COMPARISON OF STANDARD AND AUGMENTED SURGICAL PROCEDURES IN THE MANAGEMENT OF PARTIAL ACCOMMODATIVE ESOTROPIA

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Abstract - The results of standard and augmented surgical treatment of partial accommodative esotropia have been compared in this study.

In this sequential matched randomized double blind clinical trial, we studied 48 patients (96 eyes) with partial accommodative esotropia between the ages of 13 to 144 months, referring to strabismus clinic of Farabi Eye Hospital between 1999-2000. These patients were grouped according to age degree of hyperopia and AC/A ratio and then were randomly divided in two standard and augmented groups (24 patients in each group). All patients were followed for at least 6 months after standard or augmented biomedial recession with or without inferior oblique weakening procedure. Post operative visual acuity, hyperopia, eye deviation, stereopsis, fusion and AC/A ratio were compared between the two groups. Post operative acceptable deviation was observed in 37.5% and 87.5% at first week follow up ($P < 0.001$), 66.6% and 91.5% at 6th week of follow up ($P < 0.05$), 91.6% and 95% at 6th month of follow up (not significant {N.S}) of patients in standard and augmented groups respectively.

Other results of standard and augmented groups are as follow:

- Improvement of visual acuity (at least one line) in 8.3% and 20.8% (N.S).

- Improvement of fusion in 8 out of 13 patients (61.5%) and in 9 of 14 patients (64.3%) (N.S).

- Reduction of post operative hyperopia in 3 patients (12.5%) & 6 patients (25%) (N.S).

- Reduction of AC/A ratio in all patients with high AC/A ratio, in both groups.

- Improvement of stereopsis in 2 of 13 patients (15.4%) and in 3 of 13 patients (23%) (N.S).

This study shows that augmented surgery improves longterm alignment, visual acuity, stereopsis and fusion greater than the standard group, but with statistically insignificant difference, which might be due to short duration of follow up and the small number of cases in each group.

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Key Words: Partial accommodative esotropia, standard surgery, augmented surgery.

INTRODUCTION

Strabismus, or misalignment of the eyes, is a common problem in pediatric ophthalmology. The prevalence of it is estimated to be up to 5% in the general preschool children population (1). Early detection and management of this problem is of crucial importance and failure to do so may lead to amblyopia and loss of binocular vision (2). Esotropia comprises 80% of all cases of strabismus. Approximately 1.3 to 2.3% of esotropia cases are of accommodative type (3,4) and 1.3% of patients with accommodative esotropia suffer partial accommodative esotropia (PAET) (4). This group of patients may receive limited benefit using corrective glasses. This treatment, however, remains insufficient in most cases, thus necessitating surgery (5). Considering the high prevalence of esotropia, the importance of meticulous choice of surgical method becomes paramount. The standard method of surgery is used mostly for these patients (6). Undercorrection is a common result and is reported to occur in 25% to 49% of cases in different studies (6,7). This fact has convinced many ophthalmologists to use augmented method, which has yielded good results in some studies but failed in others, especially when used to correct cases with hyperopia of more than 2.5 diopter (8).

Considering the existing controversy and lack of evidence about the superiority of either method in Iran, we have conducted this clinical trial on the patients suffering from PAET who were referred to the Strabismus Clinic of The Farabi Eye Hospital.

MATERIALS AND METHODS

In the period between December 1999 to October 2000, all patients reporting to the Strabismus Clinic of Farabi Eye Hospital who had esotropia in the cover test performed by the evaluating ophthalmologist were referred for evaluation of refraction. Those with hyperopia on evaluation with cycloplegic drop and whose strabismus was not corrected completely even with full cycloplegic glasses were included in a sequential matched randomized double blind clinical

trial if met the following inclusion criteria:

- Age at the onset of problem between 4 months to 7 years and age at the time of visit less than 12 years.
- Hyperopia (spherical equivalent) of more than or equal to 3 diopter.
- Wearing full cycloplegic glasses for at least 1 month.
- Tropia of more than 10 prism diopter with correcting glasses.

Patients with nystagmus, untreated amblyopia, vertical tropia of more than 5 prism diopter, history of previous ophthalmological surgery, extraocular muscles paralysis, or any other neurological or systemic organic defect were excluded.

After obtaining written informed consent from parents, complete eye examination was done for all subjects including visual acuity testing with Snellen chart and CSM method for younger children, complete examination with slit lamp biomicroscope, and funduscopy with indirect ophthalmoscope. Hyperopia was measured in all children 30 minutes after administration of cyclopentolate eye drops (0.5% solution for children under the age of 6 months and 1% solution for older children) 3 times in 5 minutes.

Fusion was tested by Worth Four Dot (W4D) test for near (33 cm) and far (6m) distances whenever possible. Stereopsis was also tested with Titmus method whenever possible.

Prism alternate cover test was used for evaluation of deviation while wearing the corrective glasses for far and near distances by orthoptist.

Clinical AC/A ratio was determined based on the difference of far and near distance deviation with corrective glasses and cases with ratio of less than 10 were considered normal.

All subjects had used full cycloplegic glasses for at least one month and in case of amblyopia were treated before operation so that they had developed alternate deviation.

Age, gender, age at onset of problem, duration of preoperation follow up, duration of wearing glasses prior to surgery, degree of hyperopia, degree of deviation, AC/A ratio, stereopsis, fusion and surgery type were recorded for all patients. Six blocks were built based on age, AC/A ratio and degree of hyperopia as follows:

Block 1) Age < 5 years, normal AC/A, Hyperopia: 3-SD; Block 2) Age: 5-12 years, normal AC/A, Hyperopia; 3-SD; Block 3) Age < 5 years, high AC/A, Hyperopia; 3-SD; Block 4) Age: 5-12 years, high AC/A, Hyperopia; 3-SD; Block 5) Age <5 years, normal AC/A, Hyperopia> SD; Block 6) Age : 5-12 years, normal AC/A, Hyperopia> SD.

All subjects were assigned to one of the blocks. Subjects in each block were randomly allocated into standard and augmented surgery method groups. One surgeon performed all surgeries based on Marshall Parks table. In case of apparent bilateral hyperactivity of inferior oblique muscles, inferior oblique muscle weakening was also performed.

Twenty four patient underwent standard surgery (based on the average deviation of far and near distances with corrective glasses) and 24 patients underwent augmented surgery (based on the average deviation of near distance with and without corrective glasses).

Follow up sessions were held 1 day, 1 week, 6 weeks and 6 months after the operation. Visual acuity and deviation were tested in each follow up. Hyperopia was tested 6 weeks after operation and on the 6th month visit, hyperopia, stereopsis, fusion and AC/A were evaluated. Evaluations were performed by an ophthalmologist who was blinded to the treatment group (surgery type) of the patients. Patients were also blinded to their treatment method (double blind).

Optimal results were defined as residual deviation of equal to or less than 10 prism diopter with corrective glasses and presence of fusion and stereopsis. Poor results were defined as residual deviation of more than 10 prism diopter with corrective glasses and lack of fusion or presence of suppression. Group differences were tested using McNemar's test and CM-Square testing was used to statistically compare the two groups.

RESULTS

The study was carried out on 48 subjects, 24 subjects in each group. Table 1 summarizes the demographic and clinical characteristics of the study population. As seen in this table, the two groups are not significantly different with regard to the age, gender, hyperopia, AC/A ratio, age at onset of problem, duration of wearing glasses before operation, visual acuity, and preoperative deviation (Table 1).

Postoperative alignment: Figure 1 compares the results of the two surgery methods for optimal deviation for each follow up visit. As shown in this figure, optimal deviation before operation was 0% in both groups. This figure rose to 37.5% (9 subjects) in the standard method group and up to 87.5% (21 subjects) in the augmented method group ($P < 0.001$). Three patients (12.5%) in the standard method group developed consecutive exotropia during the first post operative week. This complication was not seen in the augmented surgery group. In the 6th week, optimal deviation rose to 66.6% (16 subjects) and 91.6% (23 subjects) in standard and augmented surgery groups, respectively ($P < 0.05$). In the 6th month visit these figures were 91.6% (22 subjects) and 95% (23 subjects) respectively (Not Significant [N.S.]) (Fig. 1).

Table 1. Patients characteristic and surgical methods in partial accommodative esotropia

Surgical methods	Characteristics	Standard N = 24	Augmented N = 24
Sex	Female	12	10
	Male	12	14
Percentage (month)		61±31	61±33.1
		(144-13)	121-15)
Age onset (month)		25.6±18.2	19.5±17
		(4-48)	(4-72)
Duration of using glasses		28±22.1	33±22.1
pre-op (month)		(2-84)	4.5-72)
Hyperopia (diopter)		4.4±2.2	4.55±2.3
		(+3-11)	(+3-12)
AC/A ratio	Normal	21	22
	High	4	3
	Block schedules		
	1	9	9
	2	8	8
	3	2	2
	4	1	1
	5	2	2
	6	2	2

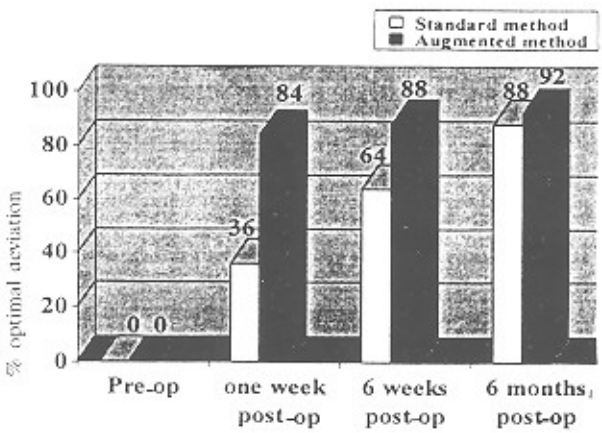

Fig. 1. Comparison of the results of pre-operative and post-operative of 48 patients with partial accomodative esotropia

Percentage of optimal deviation

There were 9 subjects with over 40 prism diopter deviation in the standard method group, 2 of which (22%) were undercorreeted. In the augmented group, however, 2 out of 14 patients (14.2%) with deviation of over 40 prism diopter were undercorreted. This difference was not statistically significant.

Postoperative hyperopia: Three patients (12.5%) in the standard method group and 6 patients (25%) in the augmented group benefited 0.5-0.75 D correction of hyperopia. The difference was not statistically significant.

Postoperative best corrected vision: In the 6th month follow up, 2 patients in the standard method group (8.3%) and 5 patients in the augmented group (20.8%) showed at least 1 line improvement of visual acuity. The change was statistically significant for the augmented group ($P < 0.05$ using McNemar's test) but not in the standard group. The two groups were not statistically different using Chi-square test. No patient had worsened visual acuity.

Postoperative fusion: As shown in table 2, in the standard group, W4D test could be obtained for 13 patients all of which had preoperative suppression. Eight patients (61.5%) developed fusion for near distance in this group and suppression remained for far distance. Five patients still had suppression for both near and far distances. In the augmented group, W4D test could be obtained for 14 patients all of which had preoperative suppression. Nine patients (64.3%) developed fusion for near distance in this group and suppression remained for far distance. Five patients still had suppression for both near and far distances. The difference between pre- and post-operative results were statistically significant in both groups using McNemar' s test ($P < 0.05$) but the two groups were not significantly different (Table 2).

Table 2. Pre-operative and post-operative fusion in patients with Partial accommodative

Fusion / Surgical Method	Pre- operative +	Pre- operative -	Post-operative +	Post-operative -
Standard	0(0)	13(100)	8(61.5)	5(28.5)
Augmented	0(0)	14(100)	9(64.3)	5(25.7)

Postoperative stereopsis: As shown in table 3, in the standard group, Titmus test could be obtained for 13 patients. Five patients had no stereopsis in this group and 8 had some degrees of stereopsis (600-2000 sec arc). Two patients (15.4%) showed improved stereopsis (60-200 sec arc). In the augmented group, Titmus test could be obtained for 13 patients. 8 patients had no stereopsis and five patients had some degrees of stereopsis (60-800 sec arc). Three patients developed stereopsis of 60-3 00 sec arc postoperatively. The two groups were not significantly different (Table 3).

Table 3. Pre-operative and post-operative stereopsis in paients with partial accommodative esotropia

Fusion / Surgical Method	Pre- operative +	Pre- operative -	Post-operative +	Post-operative -
Standard	8(61.5)	5(38.5)	10(76.9)	3(23.1)
Augmented	5(38.5)	8(61.5)	8(61.5)	5(38.5)

AC/A ratio: Three patients in the standard group and 4 patients in the augmented group had high AC/A

ratios preoperatively. This ratio was reduced in all of these patients by the 6th month follow up. All 4 patients with high preoperative AC/A ratio in the standard group needed bifocal glasses by the 6th week follow up, which was not needed for any of the patients in the augmented group. Complications such as perforation of eye ball or slippage of muscles were not observed.

DISCUSSION

This study has proven the superiority of the augmented method over the standard method in induction of optimal deviation for patients with deviation of 10 prism diopter or less in short term. Long term results, however, were not different. Consecutive exotropia, a complication which happened in 3 patients (12%) in standard group within the first week, was not observed in any patient treated by augmented method. Kenneth Wright had also shown the advantage of the augmented method for development of optimal deviation. On the other hand postoperative exotropia was a more frequent complication in the augmented group in their study (7). Primary amblyopia and defects in binocular vision in our study population may be held responsible for explanation of this discrepancy. In 2000, Watanbee had shown that untreated amblyopia may be a cause of consecutive exotropia (9). With gradual development of peripheral fusion exodeviation was controlled so that no consecutive exotropia existed at the end of the sixth month in either group of our study. Duration of follow up in our study (six months) was shorter than Kenneth Wright's study which might have prevented us from diagnosing possible exodeviations happening in cases undergoing augmented surgery in long term.

This study has shown better results for the augmented method for correction of deviations of above 40 prism diopter. Undercorrection was seen in 2 out of 14 patients in the augmented group (14.2%) and in 2 out of 9 patients (22.4%) in the standard group (N.S.). Previous studies have not proven the existence of correlation between degree of preoperative deviation and the outcome of surgery and further investigation with higher sample size seems necessary.

Eleven patients had overaction of inferior oblique muscles who underwent inferior oblique weakening operation as well as operation on medial rectus muscles. Marshall Parks has shown that weakening of the inferior oblique muscles has no effect on the degree of deviation in the primary position (10). Other studies have also emphasized on the necessity of weakening of oblique muscles in case of apparent overaction (11).

It should be pointed out that optimal postoperative alignment relies on many factors in addition to the choice of surgery method. The role of sensorial factor is very important in this regard. In the Prism Adaptation Study, 1992, it was shown that inaccuracies of up to 2mm in surgery has but little effect on the final outcome of treatment of a typical patient with acquired esotropia and sensorial factor plays a much more important role (12). In this study we have tried to determine the role of fusion and stereopsis on retaining alignment and the role of surgery on these factors. In both groups, surgery improved fusion and stereopsis ($P < 0.05$). No difference was noted between the two groups in this regard in contrast to the Kenneth Wright's study which showed better fusion and stereopsis for the augmented method. Low sample size may account for our results. Higher age (mean = 61 months) may be considered as another explanation in this regard. Parks and Bateman have shown that lower age at the time of surgery of patients with esotropia is associated with better final stereopsis (13). The mean age of the study population had not been stated in the Kenneth Wright's study.

It has been shown that stereopsis improves with time (14). This may also account for better results in the Kenneth Wright's study which had a follow up duration of 1 year. No subjects developed fine stereopsis in our study which may be explained by the long duration of problem. Fawcett has shown that the duration of suffering is the most important factor in determination of postoperative stereopsis and not the age at onset. Thus, if the duration is less than 4 month there exists a possibility of development of fine stereopsis which further underlines the importance of early detection and treatment of constant deviation (15). In this study the mean age at onset for the standard and augmented groups were 25.6 and 19.5 months respectively. Mean age at the time of surgery was 61 months. This long duration of suffering explains lack of development of fine stereopsis.

We have used cyclopentolate drops in order to measure hyperopia instead of atropin. Previous studies have shown that these two methods yield results which are not statistically different (16).

AC/A ratio was reduced in both groups in our study which is in accord with the results of previous studies (17).

We had to order bifocal glasses for 4 patients with near distance deviation of more than 10 prism diopter and controlled far distance deviation who had undergone standard method surgery. These patients all had preoperative high AC/A ratios and were operated on since they had far distance deviation of more than 10 prism diopter. Some studies, however, suggest surgical correction as the treatment of choice for patients with high AC/A ratio as the alternative for bifocal glasses (18). In our augmented group none of

the 3 patients with high AC/A ratio needed bifocal glasses which may indicate the superiority of the augmented method for treatment of patients with high AC/A ratio. Further investigation with higher sample size seems necessary in this regard.

Visual acuity did not improve significantly after standard surgery. Augmented surgery, however increased visual acuity significantly. It can be said that early development of optimal alignment in the latter group has led to better acuity as compared to the former group.

It can be concluded that augmented surgery has yielded better results for indices such as visual acuity, optimal deviation, stereopsis and fusion as compared to the standard method. Some of these differences were not proven statistically which may be explained by the low sample size, unattainable results for some patients and qualitative nature of some of measurements. The controlled sequential matched randomized design of this study allowed controlling of factors such as age, AC/A and hyperopia and can be regarded as an advantage of this study (19). We conclude that augmented method is superior to the standard method but also recommend further studies in this regard.

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