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Research Article

Distance Visual Acuity Versus Near Visual Acuity in Amblyopia

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Abstract

Purpose: To measure and compare distance and near visual acuity in amblyopic patients.

Methods: This study was conducted on 250 patients with amblyopia. In all subjects, a comprehensive ophthalmic examination including visual acuity, refraction, slit lamp biomicroscopy, and funduscopy was performed. Distance visual acuity (DVA) was measured by Snellen chart at 4m and near visual acuity (NVA) was assessed by Snellen chart at 40 cm, and then DVA and NVA were compered and analyzed.

Results: In our subjects, the mean distance and near visual acuity was 0.47 ± 0.25 and 0.59 ± 0.31 respectively. The mean NVA was 1.12 ± 1.25 lines better than DVA and difference between them was statistically significant (P < 0.001). The difference between DVA and NVA was not significantly related with age (p = 0.225), spherical equivalent (P = .932) and strabismus (P = .778) and type of amblyopia (P = .067). Although all of subjects had subnormal DVA, but 25% of them had normal NVA. In mild and moderate amblyopic groups, difference between DVA and NVA was 0.14 ± 0.10 and 0.17 ± 0.15 lines respectively, but in severe amblyopic group it was 0.03 ± 0.08 line. The difference between DVA and NVA showed a significant relation with severity of amblyopia (P < 0.001). Also, the difference between DVA and NVA was 0.16 ± 0.12 in patients with history of amblyopia therapy and 0.07. ± 0.11 in patients without treatment. This difference was statistically significant (P < 0.001).

Conclusion: Our results showed that near visual acuity in amblyopia especially in mild to moderate types was significantly better than distance visual acuity. The difference between DVA and NVA showed no relation with age, spherical equivalent, strabismus, and type of amblyopia. Also, difference between the DVA and NVA in patients with history of amblyopia therapy was better than of it in non-treated subjects.

Keywords: Amblyopia; Distance Visual Acuity; Near Visual Acuity; Screening

Introduction

Amblyopia is one of the visual impairments which involves approximately 3% of the population [1]. It affects on different parts of the visual function such as visual acuity, contrast sensitivity, and binocular vision [2]. Amblyopia has the major impact on whole-of-person functioning and occupational choices and fine

motor skills proficiency [3]. Definition and diagnosis amblyopia is based on subnormal distance visual acuity. Distance visual acuity testing is one of the important assessments of visual function and is an efficient and cost-effective method to screen children with amblyopia [4,5]. In addition to distance vision tests, there are near vision tests for evaluation of visual function and diagnosis of visual impairments. In the study by Bušić., *et al*. distance visual acuity testing along with near visual acuity increased the sensitivity and specificity of amblyopia screening [6]. Also, Huang., *et al*. showed high validity and reliability of near visual acuity measurements in children and stated that it can be applied in routine clinical practice [7]. Other studies have been conducted on the distance and near visual acuity in amblyopia and evaluated difference between them in patients. While primary studies showed that the NVA in amblyopic eyes was worse than their DVA [8,9], subsequent studies stated there was no difference between distance and near vision in amblyopia [10,11]. Also, Chun reported near vision in amblyopia was significantly better than distance visual acuity [12].

These studies showed conflicting reports and there was no study in Iranian ethnicity. Therefore, this study designed to measure near and distance visual acuities and compare them in amblyopic subjects.

Methods

Ethics statement

This cross-sectional study was conducted after approval by the Human Ethics Committee of Shahid Beheshti University of Medical Sciences (number IR.SBMU.RETECH.REC.1399.1280). Under the principles of Helsinki declaration and detailed explanation of our study, the consent form was received from all participants.

Population and samples

Our study was conducted on patients coming to eye clinic in Abhar, Iran in 2021. We did our study on patients over 6 years old with proper cooperation for visual acuity testing. All participants were healthy and had no systemic diseases or ocular diseases. In addition, we had a control group that included normal participants with similar conditions (age, sex) of the patients studied.

Examinations

All subjects had received a completed ophthalmic examination including refraction, slit lamp biomicroscopy, and funduscopy. By autorefractometer (Topcon Medical Systems, KR800) and retinoscopy (Beta200 Heine, Germany), objective refraction was determined by experienced optometrist. Spherical equivalent (SE) was considered as refractive errors of our subjects. According to spherical equivalent, three refractive conditions are defined: emmetropic refraction (SE between −0.50 to +0.50 D), hyperopic refraction (SE more than +0.50 D), and myopic refraction (SE less than −0.50 D).

Visual acuity was evaluated with spectacle correction under standard illumination. Distance visual acuity (DVA) was measured by Snellen chart at 4m. Assessment of near visual acuity (NVA) was performed by Snellen chart at 40 cm. In subjects over 40 years old, near visual acuity was recorded with near correction based on near accommodative amplitude. Also, ocular alignment was assessed by cover test in far and near distances and measured by prism bar. Assessment of anterior and posterior segments health (cornea, anterior chamber, lens, vitreous, retina, and optic nerve) was performed by experienced ophthalmologist. Additionally, patients were asked about history of amblyopia therapy (correction of refractive error, occlusion therapy, and active vision therapy) and recorded. In patients with binocular amblyopia, the eye with severe amblyopia was considered for this study.

Definitions

According to American Academy of Ophthalmology [13], diagnosis of amblyopia was made on basis of distance visual acuity (an interocular difference of 2 lines or more). According to types of amblyopia, subjects were classified into five groups: anisometropic, strabismic, mixed, ametropic, and deprivation amblyopia. Anisometropic amblyopia was considered as a difference of 1.0 diopter (D) or more in SE in the refractive errors or1.5D or more in astigmatism between the two eyes. Strabismic amblyopia was considered ocular misalignment of 10 prism diopter (PD) or more in either far or near distance by alternate cover test and prism. Mixed amblyopia included both of anisometropic and strabismus subjects. Ametropic amblyopia was defined as amblyopia with hyperopia of +5.0 D or more, myopia of −10.0 D or more, or astigmatism of −2.50D or more which did not place with anisometropic amblyopia group. Deprivation amblyopia included different ocular diseases (corneal opacities, cataract, blepharoptosis, nystagmus, optic nerve coloboma, persistent

fatal vasculature) that involved visual axis and failed to form clear images on the retina. Also, the severity of amblyopia is classified according to the visual acuity of the affected eye and divided into 3 groups: mild (visual acuity of 6/9 to 6/12), moderate (visual acuity of 6/12 to 6/36), and severe (visual acuity worse than 6/36).

Statistics

Our data was analyzed by SPSS software version 18. After assessment of normal distribution of data with the Shapiro-wilk test, we used chi-square, Kruskal-Wallis, Wilcoxon, and spearman's correlation tests. A P value < .05 was considered to be statistically significant.

Results

In this study, we assessed 50 normal participants (26 male and 24 female) with mean age of 30.12 ± 11.50 years as a control group. There was no difference between DVA and NVA in normal participants. Amblyopic subjects were 250 patients (127 male and 123 female) with mean age of 29.61 ± 12.60 (range 6 - 50) years. The mean spherical equivalent of patients was -0.37 ± 7.08 D with the range of -22.00 to +18.00 D. 19 patients were in emmetropic range of refraction, 147 patients had hyperopia, and 84 subjects were myopic. 76 patients had strabismus with the mean size of 28.97 ± 16.24 prism diopter. 41 subjects were isotropic with the mean size of 25.6 ± 18.9 PD (10 - 70) and 30 patients had exotropia with the mean size of 30.23 ± 15.25 PD (10 - 60), and 5 of them had vertical strabismus with the mean size of 16.40 ± 6.84 PD (12 - 28). While the mean distance visual acuity of our subjects was 0.47 ± 0.25, the mean near visual acuity was 0.59 ± 0.31. The mean NVA was 1.12 ± 1.25 lines better than DVA and difference between DVA and NVA was statistically significant (P < 0.001). In 107 patients (43%), there were no difference between DVA and NVA, but in 101 subjects (40%), NVA was 1- 2 lines more than DVA, and NVA of 42 patients (17%) was more than 2 lines (2 - 5) better than DVA. The difference between DVA and NVA was not significantly related with types of spherical equivalent (P = .932) or amount of spherical equivalent (P = .579). Also, this difference was not significantly related with type of strabismus (P = .972) or amount of strabismus (P = .778) (Table 1). According to type of amblyopia, patients were divided to 125 anisometropic subjects, 22 strabismic subjects, 40 mixed subjects, 29 ametropic subjects, and 34 deprivation subjects. From 34 patients with deprivation amblyopia, 1 patient had corneal opacity, 9 subjects had a history of cataract surgery, 9 patients had nystagmus, and 15 of them had retinal problem (coloboma, hypoplasia, retinopathy of prematurity). In all types of amblyopia, our finding showed that NVA was significantly more than DVA and type of amblyopia had no effect on difference between DVA and NVA (P = .067) (Table 1). Additionally, the difference between the DVA and NVA was not affected by age of subjects (p = 0.225).

	Type of amblyopia					
	Overall (n = 250)	**Anisometropia (n = 125)**	**Strabismus (n = 22)**	**Mixed (n = 40)**	**Ametropia (n = 29)**	**Deprivation (n = 34)**
Age (y)	29.61 ± 12.61	30.60 ± 12.21	30.09 ± 11.98	27.00 ± 14.0	32.72 ± 13.04	26.06 ± 11.65
Spherical equivalent	-0.37 ± 7.08	0.54 ± 6.47	0.58 ± 1.82	1.06 ± 5.86	-6.28 ± 11.90	-1.00 ± 4.60
Distance VA	0.47 ± 0.25	0.55 ± 0.22	0.42 ± 0.25	0.45 ± 0.27	0.43 ± 0.25	0.30 ± 0.23
Near VA	0.59 ± 0.31	0.66 ± 0.28	0.58 ± 0.32	0.59 ± 0.33	0.58 ± 0.31	0.37 ± 0.31
DVA –NVA	0.12 ± 0.12	0.11. ± 0.11	0.15 ± 0.15	0.13 ± 0.13	0.15 ± 0.13	0.07 ± 0.13
P	< 0.001	< 0.001	0.001	< 0.001	< 0.001	< 0.007

Table 1: Baseline characteristics of study patients.

From total patients, 140 subjects had a previous history of amblyopia therapy and 110 of them received no treatment or did not therapy correctly. The difference between DVA and NVA was 0.69 ± 1.08 line in treated group and 1.56. ± 1.23 lines in non-treated group. This difference was statistically significant (P < 0.001) (Table 2).

Amblyopia		
	Treated (n = 140)	**Non-treated (n = 110)**
Age (Y)	27.44 ± 13.70	32.36 ± 10.47
Spherical equivalent (D)	-0.29 ± 7.26	-48 ± 6.89
Strabismus (PD)	23.50 ± 13.79	34.45 ± 16.86
Distance VA	0.56 ± 0.21	0.36 ± 0.26
Near VA	0.72 ± 0.24	0.43 ± 0.32
DVA – NVA	0.16 ± 0.12	0.07. ± 0.11
P	< 0.001	

Table 2: Baseline characteristics of study patients according to history of amblyopia therapy.

According to severity of amblyopia, patients were divided into 3 groups: 107 mild amblyopic subjects, 79 moderate amblyopic subjects, 64 severe amblyopic subjects. In mild and moderate amblyopic groups, difference between DVA and NVA was 1.38 ± 1.00 line and 1.61 ± 1.49 line respectively, but in severe amblyopic group it was 0.30 ± 0.78 line. The difference between DVA and NVA showed a significant relation with severity of amblyopia (P < 0.001) (Table 3). Although all of subjects had decreased DVA and were diagnosed as amblyopic, but 188 patients (75%) were decreased NVA and 62 subjects (25%) had normal NVA. From this 62 patients, 59 subjects had mild amblyopia and only three of them had moderate amblyopia.

Severity of amblyopia			
	Mild (n = 107)	**Moderate (n = 79)**	**Severe (n = 64)**
Age (y)	29.00 ± 12.50	29.14 ± 13.64	31.20 ± 11.42
Spherical equivalent (D)	0.58 ± 5.34	-1.02 ± 7.79	-1.17 ± 8.51
Strabismus (PD)	20.12 ± 14.53	23.22 ± 10.78	38.93 ± 17.01
Distance VA	0.72 ± 0.08	0.40 ± 0.08	0.14 ± 0.12
Near VA	0.86 ± 0.13	0.57 ± 0.17	0.18 ± 0.15
DVA – NVA	0.14 ± 0.10	0.17 ± 0.15	0.03 ± 0.08
P	< 0.001		

Table 3: Baseline characteristics of study patients according to severity of amblyopia.

Discussion

This study showed that near visual acuity was better than distance visual acuity in amblyopic patients. In 57% of patients with amblyopia, near visual acuity was 1 or more than distance visual acuity in. In mild to moderate amblyopia, near visual acuity was 1.5 lines better than distance visual acuity, but severe amblyopia showed similar distance and near acuities. Also, difference between the DVA and NVA had no relation with age, spherical equivalent, strabismus, and type of amblyopia. There were some studies in this field with controversy findings. Similar to our study, Chun [12] in a retrospective study on 73 amblyopic patients (4 - 30 years) showed that the NVA was 0.24 log MAR better than the DVA. The difference between the DVA and NVA was not affected by age, type of amblyopia, spherical equivalent, and PD [12]. However, Christoff [10] and Wang [11] in their studies on amblyopic children found no difference between distance and near visual acuity in children with amblyopia. These different findings may be due to differences in the age and race of patients.

Although subnormal distance visual acuity is the criterion for definition and diagnosis of amblyopia, some studies [6,7] have

suggested that near visual acuity tests can also be used to increase the sensitivity and specificity of distance visual acuity tests for screening and diagnosis of amblyopia. Jin., *et al*. [14] reported that DVA was more accurate for detecting high myopia but NVA was better for detecting high hyperopia and high astigmatism [14]. In our study, from all of patients that were amblyopic and had subnormal distance visual acuity, only 75% of them had subnormal near visual acuity. 95% of subjects with normal NVA were in mild amblyopic group and showed no relation with spherical equivalent. Then, using of near visual acuity tests underestimates diagnosis of mild amblyopia and is suitable in moderate and severe cases.

Based on our results, difference between the DVA and NVA in patients with history of amblyopia therapy was more than twice of it in non-treated subjects. Jin., *et al*. [15] compared the improvement rates of DVA and NVA in amblyopia. In his study, 68% of patients had initial NVA better than DVA. Children with better initial NVA tended to have a faster improvement rate of DVA and in mild amblyopia, the improvement rate of distance VA was significantly faster than near [14]. However, in a study by PEDIG [16], there was no difference in visual acuity improvement between children who performed common near activities and those who performed distance activities during patching [16]. Amblyopia therapies seem to be more effective on patients' near visual acuity and even incomplete treatments have their positive effects. Most of active amblyopia therapy such as games by digital devices, reading books, and writing perform in near distances and involve near vision more than far vision. Also, patients may perform near activities such as near vision tests more easily, or they can easily concentrate on performing them.

Limitation of the Study

The limitation of our study is that study sample was not large and we had no patients with other ethnicity. We suggest further studies with large sample with different ethnicities.

Conclusion

In conclusion, near visual acuity of amblyopic patients was significantly better than distance visual acuity. This difference between distance and near visual acuity had no relation with age, type of amblyopia, spherical equivalent, and strabismus. Despite all of patients had subnormal distance visual acuity, more than 50% of subjects with mild amblyopia had normal near visual acuity. Finally, difference between the DVA and NVA in patients with a history of amblyopia therapy was better than of it in non-treated subjects.

Conflicts of Interest

None.

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