateral LR recession in both types of exotropia. After augmented surgery, patients with divergence excess type-exotropia showed much higher cumulative success rates after 2 years (84%), compared to that of the basic-type (67%, $P = 0.010$, log rank test). Whereas in the original group, cumulative success rates after 2 years were similar in both types of exotropia (59% vs 50%, $P = 0.323$, log rank test).

Stereoacuity
Among the patients, 72 in the original group and 293 in the augmented group were able to be tested for stereoacuity at the preoperative and final examination. Good stereoacuity was present in 73% (66/91) in the original group and 76% (256/338) in the augmented group ($P = .530$) at the last follow-up examination. Improvement in stereopsis was found in 51% (37/72) in the original group and 54% (159/293) in the augmented group, which was not significantly different between both groups ($P = .661$). Stationary stereopsis was found in 19% (14/72) in the original group and
17% (50/293) in the augmented group. Decreased stereopsis was found in 29% (21/72) in the original group and 29% (84/293) in the augmented group. Consequently, postoperative sensory outcomes were similar between both groups (P= .933).

**Risk factors for recurrence and overcorrection**

The risk factors associated with recurrence or overcorrection after operation were evaluated. The type of surgery (original surgery) was the only significant risk factor associated with recurrence by univariate (P= .043) and multivariate (P= .037) analysis of variance. In contrast, overcorrection was not significantly associated with any risk factors, including the type of surgery in both groups. (P= .969). Factors including age of onset, age of surgery, type of exotropia, sex, amount of preoperative exodeviation, refractive errors, surgical results at 1 month after surgery, and existence of hypertropia over 5 PD, DVD, A or V pattern, oblique muscle dysfunction, lateral incomitance, fixation preference and preoperative stereoscopic status were not associated with recurrence or overcorrection by univariate and multivariate analyses.

**Discussion**

Our study compared the long-term outcomes of augmented bilateral LR recession with original surgery and concluded the following findings. First, augmented bilateral LR recession showed more successful results compared to original surgery by reducing the rate of recurrence not only at 6 months but up to more than 2 years. Second, despite the concerns of complication, overcorrection rates after augmented surgery was not higher than original surgery. Finally, augmented surgery was particularly more successful in patients with divergence excess-type exotropia compared to the basic-type.

Although the cause of the high rate of recurrence after surgery of intermittent exotropia is still not clear, variability in the preoperative measurement of exotropia and continuous exodrift with time could be possible explanations. The strategy of planning the surgical dose based on the largest angle ever measured and setting the target as a small to moderate angle of initial overcorrection have been tried to overcome undercorrection of intermittent exotropia. The need to uncover latent exodeviation by occlusion of one eye for 30-45 minutes or taking outdoor measurements have been described. However, it is still difficult to accurately measure the deviated angle, because many factors including tonic vergence, accommodative convergence, vergence aftereffect at distance, or luminance at different times may affect the angle of deviation. Despite the widely agreed concept that initial postoperative overcorrection provides long-term stability of ocular alignment, there is no consensus on the appropriate target of postoperative esodeviation. For this reason, establishing the maximum surgical amount of bilateral LR recession to overcome undermeasured deviation and exodrift along time, without encountering complications like diplopia or eye movement limitation is necessary. Thus, we planned our surgery to achieve an initial overcorrection by increasing the surgical dosage to 1.0 mm or more which has been observed safe and effective during our clinical experience.

The surgical success rate of augmented bilateral LR recession has been reported to range from 68% to 89%. Lee et al reported the
effectiveness of 1.5 to 2.5 mm augmentation of bilateral LR recession versus original surgery in basic-type exotropia and final success rates were higher after augmented surgery (68.2% vs 43.9%). However, the final follow-up period was only 6 months after surgery, and long-term success rates were not determined. Arda et al increased the amount of bilateral LR recession to the amount needed to correct a preoperative angle that was 5 PD larger than the real angle, and the success rate was 89%. Song and Paik performed augmented asymmetric bilateral LR resections of 2 mm or greater in the deviating eye than in the fixing eye. They compared the outcomes with original symmetric bilateral LR recession, and found that there was no significant difference in success rates at 24 months after surgery (81% vs 76%). Their study subjects were small with 24 patients in augmented surgery and 27 patients in the original group. In our study, the long-term success rates of augmented versus original bilateral LR recession were 59% vs 48%. The strength of our results is based on the large number of patients and a longer follow-up compared with most of the previously published reports. As hitherto known effectiveness and safety of augmented bilateral LR recession was validated only for a short-term and on limited applications of basic-type exotropia, this study could prove the reliability of augmented bilateral LR recession by evaluating the results over 2 years in a large number of subjects.

In the present study, overcorrection was observed in 14 patients (4%) who had undergone augmented surgery and 3 patients (4%) who had received original surgery. The overcorrection rate of augmented bilateral LR recession has been reported to range from 0% to 8.1%, and from 2% to 11% after original surgery. Our results are comparable to those published reports, suggesting that larger amount of recession did not cause significantly more overcorrection.

Regarding the time of recurrence, the success rates of original surgery dropped from 77% at postoperative 1 month to 61% at 6 months, and 51% at 1 year. Meanwhile, after augmented surgery, success rates over 70% were maintained until postoperative 1 year. After that, it dropped to 64% at 2 years after surgery. The slopes of success and recurrence rates in Figure 2 show this tendency of reduced recurrence rates at each time point and delayed time to recurrence after augmented bilateral LR recession. Early recurrence of exotropia within 1 or 2 years after surgery can be frustrating for both the surgeon and the patient’s family, which may cause excessive worries for making decisions on reoperation. Regarding the type of exotropia, augmented surgery was more successful in divergence excess-type than basic type-exotropia (P= .036). Generally, it is thought that operating on the lateral rectus muscle would have more effect on the distance divergent component. Previous studies recommended symmetrical lateral rectus recessions for patients...
with divergence excess-type exotropia. Moreover, Chia et al. also reported that success rates after bilateral LR recession were higher in divergence excess-type exotropia than those with basic-type exotropia. One possible assumption to explain these better results including our analysis is that better near fusional capacity in children with divergence excess intermittent exotropia might aid them in maintaining a better fusional lock postoperatively.

Our findings should be understood within the limitations of the study. First, our retrospective design has an intrinsic drawback. Patients were not randomly allocated in the original or augmented surgery groups. Augmented surgery was selectively performed after 2005 in exotropia subjects over 3 years of age, and not in those who had a high risk of overcorrection, such as a greater exodeviation at distance than at near fixation by 20 PD or more, and those who were reluctant to the possibility of wearing prism glasses after surgery. We excluded young patients under 3 years of age, and as nothing else changed, such as a new type of intraoperative caliper or an alteration in suturing techniques, except the surgical amount during the whole period of time in our study, it is reasonable to compare results of these two procedures. Prospective studies with surgeries performed in a randomized controlled fashion will be needed to further compare the two methods. Second, the range of ages and follow-up time was variable within our patient population. The percentage of patients with basic-type exotropia was significantly higher than divergence excess-type in the augmentation group, but the cumulative probability of achieving successful ocular alignment were similar in both types of exotropia (P = 0.186, log rank test). The difference in the percentage of DVD may also be considered negligible due to the small number of patients, compared to the entire enrolled patients. Moreover, univariate and multivariate analyses revealed that the type of exodeviation and presence of DVD were not a significant risk factors associated with recurrence in this study. Finally, only patients with exodeviations ≤ 35 PD were included in the study and patients with moderate or severe amblyopia or a history of previous strabismus surgery were excluded. Thus, results of this study cannot be extrapolated to those patients. Despite the limitations, our study is the largest retrospective, non-randomized clinical study with at least 2 years of postoperative follow-up after augmented bilateral LR recession for intermittent exotropia by a single surgeon.

In conclusion, augmented bilateral LR recession resulted in more successful alignment and lower recurrence rates compared to the original table after 2 years of follow-up. Clinicians should consider 1.0 mm to 1.5 mm augmentation of recession when planning bilateral LR recession, especially in the patients with divergence excess-type exotropia.
Acknowledgment

A. Funding / Support: none

B. Financial Disclosures: No financial disclosures.

C. Other acknowledgments: none
References

Figure Captions

**Figure 1.** Kaplan-Meier survival analysis of the entire patients and subgroup analysis according to type of exotropia, showing the cumulative probabilities of surgical success after original and augmented bilateral rectus recession at 2 years after surgery according to life-table analysis. (Left) The total enrolled patients showed 52% success after original bilateral LR recession and 69% success after augmented bilateral LR recession. (Middle) The basic type-exodeviation patients showed 51% success after original bilateral LR recession and 67% success after augmented bilateral LR recession. (Right) The divergence excess type-exodeviation patients showed 59% success after original bilateral LR recession and 84% success after augmented bilateral LR recession.

**Figure 2.** Surgical Outcomes at 1 month, 6 months, 1 year, 2 years, and the final examination after original and augmented bilateral rectus recession. Correlations between outcomes at each follow-up period were examined with McNemar-Bowker test and generalized estimating equation.
<table>
<thead>
<tr>
<th>Deviation (PD)</th>
<th>Original Surgery OU (mm)</th>
<th>Augmented Surgery OU (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>25</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>30</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>35</td>
<td>7.5</td>
<td>8.5</td>
</tr>
</tbody>
</table>

PD = prism diopters; Original surgery = original bilateral rectus recessions; Augmented surgery = augmented bilateral rectus recessions; OU = both eyes.
<table>
<thead>
<tr>
<th>Variable</th>
<th>Original (n=101)</th>
<th>Augmentation (n=346)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender (M:F)</td>
<td>51:50</td>
<td>145:201</td>
<td>0.126&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Age of onset (years)</td>
<td>3.3±2.4</td>
<td>3.6±2.5</td>
<td>0.321&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Age at surgery (years)</td>
<td>6.9±4.8</td>
<td>7.2±3.3</td>
<td>0.491&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Period of follow up (years)</td>
<td>4.1±2.8</td>
<td>4.0±2.0</td>
<td>0.572&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Duration of deviation (years)</td>
<td>3.7±3.4</td>
<td>3.6±3.1</td>
<td>0.960&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Refractive errors (S.E., Diopters)</td>
<td>-0.4±1.5</td>
<td>-0.2±1.7</td>
<td>0.255&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Preoperative deviation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum (PD)</td>
<td>29.6±5.3</td>
<td>29.2±4.3</td>
<td>0.511&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Distance (PD)</td>
<td>28.4±6.1</td>
<td>28.2±4.4</td>
<td>0.720&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Near (PD)</td>
<td>24.6±7.5</td>
<td>26.0±6.1</td>
<td>0.106&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Distance - Near (PD)</td>
<td>4.1±7.3</td>
<td>2.2±5.7</td>
<td>0.016&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Type of exodeviation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic (+ simulated DE)</td>
<td>74 (73.3%)</td>
<td>297 (85.8%)</td>
<td>0.003&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Divergence excess</td>
<td>27 (26.7%)</td>
<td>49 (14.2%)</td>
<td></td>
</tr>
<tr>
<td>Associated features</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypertropia over 5 PD</td>
<td>7 (6.9%)</td>
<td>22 (6.4%)</td>
<td>0.837&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>DVD</td>
<td>5 (7.0%)</td>
<td>3 (0.9%)</td>
<td>0.001&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>A or V pattern</td>
<td>0 (0.0%)</td>
<td>4 (1.2%)</td>
<td>0.278&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>IO overaction</td>
<td>8 (7.9%)</td>
<td>29 (8.4%)</td>
<td>0.882&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>SO overaction</td>
<td>3 (3.0%)</td>
<td>2 (0.6%)</td>
<td>0.079&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Lateral incomitance</td>
<td>1/60 (1.0%)</td>
<td>31/346 (9.0%)</td>
<td>0.053&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Fixation preference</td>
<td>31 (30.7%)</td>
<td>113 (32.7%)</td>
<td>0.710&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Good stereopsis</td>
<td>47/75 (62.7%)</td>
<td>210/294 (71.4%)</td>
<td>0.141&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Original = original bilateral rectus recessions; Augmentation = augmented bilateral rectus recessions; S.E. = spherical equivalent; PD = prism diopters; DE = Divergence excess; DVD = dissociated vertical deviation; IO = inferior oblique; SO = superior oblique.

<sup>a</sup> chi-square test.
<sup>b</sup> independent t-test.
<sup>c</sup> Fisher exact test.

Continuous variables are reported as mean ± standard deviation.
Table 3. Surgical Outcomes at 1 month, 6 months, 1 year, 2 years, and the Final Examination after Original and Augmented Bilateral Lateral Rectus Recession

<table>
<thead>
<tr>
<th></th>
<th>Successful alignment</th>
<th>Recurrence</th>
<th>Overcorrection</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1m</td>
<td>6m</td>
<td>1y</td>
</tr>
<tr>
<td>Original</td>
<td>(n,%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>78</td>
<td>60</td>
<td>47</td>
</tr>
<tr>
<td>(n,%)</td>
<td>(77)</td>
<td>(61)</td>
<td>(51)</td>
</tr>
<tr>
<td>Augmented</td>
<td>(n,%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>245</td>
<td>199</td>
<td>222</td>
</tr>
<tr>
<td>(n,%)</td>
<td>(71)</td>
<td>(77)</td>
<td>(77)</td>
</tr>
<tr>
<td>P value</td>
<td>0.205</td>
<td>0.003</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Original = original bilateral rectus recessions; Augmentation = augmented bilateral rectus recessions;
Successful alignment was defined as ≤5 prism diopters (PD) of esophoria/tropia to ≤10 PD of exophoria/tropia at distance.
Recurrence was defined as >10PD of exophoria/tropia and overcorrection as >5 PD of esophoria/tropia.
P value by chi-square test.
Divergence excess type exotropia

Cum Survival

Follow-up (m)

Type of surgery
- Original
- Augmentation
- Original - censored
- Augmentation - censored
Hyuna Kim, MD is a clinical and research fellow in the Department of Ophthalmology at Seoul National University Bundang Hospital. Dr Kim received her MD from Soonchunhyang University College of Medicine in 2010 and completed an internship and residency in Soonchunhyang University Hospital in 2015. Her current research of interests includes fields of pediatric ophthalmology, strabismus and neuro-ophthalmology.