Distance Visual Acuity Versus Near Visual Acuity in Amblyopia.

masoumeh ahadi (sepid01@yahoo.com)
Shaheed Beheshti University of Medical Sciences
Afsaneh Ebrahimi
Shaheed Beheshti University of Medical Sciences
Shahrokh Ramin
Shaheed Beheshti University of Medical Sciences

Research Article

Keywords: amblyopia, distance visual acuity, near visual acuity, screening.

Posted Date: June 3rd, 2021

DOI: https://doi.org/10.21203/rs.3.rs-371532/v1

Abstract

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

Methods: This study was evaluated 167 patients with amblyopia between ages of 6 and 55 years. 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 4 m and near visual acuity (NVA) was measured 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 0.39± 0.30 log MAR and 0.30± 0.32 log MAR respectively. The mean NVA was 0.12±0.12 log MAR better than DVA and difference between them was statistically significant (P<0.001). In 40% of patients, there were no difference between DVA and NVA, and in 60% of them, NVA was 0.1 or more log MAR better than DVA. The difference between DVA and NVA was not significantly related with age (p=0.225), spherical equivalent (P=.820) and strabismus (P=.336) and type of amblyopia (P=.405). Although all of these subjects had subnormal DVA, but 43 subjects (26%) had normal NVA. In mild and moderate amblyopic groups, difference between DVA and NVA was 0.14±0.10 log MAR and 0.15±0.14 log MAR respectively, but in severe amblyopic group it was 0.03±0.08 log MAR. The difference between DVA and NVA showed a significant relation with severity of amblyopia (P<0.001). The difference between DVA and NVA was 0.16±0.11 log MAR in patients with history of amblyopia therapy and 0.07.± 0.11 log MAR 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. More than 50% of subjects with mild amblyopia had normal near 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.

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 performed about 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 subjects with deprivation amblyopia, especially 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. 167 amblyopic patients between ages of 6 to 55 years old were participated in our study. All participants were healthy and had no systemic diseases or ocular diseases.

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 and then, by experienced optometrist was determined subjective refraction. 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 4 m. Assessment of near visual acuity (NVA) was performed by Snellen chart at 40 cm. Then, the recorded VA in decimal notation was converted to Log MAR (Minimum

Angle of Resolution). 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. Also, patients questioned about history of amblyopia (correction of refractive error, occlusion therapy, and active amblyopia therapy) treatment and recorded.

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.

Results

In this study, we assessed 40 normal subjects (22 male and 18 female) with mean age of 30.6 ± 11.5 years. In normal subjects, DVA and NVA were 0.0 log MAR without any difference. Amblyopic subjects were 167 patients (88 male and 79 female) with mean age of 29.1 ± 12.8 (range 6– 55) years. The mean spherical equivalent of patients was − 0.91 ± 7.48 D with the range of -29.00 to + 18.00 D. 12 patients were in emmetropic range of refraction, 97 patients had hyperopia, and 58 subjects were myopic. 40 patients had strabismus with the mean size of 6.9 ± 14.7 prism diopter. 19 subjects were esotropic with the mean size of 25.6 ± 18.9 PD (10–70) and 17 patients had exotropia with the mean size of 32.2 ± 18.8 PD (10–65), and 4 of them had vertical strabismus with the mean size of 12.5 ± 4.5 PD (11–22). While the mean distance visual acuity of our subjects was 0.39 ± 0.30 log MAR, the mean near visual acuity was 0.30 ± 0.32 log MAR. The mean NVA was 0.12 ± 1.2 log MAR better than DVA and difference between

DVA and NVA was statistically significant (P < 0.001). In 63 patients (40%), there were no difference between DVA and NVA, but in 73 subjects (45%), NVA was 0.1–0.2 log MAR more than DVA, and NVA of 24 patients (15%) was 0.2 log MAR more than DVA. The difference between DVA and NVA was not significantly related with types of spherical equivalent (P = .776) or amount of spherical equivalent (P = .820). Also, this difference was not significantly related with type of strabismus (P = .336) or amount of strabismus (P = .063). (Table 1) According to type of amblyopia, patients were divided to 86 anisometropic subjects, 14 strabismic subjects, 18 mixed subjects, 22 ametropic subjects, and 27 deprivation subjects. From 27 patients with deprivation amblyopia, 5 subjects had a history of cataract surgery, 7 patients had nystagmus, and 15 of them had retinal problem (coloboma, hypoplasia, ROP). 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 = .405) (Table 1). Additionally, the difference between the DVA and NVA was not affected by age of subjects (p = 0.225).

Table 1
Baseline characteristics of study patients.

Type of amblyopia						
	Overall (n = 167)	**Anisometropia (n = 86)**	**Strabismus (n = 14)**	**Mixed (n = 18)**	**Ametropia (n = 22)**	**Deprivation (n = 27)**
Age (y)	29.1 ± 12.8	29.7 ± 12.5	31.1 ± 13.3	24.0 ± 13.1	25.1 ± 12.6	25.1 ± 12.7
Spherical equivalent	-0.91 ± 7.48	0.91 ± 6.06	0.72 ± 2.22	-1.13 ± 6.71	-8.31 ± 12.57	-1.40 ± 4.33
Distance VA (log MAR)	0.39 ± 0.30	0.30 ± 0.22	0.47 ± 0.34	0.31 ± 0.25	0.51 ± 0.37	0.58 ± 0.32
Near VA (log MAR)	0.30 ± 0.32	0.22 ± 0.25	0.36 ± 0.38	0.23 ± 0.25	0.39 ± 0.39	0.51 ± 0.37
DVA –NVA	0.12 ± 0.12	0.12.±0.11	0.13 ± 0.14	0.13 ± 0.10	0.13 ± 0.13	0.09 ± 0.14
P	< 0.001	< 0.001	< 0.001	0.001	0.001	< 0.017

From total patients, 97 subjects had a previous history of amblyopia therapy and 70 of them received no treatment or did not therapy correctly. The difference between DVA and NVA was 0.16 ± 0.11 log MAR in treated group and 0.07.± 0.11 log MAR in non-treated group. This difference was statistically significant (P < 0.001). (Table 2)

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

Amblyopia		
	Treated (n = 97)	**Non-treated (n = 70)**
Age (Y)	27.0 ± 13.7	32.3 ± 11.0
Spherical equivalent(D)	-0.65 ± 7.50	-1.15 ± 7.50
Strabismus(PD)	5.2 ± 11.9	8.6 ± 17.3
Distance VA(log MAR)	0.30 ± 0.22	0.51 ± 0.34
Near VA (log MAR)	0.19 ± 0.22	0.45 ± 0.37
Distance VA – Near VA	0.16 ± 0.11	0.07.± 0.11
P	< 0.001	

According to severity of amblyopia, patients were divided into 3 groups: 78 mild amblyopic subjects, 55 moderate amblyopic subjects, 34 severe amblyopic subjects. In mild and moderate amblyopic groups, difference between DVA and NVA was 0.14 ± 0.10 log MAR and 0.15 ± 0.14 log MAR respectively, but in severe amblyopic group it was 0.03 ± 0.08 log MAR. 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 124 patients (74%) were subnormal NVA and 43 subjects (26%) had normal NVA. From this 43 patients, 42 subjects had mild amblyopia and only one of them had moderate amblyopia.

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

Severity of amblyopia			
	mild (n = 78)	**moderate (n = 55)**	**Severe (n = 34)**
Age (y)	28.5 ± 12.3	30.0 ± 14.4	28.9 ± 11.1
Spherical equivalent(D)	0.48 ± 5.35	-1.00 ± 7.63	-3.96 ± 10.2
Strabismus(PD)	5.7 ± 13.0	3.8 ± 8.23	13.4 ± 22.0
Distance VA(log MAR)	0.15 ± 0.52	0.42 ± 0.90	0.88 ± 0.17
Near VA (log MAR)	0.07 ± 0.07	0.29 ± 1.36	0.84 ± 0.23
Distance VA – Near VA	0.14 ± 0.10	0.15 ± 0.14	0.03 ± 0.08
P	< 0.001		

Discussion

This study showed that near visual acuity was better than distance visual acuity in amblyopic patients. In our findings, near visual acuity was 0.1 or more log MAR than distance visual acuity in 60% of patients. In mild to moderate amblyopia, distance visual acuity was 0.15 log MAR better than near 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. 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. In our study, from all of patients that were amblyopic and had subnormal distance visual acuity, only 74% of them had subnormal near visual acuity. All of these (26% of patients) 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. 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.

The limitation of this 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.

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.

Declarations

Conflicts of interest: None

Funding: Student Research Committee, Shahid Beheshti University of Medical Sciences.

Acknowledgment

This study is related to the project with number IR. SBMU. RETECH. REC. 1399.1280 from Student Research Committee, Shahid Beheshti University of Medical Sciences, Tehran, Iran. We also appreciate the “Student Research Committee” and “Research & Technology Chancellor” in Shahid Beheshti University of Medical Sciences for their financial support of this study.

Availability of data and material: there are all of data and statistical analysis and Will be sent if needed

Authors' contributions: Clinical examination**:** Masoumeh Ahadi, Afsaneh Ebrahimi.

Writing – review & editing: Masoumeh Ahadi, Afsaneh Ebrahimi, Shahrokh Ramin.

Ethics approval: 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).

Consent to participate: Informed consent for research has received from all subjects.

Consent for publication: all authors of this article are informed about the article and We are satisfied with its publication.

References

1. -Hashemi H, Pakzad R, Yekta A, Bostamzad P, Aghamirsalim M, Sardari S, Valadkhan M, Pakbin M, Heydarian S, Khabazkhoob M (2018 Dec) Global and regional estimates of prevalence of amblyopia: A systematic review and meta-analysis. Strabismus 26(4):168–183
2. -Webber AL, Wood JM, Gole GA, Brown B. The Effect of Amblyopia on Fine Motor Skills in Children. Investigative Ophthalmology & Visual Science February 2008, Vol.49, 594–603
3. -Webber AL (2018) The functional impact of amblyopia. lin Exp Optom 101:443–450
4. -Levi DM (2013 Nov) Linking assumptions in amblyopia. Vis Neurosci 30(5–6):277–287

5. -Ciner EB, Dobson V, Schmidt PP, Allen D, Cyert L, Maguire M, Moore B, Orel-Bixler D, Schultz J (1999) A survey of vision screening policy of preschool children in the United States. Survey of ophthalmology 43(5):445–457
6. -Huang YQ, Huang H, Huang RZ (2014) A near-vision chart for children aged 3–5 years old: new designs and clinical applications. Int J Ophthalmol 7:457–462
7. -Busic M, Bjelos M, Petrovecki M et al (2016) Zagreb amblyopia preschool screening study: near and distance visual acuity testing increase the diagnostic accuracy of screening for amblyopia. Croat Med J 57:29–41
8. -Catford GV (1956) Amblyopia: a comparison between distance and near vision. Br J Ophthalmol 40:633–635
9. -Lennarson L, France T, Portnoy J. Ravault AP, Lent M et al. A comparison of distance and near vision in amblyopia. Transactions of the Fifth International Orthoptic Congress Lyon, France: LIPS; 1984; 329–36
10. -Christoff A, Repka MX, Kaminski BM et al (2011) Distance versus near visual acuity in amblyopia. J AAPOS 15:342–344
11. -Wang L, Lu W, Fu T et al (2013) Clinical observation of near visual acuity and distance visual acuity in amblyopia children. Ophthalmol China 22:266–268
12. -Chun H, Lee YC (2020) Comparison between distance and near visual acuity in amblyopes. Medicine 99:46
13. -Benetti Zagui RMJUN 25, 2019. Amblyopia: Types, Diagnosis, Treatment, and New Perspectives. From https://www.aao.org
14. -Jin P, Zhu J, Zou H et al (2015) Screening for significant refractive error using a combination of distance visual acuity and near visual acuity. PloS One 10:e0117399
15. -Jin H, Chung SA (2015) Comparison of improvement rates between distance and near visual acuity in children with unilateral amblyopia. J Korean Ophthalmol Soc 56:1432–1438
16. -Pediatric Eye Disease Investigator Group (2008) A randomized trial of near versus distance activities while patching for amblyopia in children aged 3 to less than 7 years. Ophthalmology 115:2071–2078