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Original Article

Relationship between Control Grade, Stereoacuity and Surgical Success in Basic Intermittent Exotropia

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Purpose: This study was conducted to identify the relationship between control grade, stereoacuity and surgical success in basic intermittent exotropia.

Methods: This retrospective study involved 44 basic intermittent exotropia patients who underwent strabismus surgery and completed at least 6 months of follow-up. The 44 patients were divided into three subgroups according to their control grade: group 1 (good control group, n = 12), group 2 (fair control group, n = 18), and group 3 (poor control group, n = 14). Evaluation was done to identify the relationships between near and distance stereoacuity and control grade, and between surgical success and control grade. Surgical success was defined as ocular alignment between 5 prism diopters esodeviation and 10 prism diopters exodeviation in the primary position at the final visit.

Results: Mean near stereoacuity measured by the graded circle test was 57.50 seconds of arc (seconds) in group 1, 77.77 seconds in group 2, and 131.43 seconds in group 3 ($p < 0.01$). Mean distance steroacuity measured by Mentor B-VAT II BVS contour circle was 108.33 seconds in group 1, 148.33 seconds in group 2, and 262.82 seconds in group 3 ($p < 0.01$). Ten patients (83.33%) in group 1, 12 (66.67%) in group 2, and 9 (64.29%) in group 3 obtained surgical success ($p = 0.28$).

Conclusions: In basic intermittent exotropia, better control grade was significantly accompanied by better stereoacuity. Better control grade was accompanied by higher surgical success rate but with no statistical significance.

Key Words: Exotropia, Prevention & control, Stereoacuity, Strabismus

Intermittent exotropia is one of the most common types of childhood strabismus in Asia [1,2]. It is a progressive disorder that usually begins as a poorly controlled exophoria. With time, the manifest state tends to increase as the patient's fusional vergence system becomes unable to control the deviation. Distance fixation usually deteriorates first, with most patients preserving better control at close distance with additional accommodative convergence. As control deteriorates, anomalous retinal correspondence or suppression may occur. Eventually, if untreated many intermittent exotropias advance to constant exotropias at distance. To preserve and develop steroacuity, surgical intervention at an appropriate time is mandatory [3].

Rosenbaum and Stathacopoulos [3] argued that evaluating the control grade in strabismus helps follow the prog-

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ress of intermittent exotropia and deciding on the timing of surgery. O'Neal et al. [4] opined that the timing of intervention should be decided using distance stereoacuity, which helps evaluate control grade and fusional deterioration. Lee at al. [5] stated that there is a significant correlation between fusional status and surgical success in intermittent exotropia patients, but Yang et al. [6] reported no correlation.

The purpose of this study was to assess a patient's control of the deviation in the office setting using cover testing, and to describe the relationships between control grade and stereoacuity, and control grade and surgical success in basic intermittent exotropia.

Materials and Methods

The surgical records of cases from August 2011 to December 2012 of one surgeon (LSY) were retrospectively reviewed. An attempt was made to review 44 patients who underwent bilateral lateral rectus recession or monocular lateral rectus recession and medial rectus resection, and who were able to be followed-up for at least 6 months. Patients were excluded if there was any history of ocular surgery, more than two lines of visual acuity difference between both eyes, more than two diopters of anisometropia in spherical equivalent, and those who were too young to accurately perform the near and distance stereoacuity tests. All patients were assessed for age, sex, age at surgery, and refractive error.

Observed office control was measured at a distance of 5 m with a cover test and assessed on a three-point scale. Group 1 denoted good control (patient manifests a deviation only after cover testing but is able to resume fusion rapidly without blinking or refixating). Group 2 denoted fair control (patient manifests a deviation after fusion disrupted by cover testing but is able to resume fixation after blinking or refixating). Group 3 denoted poor control (patient manifests a deviation spontaneously in the office without disruption of fusion by cover testing). Results that were repeated at least twice during the office examination were included.

Stereopsis tests were administered at both near and distance. Near stereoacuity was evaluated by the graded circle test (Stereo Optical, Chicago, IL, USA) at 40 cm with polarized glasses and the booklet held perpendicular to the patient's visual axis. Disparities of the graded circle were 800, 400, 200, 140, 100, 80, 60, 50, and 40 seconds of arc (seconds). Distance steroacuity was evaluated with the Mentor B-VAT II SG videoacuity tester (Mentor O&O, Norwell, IL, USA) at 6 m with liquid crystal binocular glasses. Disparities of B-VAT II BVS contour circle (BVC) were 240, 180, 120, 60, 30, and 15 seconds. These procedures were continued until two successive mistakes were made. The examiner then returned to the last correct response and retested that group. If a correct response was obtained, the threshold stereoacuity was recorded at that level. If an incorrect response was obtained, the examiner proceeded successively backwards until a correct response was made, with steroacuity recorded at that level.

The preoperative and postoperative size of the exodeviation was assessed at 6 m and 33 cm by alternative prism cover test after the refractive error was corrected. Surgical techniques were determined by the surgeon's preference and surgical success was defined as distance ocular alignment at the primary position between 5 prism diopters esodeviation and 10 prism diopters exodeviation at 6 months after the operation.

SPSS ver. 18.0 (SPSS Inc., Chicago, IL, USA) was used for statistical analysis. A *p*-value $\leq$0.05 was statistically significant. The associations between control grade and stereoacuity among all three groups were assessed with the Kruskal-Wallis test. The associations of control grade and stereoacuity between each group were assessed by the Mann-Whitney *U*-test. In addition, the association between control grade and surgical success was measured with the chi-square test.

Results

Forty-four patients met the inclusion criteria. The mean age at the time of the examination was 7.40 ± 2.71 years (range, 4 to 39 years). Group 1 consisted of 12 patients, group 2 of 18 patients, and group 3 of 14 patients. No statistical difference in mean age and gender ratio of each group was evident (Table 1). Results of mean logarithm of the minimum angle of resolution visual acuity tested with the Snellen visual acuity chart and mean refractive error are shown in Table 2; no statistical differences were evident.

Data for mean near and distance stereoacuity are shown in Table 3. Group 3 (poor control grade) had poor stereoacuity at both near and distance when comparing the three groups at the same time ($p < 0.01$ and $p < 0.01$, respectively). Comparing each group in pairs at both near and distance, group 2 had better stereoacuity than group 3 ($p = 0.04$ and $p < 0.01$, respectively), and group 1 had better steroacuity than group 3. Groups 1 and 2, however, had no statistically significant difference ($p = 0.64$ and $p = 0.49$, respectively).

Table 1. Subject and subgroup demographics

Control grade	No. of subjects	Mean age (yr, mean ± SD)	Gender distribution (male : female)
Good	12	8.17 ± 2.66	6 : 6
Fair	18	6.56 ± 1.69	6 : 12
Poor	14	7.86 ± 3.59	6 : 8
Total	44	7.40 ± 2.71	18 : 26

Table 2. Comparison of mean logMAR visual acuity and refractive errors in each group

Control grade	logMAR visual acuity		Refractive error (diopter)	
	OD	OS	OD	OS
Good	0.09 ± 0.20	0.10 ± 0.15	-0.29 ± 0.67	-0.52 ± 0.75
Fair	0.05 ± 0.14	0.07 ± 0.20	-0.26 ± 0.50	-0.29 ± 0.75
Poor	0.06 ± 0.10	0.10 ± 0.15	-0.13 ± 0.67	-0.38 ± 0.68
p-value	0.33*	0.23*	0.34*	0.21*

logMAR = logarithm of the minimum angle of resolution; OD = oculus dexter; OS = oculus sinister.
*Statistics by Kruskal-Wallis test.

Table 3. Mean near and distance stereoacuity values in each group

Control grade	Mean stereoacuity (seconds of arc)	
	Near	Distance
Good	57.50 ± 23.01	108.33 ± 67.93
Fair	77.77 ± 30.59	148.33 ± 91.80
Poor	131.43 ± 98.52	262.82 ± 110.62
p-value	<0.01*	<0.01*

*Statistics by Kruskal-Wallis test.

Preoperative and postoperative mean deviation angles are shown in Table 4. No statistical difference between each group was demonstrated. Surgical success rates are summarized in Table 4. The data showed that group 3 had a lower surgical success rate and the difference was not statistically significant ($p = 0.28$).

Discussion

Intermittent exotropia is common in Asians and is the most common type of strabismus [1]. Intermittent exotropia is a progressive disorder where ocular alignment is good and stereopsis is normal at the exophoric phase, which shows normal binocular function. As time passes, however, motor convergence decreases and abnormal binocular function develops with tropia manifesting more often at distance [7]. Jampolsky [8] also stated that intermittent exotropia is a disorder that progresses toward constant tropia with fusional control suppression.

Although the degree of exodeviation, and frequency and duration of the prominent exotropia phase have been used to assess the progression of intermittent exotropia and to decide on surgical intervention, they have not been established as objective methods. Also, assessing the deterioration of control grade has been commonly used to decide the time for surgical intervention. Rosenbaum and Stathacopoulos [3] presented subjected methods that

Table 4. Comparison of preoperative and postoperative mean deviation angle and surgical success rate in each group

Control grade	Deviation angle (PD)				Success rate (%)
	Preoperative		Postoperative		
	Near	Distance	Near	Distance	
Good	24.17 ± 3.59	20.92 ± 5.37	3.08 ± 3.34	2.83 ± 3.66	83.33
Fair	24.22 ± 5.01	22.78 ± 4.52	5.28 ± 5.55	6.17 ± 5.94	66.67
Poor	25.50 ± 8.16	25.14 ± 7.27	5.93 ± 6.52	5.29 ± 7.23	64.29
p-value	0.46*	0.11*	0.16*	0.09*	0.28†

PD = prism diopters.
*Statistics by Kruskal-Wallis test; †Statistics by chi-square test.

assessed the progression of intermittent exotropia in an office setting and at home. Rosenbaum and Santiago [9] evaluated the recovery of fusion after an office-based cover test. They presented distance stereoacuity as an objective method because it was diminished in intermittent exotropia first.

This study was performed to evaluate the relationship between control grade as an objective method and stereoacuity as a subjective method, and to evaluate the correlation between control grade and the surgical success rate.

Rosenbaum and Santiago [9] stated that no difference of near stereoacuity was found between normal controls and intermittent exotropia patients. Park and Lee [10] argued that worse near stereoacuity was found in patients with a poor control grade. Han et al. [11] also stated that fusional control degree and near stereoacuity were correlated because decreased near stereoacuity was demonstrated in patients with suppression or anomalous retinal correspondence. In our study when comparing near stereoacuity, groups 1 and 2 had a better control grade compared to group 3, but there was no significant difference between groups 1 and 2. The reason why group 3 had poor near stereoacuity may be that the intermittent exotropia progressed to the basic type and near stereoacuity decreased along with distance stereoacuity. Therefore, it is obvious that poor near stereoacuity is accompanied with poor control grade.

In the research performed by Stathacopoulos et al. [12] concerning the correlation between distance stereoacuity and control grade of strabismus comparing intermittent exotropia patients to a normal control group, it was stated that poor distance stereoacuity was associated with poor control grade and showed progression of strabismus. In addition, although near stereoacuity remained nearly normal, distance stereoacuity in intermittent exotropia patients was poorer than in normal controls, and it was able to estimate the progression of strabismus. Lee [13] argued that distance stereoacuity measured by BVC was poor in intermittent exotropia patients and helped predict the control grade and sensory function objectively; also, poor control grade was accompanied with poor distance steroacuity in this study. Therefore, distance stereoacuity is an objective measurement of control grade, and can help to assess the progress of exotropia and to decide on surgical intervention timing.

Scott et al. [14] reported that the preoperative deviation angle, difference between near and distance deviation angle, age at the time of intervention, mean spherical equivalent, and difference between up-gaze and down-gaze deviation angle accounted for about 94% of the surgical success rate of intermittent exotropia surgeries. Kim et al. [15] stated that the patient group with poor near stereoacuity showed a high recurrence rate after the exotropia surgery, and Yang et al. [6] argued that degree of fusion and surgical success have no correlation. In the current study, the surgical success rate was higher in the better control grade group but there was no statistical difference between them, which is similar to the results of Yang et al. [6]. Kushner et al. [16] suggested that assessing the degree of control grade may be used to help determine the timing of surgical intervention, but the surgical success rate is defined by other factors such as preoperative deviation angle and mean spherical equivalent. Thus, further evaluation will be necessary to deduce the factors affecting the surgical success rate.

In conclusion, control grade and stereoacuity are correlated in intermittent exotropia, and assessing the progress of exotropia and determining the time of surgical intervention using this correlation are recommended. In patients with good or fair control grade, however, both control grade and stereoacuity should be monitored since it is difficult to predict the progress of strabismus only with stereoacuity. Both near and distance stereoacuity contribute to the assessment of progress of strabismus in basic intermittent exotropia. However, control grade in basic intermittent exotropia showed no significant correlation with surgical success rate.

Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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