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ARAŞTIRMA / RESEARCH

Evaluation of the equality of medial rectus advancement to medial rectus resection for consecutive exotropia

Konsekütif ekzotropya için medial rektus ilerletmesinin medial rektus rezeksiyonuna eşitliğinin değerlendirilmesi

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Abstract

Purpose: The aim of this study was to analyze the amount of medial rectus (MR) advancement in the treatment of consecutive exotropia by comparing it with the amount of MR resection in a sample of patients with constant exotropia and evaluate the effectiveness of MR advancement with lateral rectus (LR) recession in the management of consecutive exotropia.

Materials and Methods: A retrospective chart review of patients who underwent unilateral MR strengthening with LR weakening due to consecutive or constant exotropia was performed. Patients with consecutive exotropia underwent MR advancement with LR recession, and those with constant exotropia underwent MR resection with LR recession. The surgical dosages were determined according to a standard table. A successful result was defined as alignment within 10 prism diopters of orthotropia.

Results: A total of 36 patients fulfilled the inclusion criteria: 18 had consecutive exotropia and 18 had constant exotropia. Successful alignment was obtained in 83.3% of patients with consecutive exotropia and 88.9% of patients with constant exotropia. There was no difference between the amount of MR advancement performed in consecutive patients with exotropia and the amount of MR resection performed in patients with constant exotropia. Postoperatively, while consecutive exotropes with a poor result showed overcorrection, constant exotropes with a poor result showed undercorrection.

Conclusion: This study suggests that there is no difference between the amount of previously recessed MR advancement and that of untouched MR resection. They also showed that MR advancement with LR recession is an effective means of correcting secondary exotropia.

Keywords:. Advancement, lateral, medial, recession, rectus

Öz

Amaç: Bu çalışmada konsekütif ekzotropya tedavisinde medial rektus (MR) ilerletme miktarını sabit ekzotropyası olan hastalardaki MR rezeksiyonu ile karşılaştırarak incelemek ve konsekütif ekzotropya tedavisinde MR ilerletmesi ile birlikte lateral rektus (LR) geriletmesinin etkinliğinin değerlendirilmesi amaçlanmıştır.

Gereç ve Yöntem: Konsekütif veya sabit ekzotropya nedeniyle tek taraflı MR güçlendirilmesi ile birlikte LR zayıflatılması yapılmış hastaların kayıtları retrospektif olarak incelendi. Konsekütif ekzotropyalı hastalarda MR ilerletmesi ile birlikte LR geriletmesi ve sabit ekzotropyalı hastalarda MR rezeksiyonu ile birlikte LR geriletmesi yapılmıştı. Cerrahi dozlar standart bir tabloya göre belirlenmişti. 10 prizma dioptri ve daha az kayma başarılı sonuç olarak kabul edildi.

Bulgular: 18 konsekütif ekzotropyalı ve 18 sabit ekzotropyalı toplamda 36 hasta çalışmaya kabul edilme kriterlerini karşıladı. Başarılı hizalanma konsekütif ekzotropyalı hastaların %83.3' ünde, sabit ekzotropyalı hastaların %88.9'unda elde edildi. Konsekütif ekzotropya olan hastalarda yapılan MR ilerletme miktarı ile sabit ekzotropya olan hastalarda yapılan MR rezeksiyonu miktarı arasında fark yoktu. Postoperatif dönemde, başarısız sonuç elde edilen konsekütif ekzotropyalı hastalarda fazla düzelme mevcut iken, başarısız sonuç elde edilen sabit ekzotropyalı hastalarda yetersiz düzelme vardı.

Sonuç: Bu çalışma daha önceden geriletilmiş MR'nin ilerletilme miktarı ile cerrahi olarak hiç dokunulmamış MR'nin rezeksiyon miktarı arasında bir fark olmadığını öne sürmektedir. Bu çalışma aynı zamanda MR ilerletmesi ile birlikte LR geriletmesinin sekonder ekzotropyayı düzeltmek için etkili bir yöntem olduğunu göstermiştir.

Anahtar kelimeler: İlerletme, lateral, medial, geriletme, rektus

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INTRODUCTION

Consecutive exotropia is an outward ocular deviation that appears either spontaneously or after surgical or optical treatment in a patient who previously had esotropia[1,2]. The reported prevalence rates range between 2% and 29%[3,4]. The possible risk factors for consecutive exotropia include many previous surgeries, excessive bimedial recession, postoperative limited adduction, dissociated vertical deviation, amblyopia, high hyperopia, A- or V-pattern strabismus, poor binocularity, nystagmus, and growth retardation[5-9].

Although many techniques have been described for the surgical management of consecutive exotropia, the best surgical procedure is yet to be determined. Patel et al. recessed both lateral rectus (LR) muscles for consecutive exotropia in patients who previously underwent both medial rectus (MR) recession[9]. Nabie et al. performed bilateral MR advancement for consecutive exotropia after bilateral medial rectus recession[10]. Chang and Lin divided consecutive patients with extropia into three surgical groups and performed one eye surgery, MR advancement, LR recession, or combined surgery[11]. Mohan et al. performed unilateral LR recession and MR resection with or without advancement in treating postoperative consecutive exotropia[12]. In the study by Kasi et al., consecutive patients with exotropia underwent MR advancement alone or in combination with resection or LR recession[13].

The surgical dose of MR advancement for correcting consecutive exotropia does not exist in the standard surgical dose tables. In most previous studies that performed MR advancement for correcting consecutive exotropia, the amount of MR advancement was assumed to be equivalent to the amount of this muscle resection recommended from standard tables for that angle of deviation. We believe that this assumed equality should be proven comparatively. The current study aimed to verify this assumption by comparing the amount of previously recessed MR advancement and the amount of untouched MR resection and evaluate the efficiency of unilateral MR advancement with LR recession in the treatment of consecutive exotropia.

MATERIALS AND METHODS

Patients

The clinical records of patients who underwent unilateral surgery for consecutive or constant exotropia between 2011 and 2018 were reviewed retrospectively. The study group consisted of consecutive exotropes who had undergone bilateral medial rectus recession as an initial surgery due to esotropia while control group consisted of constant exotropes who had never undergone surgery. The study was conducted at the Ophthalmology Department of Inonu University Medical Faculty, and the data were obtained from the records of the patients followed up in the Strabismus Unit. Informed consent was obtained from the patients or families of the children before the surgery.

The Inonu University Scientific Research and Publication Ethics Committee approved the procedures used in this study (approval number: 2019/7–29), and the rules of the Helsinki Declaration were followed at every stage of the study. Patients with dissociated vertical deviation, inferior oblique muscle hyperfunction, corneal and lens pathologies preventing posterior segment examination, retinal pathologies, history of ocular trauma, and neurological or systemic diseases were not included in the study. In addition, patients with a postoperative follow-up duration of < 6 months were not included in the study. Consecutive exotropia was defined as an exodeviation of ≥ 10 prism diopters (PD) in the primary position near (1/3 m) and distance (6 m) with appropriate refractive correction in individuals who had undergone esotropia surgery. Constant exotropia was defined as exodeviation with a constant angle in different directions of gaze at both near and distance fixation.

Clinical evaluation

All patients underwent an ocular examination, including cycloplegic refraction, best spectacle-corrected visual acuity using the Snellen chart, careful observations with a slit-lamp microscope, dilated fundus evaluation, ocular motility, and measurements of ocular misalignment at near and distance by the prism cover test. All patients were examined before surgery, on the first day and the first month after surgery, and at the last visit.

Data collection

The following data were collected: age at diagnosis and exotropia surgery, sex, refractive errors, results of visual acuity testing, presence of ambliyopia and pattern strabismus, detection of adduction deficiency, angles of deviation at preoperative and postoperative examinations, amount of LR recession, amount of improvement in exotropia, and follow-up time.

Surgeries and surgical dosing

Patients with consecutive exotropia underwent MR advancement and LR recession. In these patients, the amount of LR recession was determined according to the amount of MR advancement and degree of preoperative exodeviation using a surgical dosing table advised by Santiago and Rosenbaum[14] and also adjusted based on our clinical experience. In patients with constant exotropia, the amount of both MR resection and LR recession was determined based on the preoperative exodeviation angle using the same table. All surgeries were performed under general anesthesia by the same surgeon (A.G.) on the non-fixing eyes of the participants. Distant eye alignment within 10 PD of orthotropia at 6 months postoperatively was considered a successful outcome.

MR muscle advancement

In consecutive patients with exotropia, the conjunctiva was initially incised and dissected on the nasal side to expose the sclera. After careful dissection, the previously recessed MR muscle was detached from the surrounding tissues and post-surgical adhesions. The muscleswere isolated using a hook. The original insertion location of the MR was assumed as a point 5.5 mm behind the limbus and was measured with a curved scleral ruler. Subsequently, the muscle was separated from the sclera, advanced to the original insertion location, and sutured to the sclera with a 6-0 polyglactin suture. Finally, the conjunctiva was sutured using interrupted 8-0 polyglactin sutures.

Statistical analysis

SSPS for Windows statistical software (ver. 22.0; IBM Corp., Armonk, NY, USA) was used for statistical analyses. The results are expressed as mean ± standard deviation or median (min-max). The Shapiro-Wilk test was used to determine the consistency of continuous variables with a normal distribution. To investigate the differences between the two groups, we used the chi-square test for qualitative data and the Mann-Whitney U test for quantitative data. Specifically, the chi-square test was used for surgical success, which is one of the two most valuable variables in the study, and the Mann-Whitney U test was used for the amount of MR surgery, another valuable variable. Statistical significance was set at $p < 0.05$.

RESULTS

The records of 39 patients were reviewed. Of these, 2 patients were excluded because of an intervening LR at the initial surgery for esotropia, and one patient was excluded because of the inability to participate in postoperative follow-up. Finally, 36 patients were identified: 18 with consecutive exotropia and 18 with constant exotropia. All consecutive patients with exotropia had previously undergone bilateral MR recession for esotropia during their first surgery. None of the patients with consecutive exotropia had undergone more than one operation, and none of the patients with constant exotropia had undergone any operations before corrective surgery. Amblyopia was found in 11 patients with consecutive exotropia and 8 with constant exotropia. The V pattern was diagnosed in 2 patients with consecutive exotropia and 3 with constant exotropia. Four patients with consecutive exotropia had a limited adduction. The demographic and ocular examination findings, mean amount of LR recession, mean improvement of exotropia, and mean follow-up time of the two groups are presented in Table 1. Preoperative and postoperative exodeviation angles and millimeters of surgery performed in these cases are listed in Table 2.

There were no significant differences in sex distribution, age at diagnosis and exotropia surgery, visual acuity of the right and left eye, and follow-up time between the case groups (P=0.31, P=0.58, P=0.84, P=0.81, P=0.37, and P=0.58, respectively). In addition, no significant difference was detected in the pre- and postoperative misalignment, the amount of improvement in exotropia, and the amount of LR recession between our study groups (P=0.52, P=0.40, P=0.92, and P=0.74, respectively). Scatterplots of the preoperative and postoperative deviations in the surgical groups are shown in Figure 1. We only found a significant difference in the spherical equivalent in both the right and left eyes (P=0.019 and P=0.006, respectively).

We performed a mean 5.58±1.07 mm of MR

advancement in the consecutive exotropia group and a mean 5.13±0.76 mm of MR resection in the constant exotropia group. There was no significant difference between the amount of MR advancement performed in patients with consecutive exotropia and the amount of MR resection performed in patients with constant exotropia (P=0.38). Figure 2 represents the scatterplot of the improvement in exodeviation resulting from MR muscle surgery performed in the two surgical groups.

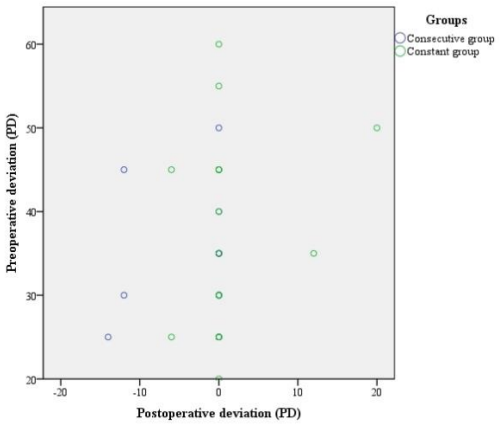

Figure 1. The scatterplot of preoperative and postoperative deviations in the groups. PD: prism diopter.

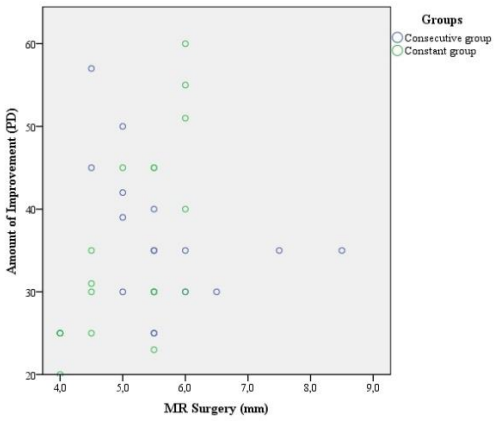

Figure 2. The scatterplot of improvement in the exodeviation resulting from medial rectus surgery performed in the groups. PD: prism diopter, mm: milimeter.

Table 1. Data of consecutive and constant exotropia patients' groups.

	Consecutive XT (n:18)	Constant XT (n:18)	P value
Gender			
Male (n)	12	8	
Female (n)	6	10	P:0.31[a]
Age at diagnosis (years)	20.0 ± 9.4	18.19 ±10.3	P:0.58[b]
Age at XT surgery (years)	20.4 ± 9.3	19.6 ± 10.3	P:0.84[b]
Visual acuity			
Right	0.72 ± 0.3	0.71 ± 0.4	P:0.81[b]
Left	0.77 ± 0.3	0.68 ± 0.3	P:0.37[b]
SE (D)			
Right	0.75 (-0.75 - +3.75)	0 (-4.0 - +1.0)	P:0.019[b]
Left	0.50 (-0.75 - +4.25)	0 (-3.5 - +3.5)	P:0.006[b]
Preoperative deviation (PD)	33.61 ± 7.4	36.94 ± 11.6	P:0.52[b]
Postoperative deviation (PD)	0 ((-14) - 0)*	0 ((-6)- 20)*	P:0.40[b]
MR advancement &resection (mm)	5.58±1.07	5.13±0.76	P:0.38[b]
LR recession (mm)	7.47 ±1.7	7.63 ± 1.2	P:0.74[b]
Amount of improvement (PD)	35.50 ± 8.3	35.83 ± 11.8	P:0.92[b]
Follow-up(months)	12.0 ± 9.4	8.6 ± 2.7	P:0.58[b]

XT: Exotropia, MR: Medial rectus, LR: Lateral rectus, SE: Spherical equivalent, PD: Prism diopter, D: Diopter, mm: Milimeter, n: Number
*: Minus indicates postoperative esotropia, [a]: Chi-Square test, [b]: Mann-Whitney U test

Table 2. Preoperative and postoperative exodeviation angles, and milimeters of surgery in the patients.

Groups	Patient No	Preoperative Deviation (PD)	Postoperative Deviation (PD)	MR (milimeters of advancement &resection)	LR (milimeters of recession)
Consecutive group	1	50	0	5.0	11.0
	2	45	-12*	4.5	9.0
	3	25	0	5.5	6.0
	4	25	0	5.5	6.0
	5	30	0	6.5	6.0
	6	30	0	5.5	8.0
	7	45	0	4.5	9.0
	8	40	0	5.5	9.0
	9	30	-12	5.0	8.5
	10	35	0	5.5	8.0
	11	30	0	5.0	8.0
	12	30	0	6.0	7.0
	13	35	0	6.0	7.0
	14	25	-14	5.0	7.0
	15	35	0	7.5	5.0
	16	35	0	8.5	5.0
	17	25	0	4.0	7.0
	18	35	0	5.5	8.0
Constant group	19	60	0	6.0	9.5
	20	35	0	4.5	7.5
	21	25	0	4.0	6.0
	22	45	0	5.5	8.0
	23	25	-6	4.5	7.0
	24	35	12	5.5	7.0
	25	30	0	5.5	7.5
	26	50	20	6.0	8.0
	27	45	-6	6.0	9.0
	28	25	0	4.5	8.0
	29	45	0	5.0	9.0
	30	40	0	6.0	8.0
	31	55	0	6.0	10.0
	32	45	0	5.5	8.0
	33	30	0	5.5	6.0
	34	25	0	4.0	5.5
	35	30	0	4.5	7.0
	36	20	0	4.0	6.5

PD: Prism diopter, MR: Medial rectus, LR: Lateral rectus, * The sign "-" indicates esotropia.

In the consecutive group, surgical success was achieved in 15 of the 18 patients (83.3%). In this group, 2 patients were diagnosed with esotropia of 12 PD and 1 with esotropia of 14 PD at 6 months postoperatively. In 13 of 18 patients with consecutive exotropia, the insertion site of the MR was found at a distance of 11 mm or more behind the limbus at the time of surgery and in 5 patients at a distance of < 11 mm. In the constant group, surgical success was achieved in 16 of the 18 patients (88.9%). Two patients had residual exotropia; the surgery was able to reduce exotropia from 50 to 20 PD in one patient and from 35 to 12 PD in another. The patient with a residual exotropia of 20 PD required additional surgery.

DISCUSSION

Several surgical procedures have been described for the treatment of consecutive exotropia, which is a challenging complication of esotropia surgery. A standard dose-effect relationship for horizontal muscle surgery has not yet been determined. To the

best of our knowledge, all previous studies for correcting consecutive exotropia have been performed in patients who had previously undergone surgery. The present study evaluated the effectiveness of MR advancement along with LR recession for the correction of consecutive exotropia by comparing MR resection with LR recession in patients with constant exotropia, who had no history of strabismus surgery.

Chang and Lin[11] performed unilateral MR advancement with LR recession in 14 patients with consecutive exotropia following MR recession and obtained a success rate of 71.4%. They advanced the MR to its original insertion point and recessed the LR according to a standard table, based on the measured preoperative deviation angle and intraoperative findings. They reported that combined surgery could be a more effective approach for the treatment of larger consecutive exotropia.

Donaldson et al.[15] performed MR advancement and LR recession with additional adjustable sutures whenever indicated in 42 patients with consecutive exotropia who had previously undergone surgery for esotropia and reported that this surgery is an efficient procedure for the treatment of consecutive exotropia with a success rate of 69%. In their study, the amount of advancement was presumed to be equal to the amount of resection recommended by a standard table for that degree of exodeviation.

Chatzistefanou et al.[16] advanced the previously recessed MR and recessed the previously resected LR by an amount corresponding to a reversal of the initial surgery in one eye of 52 patients with consecutive exotropia who had previously undergone esotropia surgery. They reported that a standard reversal of unilateral MR recession and LR resection is an effective treatment for correcting consecutive exotropia, with a success rate of 78.8%. In their study, the amount of MR advancement was assumed to be equivalent to the amount of resection of this muscle based on a standard table.

In a study on the non-dominant eyes of patients with consecutive exotropia by Mohan et al.[12], MR resection with LR recession was performed in 17 patients, and LR recession and MR partial resection combined with advancement were performed in 14 patients according to a standard table, and the success rates were reported to be 64.7% and 71.4%, respectively. They advanced the MR only if the desired amount of resection of the muscle was not possible because of a very posterior MR muscle attachment to the sclera as a result of a former large recession for esotropia surgery. In their study, a 1 mm advancement of the MR was assumed to be equal to a 1 mm resection of the muscle in correction of the exodeviation.

In a study conducted by Nabie et al.[10], 14 patients with consecutive exotropia following bilateral MR recession were randomly selected for either bilateral MR advancement or bilateral LR recession surgery, and an overall success rate of 78.5% was reported. They determined the amount of muscle advancement or recession according to a standard table and presumed that every 1 mm of advancement was equal to 1 mm of resection.

In the current study, we obtained a success rate of 83.3% with MR advancement plus LR recession in patients with consecutive exotropia and a success rate of 88.9% with MR resection plus LR recession in patients with constant exotropia when an ocular alignment within 10 PD of orthotropia at the postoperative sixth month is assumed a successful outcome. The surgical success at 6-month follow-up after surgery for consecutive exotropia seems to be comparable to that after the correction of constant exotropia. In the two surgical groups, the surgical dosage was determined according to a standard table, and a 1 mm advancement of MR was presumed to be equivalent to a 1 mm resection of this muscle. Our success rate for MR advancement with LR recession in patients with consecutive exotropia was higher than that reported in the abovementioned studies[10-12,15,16]. We believe that the differences in the success rates are related to the nonhomogeneity of primary surgery for esotropia or corrective surgery for consecutive exotropia in each study, as well as the differences in the use of surgical dosing tables in each study. Similar to our study, all previous studies assumed that the amount of advancement of the MR is equal to the amount of resection of this muscle. Unlike previous studies, the present study compared the amount of MR advancement in patients with consecutive exotropia and the amount of MR resection in patients with constant exotropia who had an untouched MR to verify this assumption and determined no significant difference (P=0.38). The major strengths of the present study were the study of intact MR muscles and the comparison between the amount of intact MR resection and the amount of previously recessed MR advancement.

In our study, adduction deficiency was improved by MR advancement in 4 patients with consecutive exotropia who had preoperative adduction deficiency. Three patients with consecutive exotropia were diagnosed with esotropia after surgery: two patients had esotropia of 12 PD, and one patient had esotropia of 14 PD. It is unclear whether these overcorrections resulted from improper surgery or poor binocularity, which may result in greater variability in the predicted results of a surgical plan. The unpredictability of surgical dose response remains a serious problem, especially in reoperations. Contrary to what we believed, in patients with overcorrection, the MR muscle was not excessively recessed in the initial surgery for correction of esotropia. In these three patients, the MR attachment to the sclera was found at a distance of less than 11 mm from the limbus, with a range of 10–10.5. The patient showed esotropia of 14 PD after surgery, requiring additional surgical intervention.

This study had some limitations. First, a limited number of cases were included in each group because of its retrospective design. Second, all the patients with consecutive exotropia in our study had only been operated on MR muscles for esotropia, and the study lacked patients with consecutive exotropia who had undergone LR muscle resection during the initial surgery; therefore, our results cannot be generalized. Furthermore, considering the appearance of greater exodrift over time, the postoperative follow-up time was short.

In summary, the results of the present study suggest that there was no significant difference between the amount of previously recessed MR advancement and that of untouched MR resection advised from a standard surgical dosing table. In addition, we demonstrated that unilateral MR advancement with LR recession is an effective surgical procedure for treating consecutive exotropia, with minimal side effects. Advancement of the previously recessed MR to the original insertion improved the adduction deficits. However, our data need to be confirmed by prospective studies with more patients and longer follow-up periods.

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