Outcome Of Treatment Modalities Of Exotropia In Hyperopic Patients

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Background:.

Aim: The aim of this work is to identify whether full correction or under correction of hyperopia (hyperopic error-1), in exotropic patients, will show the best postoperative ocular alignment.

Methods: It is a prospective clinical study comprised of 31 patients examined and operated at Alexandria main university hospital, Egypt, during the period from September 2020 to January 2023. All patients have intermittent alternating exotropia and hypermetropia ≥ +2.00 D.

Results: A total of 31 patients of exotropia and hyperopia were divided in to two groups, 15 assigned in group A and were prescribed the full hyperopic correction as glasses and 16 assigned in group B and were prescribed the hyperopic correction -1 (under corrected) as glasses. At 2 months post operative follow up, there was statistically significant increase in the no. of aligned cases in group B than in group A (*P*=0.018). Furthermore, there was statistically significant increase in the no. of cases who were aligned with glasses but esotropic (5-16PD) without glasses in group A than in group B (*P*=0.002). At 4 and 6 months postoperative follow up, there was statistically significant increase in the no. of cases who were aligned with glasses but esotropic (5-16PD) without glasses in group A than in group B (*P*=0.002 and *P*=0.018 respectively) and no statistically significant difference in the no. of cases who were aligned in both groups.

Conclusions: Full hyperopic correction group had the best results at 6 months post operative follow up as regarding alignment if we included those who were aligned with glasses esotropic (5-16 PD) without glasses in the alignment group as they are actually aligned. Exotropic drift is more common in patients who received partially hyperopic correction.

Key words: Hyperopia, Exotropia, Glasses, Alignment.

INTRODUCTION

Exotropia is a type of ocular misalignment in which there is outward deviation of one or both eyes. The term is derived from Greek, exo means "outward" and trope means "a turning".[1] There are many theories attempting to explain how exotropia develops such as **i**nnervational factors, mechanical factors, refractive errors, defective fusion, AC/A ratio, genetics, hemiretinal suppression theory and associated neurological defects. [1, 2, 3, 4, 5, 6, 7, 8] In uncorrected myopia, no or less than normal accommodation is required during near vision with decrease in accommodative convergence and convergence resulting in exodeviation. Hypermetropia is a known risk factor for esotropia. Moreover, the risk for developing esotropia is increased with increasing degrees of the hyperopic error.[9] Exotropia can also occur in hyperopic patients but in lower percentage. In uncorrected high errors of hypermetropia, no further accommodative effort can be made to overcome this high error as well as presence of blurred vision can lead to exodeviation. Clear retinal image which cannot be obtained even with maximal accommodative effort leads to asthenopia with resultant underactive convergence mechanism that causes a low AC/A ratio

and exotropia. Moreover, children with hyperopia >+4.00 D are more likely to have amblyopia and poor stereopsis which encourage occurrence of strabismus usually esotropia, but may be to a lesser extent exotropia. Anisometropia is considered to be fusion obstacle, causing suppression, amblyopia and exotropia. Thus refractive errors and their effect on accommodation are one of the primary causes of exodeviation.[1, 3, 4] In patients with exotropia and hyperopia, correction of hyperopia may decrease the need of the accommodative convergence and thus increase exodeviation. However, some studies reported a decrease in exodeviation after hyperopic correction. [4, 10] Chung *et al* suggested refractive correction of exotropic cases as it was useful even if the surgical correction of intermittent exotropia was the option because the new angle of exotropia obtained after spectacle correction should be considered and thus it can produce better results. [10] However, the amount of hyperopia, must be given to exotropic patients, is not clear in accessed literature. Bilateral lateral rectus muscle recession (BLR) is the surgical procedure of choice in cases with intermittent alternating exotropia of basic type. [3, 11]

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PATIENTS & METHODS

It is a prospective study conducted on 31 patients who have concomitant alternating intermittent exotropia of basic type and hyperopic error >+2.00 D. They were examined and operated at Alexandria main university hospital, Egypt, during the period from September 2020 to January 2023. The study followed the tenets of the 1964 Declaration of Helsiniki and was approved by the local ethics committee; detailed informed consent was provided to all patients. Patients with associated neurological disorders, those who underwent previous strabismus surgery, those with sensory exotropia and those with deep amblyopia were excluded. Full history was taken from all patients to exclude presence of global developmental delay. Complete clinical ophthalmic examination including fundus examination and cycloplegic refraction was done for all patients.

Evaluation of exotropia

Alternate cover test is done to identify the type of squint (exotropia or esotropia), alternating or not and intermittent or constant. The test also can determine associated conditions such as dissociated vertical deviation (DVD). Prism and alternate cover test was used to determine the initial angle of exotropia without glasses in the first examination. The same test was used to determine the angle of exotropia with glasses in each visit which was at 2 monthly intervals for 6 months preoperatively and then at 2 monthly interval for 6 months postoperatively. Evaluation of the angle was done for near and far to detect any disparity between the far and near angle.

Diagnostic occlusion test (1 hour occlusion test)

It is used to block the tonic fusional convergence. So, it can be used to differentiate pseudo-divergence excess from true divergence excess. If the angle of exodeviation at distance is larger than that at near fixation by more than 10 PD, we use the diagnostic occlusion test in which one eye is patched for one hour and the angle of exodeviation, for near and distance, is immediately re measured after removal of the patch. In cases of pseudo divergence excess, the amount of exodeviation increase, especially at near fixation.

Evaluation of ocular motility

Holding a light pen or a small toy and ask the patient to follow it with his /her eyes without moving his /her head. Version is movements of both eyes in the same direction. The nine gaze positions were examined (primary position, right gaze, left gaze, straight up gaze, straight down gaze, up and right gaze, up and left gaze, down and right gaze, down and left gaze). Ocular motility examination is important to exclude restrictive types of exotropia and to identify muscle over action esp. inferior oplique overaction.

Evaluation of the refractive condition

Refractive error of all patients was determined after instillation of cyclopentolate HCL 1 % three times 10 minutes in between and 20 minutes between the last one and examination with total 40 minutes between the first drop and the start of examination. Then, the refractive error was determined using the autorefractometer. Hyperopia was represented as positive numbers. Patients with post cycloplegic refraction more than +2.00 D were prescribed glasses. The patients were assigned in to two groups. Group A: The number of those patients was 15. They were prescribed the full hyperopic correction as glasses. Group B: The number of those patients was 16. They were prescribed the hyperopic correction -1 (under corrected) as glasses. Both groups were followed up at 2 monthly intervals for 6 months. Surgery was recommended if there was a deterioration or persistence of exotropia (frequency or magnitude of exotropia) or if exotropia was present more than 50% of the time as determined by obtaining an ophthalmic history. All surgeries were performed under general anaesthesia by the same surgeon. Bilateral lateral rectus recession was the gold standard for all patients with or without inferior oblique myectomy incases with inferior oblique overaction. Post operatively, all patients were followed up at 2 monthly intervals for 6 months for their alignment, visual acuity and ocular motility. Patients were, then, assigned in to 3 groups according to surgical outcome: Resolution group (aligned patients), residual group (residual exotropia) and overcorrection group (postoperative esotropia with or without glasses).

Statistical significance was tested using Chi-square test, Fisher's Exact or Monte Carlo correction, Student t-test and Mann Whitney test. A *P* value less than 0.05 was considered statistically significant. Normally distributed values were reported as mean standard deviation.

RESULTS

A total of 31 patients who have alternating intermittent exotropia of the basic type, hypermetropia and fit all of the inclusion criteria were enrolled, of which 15 (48.4%) were fully corrected of their hyperopic refractive error (Group A) and 16 (51.6%) were under corrected of their hyperopic refractive error by 1D (Group B). There was no statistical difference between the two groups as regarding sex or age. In group A, the hyperopic error was ranged in the right eye from +2.00 to +8.75 with a mean of4.15 ± 1.86 and median of 3.50 (3.0 – 4.50) and in the left eye from +2.00 to +8.25 with a mean of3.73 ± 1.74 and median of 3.0 (3.0 – 4.0). In group B, the hyperopic error was ranged in the right eye from +2.50 to +8.25 with a mean of5.17 ± 1.66 and median of 5.13 (4.0 – 5.88) and in the left eye from +3.00 to +7.75 with a mean of 4.91 ± 1.38 and median of 5.0 (3.63 – 5.63). There was statistically significant increase of the median and mean of the hyperopic error of the left eye of group B than in group A (*P*=0.011) with no statistically significant difference in the right eye between the

two groups. The initial angle of exotropia in selected patients of group A was ranged between 20-40 PD with a mean of 31.0 ± 6.32 and median of 30.0 (30.0 – 35.0) while in patients of group B was ranged between 20-45 PD with a mean of 32.81 ± 6.05 and median of 35.0 (30.0 – 35.0). All patients were followed up for 6 months preoperatively at 2 monthly intervals as regarding the new angle of exotropia. There was no statistically significant difference between the two groups as regarding the angle of exotropia whether the initial angle or during the 6 months of preoperative follow up. The angles of exotropia in group A patients increased by 5-15 PD after wearing their full hyperopic prescribed glasses during their subsequent follow up visits while in group B, the angles of exotropia either remained constant or inceased by only 5 PD. However, this didn't reach clinical significance which may be due to the small number of cases. The best corrected visual acuity (BCVA) of the two groups was measured one week preoperatively and 6 months postoperatively. There was statistically significant increase in the no. of cases whose BCVA was 20/20 in the right eye and left eye in group A. (P=0.045, P =0.037 respectively) at 6 months post operatively while there was no statistically significant difference in the BCVA between the two groups preoperatively. So, according to our study, the full hyperopic correction, surgery for exotropia and may be improvement of the binocularity and fusion post operatively resulted in better BCVA. Bilateral rectus recession (BLR) was the operation of choice in all patients of both groups. The range of BLR done for group A was 4.0 - 7.50mm with mean of 5.93 ± 0.82 and median of 6.0 (5.75 – 6.50). While the range of BLR done for group B was 5.0 – 8.0 mm with mean of 6.28 ± 0.75and median of 6.50 (5.75 – 6.50). The following table shows the amount of bilateral lateral rectus recession (BLR) done in our cases as regarding their final preoperative angle of exotropia with their spectacles and whether inferior oblique myectomy was done or not intraoperatively. All amounts of BLR were reduced by 1 mm in each eye than the regular known tables and if inferior oblique myectomy was decided further 1mm is reduced in each eye. This is according to the surgeon experience.

Table (1): The amount of bilateral lateral rectus recession (BLR) done according to the surgeon experience.

The final operated angle in PD	The amount of BLR in mm	The amount of BLR when associated with other procedures
45 PD	8.00 mm (ou)	
40 PD	7.5 mm (ou)	
35 PD	6.5 mm (ou)	BLR 5.50 mm when associated with inferior oblique myectomy.
30 PD	6.00 mm (ou)	BLR 5.00 mm when associated with inferior oblique myectomy.
25 PD	5.50 mm (ou)	
20 PD	5.00mm (ou)	BLR 4.00 mm when associated with inferior oblique myectomy

The type of squint in all patients of the two groups was alternating intermittent exotropia of basic type in which the distance and near angle are nearly equal or within 10 PD with freely mobile extra ocular muscles. There was no statistically significant difference between the two groups as regarding the ocular motility whether the no. of cases who were freely mobile in all directions only, those who were associated with inferior oblique over action or those who were associated with dissociated vertical deviation (DVD) either pre or post operatively. At 2 months postoperatively, There was statistically significant increase in the number of aligned cases in group B than in group A (*P*=0.018). There was statistically significant increase in the no. of cases which are aligned with glasses but esotropic (5-16PD) without glasses in group A than in group B (*P*=0.002). At 4 and 6 months post operatively, there was no statistically significant difference in the no. of cases who were aligned in both groups while there was still statistically significant increase in the no. of cases which are aligned with glasses but esotropic (5-16PD) without glasses in group A than in group B (*P*=0.002, *P*=0.018 respectively at 4 &6 months). The no. of cases which were aligned in group B decreased from 13 (81.3%) at 2 months to 9 (56.3%) at 6 months and these 4 cases became exotropic throughout follow up. Additional 3 cases of group B which were aligned became exotropic at follow up at 1 year. This may require further follow up of all cases which may augment our results. In a trial to find the possible preoperative and intra operative factors leading to postoperative exotropia in both groups, we compared between postoperative XT cases (n=9) and post operative non XT cases (n=22) cases at 6 months postoperatively. There was increase in the operated angle among post operative XT cases than in post operative non XT cases, but this increase is slightly non clinically significant.(*P*=0.056). This may be due to the small number of cases in both groups which made this difference slightly non significant. There was clinically significant increase in the amount of BLR done in post operative XT cases than in postoperative non XT cases (P=0.022). So, according to our study, the amount of BLR done, and may be the operated angle, are among the accused factors of post operative XT. There was no clinical significant difference between post operative XT and postoperative non XT cases as regarding the spherical equivalent. There was a negative correlation found between the angle of exotropia at 6 months post operatively and the amount of BLR done (r= -0.357). However, this negative correlation didn't reach the clinical significance (*P*=0.345). There was a negative correlation found between the angle of exotropia at 6 months post operatively and the operated angle(r= -0.361). However, this negative correlation didn't reach the clinical significance (P=0.339). This may be due to the small number of cases which made the results non significant.

DISCUSSION

In our study, none of our cases' exotropia improved, or turned esotropic after hyperopic correction. Either the hyperopic error was corrected fully or partially, the exodeviation either remained constant or increased by 5-15PD. L.Iacobucci, et al, reported resolution, small angle esophoria and small angle esotropia after spectacle correction of hyperopia in exotropic patients.[12]However, there is no enough data about the amount of hyperopic correction given to those patients. Seung Ah Chung, et al, reported increase in exodeviation after hyperopic correction

which was significant and more than 10 PD in one third of the study hyperopic cases. The study recommended spectacle correction trial before surgery in patients with hyperopia and exotropia. The amount of hyperopic correction given to the study cases is not unfortunately obvious.[13]This study agrees with ours as also, in some of our cases, the exodeviation increased after hyperopic correction especially after full hyperopic correction which reached in some cases to 15 PD increase after 6 months of wearing spectacles. Although correction of the hyperopic error in exotropic patients is a must in literature either as a preoperative measure or as a non surgical measure for management of exotropia, the amount of hyperopic correction to be given to the exotropic patient is unclear. Moreover, the effect of full versus partial hyperopic correction on the surgical outcome of exotropic hyperopic patients is not clear in literature we accessed. According to our study, the amount of BLR done, and may be the operated angle, are among the accused factors of occurrence of post operative exotropia. A study, published in American journal of ophthalmology, discussed the preoperative and postoperative clinical factors incriminated in recurrence of XT after surgery. In this study, the follow up was as long as 24 months. Preoperative clinical factors were found to increase the risk of recurrence of XT, in this study, were the younger age at onset with no significance of the age at surgery, larger preoperative angle, and less immediate postoperative overcorrection.[14]In our study, the duration of postoperative follow up was only six months which is too short to reveal exotropic drift tendencies in the cases if we compared it with the previous study post operative duration of follow up. However, there was no statistically significant difference between our two comparison groups as regarding the age at surgery nor the preoperative angle. There was no enough clear data about the age of onset in our cases. However, non of our study cases were of congenital exotropia. In our study cases, those who were immediately esotropic without glasses aligned with glasses in the postoperative period revealed no exotropic drift throughout follow up. In our study, there was statistically significant increase in the no. of cases whose BCVA was 20/20 in the right eye and left eye in group A (p=0.045, =0.037 respectively). This was only in the post operative follow up and not in the preoperative one (p=0.252, p=0.133 respectively in the right and left eye). Ji Woong Chang discussed the effect of full hyperopic correction versus under hyperopic correction on visual acuity, emmetropization and amblyopia in moderate to severe hyperopia. The author reported more beneficial effects on emmetropization and amblyopia among those who were partially hyperopic corrected. Improvement of visual acuity was especially more rapid among those who were partially hyperopic corrected based on achieving best corrected visual acuity by decreasing -0.25D in step wise manner from the cycloplegic refraction done one week earlier than those who were prescribed fixed under correction of their hyperopic error by 1-1.5 D.[15] In our study, all amounts of BLR were reduced by 1 mm in each eye than the regular known tables and if inferior oblique myectomy was decided further 1mm is reduced in each eye. This is according to the surgeon experience. A study published by A Awadein et al in 2014 discussed the effect of age on the response to BLR. The study used change point analysis which is capable of detecting changes which may be missed by usual control charts. The author reported that there is negative correlation between the age and the response to surgery. For age 4-7 years, decreasing the amount the BLR by 1mm decreased the

incidence of postoperative overcorrection but didn't change the success rate. So, the standardized tables may work well. For ages 7-12 years, the author recommended also the standardized tables to operate accordingly. However, for ages >12 years, the author recommended increase in the dose of BLR by 1.5 mm than the standardized tables.[16] Our study groups were of small number making the age factor very difficult to determine its effect on the surgical response to BLR.

CONCLUSION

Spectacle correction of the hyperopic refractive error in exotropic patients is a must as a non surgical measure whether the patient needed squint surgery or not later on. Even if the exotropia doesn't improve with glasses and surgery was the decision, we can get benefit by operating on the new resultant exotropic angle. Patients who received full hyperopic correction had the best results at 6 months post operative follow up as regarding alignment and the least incidence of post operative exotropic drift or residual exotropia especially if we included those who were aligned with glasses esotropic (5-16 PD) without glasses in the alignment group as they are actually aligned. The amount of BLR done, and may be the operated angle, are among the accused factors of post operative XT.

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