Comparing graded anterior transposition with myectomy in primary inferior oblique overaction — A clinical trial

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Abstract

Purpose: To compare the effects of graded anterior transposition with myectomy in primary inferior oblique overaction (IOOA).

Methods: In a randomized clinical trial study, patients entered into two groups: graded anterior transposition (Group 1) and myectomy (Group 2). In the myectomy method, 8 mm of the inferior oblique (IO) muscle was excised in the lower temporal side, and in the graded anterior transposition group, the IO muscle was recessed according to Wright's method. Patients were followed up for at least 1.5 months. IOOA was graded from 0 to +4. Surgical success was defined as reduced IOOA to a grade of +1 or less.

Results: In a randomized clinical trial study, a total of 30 patients (60 eyes) were included in the study (32 eyes in Group 1 and 28 eyes in Group 2). Pre-operation IOOA was 3.18 ± 0.78 and 3.25 ± 0.70 in Groups 1 and 2, respectively. Mean IOOA in Group 1 and 2 was 0.95 ± 0.24 and 0.40 ± 0.10 at 6 months after the surgery, which means the mean correction of the overaction was statistically significant in both methods (P < 0.001). The success rate in the myectomy procedure was higher than graded recession. The weakening effect was better in higher grades of overaction (P < 0.001). The overall success rate of Groups 1 and 2 was 75% and 96.4%, respectively (P = 0.029).

Conclusions: In both groups, IOOA significantly decreased after the operation. The success rate of the myectomy procedure was found to be significantly higher than graded anterior transposition.

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Keywords: Inferior oblique overaction; Myectomy; Recession; Transposition

Introduction

Inferior oblique overaction (IOOA) may be primary or secondary. Primary overaction is increased inferior oblique (IO) muscle function of unknown cause and is commonly associated with infantile deviations, such as esotropia or exotropia, or it might occur as an isolated IOOA without other strabismus.1,2

Secondary IOOA is generally caused by underaction or paresis of the superior oblique muscle. Several surgical procedures have been reported for weakening IO muscles, including myectomy, recession, anterior transposition and recession, denervation, and extirpation. The most commonly used surgical techniques are myectomy, recession, and myotomy.1,3 It has been shown that both myectomy and recession procedures might be followed by self-grading correction of overaction, as the more severe the IOOA, the greater the effect of surgery.3–8

Results from some studies have reported the recession method as a safe, predictable, and accurate procedure when
compared with myectomy while others suggested myectomy as the superior option.\textsuperscript{4–7} Anteriorization of IO was performed by Elliot and Nankin\textsuperscript{8} in moderate to severe cases of IOOA. While this method significantly reduced the overaction, it was associated with complications such as hypotropia and limited eye elevation. Guemes and Wright\textsuperscript{10} introduced a modified method in which the new IO insertion was parallel to the inferior rectus (IR) muscle axis. Deformity is avoided in this method, and transposition is calibrated according to the severity of IOOA.

In this randomized clinical trial study, we aim to compare the outcomes of myectomy with graded transposition and recession in treatment of primary IOOA.

Methods

A total of 60 eyes of 30 patients with primary IOOA were enrolled in a randomized clinical trial (IRCT201105166033N3). The study was approved by the Ethics Committee of Tabriz University of Medical Sciences (Ref No: 5418). Informed written consent was obtained from the patients or their parents at the beginning of the study. Patients were randomly assigned (double blind randomization) into the two groups of graded transposition and recession and myectomy. Patients with secondary IOOA, craniofacial abnormalities, previous surgery on the IO muscle, simultaneous dissociated vertical deviation (DVD), and vertical deviation more than 5 prism diopter (PD) were excluded from the study. We included patients with primary IOOA $\geq +2$. All surgeries were performed by one surgeon (R.N.) and pre- and post-operation IOOA was evaluated by the other surgeon (S.H.) who was masked regarding the type of surgery. Random allocation was done by other colleagues.

Postoperative follow-up periods were at least 1.5 months. Pre and postoperative over-elevation were scored on a scale ranging from 0 to +4. The abducting eye fixes a target that was placed at 45° up and out. In grade +4 overaction, the adducting eye elevates and stands at 90°. If it aligned with the abducting eye, there was not IOOA (grade 0). In grade +2, the adducting eye position is midway between 45 and 90°. The position between grade 0 and 2 was defined as grade +1, and the grade +3 is the position between grade +2 and +4.\textsuperscript{5} For myectomy, the standard inferior-temporal incision was made through the conjunctiva, and then the IO muscle was isolated from facial attachments. Eight mm of the IO at the temporal side of IR was placed between two clamps and excised. After complete cauterization of the cut edges, the clamps were released. The conjunctival incision was sutured by 8-0 Vicryl. In cases with simultaneous surgery on the lateral rectus (LR) muscle, common limbal incision was used for both LR and IO muscles. For graded anterior transposition, the same method was used for incision and IO isolation. Then the IO muscle was cut at insertion and sutured according to the method previously described by Wright and Guemes,\textsuperscript{10,11} so that the reinsertion line was parallel to the IR axis. Distance of the IO suture point from IR insertion was determined according to the grade of the overaction as follows:

1 + overaction: 4 mm posterior to the IR insertion and 2 mm temporal to the IR edge.
2 + overaction: 3 mm posterior to the IR insertion.
3 + overaction: 1 mm posterior to the IR insertion.
4 + overaction: Full anterior transposition (at inferior rectus insertion).

In both methods, we performed traction test in order to ensure the total isolation and grasping the IO muscle fibers.

Success was defined as a post-operation IOOA of 0 and + 1. Variables such as age, gender, IOOA grade before and after the operation, follow-up period and operation time were analyzed using SPSS version 16. Normal distribution of data was analyzed by Kolmogorov-Smirnov test. Independent samples $t$-test was used to analyze data with normal distribution, and non-normal distributed data were analyzed by Mann-Whitney. Qualitative variables were analyzed using chi-squared test (by method Monte Carlo), and the two groups were compared by independent samples $t$-test. A $P$-value of $<0.05$ was considered statistically significant.

Results

Overall, 59 patients (118 eyes) were enrolled in this study. Fifteen patients (30 eyes) were excluded. Eight of these 15 patients did not meet inclusion criteria, and 4 refused to participate in the study. During the study, we found the signs of secondary IOOA in 3 patients, so they were excluded from the study. The remaining 44 patients allocated into two groups (22 in each group) received the surgery. Six patients in Group 1 and 8 patients in Group 2 were missed to follow-up. Sixteen patients in graded anterior transposition method (Group 1) and 14 patients in myectomy method (Group 2) were analyzed. The mean age of patients was 9.87 ± 2.07 years in Group 1 and 9.64 ± 2.40 years in Group 2. Age range of the patients was 1–31 years with mode and median of 5 and 6 years, respectively. The outcomes from 60 eye surgeries were analyzed through follow-up periods ranging from 1.5 to 15 months. One patient in each group was followed up for 1.5 month (3.13% and 3.57% in Groups 1 and 2, respectively). In all other patients, minimum follow-up were 6 months. Demographic data of the patients before the surgery is summarized in Table 1. No significant difference was found between the two groups regarding these characteristics.

Table 2 shows the changes in the IOOA grade in the two groups in 1.5, 3, and 6-month post-operation follow-ups. Statistical analysis showed that at the 1.5-month follow-up visit, the difference between post-operative IOOA grades was not statistically significant between the two methods; however, the difference was found statistically significant at the 3 and 6-month postoperative follow-ups.

In group one's first follow-up (1.5 months), the difference between mean IOOA grade before and after this procedure was significant. Mean IOOA was dramatically decreased at the second follow-up visit (3 months after the surgery) when compared with the preoperative grade (0.76 ± 0.14 vs 3.16 ± 0.79). Overall, a significant decrease in IOOA was found in the 22 eyes at last follow-up. An important
IOOA: Inferior oblique overaction.

There was a significant decrease postoperatively in the myectomy group when compared with the graded anterior transposition method, particularly at 3 and 6-month follow-ups. In Rajavi et al.'s study, the preoperative mean IOOA in the myectomy group was higher than the classic recession group. In another study, their results showed that satisfactory improvement in IOOA to a 0 or +1 grade was observed in 26 eyes of the myectomy group (61.9%) and 27 eyes of the classic recession group (67.5%). Our success in the myectomy group was higher than Rajavi et al. study, and we speculate it was because of the amount of myectomy in the two studies (8 mm vs 5 mm). This difference was also seen in the recession group. Rajavi's technique was classic recession without changing the axis of IO, whereas IO axis was changed in our graded anterior transposition technique. Burk and Shipman compared the results of two methods of unilateral myectomy and classic recession of IO in the treatment of IOOA on 23 patients. In this study, the pre-operation mean IOOA grade was +3 in both groups. Post-operation reduction of overaction was 1.5 in the classic recession method and 1.75 in the myectomy group. Both procedures were effective in weakening the IO muscle during a one-year follow-up period with the myectomy method being the superior option.

In Masaya-anon et al.13 study on effect of IO recession in superior oblique palsy, IOOA was reduced from +3 to +0.4 postoperatively. Consistently, in our study the final IOOA was +0.95 in Group 1, which is slightly less effective than Masaya's study.

Moon et al.14 studied the effect of graded recession and anteriorization on unilateral superior oblique palsy and reported a success rate of 81.8%, which is slightly higher than our result. It must be mentioned that the Moon et al. study was carried out on patients with superior oblique palsy. Our success rate is mostly consistent with results from a study by Singh et al.15 in which classic recession was reported to have satisfactory outcomes in 100% of unilateral IOOA and 77% of bilateral IOOAs. It must be considered that studies use different criteria and definitions for satisfactory outcomes and success rates. For instance, they define successful operations as a postoperative overaction grade of +2 or less, while in our study, a satisfactory outcome was postoperative

### Table 1

| Number of eyes (patients) | Graded anterior transposition | Myectomy | P-value |
|---------------------------|-----------------------------|----------|---------|
|                           | 32 (16)                     | 28 (14)  |         |
| Age (year) (mean ± SD)    | 9.87 ± 2.07                 | 9.64 ± 2.40 | 0.94   |
| Visual acuity (logMAR)    | 0.01 ± 0.004                | 0.011 ± 0.001 | 0.20   |
| Horizontal deviation      | 32.6 ± 3.03                 | 34.4 ± 4.5 | 0.07   |

| Gender N (percent)        | Male 10 (62.5)               | 7 (50)   | 0.71   |
|                          | Female 6 (37.5)              | 7 (50)   |         |
| Mean follow-up (month)    | 6.46 ± 3.49                 | 5.07 ± 1.73 | 0.18   |

SD: Standard deviation.

### Table 2

| IOOA grading | Graded anterior transposition | Myectomy | P-value |
|--------------|-------------------------------|----------|---------|
| Pre-operation|                               |          |         |
| 4+           | 12 (37.5%)                    | 10 (35.7%) | 0.538  |
| 3+           | 15 (46.9%)                    | 16 (57.1%) |         |
| 2+           | 5 (15.6%)                     | 2 (7.2%)  |         |

| IOOA at 1.5-month follow-up | Graded anterior transposition | Myectomy | P-value |
|-----------------------------|-------------------------------|----------|---------|
| 4+                          | 4 (12.5%)                     | 3 (10.7%) | 1.00    |
| 3+                          | 2 (6.25%)                     | 1 (3.57%) |         |
| 2+                          | 2 (6.25%)                     | 1 (3.57%) |         |
| 1+                          | 4 (12.5%)                     | 3 (10.7%) |         |
| 0                           | 20 (62.5%)                    | 20 (71.4%)|         |

| IOOA at 3-month follow-up | Graded anterior transposition | Myectomy | P-value |
|---------------------------|-------------------------------|----------|---------|
| 4+                        | 4 (12.5%)                     | 0 (0.0%)  | 0.037   |
| 3+                        | 3 (9.38%)                     | 0 (0.0%)  |         |
| 2+                        | 1 (3.13%)                     | 5 (17.9%) |         |
| 1+                        | 3 (12.5%)                     | 2 (10.7%) |         |
| 0                         | 20 (62.5%)                    | 20 (71.4%)|         |

| IOOA at 6-month follow-up | Graded anterior transposition | Myectomy | P-value |
|----------------------------|-------------------------------|----------|---------|
| 4+                         | 5 (15.6%)                     | 0 (0.0%)  | 0.041   |
| 3+                         | 3 (9.38%)                     | 0 (0.0%)  |         |
| 2+                         | 0 (0.0%)                      | 1 (3.57%) |         |
| 1+                         | 3 (12.5%)                     | 4 (17.91%)|         |
| 0                          | 20 (62.5%)                    | 22 (78.57%)|        |

#### Discussion

The results of the present study showed that both surgical methods can effectively weaken the IOOA; however, the rate of weakening was higher in the myectomy procedure during the follow-up visits and the outcomes were better in this method. Mean IOOA grades were similar between the two groups before the operation, but IOOA showed a more significant decrease postoperatively in the myectomy group when compared with the graded anterior transposition method, particularly at 3 and 6-month follow-ups. In Rajavi et al.'s study, the preoperative mean IOOA in the myectomy group was higher than the classic recession group. In another study, their results showed that satisfactory improvement in IOOA to a 0 or +1 grade was observed in 26 eyes of the myectomy group (61.9%) and 27 eyes of the classic recession group (67.5%).

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IOOA grade of equal to or less than $+1$. Using the criteria from the Singh et al. study will result in a higher success rate in the present study.

Ghazawy et al.\textsuperscript{16} compared the effect of myectomy and anterior transposition on IOOA and concluded that these two methods led to similar success rates in the correction of primary and secondary IOOA. In contrast, Min et al.\textsuperscript{17} reported a success rate of 25% for the myectomy method, and 75% of the cases operated with this method showed significant residual overaction. In our study, despite the similar pre-operation grade of IOOA in the two groups, the myectomy group showed lower grades of overaction in 3 and 6-month follow-ups. Sanjari et al.\textsuperscript{18} in a retrospective study found a 97.8% and 89.5% success rate for myectomy and anterior transposition, respectively. Their success rate was higher in the myectomy group, which was compatible with our results.

Our findings indicate that the success rate of the myectomy procedure (96.4%) is significantly higher than graded anterior transposition (75%). In addition, some other studies have reported similar outcomes for these two methods on correction transposition (75%). In addition, some other studies have reported similar outcomes for these two methods on correction transposition (75%).

Rajavi et al.\textsuperscript{5} suggested that the correction effects are higher in cases with higher grade of IOOA using both methods of surgery. In this study, mean postoperative improvement in cases with grade $+4$ IOOA was $2.12 \pm 0.97$ in the myectomy group and $2.67 \pm 0.82$ in the classic recession group. Consistently, our results show more weakening effects in higher grades of overaction. Although mean changes in IOOA grades were higher in our study, as in $+4$ overaction, mean improvement was $3.00 \pm 0.85$ and $3.10 \pm 0.56$ in groups 1 and 2, respectively. Statistical analysis showed that the severity of IOOA is significantly correlated with the postoperative weakening effect.

A noticeable finding of the present study is operation time in the two procedures, which is not discussed in the previous studies. Mean operation time was $6.49 \pm 0.14$ min in Group 1 and $5.80 \pm 0.86$ min in Group 2. This difference might well be considered as one of the advantages of myectomy to graded transposition and recession. On the contrary, the main advantage of anterior transposition and recession over myectomy is preservation of the muscle. Indeed, if one encounters with reoperation on IO muscle, such as DVD, anterior transposition may be a superior option.

To the best of our knowledge, this is the first study that has compared the effect of graded anterior transposition according to Wright’s method with myectomy in weakening of primary IOOA. Results from this study can be of great significance in future investigations. However, some limitations might also be mentioned for the present study, including a small study sample in both groups and combined horizontal and IO operation in 70% of patients. The rather long follow-up period and randomized clinical trial design are two considerable strengths of this study. Further studies with larger study populations might lead to more accurate results.

In conclusion, both graded anterior transposition and myectomy can effectively reduce IOOA grade while the success rate in myectomy is found to be significantly higher.

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