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Comparison of surgical outcomes between lateral rectus recession and medial rectus advancement for postoperative consecutive exotropia

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Abstract

To compare the surgical outcomes of medial rectus advancement and lateral rectus recession in postoperative consecutive exotropia with single-stage adjustable suture surgery.

Among 1003 patients who underwent bilateral medial rectus recession between November 1996 and March 2013, the patients who required surgery for consecutive exotopia were retrospectively reviewed. Nineteen patients underwent medial rectus advancement and 15 patients underwent lateral rectus recession. All patients underwent single-stage adjustable surgery under topical anesthesia and were followed up for at least 12 months.

The mean follow-up duration was 2.4 years. At final follow-up, a successful surgical outcome was found in 12 patients (63.0%) in the medial rectus advancement group and 14 patients (93.3%) in the lateral rectus recession group ($P = .039$). The change in ocular deviation was correlated with the amount of recession ($P = .008$) and preoperative angle ($P < .001$) in the lateral rectus recession group.

Lateral rectus recession showed a higher success rate with predictable and easily performed procedure than medial rectus advancement for the treatment of postoperative consecutive exotropia with adjustable suture.

Abbreviations: BMR = bimedial rectus, D = diopter, LR = medial rectus, MR = medial rectus, PD = prism diopters, SE = spherical equivalents.

Keywords: adjustable suture surgery, consecutive exotropia, surgical outcome

1. Introduction

Consecutive exotropia is an exotropia that develops with a previous history of esotropia, usually after surgical treatment for esotropia.[1–3] The prevalence of consecutive exotropia has been reported as being from 3% to 29%[1,2,4–6] following surgery for esotropia and higher rates have been reported with longer follow-up.[4,7] Risk factors for consecutive exotropia include ambylopia, dissociated vertical deviation, hyperoipa, presence of A- or V-patterns, early-onset esotropia, and multiple previous strabismus surgeries.[1,8,9] The primary surgery for esotropia is usually bimedial rectus (BMR) recession. Treatment of consecutive exotropia varies based on viewpoint: either reversal of previous esotropia surgery,[10] which involve medial rectus (MR) advancement or cooper's dictum[11] which involve lateral rectus (LR) recession of unoperated or previously resected muscles, or a combination of the above.[1,12]

Adjustable suture in strabismus surgery was first described by Jampolsky in 1979[13] and has the advantage of decreased frequency of reoperation and increased accuracy of strabismus correction.[14] One-stage adjustment surgery with topical anesthesia does not have complications related to retrobulbar anesthesia such as optic nerve damage, eyeball perforation, or retrobulbar hemorrhage and save time for fading out the anesthetic effect.[14,15]

It is difficult to predict the outcomes of a secondary operation but there is no standardized procedure with only a few studies comparing different surgeries with small series and short-term follow-up.[12,16] In this study, we evaluated the surgical outcomes of MR advancement and LR recession in postoperative consecutive exotropia with single-stage adjustable suture surgery.

2. Materials and methods

This retrospective comparative research was performed at a single medical center (Severance Hospital, Seoul, South Korea) from November 1996 through March 2013. This study adhered to the tenets of the Declaration of Helsinki and was approved by

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The authors have no conflicts of interest to disclose.

The datasets generated during and/or analyzed during the current study are not publicly available, but are available from the corresponding author on reasonable request.

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the Institutional Review Board of Severance Hospital in Seoul, Korea. A waiver of informed consent was granted because of the low risk of this study.

2.1. Patients

We undertook analysis of the medical records of patients who underwent surgical treatment for consecutive exotropia after esotropia surgery. Inclusion criteria were patients who underwent BMR recession for the first esotropic surgical treatment; consecutive exotropia surgery with intraoperative adjustable suture under topical anesthesia; either unilateral or bilateral MR advancement or lateral rectus LR recession for consecutive exotropia surgery. Exclusion criteria were patients who underwent combined vertical strabismus treatment during consecutive exotropia surgery; were followed up on for less than 12 months after consecutive exotropia surgery; had restrictive or paralytic strabismus; had systemic neurologic disorder; had pre-existing ocular pathology; had sensory exotropia. The amount of BMR recession used in patients who performed in Severance Hospital were derived from Parks' table[17] for the angle of deviation.

2.2. Preoperative examination

Manifest refraction and fundus examination were performed preoperatively. The patients were prescribed spectacles when spherical equivalents (SE) were the following degrees: myopia as SE≤ -1.50 diopter (D), hyperopia as SE$\geq +2.00$ D. The angle of deviation was measured under their best corrected prescription using the alternate prism cover test while the subject was fixed at a 20/30 target at 6 m and 33 cm.

2.3. Surgical procedure

All the procedures for consecutive exotropia surgery were performed by 1 ophthalmologist (JBL). MR advancement was preferred because of saving new muscle and explored the previous surgery status though there were no preoperative restriction. However, LR recession surgery was performed to the patients who were relatively poor cooperative or worrying about the intraoperative pain and voluntarily preferred LR recession.

No premedication was administered and topical anesthetic consisted of 0.5% proparacaine (Alcaine, Alcon-Couvreur, Puurs, Belgium) eyedrops which were instilled prior to surgery. Additional eyedrops were administered during the incision of conjunctiva and Tenon capsule, to patients who complained of discomfort during surgery. The patients were monitored continuously with pulse oxymetry and electrocardiography. If the procedure was performed on 2 muscles, the first procedure was performed according to preoperative angle deviation using the conventional technique. Then the patient was asked to sit on the operative table and ocular alignment was measured with the alternative prism cover test using fixation target for near and distance. If exotropia persist or esotropia was noted, surgery was performed on the second muscle with adjustable suture or adjusted the first treated muscle. Consecutive exotropia surgery was completed when there was no deviation or diplopia. For the patients who required glasses, the glasses were gas-sterilized and used during adjustment.

2.4. Postoperative examination

Strabismus angle deviation measurements at distance and near were measured postoperatively 1 day, 1 week, 1 month, 3 months, 6 months, 12 months, and annually thereafter. Surgical success was defined as an esotropia deviation $\leq$5 prism diopters (PD) to exotropia deviation $\leq$10 PD while viewing distant and near targets. Surgical failure was defined as greater than 5 PD esotropia, which represented overcorrection, or greater than 10 PD exotropia, which represented undercorrection. If the patient complained of persistent diplopia it was also considered surgical failure.

2.5. Statistical analysis

Statistical analysis was performed using IBM SPSS Statistics (version 20.0.0, IBM Corp, Armonk, NY) software. Continuous data were expressed as mean ± standard deviation and preoperative and postoperative values were compared using independent t test. Categorical values were expressed in ratios and compared using the χ^2 test. The Mann–Whitney U test was used to compare refraction of the left eye. Repeated measures ANOVA were used for analyses of differences in clinical course between MR advancement and LR recession surgery. The Kaplan–Meier survival estimator and log rank tests were used to compare the cumulative probabilities of the success of consecutive exotropia surgery. Linear regression analysis was performed to calculate dose–effect relationship as the ratio between change in deviation (difference between preoperative and postoperative deviations at 12 months) and surgical dose (millimeters of MR advancement or LR recession). P values less than .05 were considered statistically significant.

3. Results

The total records of 139 patients were reviewed and 56 patients underwent consecutive exotropia surgery under topical anesthesia with intraoperative adjustment suture. Twenty-two patients were excluded and only 34 patients fulfilled the inclusion criteria. The study consisted of 19 patients from the MR advancement group and 15 patients from the LR recession group (Fig. 1). Preoperative patient characteristics were not significantly different between the 2 groups (Table 1).

Every patient showed the basic type of exotropia and there was no preoperative limited adduction. Mean age at the BMR recession surgery was 3.43 ± 1.75 years in MR advancement group and 4.35 ± 2.52 years in LR recession group ($P = .216$). Mean interval between BMR recession and consecutive exotropia surgery was 10.74 ± 2.20 years in the MR advancement group and 12.30 ± 4.27 years in LR recession group ($P = .158$). Fifteen patients (78.9%) and 14 patients (93.3%) underwent esotropia surgery at Severance hospital in the MR advancement group and the LR recession group, respectively. Surgical records on previous surgery were available for 4 of the 5 patients who had been operated on at other hospitals. Details of the MR recession amount from original esotropia surgery were not available in 1 patient who underwent LR recession surgery. Before consecutive exotropia surgery, 3 patients in the MR advancement group and 4 patients in the LR recession group underwent the second esotropia surgery which was LR resection.

Mean follow-up period was 32.26 ± 37.40 months in the MR advancement group and 26.53 ± 26.72 months in the LR recession group ($P = .620$). Preoperative angle deviation at distance was 25.16 ± 6.63 PD in the MR advancement group and 23.93 ± 9.32 PD in the LR recession group ($P = .442$). Mean

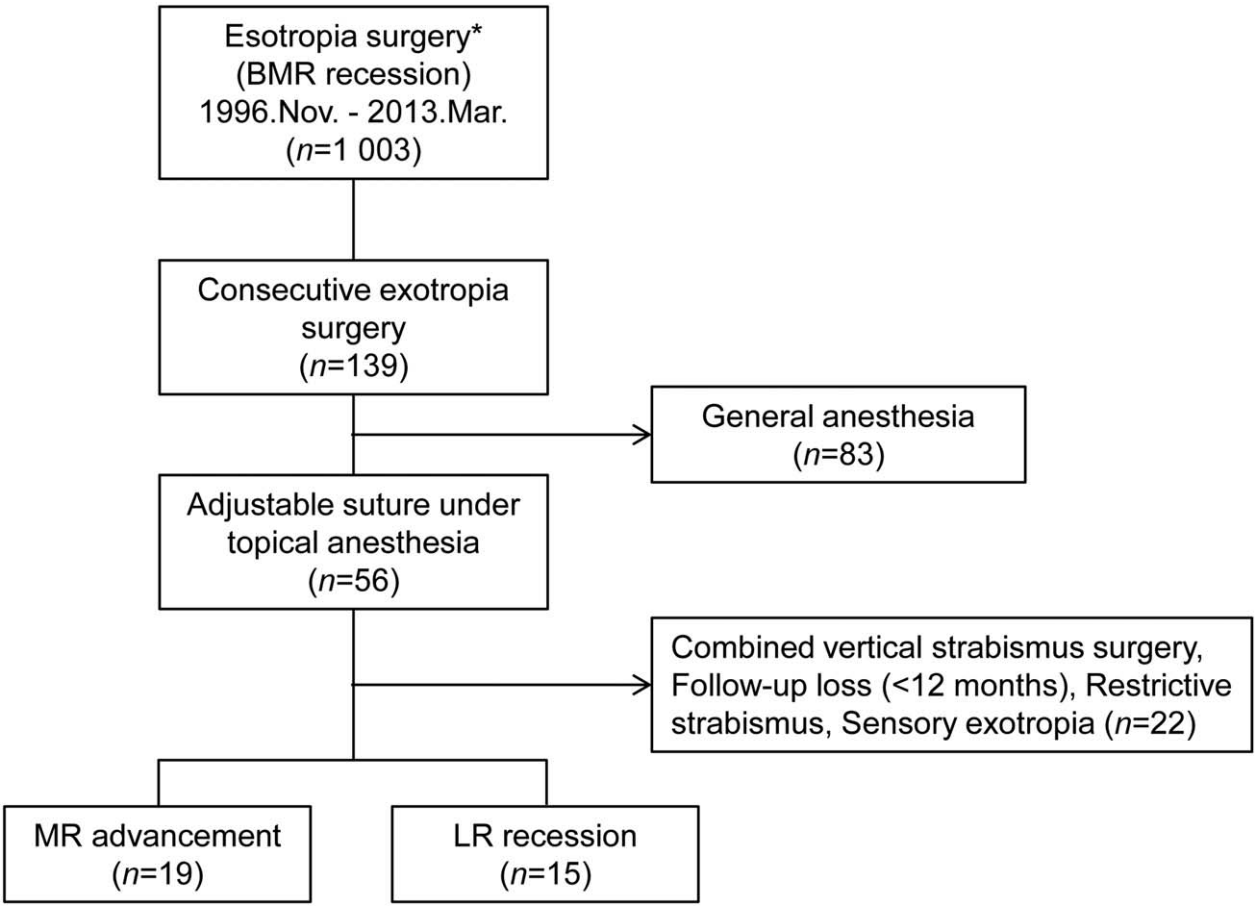

Figure 1. Schematic diagram for patient selection. BMR = bilateral medial rectus, LR = lateral rectus, MR = medial rectus. * All patients underwent esotropia surgery at Severance Hospital except for 5 patients.

Table 1

Demographics.

	MRA group (N = 19)	LRR group (N = 15)	*P* value
Sex, n (%)			
Female	12 (63.2%)	7 (46.7%)	.270
Male	7 (36.8%)	8 (53.3%)	
Type of ET, n (%)			.688
Infantile esotropia	6 (31.6%)	4 (26.7%)	
Nonrefractive ET	4 (21.1%)	6 (40.0%)	
Partially accommodative ET	6 (31.6%)	3 (20.0%)	
Unknown	3 (15.8%)	2 (13.3%)	
Age of ET onset (y)	1.33 ± 1.66	2.05 ± 1.90	.294
Age of BMR recession surgery (y)	3.43 ± 1.75	4.35 ± 2.52	.216
Age of XT surgery (y)	17.89 ± 4.27	16.73 ± 4.33	.440
Operation interval (y)	14.42 ± 4.25	12.30 ± 4.27	.158
Mean amount of BMR recession (mm)	10.74 ± 2.20	11.00 ± 2.72	.770
Refraction at XT surgery (SE, D)			
Right eye	−0.47 ± 1.98	−0.73 ± 1.53	.679
Left eye	0.00 ± 1.98 (−1.00, 1.00)	1.00 ± 0.50 (1.00, 2.00)	.198
Follow-up period after XT surgery (mo)	32.26 ± 37.40	26.53 ± 26.72	.620

MRA = medial rectus advancement, LRR = lateral rectus recession, ET = esotropia, BMR = bimedial rectus, XT = exotropia, SE = spherical equivalent, D = diopter.

Table 2

Preoperative and postoperative ocular alignment at consecutive exotropia surgery.

	MRA group (N = 19)	LRR group (N = 15)	*P* value
Preoperative XT deviation			
Near (PD)	26.58 ± 7.95	24.27 ± 9.37	.658
Distance (PD)	25.16 ± 6.63	23.93 ± 9.32	.442
Last ocular deviation			
Near (PD)	7.89 ± 8.24	2.87 ± 7.86	.048
Distance (PD)	7.53 ± 7.50	2.40 ± 6.80	.049
MR advancement amount	5.12 ± 1.45		
LR recession amount		11.27 ± 4.30	

MRA = medial rectus advancement, LRR = lateral rectus recession, XT = exotropia, PD = prism diopter.

MR advance amount was 5.12 ± 1.45 mm and mean LR recession amount was 11.27 ± 4.30 mm (Table 2).

There were no complications during or after surgery. There was no limited adduction in all patients and slipped muscle or stretched scars were not found during MR advancement surgery. Bilateral surgery was performed in 2 patients in the MR advancement group and 10 patients in the LR recession group. Twelve months postoperatively, successful surgical outcome was seen in 14 (73.7%) patients in the MR advancement group and 15 (100%) patients in the LR recession group ($P = .031$). At final follow-up, there were no overcorrections and 12 (63.2%) patients in the MR advancement group and 14 (93.3%) patients in the LR recession group showed successful surgical outcome ($P = .039$) (Table 3). Among the undercorrected cases, 5 patients in the MR advancement group were all unilateral surgeries, and underwent secondary consecutive exotropia surgery as contralateral MR advancement except for 1 patient who refused the additional surgery.

The postoperative angle of deviation revealed exotropic shift after 1 postoperative day. A repeated measure ANOVA analysis showed statistically significant group by time effects which had a lower exotropic shift in the LR recession group for the postoperative angle of deviation (Fig. 2, $P = .024$).

Kaplan–Meier survival curves showed that the estimated mean survival times were 25.74 ± 3.78 months for the MR advancement group and 90.00 ± 5.80 months for the LR recession group (Fig. 3, log-rank test, $P = .031$).

In the MR advancement group, a mean correction ratio was 3.68 ± 2.28 PD/mm and change in deviation showed correlation with preoperative angle deviation ($R^2 = 0.333$, $P = .010$) but no statistically significant relationship in the amount of MR advancement. In the LR recession group, a mean correction ratio was 1.98 ± 0.89 PD/mm and change in deviation was correlated with both preoperative angle deviation (Fig. 4, $R^2 = 0.634$, $P < .001$) and LR recession amount (Fig. 5, $R^2 = 0.431$, $P = .008$). With multiple linear regression analysis, change in deviation (y) with amount of LR recession (x_1) and preoperative angle deviation (x_2) was calculated as $y = -0.692$ to $0.674x_1 + 1.246x_2$ ($R^2 = 0.648$, $P = .002$).

Table 3

Surgical outcomes of consecutive exotropia surgery.

	MRA group (N = 19)	LRR group (N = 15)	*P* value
Postoperative month 12			
Success	14 (73.7%)	15 (100%)	.031
Undercorrection	5 (26.3%)	–	
Overcorrection	–	–	
Final follow-up			
Success	12 (63.2%)	14 (93.3%)	.039
Undercorrection	7 (36.8%)	1 (6.7%)	
Overcorrection	–	–	

MRA = medial rectus advancement, LRR = lateral rectus recession.

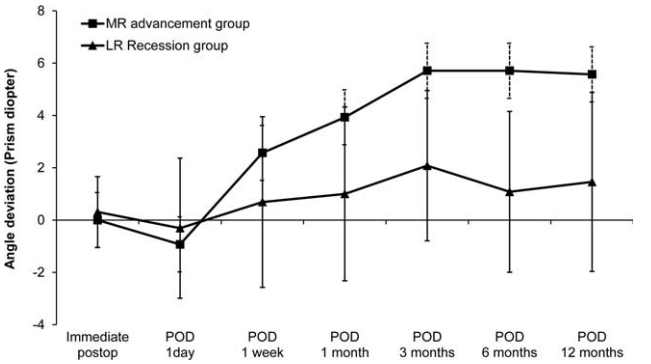

Figure 2. Exotropic shift changes after consecutive exotropia treatment with a repeated measure ANOVA analysis. The group by time effects showed significant which were lower exotropic shift in the LR recession group than the MR advancement group for the postoperative angle of deviation ($P = .024$). LR = lateral rectus, MR = medial rectus, POD = postoperative day.

4. Discussion

Several studies have reported on surgical treatment of consecutive exotropia including MR advancement,[18,19] LR recession,[11,20,21] or a combination of several methods.[1,9,22]

Reoperation in strabismus is a challenging and complex problem.[23] Especially for the consecutive strabismus, 2 different

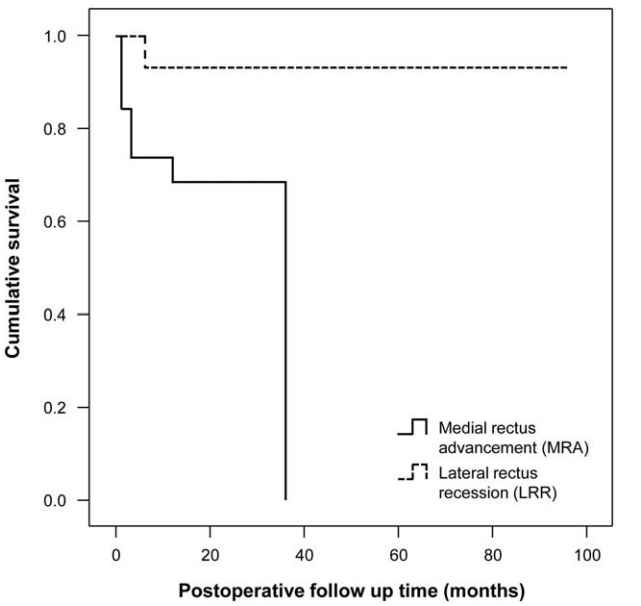

Figure 3. Kaplan–Meier survival curves of LR recession group and MR advancement group. LR recession group showed statistically significant higher survival rate than MR advancement group (log-rank test, $P = .031$). LR = lateral rectus, MR = medial rectus.

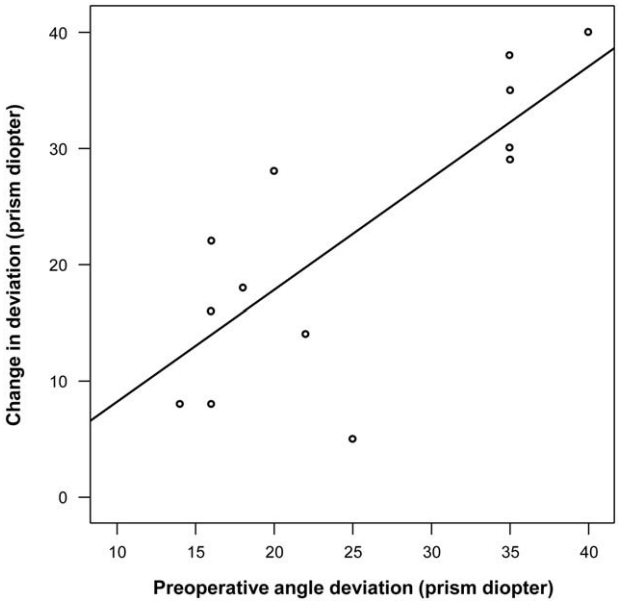

Figure 4. Linear regression analysis of change in deviation and preoperative angle deviation of LR recession. The change in deviation was statistically correlated with preoperative angle deviation of LR recession ($P < .001$). LR = lateral rectus.

perspectives can be considered. Coopers suggested that over-correction after strabismus surgery should be considered a new deviation and returning to preoperative condition may not be the best solution.[11] He proposed that bilateral LR recession is superior to bilateral MR advancement in cases with no limitation of adduction or divergence at consecutive exotropia after bilateral MR recession. Surgical approach to the unoperated muscles is relatively simple, but there is a danger in not leaving any fresh muscle for possible reoperation.

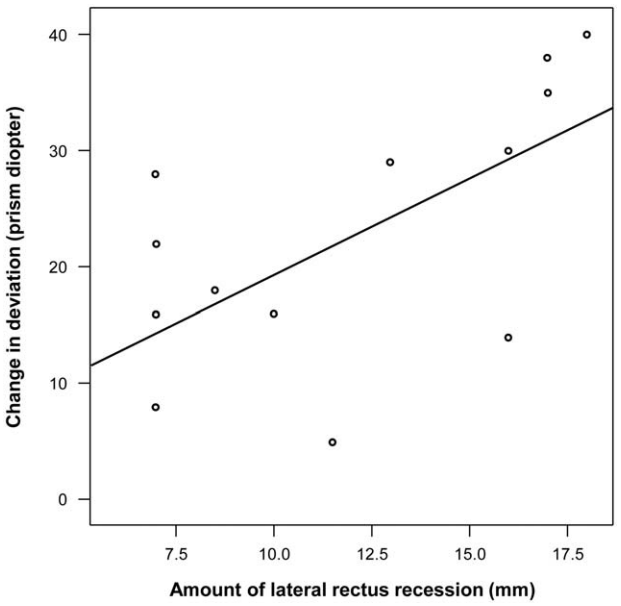

Figure 5. Linear regression analysis of change in deviation and LR recession amount. The change in deviation was statistically correlated with lateral rectus recession amount ($P = .008$). LR = lateral rectus.

Advancing the recessed MR muscle is necessary in patients with limited adduction, where a slipped muscle or lost muscle is suspected. It also can be an option with normal duction and version condition with the advantage of saving fresh LR for further management. The patient with vertical deviation such as DVD may require further operation and in that case MR advancement may avoid the risk of anterior segment ischemia. However, when planning the amount of MR advancement it can be difficult to predict the results and various responses may occur even in patients without limited adduction.[18,20,22]

Donaldson et al[1] reported MR advancement and LR recession as an effective procedure with a 71% rate of success. Bilateral LR recession was performed on 7 patients and 6 patients experienced a successful outcome. Chatzistefanou et al[22] performed MR advancement and LR recession with a mean corrective effect of 2.9 PD/mm. The results may be affected by previous surgery because LR recession was the reversal of formerly resected LR. Ohtsuki et al[18] reported a 46% success rate following one or bilateral MR advancement. They found there was no significant difference in the mean amount of exotropia correction between one and both MR advancement, suggesting that the amount of correction does not depend on the degree of advancement. Kim et al[24] evaluated surgical dose–effect relationship in single muscle advancement in consecutive strabismus and showed a 91% rate of success in 11 patients in the consecutive exotropia group. The mean correction ratio was 4.03 ± 0.97 PD/mm which was larger than our result and there was no significant relationship in the amount of MR advancement and preoperative angle deviation. In our study, the mean correction ratio was larger than LR recession and the change of deviation showed no relationship in the amount of MR advancement. We first planned the amount of MR advancement as a MR resection, but we performed an intraoperative adjustable suture so after unilateral MR advancement, we checked the ocular alignment at distance and near before begin the other eye. Most of the patients (89%) showed orthotropia and no limited eye movement which means there was no reason to operate on the other MR. There was no apparent adhesion at MR muscle but muscle may have become contracted or stiff than original unoperated MR, which resulted in decreased amount of MR advancement than the first plan. Cho and Ryu[10] reported mean corrective ratio of 3.1 ± 1.03 PD at final follow-up with MR advancement and bilateral MR advancement had a greater effect than unilateral MR advancement. The difference may exist because they only included the infantile esotropia patients. Though there was no significant relationship in the amount of MR advancement and the change in deviation, preoperative angle deviation was related to the change of deviation as in previous studies[10,22] indicating that the larger preoperative deviation resulted in a higher dose–effect. Linear regression analysis with LR revealed that larger preoperative angle and LR recession amount were associated with change of deviation.

Patel et al[21] performed bilateral LR recession with a 65% rate of success after a mean follow-up of 30 months which was lower than our study. It may be affected by combined vertical strabismus treatment at either the time of esotropia correction surgery or bilateral LR recession, which was performed on 12 patients of a total of 31 patients. Nabie et al[16] performed bilateral MR advancement in 7 patients and bilateral LR recession in 7 patients for consecutive exotropia. The success rate was 71% in the MR advancement group after a mean 19.1 months follow-up and 86% in the LR recession group after a mean 14.2 months follow-up

without statically significant difference. Mean correction ratio was 5.9 PD/mm of MR advancement group and 4.9 PD/mm of LR recession group which is larger than our result presumably because of the shorter follow-up period. The overall success rate in our study was 78% which was consistent with the previous studies with long-term follow-up.

Donaldson et al [1] reported a mean exodrift of 7.6 PD within a 6-week postoperative period. Cho and Ryu [10] reported 9.3 PD at the final follow-up with mean 47 months of follow-up period. In our study mean exodrift was 5.6 PD in the MR advancement group and 1.2 PD in the LR recession group at postoperative 12 months which was statistically significant but clinically both within success range. Contrary to other studies, we performed consecutive exotropia surgery on older patients with intraoperative adjustable suture. We tried to avoid the target over 5 PD of esotropia because the patients complained of diplopia while adjusting which may result in adverse effects in quality of life after surgery. At final follow-up, the MR advancement group showed more undercorrection than the LR recession group and there was no overcorrection in both the groups.

There are some limitations to this study. It was a retrospective study in a single center with a relatively small number of patients. Our study did not include sensory outcomes because of missing values in subjects. The patients were not randomized into the 2 groups and some aspects may differ which we are unable to identify. However, few studies have compared the different surgical treatments for consecutive exotropia.[16,25] To the best of our knowledge, this is the first study comparing the surgical effect of MR advancement and LR recession with adjustable suture under local anesthesia. Moreover, the surgical dose–effect relationship of MR varied widely among the patients and was unpredictable; thus, it is difficult to decide the amount of advancement. Therefore, when performing adjustable suture, it is recommended to perform MR advancement to predict results and may prevent overcorrection. Further randomized, prospective study with pathology of advancing MR muscle is required in the future to confirm the results in our study.

In conclusion, LR recession showed a higher success rate than MR advancement. LR recession is a predictable and effective surgical treatment and could be relatively easily performed. LR recession is recommended in consecutive exotropia patients without vertical deviations. MR advancement may be more suitable for patients with abnormal ductions or situations when confining surgery to the nondominant eye with adjustable suture.

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