

Medial Rectus Advancement Compared to Lateral Rectus Recession for Small to Moderate Angle Consecutive Exotropia

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Short title: MRA Compared to LRR Among Patients with angle Consecutive Exotropia

ABSTRACT

Background: Consecutive exotropia is an exodeviation type that appears after surgically correcting esodeviation and is distinguished by postoperative exotropia lasting longer than a month.

Aims: to assess the bilateral medial rectus advancement (MRA) compared to bilateral lateral rectus recession (LRR) among patients with consecutive exotropia.

Methods At Menoufia University Hospital, a prospective clinical trial included 24 patients was conducted in the period from May 2022 to June 2023. The patients were divided into 2 groups, each group contained 12 patients who underwent bilateral medial rectus advancement and bilateral lateral rectus recession. Demographic data, as well as preoperative and postoperative ocular alignment were determined for each patient. All patients were followed up by one weeks, 2, 4, 8, and 12 months postoperative.

Results: Half of group MRA group's patients (50%) were males vs five (41.66%) of the LRR group's patients, with no obvious differences between the two groups ($P=0.682$). There were no appreciable changes between the MRA and LRR groups ($P>0.05$) in preoperative and postoperative ocular alignment.

Conclusions: The two surgery groups in this study did not significantly differ from one another. Both of these surgical techniques can be used to effectively treat consecutive exotropia, but LR recession is a reasonably straightforward to perform. Recession of the LR should be performed on patients with chronic exotropia and no vertical abnormalities.

Keywords: Consecutive exotropia • Lateral rectus recession • Medial Rectus Advancement.

INTRODUCTION

Consecutive exotropia is a manifest exotropia that appears in a patient who was previously esotropic following esotropia surgery¹. According to several research, the incidence of consecutive exotropia ranges from 3% to 29%²⁻⁴. After strabismus surgery for esotropia, consecutive exotropia may develop⁵. Adduction deficit, amblyopia, anisometropia, A or V pattern, hypermetropia, absence or poor binocularity, and iatrogenic reasons, such as past medial rectus retraction of more than 7 mm, multiple operations, calculation error, are risk factors for consecutive exotropia⁶. Adduction deficiency may be improved by advancing one or both of the previously

recessed medial rectus muscles^{7,8}. This has the benefit of including surgical exploration of the medial rectus muscle to find slippage without disturbing the antagonist lateral rectus muscle⁶.

Medial rectus advancement successfully corrected consecutive exotropia, attaining correction of around 4 of exotropia per mm total medial rectus advancement, properly aligning 95% of patients in the immediate postoperative period⁹⁻¹¹.

The aim of this study is to compare lateral rectus recession to medial rectus advancement in a sample of

Egyptian patients with small to moderate angle consecutive exotropia.

METHODS

At Menoufia University hospital's ophthalmology department, a prospective clinical trial included 24 patients with history of bilateral MR recession and consecutive exotropia. Age, gender, refraction, and the interval (months) between operations were all noted. A manifest refraction and fundus examination were performed prior to surgery. The patients were given prescriptions for glasses when refractive error was found. The subject was fixated at a 20/30 target at a distance of 6 meters and 33 cm when the angle of deviation under the subject's best corrected prescription was calculated using the alternative prism cover test. Prism and alternate cover tests were used to measure the pre-operative deviation at distances of 6 m and 1/3 m, respectively.

All studied patients were divided into two groups as: Group I (MRA) included 12 patients with consecutive exotropia who underwent medial rectus advancement. Group II (LRR) included 12 patients with consecutive exotropia who underwent lateral rectus recession.

Ethical consideration

All procedures were carried out in accordance with the institutional committee's code of ethics (IRB: 12-2022 OPTH 6-1). The Menoufia University Faculty of Medicine's Ethical Committee gave its approval to the study. After being informed of the goals and procedures of the study and having the nature and scope of the inquiry explained to them, all patients provided signed informed consent.

Inclusion criteria: Consecutive exotropia among individuals of both sexes, aged 5 to 20 years, with normal ocular motility, exotropia 20 PD, a far-near discrepancy 10 PD, and history of bilateral medial rectus recession.

Exclusion criteria: restricted adduction, history of operation on the lateral rectus, and positive forced duction test of the lateral rectus.

Postoperative examination

For one week, and 2, 4, 8, and 12 months after surgery, the strabismus angle deviation was assessed from a distance and up close. An indication of surgical success was postoperative esophoria or exophoria of less than 8 PD that

didn't necessitate a third procedure. The variance in surgical outcomes at distant (6 m) and close (1/3 m) locations was assessed using the prism and alternating cover tests.

Methods of examinations of anterior segment by Slit lamp, fundus by indirect ophthalmoscope, visual acuity using snellen chart, and refraction by autorefractometer.

Surgical procedure

The procedure applied to both eyes of the patient and who underwent previous bilateral MRR. The amount of MRA or LRR done in mm according to standard tables of strabismus surgery.

Bilateral MRA steps

Firstly, a limbal conjunctival flap is created. The blood vessels are identified at the muscle insertion and cauterized. Then For nonadjustable procedures, two single-armed absorbable 6-0 polyglactin 910 sutures were passed in full thickness, double loop, locking fashion at the superior and inferior margins of the medial rectus tendon at its insertion. The medial rectus muscle was sharply disinserted from the sclera and was advanced according to Parks's medial rectus resection table, aiming to achieve initial postoperative alignment of orthotropia to 8^A of esotropia. Medial rectus advancement of 1 mm was considered equivalent to 1 mm of medial rectus resection. The muscle was resutured to the sclera at the new insertion site. Response to advancement was studied by comparing pre- and postoperative deviations at 1 week, 4–8 weeks, and final follow-up. Successful outcome was defined as orthotropia within 10^A.

Bilateral LRR steps

Firstly, a limbal conjunctival flap is created. The blood vessels are identified at the muscle insertion (arrow) and cauterized. One half of the muscle tendon is secured with the suture. Two-thirds of the tendon is detached from the globe, while the other third remains untouched. Response to surgery was studied by comparing pre- and postoperative deviations at 1 week, 4–8 weeks, and final follow-up. Successful outcome was defined as orthotropia within 10^A. Postoperative treatment: systemic antibiotics, combined topical antibiotic and steroid drops and ointment.

Postoperative follow-up

All patients received systemic and biotic combined topical antibiotic and steroid drops and ointments. All patients were followed up one week, and 2, 4, 8, and 12 months after surgery. The ocular modality and ocular alignment were measured in every visit for all patients.

Outcomes of the study

- Determined of ocular alignment preoperative and after one week, and 2, 4, 8, and 12 months after surgery for each patient.
- Detection of success rate %.

Statistical analysis

All data were compiled and analyzed using SPSS version 21 (SPSS Inc., Chicago, IL). Continuous variables are presented as means (\pm standard deviation (SD)), and categorical variables are presented using relative frequency distributions and percentages. Continuous variables were compared among MRA and LRR groups using Student's t-test, or the Mann-Whitney (t) test used to compare abnormally distributed quantitative variables among MRA and LRR groups, and categorical data among different groups were analyzed using the chi-square (X²) test. The cumulative odds of the success of subsequent exotropia surgeries were

compared using the Kaplan-Meier survival estimator and log rank testing. Statistical significance was established at $p \leq 0.05$.

RESULTS

In Menoufia University hospital, Shebin El-Kom. 37 patients visited the ophthalmology section. Despite the fact that 24 patients were willing to participate and granted their approval, 13 people were not included in the trial (five patients denied consent and eight patients did not match the inclusion criteria). Ultimately, 12 patients with consecutive exotropia had lateral rectus recession and 12 patients' medial rectus advancement. In this study, the state of medial rectus during advancement was only 25% dense adhesion and no slipped no fibrotic muscle as well as no muscle behind the equator.

In our study, the surgery was done on both eyes, there was no statistically significant difference between the two groups' mean ages at surgery, which were 12.92 ± 4.74 years for the MRA group and 11.92 ± 5.48 years for the LRR group ($P=0.637$). Male patients made up half of group MRA group's patients (50%) and five of the LRR group's patients (41.66%), with no obvious differences between the two groups. ($P=0.682$), (Table 1).

Table 1. Socio demographic data among MRA and LRR groups (N=24).

Variables	MRA		LRR		Total		t	P value
	(n=12)		(n=12)		(N=24)			
Age/year								
Mean \pm SD	12.92 \pm 4.74		11.92 \pm 5.48		12.42 \pm 5.11		0.478	0.637
Gender								
	No.	%	No.	%	No.	%	X ²	P value
Male	6	50.0	5	41.7	11	45.8	0.168	0.682
Female	6	50.0	7	58.3	13	54.2		

MRA: medial rectus advancement. **LRR:** lateral rectus recession.

t: independent t-test. X²: Chi-square test.

In this study, the medial rectus advancement and lateral rectus recession groups did not significantly differ in terms of preoperative and postoperative exotropia angle

during exotropia surgery and operation interval/year ($P>0.05$), (Table 2).

Table 2. Preoperative and postoperative ocular alignment at exotropia surgery among MRA and LRR groups (N=24).

Exotropia (EX)	MRA	LRR	t	P value
	(n=12)	(n=12)		
	Mean ±SD	Mean ±SD		
Preoperative	35.0± 6.4	33.6± 6.6	0.54	0.59
On weeks	4.5±1.5	3.8±1.5	1.87	0.35
2 months	4.3±1.9	3.7±1.5	1.64	0.41
4 months	3.1±1.2	2.8±1.2	0.92	0.50
8 months	2.9±1.1	2.6±1.0	0.87	0.49
12 months	2.57± 1.0	2.00±0.0	0.980	0.36
Operation interval/year	3.25± 1.5	2.75± 1.5	0.808	0.43

MRA: medial rectus advancement. LRR: lateral rectus recession.

t: independent t-test.

Following surgery, exotropia also significantly improved postoperative among the MRA group (P<0.001). After 12 months following surgery, mean changes of exotropia angle significantly gradually increased after one week, 2, 4, 8, and 12 months after surgery. was the highest improvement identified at 12 months after surgery (34.57±6.40 PD) compared to pre-operative, (Table 3, Figure

1). In the same concern among LRR group, mean changes of exotropia angle were significantly better postoperatively (one week, 2, 4, 8,12 months) than preoperatively. The better improvement noted at 12 months after surgery (31.33±7.6 PD) compared to pre-operative, (P<0.001), (Table 4, Figure 1).

Table 3. Mean changes of exotropia pre and postoperative among MRA group (N=12).

Exotropia/PD	MRA group (n=12)			
	Preoperative	Paired t	P value	95%CI
	Mean dif.±SD	test		Lower Upper
Postoperative				
On weeks	30.5±4.9	8.03	0.012*	10.98 39.01
2 months	30.7±4.5	9.11	0.007*	7.31 40.12
4 months	31.9±5.2	12.67	<0.001*	13.60 67.54
8 months	32.1±5.3	12.95	<0.001*	9.20 52.0
12 months	34.57±6.4	14.29	<0.001*	28.7 40.5

MRA: medial rectus advancement

t: paired t-test. *Significant

CI: Confidence interval for Mean.

Table 4. Mean changes of Exotropia pre and postoperative among LRR group (N=12).

Exotropia	LRR group (n=12)				
	Preoperative Mean dif.±SD	Paired t test	P value	95%CI Lower Upper	
Postoperative					
On weeks	29.8±5.1	6.07	0.027*	6.71	29.05
2 months	29.9±5.1	7.01	0.019*	5.11	48.33
4 months	30.8±5.4	7.98	0.004*	14.76	60.10
8 months	31.0±5.6	7.61	0.019*	12.40	50.3
12 months	31.33±7.6	8.03	<0.001*	9.63	68.12

LRR: lateral rectus recession

t: paired t-test, *Significant

CI: Confidence interval for Mean.

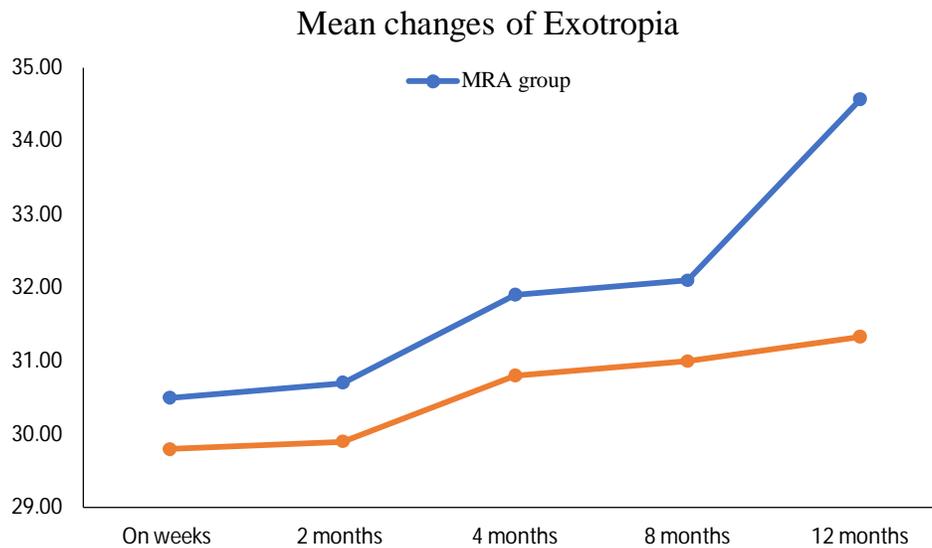


Figure 1. Mean changes of Exotropia pre and postoperative among MRA and LRR groups.

In our study, Successive exotropia occurred in 11 patients (91.7%) of MRA and occurred in 12 patients (100%) of LRR, with p value 0.682, (Table 5).

Table 5. Success rate among MRA and LRR groups (N=24).

Variables	MRA (n=12)		LRR (n=12)		Total (N=24)		t	P value
	No.	%	No.	%	No.	%	X ²	P value
Success rate								
Yes	11	91.7%	12	100%	23	95.8%	0.168	0.682
No	1	8.3%	0	0%	1	4.2%		

MRA: medial rectus advancement. **LRR:** lateral rectus recession.

X²: Chi-square test.

According to Kaplan–Meier survival curves, estimated median survival times for the MRA and LRR groups, respectively, were 4.18±0.454 and 3.81±0.493 months, respectively (Figure 2, log-rank test, P=0.863). However, the amount of MRA and LRR recession did not have a statistically significant link (Table 6, Figure 2).

Table 6. Means and Medians for Survival Time using Kaplan–Meier survival analysis among MRA and LRR groups.

Groups	Mean				Median			
	Estimate	Std. Error	95% CI		Estimate	Std. Error	95% CI	
			Lower Bound	Upper Bound			Lower Bound	Upper Bound
MRA	4.2	.45	3.29	5.08	5.0	.4	4.13	5.87
LRR	3.9	.49	2.85	4.8	5.0	1.18	2.69	7.30
Overall	4.0	.31	3.42	4.65	5.0	.39	4.23	5.78
Log Rank (Mantel-Cox)								
Chi-Square					.030			
Sig. (p value)					.863			

MRA: medial rectus advancement. **LRR:** lateral rectus recession, **CI:** Confidence interval for Mean and median.

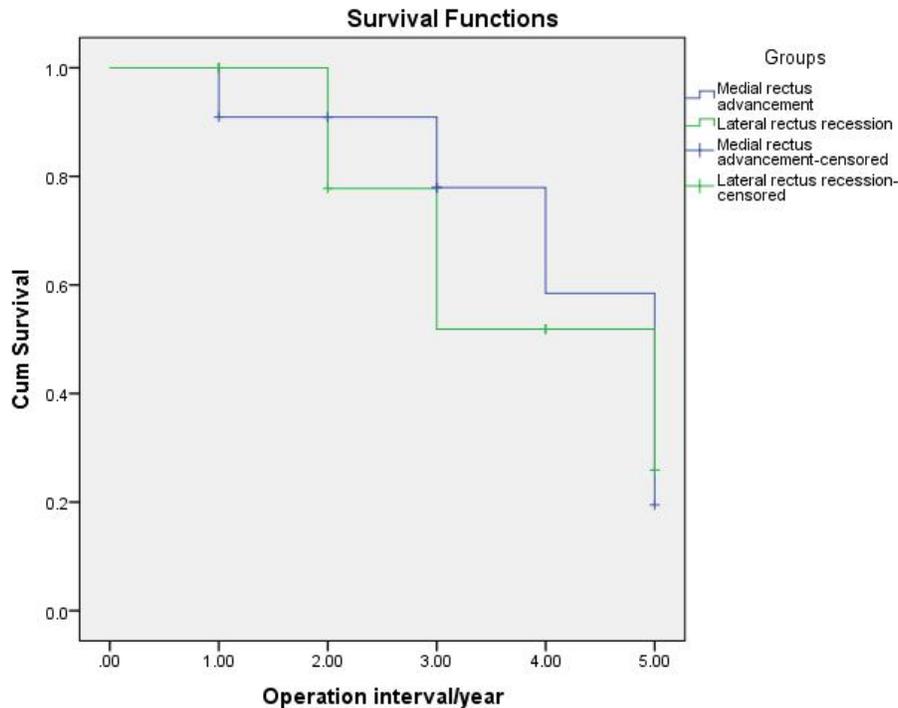


Figure 2. Kaplan–Meier survival curves of MRA and LRR groups. LR recession group start higher survival rate than MRA group but the difference between them did not reach to significant level (log-rank test, P=0.863).

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

DISCUSSION

In our study, no significant differences were found in preoperative and postoperative ocular alignment between MRA and LRR groups. However, Donaldson et al.¹² reported that MR advancement and LR recession had a 71% success

rate, making them successful operations. Six out of seven patients with bilateral LR recession had positive outcomes. According to Chatzistefanou et al.¹³, MR advancement and LR recession had a mean correction influence of 2.9 PD/mm. Results could have been affected by prior surgery since LR

recession restored previously excised LR. The success percentage for MR progression on either one or both sides was 46%, according to Ohtsuki et al.¹⁴. They found no appreciable change in the mean exotropia correction amount between one and both MR advancements, proving that the degree of correction is independent on advancement. In addition, Kim et al.¹⁵ found a 91% success rate in 11 consecutive exotropia patients when they examined the surgical dosage effect connection in single muscle advancement in consecutive strabismus.

The preoperative angle deviation and the amount of MR improvement did not considerably correlate with the mean correction ratio, which was larger than our finding and was 4.03 ± 0.97 PD/mm. Han et al.,¹⁶ observed that the mean correction ratio was bigger than the LR recession and that the change in deviation did not correlate with the amount of MR advancement. Our results supported those of Elsayed et al.¹⁷, who found no statistically significant difference between the two groups in the mean preoperative angle of consecutive exotropia,

According to Stager et al.¹⁸, expressed concern regarding a 7 mm MR recession. Exodrift regularly occurred when the MR was recessed up to 2 mm posterior to the equator, and late progressive overcorrection frequently happened when it was recessed up to 1.6 mm posterior to the equator, Cho and Ryu⁷. They observed after either unilateral or bilateral MR advancements for at least a year, the patients (mean follow-up duration, 47.04 ± 3.57 months). The average corrective effects per 1 mm of moving MR were 4.2 ± 1.13 PD after 1 day, 3.6 ± 1.0 PD after 1 month, 3.3 ± 1.13 PD after 6 months, 3.1 ± 1.03 PD after 1 year, 3.2 ± 1.17 PD after 2 years, 3.1 ± 1.36 PD after 3 years, and 2.9 ± 1.35 PD after the end of follow-up. A year after surgery, the typical 3.0 PD corrective effect was still present. Additionally, bilateral MR advancement had a stronger effect at the final visit than unilateral MR advancement (3.20 ± 1.25 versus 2.53 ± 1.39 PD, respectively). Within six weeks of surgery, 66% of 59 patients saw a mean exodrift of 7.6 PD.

According to Biedner et al.¹⁹, effective MR advancements were seen in 3 of 8 consecutive exotropia patients, 2 mm from the original implantation site and 3.5

mm from the limbus. According to Patel et al.²⁰, After a mean follow-up of 30 months, 65 percent of patients who underwent consecutive bilateral LR recession for exotropia experienced good results with fewer than 10 PD. These results did not differ significantly from those of bilateral LR recession, which was carried out using the same surgical approach as for primary exotropia ($p = 0.09$),²¹.

In the current study, when compared to preoperatively, exotropia within the MRA group considerably decreased postoperatively. One year after the procedure began, mean changes began to rise. The effectiveness of unilateral rectus recession for intermittent exotropia has been studied extensively. According to a study by Spierer and Spierer²², treatment for young neonates with moderate-angle intermittent exotropia involves unilateral lateral rectus recession. With a mean postoperative angle of deviation of 3.5 PD for far-off sites and 1.6 PD for close-by sites, a remarkable success rate of 86.2% was attained²³. Also, Suh et al.²⁴ examined Another interesting topic is the surgical outcomes of individuals with exotropia of 20–25 PD who had medial rectus excision and medial and lateral rectus recession.

In our study, Successive exotropia occurred in 91.7% of MRA patients and occurred in all patients of LRR. In our range, Kim et al.¹⁵ found a 91% success rate in 11 consecutive exotropia patients when they examined the surgical dosage effect connection in single muscle advancement in consecutive strabismus. These are nearly Spierer and Spierer (21), whose remarkable success rate of 86.2% was attained. However, Donaldson et al.¹² reported that MR advancement and LR recession had a 71% success rate, making them successful operations. In previous studies, individuals with unilateral lateral rectus recession and moderate-angle exotropia reported success in 69% of cases,²³. Another study reported a lower percentage of successive exotropia occurred in 27% of the 88 patients who received a 7-mm MR recession²³. In addition, Suh et al.²⁴ reported the most recent follow-up, the surgical success rates for the two groups 45.9% for the lateral rectus group and 39.4% for the recession-resection group had not significantly changed.

According to this study, the estimated mean survival durations for the MRA and LRR groups were 4.18 ± 20.454 and 3.81 ± 50.493 months, respectively with (log-rank test, $P=0.863$). The MRA and LRR recession amounts did not, however, show any statistically significant association. The estimated mean survival durations for the MR advancement group were 25.74 ± 3.78 months, while the anticipated mean survival times for the LR were 90 ± 5.80 months, according to Kaplan-Meier survival curves., according to a study by Han et al¹⁶.

Limitations of the current study included small sample size of patients and short term follow up.

CONCLUSION

The two surgery groups in this study did not significantly differ from one another. Both of these surgical techniques can be used to effectively treat consecutive exotropia, but LR recession is a reasonably straightforward to perform. Recession of the LR should be performed on patients with chronic exotropia and no vertical abnormalities.

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Data Availability: The authors declare that all data supporting the findings of this study are available within the article and its supplementary information file.

Competing interests: The authors declare no competing interests.

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Ethics declarations: All procedures performed in the study followed the 1964 Helsinki declaration and its later amendments, University Ethics Committee approved the project.

Conflict of interest

Ahmed Esmail, Mohamed Ibrahim, Sara Nage. all authors have no conflicts of interest that are directly relevant to the content of this review.

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