Original Article

Management of Consecutive Exotropia

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Abstract

Purpose: To determine the clinical characteristics and surgical outcomes of medial rectus (MR) advancement with or without lateral rectus (LR) recession in patients with consecutive exotropia.

Methods: This interventional case series was performed on patients with consecutive exotropia of more than 15 prism diopters (PD) at least 6 months after the esotropia surgery. All patients were operated using either unilateral or bilateral MR muscle advancement with or without simultaneous LR recession. Ocular deviation at far and near distances, adduction limitation, and exoshift were investigated at the follow-ups of 1 week, as well as 1, 3, and 6 months after the surgery. Operation was considered successful when the postoperative far deviation was <10 PD.

Results: Thirty patients were evaluated. The mean amount of MR advancement was 5.69 ± 1.33 mm with the mean dose response of 4.7 ± 3.3 and 4.55 ± 4.01 PD at 3 and 6-month follow-ups, respectively. Success rate was reduced from 93% at week 1 to 73% at month 6 due to postoperative exodrift, especially during the first 3 months. Preoperative exotropia was the only contributing factor in our study.

Conclusions: MR advancement was an effective surgical method for consecutive exotropia correction, especially in cases with MR underaction. Bilateral MR advancement and/or LR recession are suggested in cases with higher preoperative exodeviation. The presence of postoperative exodrift indicates longer follow-ups for patients.

Keywords: Advancement, Consecutive exotropia, Medial rectus muscle

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Introduction

Consecutive exotropia is defined as an exodeviation following overcorrection of esodeviation. Its prevalance is reported from 4% to 29% in the literature.[1-4] It can happen in association with various contributing factors including amblyopia, high hyperopia, lack of binocular vision, A-V pattern, and dissociated vertical deviation (DVD), large medial rectus (MR) recession, simultaneous strabismus surgery on three to four ocular muscles and measurement error of esotropic deviation.[5,6] Lost muscle or slipped MR can be considered the probable causes if exotropia is seen immediately or in a short-term follow-up after esotropia operation,[5,6] while long-term consecutive exotropia can be induced by gradual MR muscle lengthening and weakening through the scar tissue formation at the location of muscle tendon suture. Consequently, it will result in MR underaction, adduction limitation, and also convergence weakness.[7,8]

Various surgical procedures including scar tissue removal, unilateral or bilateral MR advancement with or without resection, lateral rectus (LR) recession with or without suture

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adjustment, or combination of the above-mentioned methods are recommended for treatment of patients with consecutive exotropia; which all are based on the amount of exotropia at far and near as well as adduction limitation and convergence weakness involvement.[9,10]

The success rate of these surgeries within the limits of postoperative deviation <10 prism diopters (PD) and dose response of MR advancement have been reported to be from 48% to 72% and 4–4.4 PD/mm, respectively, in the literature.[1,3]

Due to different reports of success rate for consecutive exotropia operations,[1,3,9,10] we aimed to determine the clinical characteristics and surgical outcomes of MR advancement with or without LR recession in patients with consecutive exotropia.

Methods

This prospective interventional case series was performed on patients with consecutive exotropia more than 15 PD at least 6 months after their esotropia surgery. The study procedure was approved by the Ethics Committee of the Ophthalmic Research Center affiliated to Shahid Beheshti University of Medical Sciences via the registration number IR.SBMU.ORC.REC.1398.018. All study procedures adhered to the tenets of the Declaration of Helsinki and written informed consent was obtained from all participants or their parents before entering the study.

Patients with adduction limitation of −4 (which could be due to the lost or paralyzed extraocular muscle), lack of steady foveal fixation (nystagmus, retinopathy of prematurity and eccentric fixation), and those who suffered from autoimmune diseases, collagen disorders, and any other ocular anomalies were excluded from the present study. We also did not include patients with a postoperative follow-up of <6 months after their consecutive exotropia operation.

For all patients entering the study visual and ocular examinations including cycloplegic refraction (45 min after installation of cyclopentolate 1% and tropicamide 1% eye drops), best corrected visual acuity (BCVA) assessment and amblyopia detection (either BCVA worse than 0.30 logMAR or at least two BCVA lines difference between the two eyes) as well as extraocular muscle motility function test (overaction of +4 to underaction of −4) were performed. Ocular deviation was also measured for all patients using the alternative prism cover test or Krimsky method at both far (6 m) and near (33 cm) distances. Vertical deviations and DVD were recorded as well. Stereopsis was checked using the Titmus steroacuity test, and the findings were classified in central fusion (<100 s/arc), peripheral fusion (100–3000 s/arc), and suppression (>3000 s/arc) conditions.[11] Anterior and posterior ocular segments were examined using the biomicroscope and indirect ophthalmoscope through dilated pupil, respectively.

All consecutive exotropic patients were operated using either unilateral or bilateral MR advancement procedure with the assumption that each 1 mm MR advancement would correct 3.5 PD of deviation, and simultaneous LR recession was performed based on Park's table if needed.[12] All subjects were operated by a single surgeon (Zh.R.) using an optical microscope to obtain the higher resolution and detection of muscular fibers from scar or capsular tissues.

After speculum fixation, forced duction test (FDT) was performed in all cases, and if FDT was negative, MR advancement was planned. Following the Swan conjunctival incision, recessed MR was hooked softly, and its anterior tissue up to its primary insertion was carefully evaluated under the microscope magnification. Thin, transparent, and empty tissue was considered MR capsule and MR slippage, while thick, amorphous, and cloudy tissue was considered scar tissue and was trimmed. Then MR was sutured by Vicryl #6-0 and advanced. In consecutive exotropia <20 PD with unilateral MR underaction, ipsilateral MR was advanced. If primary consecutive exotropia was slightly larger, 2 mm MR resection was added to the MR advancement. In cases with alternating consecutive exotropia from 20 to 40 PD and bilateral clinical MR underaction, bilateral MRs were advanced and in the cases with unilateral consecutive exotropia between 20 and 40 PD or the cases with positive FDT, unilateral MR advancement, and LR recession were performed. For instance, a patient with left consecutive exotropia equal to 30 PD with a history of bilateral MR recession of 5 mm underwent ipsilateral MR advancement of 5 mm (5 × 3.5 = 17.5 PD) and ipsilateral LR recession of 6 mm (6 × 2 = 12 PD).

All patients were examined at the 1st day after the surgery, and antibiotic and corticosteroid eye drops were prescribed four times per day with gradual tapering during a month period. Ocular deviation at far and near distances, adduction limitation, and exoshift were investigated at the follow-ups of 1 week, as well as 1, 3, and 6 months after the surgery.

The operation was considered successful when the postoperative far deviation was <10 PD at above-mentioned follow-ups in unilateral or bilateral MR advancement with or without simultaneous LR recession.

Statistical analysis

To describe data, we used frequency (percent), mean ± standard deviation, median, and range. To evaluate variables during follow-up period, we used paired *t*-test. Contributing factors analysis was performed using the logistic regression test. All statistical analysis was performed using SPSS software (IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY, USA: IBM Corp.). The $P < 0.05$ was considered significant.

Results

In this study, 34 patients with consecutive exotropia underwent MR advancement surgery. Four patients did not return for any follow-ups and were excluded from the study, and 30 patients completed the study (female: 52.9%).

Table 1 presents the demographic characteristics of these patients. While amblyopia was seen in 39.4% of cases, 79.4% of the patients showed no binocularity (suppression). Medial rectus underaction (MRUA) from −1 to −3 was observed in 61.8% of cases. Due to the existence of alternating consecutive exotropia and bilateral MRUA, 6 cases were operated bilaterally.

Table 2 shows the characteristics of patients' first operation for esotropia. The mean age of esotropic operation was 8 ± 7 years, and MR recession and recess-resect (R and R) surgery were reported in 62% and 38% of patients, respectively, as their basic types of operation. Inferior oblique weakening was the most accompanying operation in 8% of cases.

The characteristics of patients' second operation for consecutive exotropia are shown in Table 3. The mean age of operation was 22.67 ± 9.99 years, and the mean surgical interval between the first and second operations was 14.56 ± 5.81 years.

Another interesting observation was that in 40% of cases, MR was at farther distance compared to their esotropia operation records. Nearly in all patients, MR attachment to the sclera had a thick stretched scar tissue of 3–5 mm that was resected. In addition to stretched scar resection and MR advancement, three patients underwent 2 mm resection of MR. We did not diagnose any patients with typical presentations of MR slippage including the existence of transparent capsule from MR muscle fiber to its primary insertion during the surgery, even by microscope magnification. The patients were followed at least in the 1st week and at 3 and 6 months postoperatively [Table 4]. The dose response was calculated only in the cases of unilateral or bilateral MR advancement. The mean dose response of MR advancement was 4.73 ± 3.36 PD/mm at three and 4.55 ± 4.01 PD/mm at 6-month follow-up. Although the percentage of orthophoria was reduced from the 1st week to month 3 due to exodrift ($P = 0.013$), there was no significant

Table 1: Basic characteristics of the consecutive exotropic patients

Factors	Level	Mean±SD	Median (range)
Sex (%)	Male	16 (47.1)	
	Female	18 (52.9)	
Spherical equivalent (D)		0.15±0.35	0 (−3.75-10.5)
BCVA (logMAR)		0.39±0.56	0.05 (0-1.79)
Stereopsis (%)	Central fusion (<100 s/arc)	0 (0.0)	
	Peripheral fusion (100-3000 s/arc)	7 (20.6)	
	Suppression (0 and 3000 sec/arc)	27 (79.4)	
Amblyopia (%)*	No	20 (59)	
	Yes	13 (38)	
	N/A	1 (3)	
Preoperation exotropia at far (PD)		34.1±14.1	32.5 (15-70)
Preoperation exotropia at near (PD)		34±16	35 (0-65)
MRUA (%)	−3	1 (2.9)	
	−2	4 (11.8)	
	−1	16 (47.1)	
	0	13 (38.2)	
Laterality of exotropia (%)	Unilateral	28 (82.4)	
	Alternating	6 (17.6)	

*One patient did not answer to the Snellen visual acuity chart. BCVA: Best corrected visual acuity, MRUA: Medial rectus underaction, N/A: Not available, SD: Standard deviation

Table 2: Characteristics of the patients at their first operation for esotropia

Factors	Level	Mean±SD	Median (range)
Age of ET operation (years)		8±7	6 (1-24)
Amount of ET operation (mm)	MR recession		
	Unilateral (*n*=6)	6±1	6 (4-8)
	Bilateral (*n*=15)	6±1	6 (4-8)
	R and R		
	Unilateral (*n*=13)	9±0.75	9 (9.0-9.5)*
Type of ET operation (%)	MR recession	21 (61.8)	-
	R and R	13 (38.2)	-
Accompanying surgery of ET operation (%)	IO weakening	3 (8.0)	-
	PF	1 (3.0)	-

*The amount of R and R is calculated based on the summation of recession and resection surgeries. ET: Esotropia, MR: Medial rectus, R and R: Recession and resection, IO: Inferior oblique, PF: Peripheral fixation, SD: Standard deviation

Table 3: Characteristics of the patients during their consecutive exotropic operation

Factors	Level	*n* (%)	Mean±SD	Median (range)
Age of XT operation (years)			22.67±9.99	21 (3-43)
Interval between ET and XT operation (years)			14.56±5.81	15 (2-27)
Type of XT operation (%)	MR advancement	24 (70.6)	-	-
	Unilateral	15 (62.5)	-	-
	Bilateral	9 (37.5)		
	MR advancement + LR recession	10 (29.4)	-	-
Amount of MR advancement (mm)	MR advancement (*n*=24)		5.69±1.33	6 (3.5-8)
	Unilateral		6±1.26	6 (4-8)
	Bilateral		4.75±1.13	4.75 (3.5-6)
MR distance from limbus (mm)			11.9±1.54	11.5 (9-16)
Accompanying XT operation (%)	SR recession		2 (5.0)	
	IO anteriorization		1 (2.6)	
Last follow-up (years)			2.1±1.9	1 (1-7)

XT: Exotropia, MR: Medial rectus, LR: Lateral rectus; Res: Resection, IO: Inferior oblique, SR: Superior rectus, SD: Standard deviation, ET: Esotropia

Table 4: Postoperative characteristics of the consecutive exotropic patients in different follow-ups

	Factors	Type	Far distance			Near distance		
			n (%)	Mean±SD	Median (range)	*n* (%)	Mean±SD	Median (range)
Postoperation deviation	First week (*n*=30)	Ortho	28 (93.3)	2.7±3.2	0 (0-8)	24 (80.0)	3±3	1 (0-8)
		XT	1 (3.3)	10±0	10	2 (6.7)	10±0	10
		ET	1 (3.3)	25±0	25	4 (13.3)	11±1	11 (10-12)
	Month 3 (*n*=30)	Ortho	22 (73.30)	3.27±3.18	4 (0-8)	22 (73.30)	4.60±3.62	6 (0-8)
		XT	8 (26.6)	18±8.3	16 (10-35)	8 (26.6)	17±4	16 (12-25)
	Month 6 (*n*=30)	Ortho	21 (70.0)	3.67±3.15	4 (0-8)	18 (60.0)	3.78±3.62	4 (0-10)
		XT	9 (30.0)	12.11±7.22	12 (1-20)	8 (26.7)	15.25±7.3	14 (4-25)
		ET	0 (0.0)	0±0	0	4 (13.3)	11.5±1.91	11 (10-14)
	Last F/U (*n*=18)	Ortho	12 (66.7)	1.67±2.23	0 (0-6)	12 (66.7)	2.33±3.06	0 (0-8)
		XT	6 (33.3)	24±8.83	22.5 (14-25)	6 (33.3)	17.33±6.38	16 (10-25)
		ET	0	0±0	0	0	0±0	0
Dose response (mm/PD)	Month 3		-	4.73±3.36	4 (1.5-9.77)	-	4.20±3.04	3.87 (−1.0-12.3)
	Month 6		-	4.55±4.01	3.81 (1.5-23.33)	-	3.99±3.46	3.73 (−2.33-15.0)
Exodrift (PD)*	1st week–month 3		-	−4.07±9.35	−4 (−35-25)	-	4.31±7.03	4.0 (−8.0-25.0)
				P=0.013			*P*=0.003	
	Month 3–month 6		-	−0.68±4.81	0 (−12-8)	-	−0.22±6.03	0 (−16.0-9.0)
				P=0.462			*P*=0.85	
Postoperation success rate (%)	Week 1		28 (93.3)	-	-	24 (80.0)	-	-
	Month 3		22 (73.3)	-	-	22 (73.3)	-	-
	Month 6		22 (73.3)	-	-	18 (60.0)	-	-
	Last F/U		12 (67)	-	-	12 (66.7)	-	-

*Positive and negative signs show eso and exoshifting of the postoperative angle of deviation, respectively. ET: Esotropia, XT: Exotropia, F/U: Follow-up, SD: Standard deviation

exodrift from month 3 to month 6 ($P = 0.195$) and month 6 to the last visit ($P = 0.93$). A mean exodrift of 4.07 ± 9.35 PD was observed from the 1st week to month 3 and 0.68 ± 4.81 PD from month 6 to the last visit in the present study. The success rates (±10 PD) in months 3, 6, and at the last visit were also similar (71%, 70%, and 66.7%). No case of esotropia at far distance was seen in 6 month and last follow-ups. Figure 1 shows ocular deviation of each patient preoperatively and at 3 and 6 months postoperatively.

Factors such as the amount of the MR recession, amblyopia, and MRUA were not found to be a contributing factor for the operational success in our study. Preoperative amount of consecutive exotropia was the only contributing factor of which was related to our success ($P = 0.035$).

The case numbers in Tables 1-3 are equal to 34 since all patients underwent second operation, but the numbers of cases in Table 4 is 30 patients due to the exclusion of four cases.

Twenty-eight (82%) patients with unilateral consecutive exotropia had wider lid fissure in their deviated eye, which will improve in most patients after MR advancement with or without LR recession.

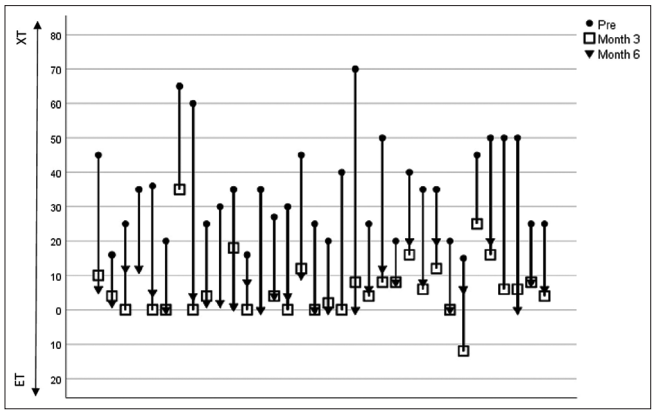

Figure 1: The ocular deviation of each patient in preoperative examination and 3 and 6-month postoperative follow-ups

Discussion

Current surgical correction of consecutive exotropia includes MR advancement ± resection, LR recession, or a combination of these two methods performed unilaterally or bilaterally according to the preoperative amount of exotropia, however, it is not always possible to predict the results of these reoperations.[2,13-15]

Our success rate among 30 cases were 71%, 73.3%, and 67% at months 3 and 6 and the final visit, respectively, which is in line with Mohan *et al*.'s[2] (67.7%) and Akbari *et al*.'s[13] (63%) studies. Gesite-de Leon and Demer[14] reported 50% success rate among 20 consecutive exotropic patients with the mean follow-up of 1.6 ± 1.8 years. The difference in success rate could be due to their study design (retrospective record review from 1997 to 2014), fewer number of cases, and wider range of follow-ups.

In another study, the success rate of 79.2% was reported by Cho and Ryu,[15] who reported the results of 77 consecutive patients after 1 year of follow-up. The reason for their relatively higher success rate could relate to the exclusion of the patients who needed LR recession or cyclovertical muscle operation with MR advancement surgery, which has been suggested as contributing factors for lower success rate in the literature.

The success rate in our previous study[10] on 10 consecutive exotropic patients with 3-month follow-up was 83.9%. The short-term follow-up could be considered the possible cause of the difference in reported success rate.

In the present study, dose response of 4.7 PD/mm was calculated at the follow-up of 3 months. Dose responses of 3.1, 4.2, and 4.25 PD/mm at different follow-ups have been reported in studies by Cho *et al*.,[15] Akbari *et al*.,[13] and Rajavi *et al*.,[10] respectively. A mean exodrift of 5 PD was observed from the 1st week to month 3 and 0.7 PD from month 6 to the last visit in the present study. A higher amount of exoshift has been reported in other studies (9.3 PD at more than 3 years and 17 PD at 6.2-year follow-ups).[14,15] The difference could be due to longer follow-ups. In general, it seems that the longer follow-up can be associated with the higher exodrift and the lower dose response.

We did not have any postoperative esotropia at 6 months and at the final visit in our study. In comparison, Cho and Ryu[15] have reported esotropia in 3.9% of their cases after 1 year of follow-up.

The interesting point in the present study was that unlike other studies, we did not observe an empty and transparent MR capsule from recessed MR location to its primary insertion, which is the standard sign of slippage. Instead there was almost always a thin or thick amorphous stretched scar tissue in this area. For example, abnormal MR attachment was reported in 16% of cases participating in a study by Hatt *et al*.[7]

In our study, the mean interval between operation of eso and exotropic deviations was 14.5 years. This interval was 9.4 and 13 years in the Akbari *et al*.[13] and Cho and Ryu[15] studies, respectively. These long periods indicate gradual appearance of exotropia in these patients. Hence, patients should be aware of the necessity of long-term follow-up visits after strabismus operations.

In the present study, among analyzed variables, only the preoperative consecutive exotropia reached to significant level as a contributing factor ($P = 0.035$). Chang and Lin[1] did not find any contributing factor in their surgical outcomes such as binocularity, A-V pattern, amblyopia, and inferior oblique muscle overaction similar to our results.

The present study had some limitations including lower number of cases at the last visit and lack of preoperative computed tomography scan of the extraocular muscles.

Operation under microscope magnification for more careful examination of the scar tissue can be considered an advantage of our study.

In conclusion, MR advancement was an effective surgical method for consecutive exotropia correction, especially in cases with MR underaction. Bilateral MR advancement and/or LR recession are suggested in cases with higher preoperative exodeviation. The presence of postoperative exodrift indicates the need for longer follow-ups.

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Conflicts of interest

There are no conflicts of interest.

References

1. Chang CY, Lin MC. Surgical results for consecutive exotropia. Taiwan J Ophthalmol 2017;7:100-3.
2. Mohan K, Sharma A, Pandav SS. Unilateral lateral rectus muscle recession and medial rectus muscle resection with or without advancement for postoperative consecutive exotropia. J AAPOS 2006;10:220-4.
3. Tinley C, Evans S, McGrane D, Quinn A. Single medial rectus muscle advancement in stretched scar consecutive exotropia. J AAPOS

2010;14:120-3.
4. Negishi T, Hikoya A, Isoda H, Tsuchiya Y, Sawada M, Hotta Y, *et al.* Magnetic resonance imaging of the medial rectus muscle of patients with consecutive exotropia after medial rectus muscle recession. Ophthalmology 2010;117:1876-82.
5. Han SY, Han J, Rhiu S, Lee JB, Han SH. Risk factors for consecutive exotropia after esotropia surgery. Jpn J Ophthalmol 2016;60:333-40.
6. Yurdakul NS, Ugurlu S. Analysis of risk factors for consecutive exotropia and review of the literature. J Pediatr Ophthalmol Strabismus 2013;50:268-73.
7. Hatt SR, Leske DA, Jung JH, Holmes JM. Intraoperative findings in consecutive exotropia with and without adduction deficit. Ophthalmology 2017;124:828-34.
8. Sawada M, Hikoya A, Negishi T, Hotta Y, Sato M. Characteristics and surgical outcomes of consecutive exotropia of different etiologies. Jpn J Ophthalmol 2015;59:335-40.
9. Lee HJ, Yu YS, Kim SJ. Long-term surgical outcomes of patients with consecutive exotropia. Graefes Arch Clin Exp Ophthalmol 2019;257:1037-44.
10. Rajavi Z, Feizi M, Mughadasifar H, Yaseri M, Haftabadi N, Sheibani K. Surgical results of consecutive exotropia. J Pediatr Ophthalmol Strabismus 2013;50:274-81.
11. Rajavi Z, Gozin M, Sabbaghi H, Behradfar N, Kheiri B, Faghihi M. Reoperation in horizontal strabismus and its related risk factors. Med Hypothesis Discov Innov Ophthalmol 2018;7:73-82.
12. Parks M. Concomitant esodeviations. In: Tasman W, Jaeger E, editors. Duane's Clinical Ophthalmology. Philadelphia: Lippincott, Williams & Wilkins; 2000.
13. Akbari MR, Hassanpoor N, Aghsaei Fard M, Nozarian Z, Yaseri M, Mirmohammadsadeghi A. Clinical and histopathologic features of consecutive exotropia. Strabismus 2018;26:84-9.
14. Gesite-de Leon B, Demer JL. Consecutive exotropia: Why does it happen, and can medial rectus advancement correct it? J AAPOS 2014;18:554-8.
15. Cho YA, Ryu WY. The advancement of the medial rectus muscle for consecutive exotropia. Can J Ophthalmol 2013;48:300-6.