Evaluation of stereopsis level and it's associated factors in patients with refractive accommodative esotropia

Refraktif akomodatif ezotropya hastalarında stereopsis düzeyi ve ilişkili faktörler

Bengi Demirayak [1]

Abstract

Aim: To investigate the level of stereopsis in patients with refractive accommodative esotropia and to find out associated factors with good stereopsis.

Methods: The hospital records of patients with refractive accommodative esotropia from January 2010 to June 2020 were retrospectively reviewed. Age, cycloplegic refractive error, the difference of refractive error between two eyes, angle of deviation at near and distance fixation, fusional ability and stereoacuity were evaluated. Patients were divided into two groups according to the stereopsis level: good stereopsis (40-100 arcsec) and poor stereopsis (>100 arcsec).

Results: A total of 62 patients were inclueed. Of them, 14 patients (22.5 %) were in good stereopsis group. The mean age was 5.35 years (range 3-11 years). The mean age at first visit, refractive differences between eyes and final deviation angle with spectacle were smaller in the good stereopsis group than in the poor stereopsis group. But, only the mean deviation angle at distance was found significant statistically between two groups. (p=0.038)

Conclusion: Residual esodeviation at distance fixation was significantly lower in patients with refractive accommodative esotropia who have good stereopsis.

Key words: Accommodative esotropia, binocular vision, fusion, stereopsis.

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Öz

Amaç: Refraktif akomodatif ezotropyası olan hastalarda stereopsis düzeyini değerlendirmek ve stereopsise etki eden faktörleri ortaya çıkarmak.

Yöntemler: Ocak 2010- Haziran 2020 yılları arasındaki refraktif akomodatif ezotropya ile takip edilen hastaların kayıtları retrospektif olarak gözden geçirildi. Yaş, sikloplejik kırma kusuru, iki göz arasındaki kırma kusuru farkı, yakın ve uzak fiksasyondaki kayma açısı, füzyon kabiliyeti ve stereo keskinlik değerlendirildi. Hastalar stereopsis düzeyine göre 2 gruba ayrıldı: iyi stereopsis (40-100 sn ark), zayıf stereopsis (>100 sn ark).

Bulgular: Toplam 62 hasta dahil edildi. Bunlardan 14 hasta (22,5%) iyi stereopsis grubundaydı. İlk vizitteki yaş ortalaması 5,35 idi (3-11 yaş aralığı). İlk vizitteki ortalama yaş, iki göz arasındaki kırma kusuru farkı, son vizitteki gözlükle kayma açısı, iyi stereopsis grubunda, zayıf stereopsis grubuna göre düşük bulundu. Ancak, yalnızca uzak fiksasyondaki ortalama kayma açısındaki düşüklük istatistiksel olarak anlamlı olarak bulundu. (p=0,038)

Sonuç: İyi stereopsise sahip olan refraktif akomodatif ezotropya hastalarında uzak fiksasyondaki artık kayma miktarı anlamlı derecede düşüktür.

Anahtar kelimeler: Akomodatif ezotropya, binoküler görme, füzyon, stereopsis.

Introduction

Accommodative esotropia can be defined as convergent deviation of the eyes related with an abnormal activation of the accommodation reflex. Refractive accommodative esotropia (RAE) includes accommodative convergence, uncorrected hyperopia and inadequate fusional divergence [1].

Stereopsis is the highest form of binocular vision and it is binocular perception of depth [2]. Possible factors affecting stereopsis in patients with esotropia were investigated by some authors. The presence of amblyopia or anisometropia, residual esodeviation, longer duration of esodeviation have been reported to be associated with poor stereopsis [3,4]. However, the factors influencing stereopsis in RAE are still unclear.

In this study, we aim to investigate the stereopsis level and factors associated with stereopsis in patients with RAE.

Material and methods

This study included patients with refractive accommodative esotropia seen at Dr. Sadi Konuk Education and Research Hospital, Pediatric Ophthalmology department from January 2010 to June 2020. The study protocol followed the tenets of the Declaration of Helsinki. Approval from the local ethics committee was obtained and written informed consent from the parents of participants was taken (2021-04-19).

The records of patients with RAE were retrospectively reviewed. The patients whose examinations were performed properly and data kept regularly and follow up time upper from a year were included. Patients with neurological and mental disorders, systemic disease, history of previous eye surgery and history of prematurity were excluded.

Full ophthalmologic examination was performed in all patients. Children over four years of age had evaluated by ARK-700 (Nidek Co. Ltd, Japan) auto refractometer for refractive errors after using 3 drops of cyclopentolate 1%, and retinoscopy was accomplished after administering 3 drops of cyclopentolate 1% to children under 4 years of age. Best corrected visual acuity was measured with Snellen chart and E chart was used to test small children. Full hyperopic correction was prescribed for treatment. Deviation at distance and near determined by Krimsky test in small children and prism cover test in older patients.

Stereoacuity was examined using the Titmus test (Stereo Optical, Chicago, IL). Children looked at the stereogram at distance of 40 cm while wearing polarizing glasses. The subject was asked to grab the wings of the fly and touch to the animal and circle that seemed to 'jump off the page'. The last correct target identified was used as the subject's stereopsis level. Stereoacuity was recorded as nil if the largest disparity could not be identified, and a score for nil stereopsis was 6000 arcsec fort he purpose of statistical analysis.

Fusion was measured using the Worth-4-Dot test at distance fixation and final examination was analyzed.

We defined refractive accommodative esotropia as a residual esotropia under 10 prism D after full hyperopic correction at both near and distance.

The following parameters were reviewed: age, cycloplegic refractive error, the difference of spherical error between two eyes, deviation at near and distance fixation, stereoacuity and fusion ability.

Statistical Analysis

All statistical analyses were performed using Number Cruncher Statistical System (NCSS Statistical Software, Kaysville, UT, USA). Shapiro-Wilk's test were used to assess the assumption of normality. Numeric variables were presented with mean±standard deviatiation. Categorical variables were summarized as counts (percentages). The Mann-Whitney U test was used the comparison of two independent groups with respect to quantitative data as the continuous variables were not normally distributed. Student-t test was used the continuous variables were normally distributed and $p<0.05$ was considered as statistically significant.

Results

A total of 62 children with RAE were included. The mean age of the subjects at the final visit was 9.5 years (range 5-16 years). The mean age of patients at first visit was 5.35 years (range 3-11 years). Demograhical and clinical datas of patients were summarized in Table 1.

Table 1. Demographics and characteristics of patients with RAE.

Age (years)	Mean±SD	9.55±2.5
	Range	5-16
Cycloplegic refractive error. SE (D)	Mean±SD	4.65±1.74
	Range	2-10
Interocular difference (D)	Mean±SD	0.46±0.69
	Range	0-4
Near deviation (PD)	Mean±SD	5.19±3.44
	Range	0-10
Distance deviation (PD)	Mean±SD	2.03±3.04
	Range	0-10
Age at first visit (years)	Mean±SD	5.35±2.00
	Range	3-11
Worth 4 dot test; n(%)	Fusion	44 (71)
	Supression	18 (29)
	Range	40-6000
Stereoacuities n(%)	≤100 sn/arc	14 (22.6)
	>100 sn/arc	48 (77.4)

RAE: Refractive accommodative esotropia, D: diopter; PD: prism diopter, SE: spherical equivalent, SD: standard deviation.

Firstly, patients were divided into groups according to the degree of final stereopsis: good (40-100 arcsec) and poor (>100 arcsec). There were 14 patients in Group 1 and 48 patients in Group 2. Age, cycloplegic refractive error, the difference of spherical error between two eyes, deviation at near and distance fixation were compared between groups. Results were summarized in Table 2. Only the measurement of distance deviation was found significant between groups ($p=0.038$).

Table 2. Comparison of patients with RAE according to level of stereoacuities at the final follow-up.

Clinical variable		Good stereopsis (n=14)	Poor stereopsis (n=48)	p
Age (years)	Mean±SD	10.07±1.49	9.40±2.72	[a]0.135
Cycloplegic refractive error SE (D)	Mean±SD	5.03±1.50	4.54±1.81	[b]0.354
Interocular difference (D)	Mean±SD	0.39±0.43	0.78±0.76	[a]0.696
Near deviation (PD)	Mean±SD	4.14±4.11	5.5±3.21	[a]0.303
Distance deviation (PD)	Mean±SD	0.57±1.65	2.46±3.23	[a]0.038*
Age at first visit (years)	Mean±SD	4.86±0.95	5.50±2.21	[a]0.711

RAE: Refractive accommodative esotropia, D: diopter; PD: prism diopter, SE: spherical equivalent, SD: standard deviation.
[a]Mann Whitney U Test, [b]Student T Test, *p<0.05

Secondly, patients were divided into groups according to fusion ability. Forty-four patients were in fusion group, and 18 patients were in suppression group. The groups were compared

in terms of age, cycloplegic refractive error, the difference of spherical error between two eyes, deviation at near and distance fixation. Only the measurement of distance deviation was found significant between groups (*p*=0.001). Results were summarized in Table 3.

Table 3. Comparison of patients with RAE according to fusion ability at the final follow-up.

Clinical variable		Fusion (n=44)	Suppression (n=18)	p
Age (years)	Mean±SD	9.59±2.53	9.44±2.50	[a]0.778
Cycloplegic refractive error. SE (D)	Mean±SD	4.75±1.65	4.42±1.97	[b]0.498
Interocular difference (D)	Mean±SD	0.39±0.53	0.61±0.99	[a]0.707
Near deviation (PD)	Mean±SD	4.68±3.61	6.44±2.71	[a]0.081
Distance deviation (PD)	Mean±SD	1.04±2.05	4.44±3.73	[a]0.001*
Age at first visit (years)	Mean±SD	5.30±1.96	5.50±2.18	[a]0.769

RAE: Refractive accommodative esotropia, D: diopter; PD: prism diopter, SE: spherical equivalent, SD: standard deviation.
[a]*Mann Whitney U Test,* [b]*Student T Test, *p<0.05*

Discussion

The present study was aimed to investigate the fusion ability, the degree of stereopsis and potential factors influencing stereopsis and fusion ability in patients with RAE. Of 62 patients, only 14 (22.5%) had 100 arcsec or better stereoacuity despite appropriate spectacle correction and well-aligned eyes. The mean age at first visit, the difference of refractive error between two eyes and final deviation angle with spectacle were smaller in the good stereopsis group than in the poor stereopsis group.

The onset of RAE usually occurs after two ages which significant maturation of stereopsis has completed. Therefore, some authors have suggested that most children with RAE should have a favorable prognosis for binocular vision [5, 6]. However, many children with accommodative esotropia have subnormal binocular single vision [6, 7]. There are two hypotheses evaluating the subnormal binocularity in accommodative esotropia: a congenital deficit infusion may predispose some children to accommodative esotropia, or brief periods of constant esotropia might disrupt stereopsis. In fact, neither hypotheses could be disproved [7]. Both the congenital deficits and the brief periods of misalignment causing abnormal visual experience could interrupt stereopsis in accommodative esotropia.

Of patients, 44 (70.9%) had fusion with Worth-4-dot test in our study. Berk et al. [8] reported 73.5% of the patients had fusion with the same test, similar with our study. Guclu et al. [3] found fusion was present 82.8% in their study. Although the results were similar about having fusion in RAE, stereopsis degrees were contradictory in the literature [9, 10]. Tomac et al. [11] reported 45% of patients had stereopsis. Berk et al. [8] demonstrated 24.2% of patients had 100 seconds of arc or better stereopsis. In our study, we found 22.5% of patients had good stereopsis. Lambert and Lynn [12] reported 30% of patients had good stereopsis and high levels of stereoacuity were found in patients whose esotropia occured at older age. It is known that if esotropia appears in first two years of life and stays uncorrected, binocular vision is broken down [13]. In our study, the mean age of patients found 5.3 years at first visit. The duration between first occuring of esotropia and accession for treatment might extended. That might be the reason of only 22.5% of our patients

had good stereopsis. But we didn't find any relationship between age and high levels of stereopsis. Cakir et al. [14] did not find any significant correlation between mean onset age and stereopsis, too.

Although previous reports have defined accommodative esotropia as angle of deviation under 10 prism diopter after hyperopic correction, Wong and collegues who demonstrated the recent neuroanatomical findings reported that the true stereopsis might be possible only with a misalignment of ≤4 PD [15]. In our study, residual deviations after full hyperopia correction were 4.14 PD in good stereopsis group and 5.50 PD in poor stereopsis group at near fixation. That difference was not found significant. But at distance fixation, they were 0.57 PD in good stereopsis group and 2.46 PD in poor stereopsis group and the difference was found significant statistically. To minimize esodeviation may be important to achieve better stereopsis.

The relationship between refractive error and stereopsis was investigated previously in patients with RAE, and the authors didn't find any relation [7, 13]. In our study, we didn't find any relationship between these parameters, too. Lee et al. [4] suggested that anisometropia might cause abnormal binocular sensory function in patients with RAE [4]. There wasn't a relationship between interocular difference and stereopsis, in our study. This item must be investigated in further studies with larger sample size.

The present study has some limitations, too. Firstly, patients were reviewed retrospectively. Second, stereopsis was measured by using the Titmus stereotest which is prone to monocular clues and variability of the results [16]. The test was performed at least twice and the last measured results were analyzed to maximize the reliability.

As a conclusion, residual esodeviation at distance fixation was found significantly lower in patients with RAE who have good stereopsis.

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