Bilateral Medial Rectus Muscle Recession Surgery: Outcome & Patients' Dose Response

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Abstract: Objective: To identify success rate and response to bilateral medial rectus muscle recession in patients with esotropia. **Methods:** In this retrospective study we reviewed records of 130 patients (aged 6month to 48 years) who had recession surgery for correction of esotropia at 1 month, 3 month and 2 years after the surgery. **Results**: One month after operation (n = 109), there were 85 (78.1%) successful cases, 18 (16.4%) cases of under correction, and 6 (5.5%) case of overcorrection. The success rate at the two postoperative years (n =82) was 78.2% with 13.3% under correction and 8.5% over correction. The preoperative angle of esodeviation and patients' age are found to significantly influence the response to the surgery. **Conclusion**: Surgery is effective because of high success rate and acceptable alignment after 2 years follow up. Dose response increased in patients with larger angle of preoperative esodeviation, and was lower for patients who were older at the time of the surgery.
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1. Introduction

Strabismus is a visual problem in which the eyes cannot maintain their proper alignment(West and Asbury, 2008). Its prevalence is about 2-4 percent(Williams, 2008; Greenberg, 2007). Esodeviations, the most common form of Strabismus, account for more than half of eye deviations in children(Pediatric Ophthalmology and Strabismus San Francisco: American Academy Of Ophthalmology, 2010). Twenty-five infants in 10000 births are born with esotropia with an age- and gender-adjusted incidence of 111.0 per 100,000 patients under 19 years annually (Greenberg, 2007; Nixon, 1985). Amblyopia therapy (covering the eye, atropine), using optical devices (glasses, prism), drugs (miotics, botulinum toxin) and orthoptics have been described as medical treatment of esotropia(West and Asbury, 2008). However, congenital cases are rarely resolved without surgical treatment. Bilateral medial rectus muscle recession (BMR) is considered as the most common method of surgery in treatment of esotropia(Pediatric Ophthalmology and Strabismus San Francisco: American Academy Of Ophthalmology, 2010). Considerable benefits have been reported for strabismus surgery. In spite of many guidelines to the amount of muscle recession, the response to the surgery is not entirely consistent in many cases. This might be due to different medial rectus muscle contraction in different angles of esotropia, e.g. because of medial rectus muscle contraction in larger angles of esotropia, less recession might lead to better results. Another example is the older patients with degenerated muscle who might need more medial rectus muscle recession (Dawson, 2013; Sarwar and Waqar, 2013; Habot-Wilner, 2006). However, its results depend on several factors. For example age, preoperative deviation and axial length have been reported to influence on outcomes of surgery (Kushner, 1993; Shen, 2013; Kampanartsanyakorn, 2005; Kushner, 1989). We aimed to study the results of this surgery as the main technique in esotropia surgery.

2. Material and Methods

In this retrospective study, medical records of 355 patients with esotropia, who underwent BMR surgery (adjustable suture technique is also included) at Hazrat Rasoul Akram hospital, Tehran, Iran, from

March 2001 to November 2011, were reviewed. We applied the exclusion criteria including recession>7 millimeter (mm) in each eye, refraction>4 diopter (D) in each eye, retinal and optic nerve abnormalities, vertical deviations, injection of butolinum toxin in rectus muscles, any prior surgery on eyes, and the existence of A, V or X pattern of esotopia. As a result only 130 patients remained in our study. Study variables included age at the time of surgery, gender, preoperative refractive errors in each eye, preoperative near and distance esotropia, the amount of recession in each eye, post-operative near and distance esotropia (one month, three months and two years after the surgery), post-operative near and distance exotropia (one month, three months and two years after the surgery), dose response in near and distance (one month, three months and two years after the surgery).

Data were extracted from medical records of patients. Refractive errors had been measured with a retinoscope after cycloplegia. The strabismus angle had been determined in the primary position at 40 cm (recorded as the near esodeviation) and 6 m (recorded as distance esodeviation), by using the alternative prism and cover test when possible, or by using the Krimsky test if the aforementioned method was not possible. For each patient, the mean of esotropia or exotropia, in near and distance, were calculated and named the new one as esotropia (ET) and exotropia (XT). Dose response is defined as the response of patient's angle deviation to the amount of recession, and is calculated from the following formula: [(pre-operative esotropia)-post-operative residual esotropia + post-operative consecutive exotropia] ÷ (sum of the amount of recession in both eyes).

Outcome of the surgery were considered successful if patients achieved ≤ 8 prism diopters (PD) of ocular alignment. Patients were divided into different groups based on age and pre-operative angle of esodeviation, and dose response was compared among these groups. Also in order to study the effect of recession on residual ET (under-correction) or post-operative XT (over-correction), patients were divided into two groups: those who underwent the muscle recession ≥ 6.5mm and those with the muscle recession < 6.5mm. The post-operative exotropia and residual esotropia were then compared between these two groups. The central index of mean and dispersion index of standard deviation were calculated. T-test, Wilcoxon test, Friedman test, ANOVA, Spearman Correlation and Mann-Whitney U were used for data analysis. The present study was approved by the ethical committee of Iran University of Medical Sciences. Its ethical issues were in adherence with the Declaration of Helsinki.

The patients' information remained confidential.

3. Results

Considering inclusion criteria, finally 130 patients were enrolled in the study. Out of them 63 cases (48.5%) were female and 67 cases (51.5%) were male. The mean age of patients was 7.16 ±7.84 years. The patients' age ranged from 6 months to 48 years. The highest frequency of age groups was 2 years (14.6%). The mean of patients' preoperative refraction in right eye and left eye were 1.26 ±1.47 D and 1.37±1.43 D, respectively. There were 100 patients (76.9%) with hyperopia as well as 16 patients (12.3%) with myopia in their right eye. Hyperopia and myopia were seen in the left eye of 101 patients (77.7%) and 16 patients (12.3%), respectively. There were 109 patients with one month follow-up, 122 patients with three months follow-up and 82 patients with two years follow-up as well. The mean angle of preoperative esotropia in patients was 46.09 ±1.30 PD (ranged from 20 to100 PD). This number changed to 2.50 ± 6.07 PD one month after the surgery, 3.16 ±6.76 PD three months after the surgery and 2.14 ±5.98 PD two years after the surgery. Based on Wilcoxon test, the difference between angle of pre-operative esotropia and post-operative esotropia was statistically significant in all follow-up periods (P=0.0001). The mean recession in right eyes and left eyes were 5.69 ± 0.71 mm (range 4-7 mm) and 5.64 ± 0.75 mm (range 3.5-7 mm), respectively. Patients were divided to two groups based on the amount of muscle recession. Table 1 shows its details.

Table 1: Post-operative deviation based on the amount of recession

The amount of recession in either the right or the left eye of patients	Post-operative follow-up	Types of eye deviation after the surgery	Number (%)
≥6.5mm (N=29)	1 month later	ET *	3(10.34%)
		XT **	0 (0%)
	3 months later	ET	4(13.79%)
		XT	6 (20.68%)
	2 years later	ET	1(3.44%)
		XT	2 (6.89%)
<6.5mm (N=101)	1 month later	ET	14(13.86%)
		XT	6(5.94%)
	3 months later	ET	21(20.79%)
		XT	13(12.87%)
	2 years later	ET	10(9.90%)
		XT	5(4.95%)

* Residual esotropia **Consecutive exotropia

Consecutive XT and residual ET were compared one month, three months and two years after the surgery between two groups of recession <6.5 mm and recession≥6.5 mm by using Mann-Whitney U test, and the results were not statistically significant (p>0.05).

Out of 109 cases with one-month follow-up, 18 cases (16.4%) had residual ET and 6 patients (5.5%) had consecutive XT; thus, in 78.1% of cases the surgery had successful outcome. Out of 130 patients 122 cases returned for a three-month follow-

up. Twenty-five of them (20.4%) had residual ET while 19 patients (15.4%) had consecutive XT; thus the success rate of the surgery in the trimester follow-up was 64.2%. Of 82 patients with two-year follow-up, 11 cases (13.3%) had residual ET and 7 cases (8.5%) had consecutive XT. This made a 78.2% success rate for the operation.

The mean of dose response one month, three months and two years post-operation were 3.91±0.93, 4.02±1.23 and 4.02±1.14, respectively. Spearman Correlation test results indicated that dose response in one month and three months after the surgery had a significant negative correlation with age at the time of surgery [(P=0.04, R=-0.19) and (P=0.02, R=-0.20)] (Figs. 1 and 2). According to the results of this test, negative correlation between age and dose response after two years was not statistically significant (P=0.06, R=-0.20) (Fig. 3).

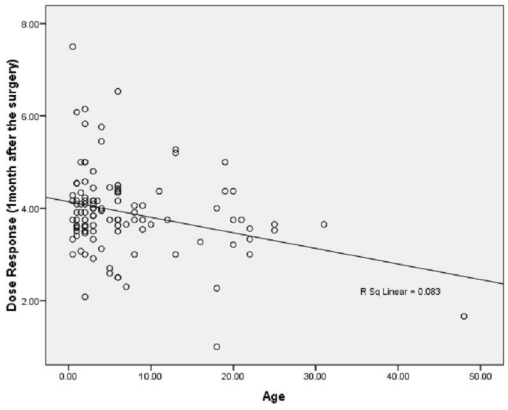

Fig 1: Correlation between dose response (1 month after the surgery) and patients' age

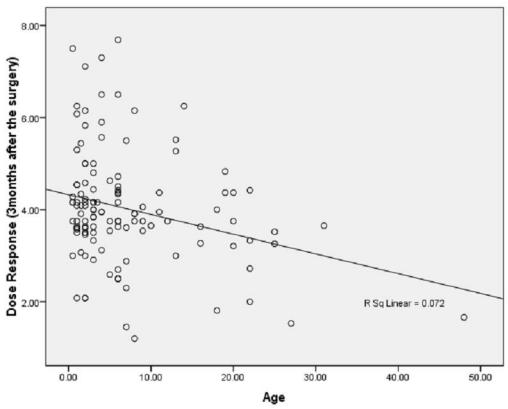

Fig 2: Correlation between dose response (3 months after the surgery) and patients' age

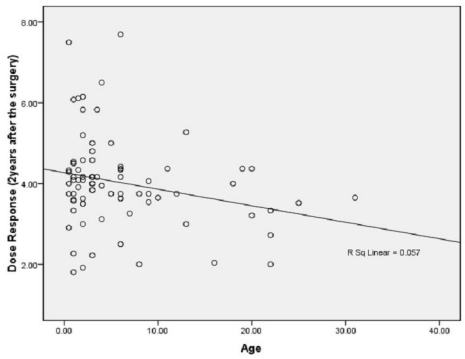

Fig 3: Correlation between dose response (2 years after the surgery) and patients' age

Also, there was a significant positive correlation between dose response (one month, three months and two years after the operation) and the angle of pre-operative esodeviation [(R=0.52, P=0.001), (R=0.42, P=0.001) and (R=0.52, P=0.001)] (Figs. 4, 5 and 6).

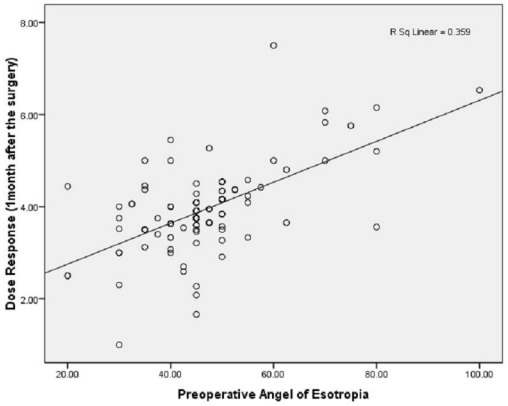

Fig 4: Correlation between dose response (1 month after the surgery) and pre-operative angle of esodeviation

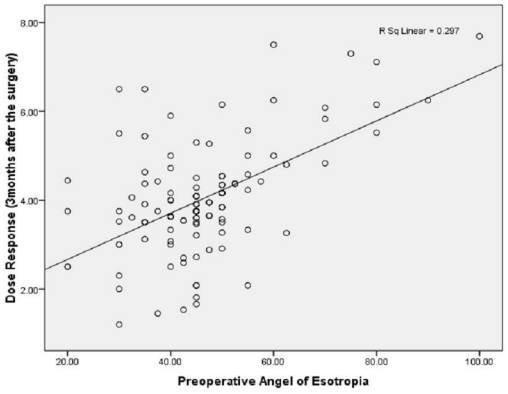

Fig 5: Correlation between dose response (3 months after the surgery) and pre-operative angle of esodeviation

Table 2: Comparison of dose response among different age groups

Age	Post-operative follow-up	Number	Minimum of dose response	Maximum of dose response	Mean of dose response	SD*
<2	1 month	24	3.00	7.50	4.15	0.97
	3 months	24	2.08	7.50	4.28	1.15
	2 years	21	1.81	7.50	4.13	1.25
2-6	1 month	41	2.08	6.15	4.00	0.85
	3 months	43	2.08	7.30	4.21	1.17
	2 years	30	1.92	6.50	4.28	1.09
6-10	1 month	21	2.30	6.53	3.80	0.88
	3 months	29	1.20	7.69	3.85	1.40
	2 years	16	2.00	7.69	3.83	1.24
10-20	1 month	12	1.00	5.27	3.76	1.25
	3 months	14	1.81	6.25	4.11	1.12
	2 years	8	2.04	5.27	3.80	0.97
≥20	1 month	11	1.66	4.37	3.40	0.67
	3 months	12	1.53	4.42	3.11	0.96
	2 years	7	2.00	4.37	3.25	0.74

* Standard Deviation

Table 3: Comparison of dose response between under 2 years and 2 years and over

age	Post-operative follow-up	Number	Mean of dose response	SD*
<2	1 month	24	4.15	0.97
	3 months	24	4.28	1.15
	2 years	21	4.13	1.24
≥2	1 month	85	3.84	0.91
	3 months	98	3.96	1.25
	2 years	61	3.98	1.11

* Standard Deviation

Table 4: Comparison of dose response between under 20 years and 20 years and over

Age	Post-operative follow-up	Number	Mean of dose response	SD*
<20	1 month	98	3.96	0.94
	3 months	110	4.12	1.22
	2 years	75	4.09	1.15
≥20	1 month	11	3.40	0.67
	3 months	12	3.11	0.96
	2 years	7	3.25	0.74

* Standard Deviation

Mean of dose response one month, three months and two years after the surgery in different age groups is given in tables 2-4. These numbers are statistically significant just between age groups under and over 20 years old, only in three months follow-up (Independent T-Test, P=0.006). Two different classifications were done based on preoperative ET and the mean of dose response one month, three months and two years after the surgery in these groups as is shown in tables 5 and 6.

ANOVA analyses revealed that dose responses were significantly different among these groups (P=0.001).

Also, the mean of residual ET, the mean of consecutive XT, and the mean of dose response one month, three months and two years after the surgery were compared by Friedman test. The results suggested that except for the three-month post-operative XT that was significantly more than one-month post-operative XT (P=0.01), there was no

significant difference between results one month, three months and two years after the surgery.

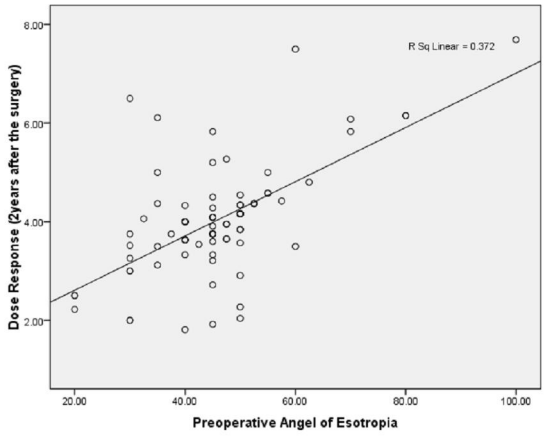

Fig 6: Correlation between dose response (2 years after the surgery) and pre-operative angle of esodeviation

4. Discussions

Several studies have evaluated the effect of different factors on the strabismus surgery results including the degree of alignment and the improvement in harmful sensory effects of strabismus. In this study, we have investigated post-operative one month, three months and two years dose response according to patients' age and the preoperative deviation angle.

The results of this study shows that dose response is significantly different in various preoperative ET groups and it has a significant positive correlation with patients' preoperative ET angle: the more preoperative deviation angle, the more change in eye's deviation degree to recession. Also, in Kushner et al study on 81 esotropic patients who went through bilateral medial rectus muscle recession, the change in the degree of ocular alignment per millimeter of rectus recession, increased significantly with higher pre-operative deviation degree ($P<0.0001$ and $r[1week]= 0.707$ and $r[6 months]= 0.651$)(Kushner, 1993).

Table 5: Comparison of dose response in different patients group based on pre-operative angles of esotropia (5 degrees interval)

Pre-operative angle of esotropia (PD*)	Post-operative follow-up	Number	Mean of dose response	SD**	Minimum	Maximum
20-25	1 month	3	3.14	1.12	2.50	4.44
	3 months	4	3.29	0.96	2.50	4.44
	2 years	3	2.40	0.16	2.22	2.50
26-30	1 month	9	2.95	0.88	1.00	4.00
	3 months	9	3.41	1.67	1.20	6.50
	2 years	8	3.37	1.41	2.00	6.50
31-35	1 month	9	3.95	0.59	3.12	5.00
	3 months	10	4.26	1.03	3.12	6.50
	2 years	6	4.36	1.08	3.12	6.11
36-40	1 month	15	3.79	0.66	3.00	5.45
	3 months	19	3.76	0.94	1.45	5.90
	2 years	11	3.64	0.66	1.81	4.33
41-45	1 month	29	3.53	0.66	1.66	4.50
	3 months	31	3.41	0.87	1.53	5.30
	2 years	19	3.84	0.83	1.92	5.83
46-50	1 month	24	4.01	0.48	2.91	5.27
	3 months	25	4.05	0.67	2.88	6.15
	2 years	20	3.85	0.73	2.04	5.27
51-55	1 month	10	4.62	1.09	3.33	7.50
	3 months	13	4.69	1.30	2.08	7.50
	2 years	9	4.74	1.10	3.50	7.50
≥56	1 month	10	5.25	1.02	3.56	6.53
	3 months	11	5.89	1.27	3.26	7.69
	2 years	6	6.11	0.92	4.80	7.69

* Prism Diopter ** Standard Deviation

Table 6: Comparison of dose response in different patients group based on pre-operative angles of esotropia (10 degrees interval)

Pre-operative angle of esotropia (PD*)	Post-operative follow-up	Number	Mean of dose response	SD**	Minimum	Maximum
20-29	1 month	3	3.14	1.12	2.50	4.44
	3 months	4	3.29	0.96	2.50	4.44
	2 years	3	2.40	0.16	2.22	2.50
30-39	1 month	20	3.46	0.85	1.00	5.00
	3 months	22	3.77	1.40	1.20	6.50
	2 years	15	3.79	1.28	2.00	6.50
40-49	1 month	66	3.77	0.64	1.66	5.45
	3 months	72	3.73	0.83	1.53	6.15
	2 years	49	3.80	0.75	1.81	5.83
≥50	1 month	20	4.94	1.08	3.33	7.50
	3 months	24	5.24	1.40	2.08	7.69
	2 years	15	5.29	1.23	3.50	7.69

*Prism Diopter ** Standard Deviation

In another study on 140 cases with esotropia, done by Abbasoglu and colleagues in Turkey, they also found that the change in the degree of deviation per millimeter of recession, increases with higher preoperative deviation degree ($P<0.0001$ and $r^2=0.33$) (Abbasoglu, 1996). Umazume and colleagues during 1984-1994 conducted a research in Japan, to identify preoperative factors that influence the effectiveness of Strabismus surgery in adults (Umazume, 1997). In 48 esotropic patients, one of the factors which had a positive and significant correlation with response to surgery, 1 month and 6 months after the operation, was determined to be preoperative deviation (multiple R[1 month]=0.57 and multiple R[6 months]= 0.77). According to these results, this group of patients may be exposed to a higher risk of over-correction. This issue might be due to better results of less recession of medial rectus muscle in larger angles of esodeviation because of the muscle's contraction.

Another result of this study was a significant negative correlation between patients' age and dose response 1 month and 3 months after the surgery. Also, dose response was found to increase significantly in age group under 20 years old in comparison with the group older than 20 years, in 3 months follow-up. Kushner and colleagues also reported a negative correlation between response and patients' age ($P<0.0001$, r[6 months]= -0.509, r[1week]= -0.489)(Kushner, 1993). Abbasoglu and colleagues found the onset age of strabismus as the second important factor -the first one being preoperative deviation- affecting response to surgery(Abbasoglu, 1996). In the same way, less increase in response was noticed in patients who were older at the time of disease ($P<0.0001$, r=0.44).

The results of these studies also support the inverse correlation between age and dose response. This might be due to the fact that more recession is needed in older patients due to medial rectus muscle degeneration. In this group of patients over-correction should also be avoided.

In our study, we compared the dose response 1month, 3 months and 2 years after the operation between two age groups of <2 years old and ≥2 years old. The results showed no significant difference between these two age groups in dose response. Although we did not evaluate the effect of axial length on dose response in our study, this result suggests that axial length does not have a significant effect on dose response. In a research done by Kushner and colleagues during 1987-1988 on 36 esotropic patients with mean age 55±73 months, patients were visited 1 week and 6 months after the surgery to see the effect of axial length on response to surgery(Kushner, 1989). It was concluded that axial length has an inverse significant correlation with response to strabismus surgery ($P<0.0008$, r=-0.53). The same researchers conducted another study that considered this correlation as the result of significant correlation between preoperative deviation and axial length ($P<0.0002$)(Kushner, 1993). They claimed that it is actually the preoperative deviation that affects the response to surgery. Therefore, regarding different dose responses in different age groups and different angles of esotropia, adjustable sutures found to be of value.

One of the limitations of our study was the small sample size in adult group as well as the study type (retrospective). Finally, it is suggested that more studies with bigger sample size should be done on adult group.

Also, prospective researches are necessary.

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