Original Article

The Effect of Refractive Error Correction on Stereopsis

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Abstract

Purpose: The present study aimed to assess the effect of refractive error (RE) correction on stereopsis.
Patients and Methods: A total of 62 participants underwent comprehensive ophthalmic examinations, which included measurements of visual acuity, RE, stereopsis, ocular alignment, as well as examinations of the anterior and posterior ocular segments. Stereopsis was evaluated using the TNO random dot stereogram booklet at a distance of 33 cm, both with and without RE correction. The results were then compared to evaluate the impact of RE correction on stereopsis.
Results: Our findings revealed that correcting one diopter of the spherical and spherical equivalent components of RE led to a significant improvement in stereopsis, with improvements of 30.884 and 30.373 seconds of arc, respectively (P = 0.001). However, the correction of other components of RE did not demonstrate a statistically significant effect on improving stereopsis. Additionally, we found no significant correlation between different types and severities of refractive errors and stereopsis.
Conclusion: Correcting the spherical and spherical equivalent components of refractive error may enhance stereopsis across various types of refractive errors.

Keywords: Refractive Errors; Myopia; Stereopsis.

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Introduction

According to epidemiological studies conducted worldwide between 1990 and 2016, the global prevalence of myopia, hyperopia, and astigmatism in adults has been reported as 26.5 % (95 % CI: 23.4 to 29.6 %), 30.9 % (95 % CI: 26.2 to 35.6 %), and 40.4 % (95 % CI: 34.3 to 46.6 %), respectively [1]. Uncorrected refractive errors (UREs) have been identified as the leading cause of visual impairment between 2001 and 2008 [2]. Stereopsis, which serves as an indicator of binocular vision and relies on good monocular vision in both eyes, can deteriorate in cases of UREs. It has been suggested that refractive errors diminish binocular function by causing visual blur and impairing sensory fusion, resulting in poor stereopsis [3-5]. The objective of this study was to investigate the effect of refractive error correction on stereopsis in patients with otherwise healthy eyes.

Materials and Methods

The study procedures adhered to the principles of the Helsinki Declaration and were approved by the Ethics Committee of Shahid Beheshti University of Medical Sciences, Tehran, Iran, with approval number IR.SBMU.RETECH.REC.1400.604. Informed written consent was obtained from all participants.

A total of 62 healthy individuals with a best-corrected visual acuity (BCVA) of 0.0 LogMAR or better, who were referred to our optometry clinic, were included in the present study. Participants with RE greater than ± 4.00 D, strabismus, amblyopia, ocular pathology, or a history of ocular surgeries were excluded. The measurement of RE was performed with and without cycloplegia using an autorefractometer (TOPCON 8900 autorefractometer, Topcon Corporation, Tokyo, Japan). Initially, dry refraction measurements were taken. Subsequently, BCVA assessment was conducted at a distance of 6 m using the Snellen E-chart under daylight conditions. Ocular alignment was measured at both far (6 m) and near (33 cm) distances using the alternative prism cover test. Stereopsis was evaluated using the TNO random dot stereogram booklet at a distance of 33 cm, with and without refractive error correction. Examination of the anterior and posterior ocular segments was performed after pupil dilation. Finally, cycloplegic refraction was conducted 30 to 45 minutes after instillation of one drop each of cyclopentolate 1 % and tropicamide 1 %. In anisometropic individuals, the eye with the higher refractive error was selected to analyze the effect of refractive error correction on stereopsis.

All refractive error criteria were considered under cycloplegia. Myopia was defined as a spherical equivalent (SE) ≤ - 0.50 D. Hyperopia was identified in cases with SE ≥ + 0.50 D. Emmetropia was defined as SE ≤ ± 0.50D. Regarding myopia classification, low myopia was classified as - 3.00 D < SE ≤ - 0.50 D, and moderate myopia was defined as SE ≤ - 3.00 D.

Results

Table 1 presents a summary of the demographic characteristics of the participants. The mean age of the participants was 23 ± 3 years, and an equal percentage of 50 % of both genders participated in the study.

Our findings indicate that regardless of the presence or absence of anisometropia, stereopsis showed a significant improvement following the correction of refractive errors ($P < 0.001$) (Table 2).

We observed that for each diopter of spherical equivalent correction, there was a significant improvement of 30.373 sec/

Table 1: Demographic characteristics of individuals entering the study

Variable	Level	Mean ± SD
Age (years)	-	23 ± 3
BCVA (LogMAR)	-	0.00 ± 0.00
Spherical refractive error (D)	RE	- 1.09 ± 1.48
	LE	-1.01 ± 1.42
Astigmatism (D)	RE	- 0.41 ± 0.56
	LE	- 0.44 ± 0.54
SE (D)	RE	- 1.29 ± 1.53
	LE	- 1.22 ± 1.42
Anisometropia (D)	SE	0.25 ± 0.39
	Spherical	0.21 ± 0.37
	Astigmatism	0.19 ± 0.31

BCVA: best corrected visual acuity; LogMAR: logarithm of the minimum angle of resolution; RE: right eye; LE: left eye; SE: spherical equivalent; D: diopter; SD: standard deviation

arc in stereopsis ($P < 0.001$). Additionally, a significant improvement of 30.884 sec/arc was observed for each one diopter correction of spherical refractive error ($P < 0.001$). However, no significant relationship was found between the correction of cylindrical isometropic refractive errors and any types of anisometropia.

Furthermore, no statistically significant correlation was observed between different types and severities of refractive errors and stereopsis (Table 3).

Discussion

This study aimed to investigate the extent to which stereopsis can be improved through refractive error correction and to compare this effect among different refractive error groups with varying severities.

Our findings revealed that the correction of the

Table 2: Comparison of stereopsis with and without refractive error corrections among participants in the present study

Variable	Before RE correction	After RE correction	Change	P value *
Stereopsis (sec/arc)	78.39 ± 72.13	133.06 ± 134.9	54.68 ± 112.18	< 0.001

RE: Refractive Error
* Based on paired t-test

Table 3: Comparison of stereopsis improvement in different groups and severities of refractive errors

Variable	Level	Stereopsis (sec/arc) Mean ± SD	P value *
Types of REs	Myopia	78 ± 76	0.280
	Emmetropia	30 ± 0	
	Hyperopia	85 ± 58	
Severity of REs	Moderate myopia	125 ± 133	0.135
	Low myopia	64 ± 36	
	Emmetropia	42 ± 16	
	Hyperopia	87 ± 61	

RE: refractive errors; SD: standard deviation; sec/arc: seconds per arc
* Based on Kruskal-Wallis test

spherical and spherical equivalent components of refractive errors had the most significant impact on improving stereopsis. This result is consistent with a study by Elamurugan et al. [6], which reported that anisometropia and astigmatism were the most influential factors determining the level of stereopsis in relation to refractive errors among their patients. Similarly, Yang et al., [7,8] found a significant correlation between astigmatism and stereopsis performance in school-aged children.

We did not observe a statistically significant correlation between different types and severities of refractive errors and stereopsis. This finding contradicts the results reported by Ahmadi et al. [9], who found a significant difference in stereopsis associated with different types of refractive errors (myopia, ametropia, hyperopia), with myopic patients having the lowest stereopsis after optical correction (P = 0.001). The difference in findings may be attributed to the relatively small sample size in our study compared to the larger sample size of 3675 in their study.

It is important to note that our study had limitations, including its relatively small sample size.

Conclusion

Correcting the spherical and spherical equivalent components of refractive errors may improve stereopsis in individuals with various types of refractive errors.

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Footnotes and Financial Disclosures

Conflict of interest:

The authors have no conflict of interest with the subject matter of this manuscript.