Original Article

Augmented surgical amounts for intermittent exotropia to prevent recurrence

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Purpose: The purpose was to evaluate the results of bilateral lateral rectus (BLR) recession which is based on augmented surgical amounts of classical surgical table of Parks' for basic and pseudo-divergence excess type intermittent exotropia [X(T)]. **Materials and Methods:** Patients with X(T) operated by the same surgeon and followed-up for at least 6 months were included. Patients with prior surgery, neurobehavioral and musculoskeletal conditions, strabismus different from that mentioned above X(T) were excluded. All the patients received BLR only. The amount of the recession was increased by the amount needed to correct 5 prism diopters (PD) more X(T) than what was measured. After the operation, 1st week, 2nd and 6 months measurements were recorded. The patients were grouped according to their 1st week (3–7 days) postoperative examination as: >10 PD esotropia (Group 1), ≤10 PD esotropia (Group 2), exotropia (Group 3), and orthotropic (Group 4), respectively. Final surgical outcomes were classified as "good" (≤10 PD exotropia and ≤5 PD esotropia), "recurrence" (>10 PD exotropia) and "overcorrected" (>5 esotropia). **Results:** Thirty-seven patients were included. The mean age was 6.78 ± 2.87 years (range: 2–12 years). Mean preoperative deviation was 29.72 ± 8.07 PD (range: 15–45 PD) at distance and 20.94 ± 11.65 PD (range: 10–45 PD) at near ($P < 0.0001$). There were 21 (56.8%) patients in Group 1, 9 (24.3%) patients in Group 2, 1 (2.7%) patient in Group 3 and 6 (16.2%) patients in Group 4. Initial esotropia was achieved in 30 (30/37) of the patients. Twenty-eight of them had good results at the end of the 6 months. Overall "motor surgical" success rate was found to be 89.2% (33/37 patients), with 1 (2.7%) overcorrection and 3 (8.1%) recurrences at the end of the 6 months. **Conclusion:** This study demonstrated that early overcorrection of 10–20 PD after X(T) surgery can achieve acceptable motor outcomes in the first 6 months postoperative period.

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The goal of surgical correction in patients with intermittent exotropia X(T) is to create a satisfactory and stable ocular alignment and maintain binocular function. The precise prediction of the surgical success rate of X(T) is difficult and varies across studies with a range between 41% and 83%.[1,2] After surgery, most of the patients may have an exotropic drift over time and some of them a recurrence of exotropia.[3-5] In the surgical management of exodeviation, there is agreement that an initial overcorrection is one of the success factors by the induction of diplopia, stimulating fusional vergence and moving the patients out of their previously induced temporal suppression scotoma.[6-8] This study is designed to look at this particular practice.

In this study, we modified the classical surgical table of Parks' for exodeviation for higher surgical amounts to achieve an initial overcorrection and evaluate the prevention of recurrence.

Materials and Methods

Medical records were reviewed for 157 exotropia patients who were operated by the same surgeon (FHO). Patients who had previous strabismus surgery, manifest or latent nystagmus, extraocular muscle palsy, A or V pattern deviation or oblique muscle dysfunction, neurologic abnormalities, developmental delay, mental retardation, any organic lesion of the orbit or the globe and postoperative follow-up <6 months were excluded. Thirty-seven patients who had basic and pseudo-divergence excess X(T) were included in this study. All patients underwent complete ophthalmologic and orthoptic examinations before the operation. Alternate prism cover test was performed at 6 m or beyond for distance fixation and 30 cm for near fixation in primary gaze. The Krimsky method was used for only two uncooperative cases. All motor evaluations were performed with the use of spectacle corrections. Pseudo-divergence excess exotropia was defined as a distance deviation at least 10 prism diopters (PD) greater than at near initially, but the near deviation increases to within 10 PD of the distance deviation following patching (tenacious proximal fusion). Patients with true divergence excess and high AC/A were eliminated from the study. The extent of the operation performed was based on the largest angle ever measured at distance target fixation. The surgery was performed based on the table recommended by Parks' where the amount of recession was increased 5 PD more than measured amount needed to correct the deviation [Table 1]. As an example, if the maximum deviation was measured as 25 PD, the surgery was performed for 30 PD, and for 30 PD the surgery was performed for 35 PD. All the patients received bilateral lateral rectus (BLR) recessions using fornix incisions under general anesthesia. All of the operations and postoperative controls were performed by the same surgeon (FHO). Each patient was seen on the 1st day, 1st week (3–7 days), 2nd month and a 6 month after the surgery and the measurements were recorded. The 1st day measurements were not taken into consideration because of pain, inflammation, blurred vision, or altered muscle dynamics. Patients were divided into four groups according

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to their immediate (3–7 days) postoperative examination such as: >10 PD esotropia (Group 1), ≤10 PD esotropia (Group 2), exotropia (Group 3), and orthotropic (Group 4), respectively. Final surgical outcomes were classified as "good" (≤10 PD exotropia and ≤ 5 PD esotropia), "recurrence" (>10 PD exotropia) and "overcorrect" (>5 esotropia).

When the patients suffered from diplopia, associated with overcorrection, we checked the patients initially at 2 weeks intervals until the diplopia was resolved. These patients were managed with alternating patching or monocular patching for the patients with fixation preference. If the patients had hyperopia, hyperopic glasses were given and/or patients without hyperopia base-out prisms were given until the esotropia was resolved. Patients with constant esotropia >10 PD lasting for >6 months postoperatively underwent re-operation.

The study protocol followed the tenets of the Declaration of Helsinki with the approval of the Institutional Review Board of the University.

All statistical data were analyzed using SPSS software version 15.0 (SPSS®, Inc., Chicago, IL, USA), for Windows®. The ratio of success between each group was examined with the Chi-square test. The correlation between 2nd and 6 month's results was examined with McNemar-Bowker test. Values of $P < 0.05$ were considered as statistically significant.

Results

Thirty-seven patients were included in this study. Mean age at surgery was 6.78 ± 2.87 years (range: 2–12 years). Mean preoperative deviation was 29.72 ± 8.07 PD (range: 15–45 PD) at distance and 20.94 ± 11.65 PD (range: 10–45 PD) at near ($P < 0.0001$). Mean follow-up period was 17.08 ± 9.46 months (range: 6–36 months). There were 21 (56.8%) patients in Group 1, 9 (24.3%) patients in Group 2, 1 (2.7%) patient in Group 3 and 6 (16.2%) patients in Group 4. Initial esotropia was achieved in 30 (30/37) of our patients using this method. Twenty-eight of them had good results at the end of the 6th month with 1 overcorrection and 1 recurrence. There were 31 (31/37, 83.8%) patients who had good results, 4 (4/37, 10.8%) overcorrection, and 2 (2/37, 5.4%) recurrence at the end of the 2nd month [Table 2]. Overall motor surgical success rate was found to be 89.2% (33/37), with 1 (2.7%) overcorrection and 3 (8.1%) recurrences at the end of the 6 months [Table 3]. The correlation of success between the 2nd and the 6th months was not statistically significant ($P = 0.135$).

Discussion

Rates of postoperative recurrence of X(T) have been reported to vary widely due to the definition of recurrence and the length of follow-up.[9] According to Maruo *et al.*,[10] 50.4% of patients became exotropic 4 years after the initial surgery. Lim *et al.*[11] reported that the recurrence rate increased to 77.9% at 5 years follow-up time which was initially reported as 27.6% at 6 months follow-up, using unilateral recession-resection procedure (RR). In our study, the recurrence rate was found to be 8.6% at 6 months follow-up. In the surgical management of exotropia, an early postoperative overcorrection has been ascribed either to the induction of diplopia and stimulation of fusional ability or to moving the patients out of their previously induced temporal suppression scotoma which provides long-term stability of ocular alignment.[6-8] When the surgical approach is BLR, while some authors (for example; Raab and Parks,[12] Lee and Lee,[13] and Oh and Hwang[4]) suggested that 10–20 PD esotropia is suitable similar to our study, the others suggested <10 PD esotropia (for example; McNeer[14] and Ruttum).[15] When the approach is an RR, Parks suggested only a few PD of overcorrection, while Souza-Dias and Uesugui suggested 5–10 PD of esotropia.[16,17]

In contrast to these studies, there are also conflicting results in the literature with unfavorable correlation between initial postoperative esotropia and final ocular alignment. For example, Pineles *et al*.[18] found that there was no association between postoperative day 1 alignment and risk of recurrent X(T) or monofixational esotropia. Schlossman *et al.*[19] found a high success rate in adults with "undercorrections" up to 14 PD. Leow *et al.*[20] found a larger exotropic drift occurring in patients who were initially esotropic or orthotropic rather than exotropic after BLR surgery.

A direct comparison between these studies is limited because of differences in the definition of successful surgery, type of surgical procedure such as unilateral or bilateral, number of patients, and duration of postoperative follow-up. Despite these controversies, we are in favor of the concept that initial postoperative overcorrection is necessary to prevent long-term recurrence and possibly avoid patients to have

Table 1: Surgical amounts for patients with X (T)

Angle of X (T) (diopters)	BLR recession (mm)
15	5
20	6
25	6.5
30	7.5
35	8.0
40	8.5
45	9.0

X (T): Exotropia, BLR: Bilateral lateral rectus

Table 2: The success rate of each group at the second-month visit

Groups	Good (*n*)	Overcorrection (*n*)	Recurrence (*n*)	Total
1	18	3	0	21
2	8	1	0	9
3	0	0	1	1
4	5	0	1	6
Total (*n*, %)	31 (83.8)	4 (10.8)	2 (5.4)	37

Table 3: The success rate of each group at the 6th month control

Groups	Good (*n*)	Overcorrection (*n*)	Recurrence (*n*)	Total
1	20	0	1	21
2	8	1	0	9
3	0	0	1	1
4	5	0	1	6
Total (*n*, %)	33 (89.2)	1 (2.7)	3 (8.1)	37

secondary surgery which was previously reported in many other studies.[3,4,7,12-17]

Thus, we planned our surgery to achieve an initial overcorrection by increasing surgical dosages. For this reason, the surgical amount of recession was increased to the amount needed to correct the amount of deviation with 5 PD more than measured. We achieved initial esotropia in 81% (30/37 patients) of our patients using this "augmented" table, and favorable results were obtained in 28 of these patients at the end of the 6 months follow-up period. Our success rate was better in the first and the second groups which were initially esotropic. Kushner *et al*.[21] have reported the success rate of their study as 52% using BLR for 19 patients. The definition of success (5 esotropia-10 exotropia) was similar to our study. Maruo *et al*.[10] reported success rates of 60.2% for 1-month and 66% for 4 years which included 349 BLR patients. The definition of success for this study was 0–4 exotropia. This ratio and the definition of success according to Maruo's study are considerably different from those in our study. Jeoung *et al*.[22] found 48.3% success rate for BLR for 58 patients while defining the success as "esotropia and exotropia of <10 PD within 6 months of follow-up". In a study by Lim *et al*.,[11] success rate was 58.1% for a follow-up of 1-year and 46.9% for 2 years which included 489 patients in their study, however, they performed only unilateral RR surgery. They described the success as 5 esotropia-10 exotropia, which is similar to our study. The surgical amounts used in their patients were observed to be lower than our table, and this may potentially be the reason for the relatively poorer outcome in the longer term.

Even though most of the authors agree that early overcorrection of 10–20 PD after exotropia surgery is optimal for the prevention of consecutive esotropia, there is also a concern with immature binocular vision systems due to the risk of developing suppression scotoma and an irreversible monofixation esotropia, which can lead to loss of stereopsis and amblyopia.[2-4,6,12,13]

Pratt-Johnson *et al*.[23] emphasize the importance of stereopsis in success criteria when they reported 81% success in motor alignment, but only 41% of patients achieving stereopsis of 40 arcsec in a group of 100 patients with divergence excess type X(T). In addition, another study by Pineles *et al*. suggested that distance stereopsis and its discrepancy from near stereopsis was another important factor in the measurement of success. Pineless *et al.* also reported that for an excellent motor result the determined success rate of 64% falls to 38% when sensory outcomes were considered.[24]

In our study, only motor surgical results were included, and the success rate was defined according to an excellent motor alignment at the end. This was mainly for the reason that measuring stereopsis would not have made any difference to the long term success since stereopsis initially would have been grossly reduced for both near and distance.

The patients with diplopia were managed temporarily with alternating or monocular patching according to fixation situation of the patients. If the patients had hyperopia, hyperopic glasses were given and/or patients without hyperopia base-out prisms were given until the esotropia was resolved. Secondary surgery was performed on a patient for consecutive esotropia whose deviation was 10 PD esotropia initially then changed to 18 PD esotropia after 1-month and stable after 6 months.

Secondary surgeries for recurrence were also performed on three patients. Bilateral medial rectus resections were performed on these three patients who had >10 PD exotropia at the end of the 6 months. In the first patient, initial deviation was found to be 8 PD exotropia which increased to 20 PD exotropia at the end of the 6 months. The second patient had 14 PD esotropia initially, the deviation changed to 10 PD exotropia; and the third patient was orthophoric initially, but ended up revealing 25 PD exotropia at the end of the 6 months.

The results of our study must be evaluated within the context of its limitations. First, data of stereopsis both preoperatively and postoperatively were not included in this study. The study disclosed only postoperative motor outcomes; if sensory data had been included, the success rates might have been less than that was found. Lack of longer term follow-up, not including the patients with true divergence excess, and evaluating patients between 3 and 7 days are the other limitations of this study. The 1st day measurements were not taken into consideration due to pain, inflammation, blurred vision or altered muscle dynamics.

Despite the aforementioned limitations, this study demonstrated that early overcorrection of 10–20 PD using higher surgical amounts with BLR after exotropia surgery appears to achieve acceptable motor outcomes in the first 6 months' postoperative period. Randomized and controlled studies with larger series and longer follow-up period are needed to evaluate the long-term success rate of this augmented surgical table.

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