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Does Axial Length Predict the Depth of Amblyopia in Anisometropic Patients?

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Authors' contributions

This work was carried out in collaboration between all authors. Authors RD and HA designed the study. Authors RD and EÇ performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors RD and HA managed the analyses of the study. Author RD managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Purpose: To compare the refractive errors, keratometric and biometric variables among the patients with anisometropic amblyopia and to evaluate the relationship between the depth of amblyopia and the degree of anisometropia and binocularity.
Study Design: A prospective cohort, clinical study.
Setting: Afyon Kocatepe University Hospital, TR.
Methods: Thirty-eight anisometropic amblyopic patients had detailed ophthalmological examinations including keratometry and axial length measurements and the results were compared.
Results: In all subjects, there is a positive correlation between axial length measurement and anisometropia was found to increase with an increase in axial length ($p = 0.000$). The depth of amblyopia was not statistically related to the anisometropic spherical value ($p = 0.09$). Nevertheless, in the anisometropic subjects with suppression, the spherical refractive error was significantly higher ($p = 0.009$). Keratometric measurements were not significantly different in amblyopic eyes in comparison to the sound eyes ($p = 0.15$).

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Conclusions: In anisometropic subjects, we found that there was a significant relationship between the suppression and the axial length. We have shown that axial length is a significant predictive value in terms of binocular vision functions.

Keywords: Anisometropic amblyopia; axial length; stereopsis; fusion.

1. INTRODUCTION

Amblyopia is defined as a unilateral or bilateral decrease in visual acuity caused by the deprivation of form vision or abnormal binocular interaction or both. Unilateral amblyopia is the most common cause (1-5%) of preventable blindness in children and young adults. [1]. Anisometropia is a frequent cause of amblyopia and binocular vision impairment, and it is defined as a difference of ≥ 1,5 D in either spherical or cylindrical refractive error between the eyes [2,3]. The mechanism of anisometropic amblyopia is not clear, but von Noorden has suggested that there may be active inhibition of the fovea to eliminate sensory interference, caused by superimposition of images in two eyes [4]. In anisometropic amblyopia, usually one eye is affected, and diagnosis and treatment are usually delayed.

It's known that ocular biometric and topographical features may have a significant impact on the visual system, and previous several studies have reported associations between refractive errors and ocular parameters such as axial length and corneal curvature [5,6].

The purpose of this prospective study was to compare the refractive errors, keratometric and biometric variables among the patients with anisometropic amblyopia and to evaluate the relationship between the depth of amblyopia, the degree of anisometropia and binocularity.

2. MATERIALS AND METHODS

Thirty-eight patients who were followed up with the diagnosis of anisometropic amblyopia at Department of Ophthalmology without any systemic disorder were enrolled in the study. Anisometropia was defined as a difference of ≥ 1,5 D in either spherical or cylindrical refractive error between the eyes. Detailed ophthalmological examinations including best corrected visual acuity, ocular alignment and motility, Worth 4 dot test and stereopsis with Titmus test were performed. Retinoscopy with cycloplegia and dilated fundus examination were done in every patient. Intraocular pressures (IOP) were measured with the Goldmann applanation tonometer (GAT; Haag-Streit AG, Koeniz, Switzerland). Best-corrected visual acuity (BCVA) was measured with the Snellen or 'E' chart and converted into the logMAR scale. Retinoscopy was performed 30 minutes after administration of 1% cyclopentolate and 0.5% tropicamide. Measurements of keratometry (Javal manual keratometry) and anterior-posterior axial lengths with a scan ultrasonography (Orbscan) were performed. We performed ultrasonography at the end of the ophthalmological examinations. Presence or absence of fusion with Worth's four- dot test was used to group the patients. The patients were divided into 2 groups as; fusion and suppression. The results of amblyopic and the sound eyes were compared.

Statistical analyses were performed using SPSS v.18.0 for Windows (SPSS Inc., Chicago, IL, USA). Continuous variables were presented as mean and median, and categorical variables as frequencies and percentages. Correlations between parameters were determined using the Spearman correlation test. Differences between patients with suppression and without suppression were evaluated using the Mann-Whitney U Test The level of statistical significance was set at $P < 0.05$.

3. RESULTS

Among the 38 patients, 25 (66%) were male and 13 (34%) were female. Mean age of the patients was 12.1 ± 5.2 years (range: 5-34). (Table 1) No patient had any limitation upon examination of eye movements. Mean visual acuity in amblyopic eyes was logMar 0.38 (0.1-1) and in the sound eye. The mean keratometry value was 43.5/45 diopter (D), and 44/46 D in sound eyes, and amblyopic eyes, respectively ($p = 0.15$). Two patients were anisomyopic, 36 patients had anisohypermetropic amblyopia, and 8 patients had astigmatic refractive error ≥ 1.5. The differences for the spherical refractive error and the cylindrical refractive error were not

statistically significant between the amblyopic and the sound eyes (p = 0.00, p = 0.12, respectively). However, the mean axial length in the sound eyes was 22.39 mm ± 1.01 versus 21.66 mm ± 1.57 in amblyopic eyes, and the difference was significant (p = 0.00). Mean visual acuity, keratometric and biometric values in two groups were summarized in Table 1.

Table 1. Demographic characteristic of patients

Gender ratio	25 (66%) male / 13 (34%) female
Mean age	12.1 ± 5.2 years (range: 5-34).

Axial length correlated positively with spherical value in both sound and amblyopic eyes (p = 0.002 Spearman's correlation coefficient: -0.496, and p = 0.000 Spearman's correlation coefficient: -0.674). Furthermore, in anisometropic patients, the difference in spherical refractive error between two eyes correlated positively with the axial length difference (p = 0.000, Spearman's correlation coefficient: 0.624). Correlations between axial length and spherical values were presented in Fig. 1. However, there was not a statistically significant correlation between depth of amblyopia (LogMar 0.45) and anisometropic spherical value (2.18 D) in all eyes (p = 0.09).

Table 2. Comparison between sound and amblyopic eyes according to mean visual acuity, keratometric and biometric values

Parameter	Sound eyes	Amblyopic eyes	p
Visual acuity, logmar (Range)	0 (0-0.1)	0.38 (0.1-1)	
Spherical value, D (Range)	1.6 (-3.5/+8.5)	3.78 (-8.5/+11.0)	< 0.001
Cylindrical value, D (Range)	0.4 (-1.5/+5)	0.48 (-2.5/+4.75)	0.12
Axial length, mm	22.39 ± 1.01	21.66 ± 1.57	< 0.001
Keratometry	43.5/45	44/46	0.15

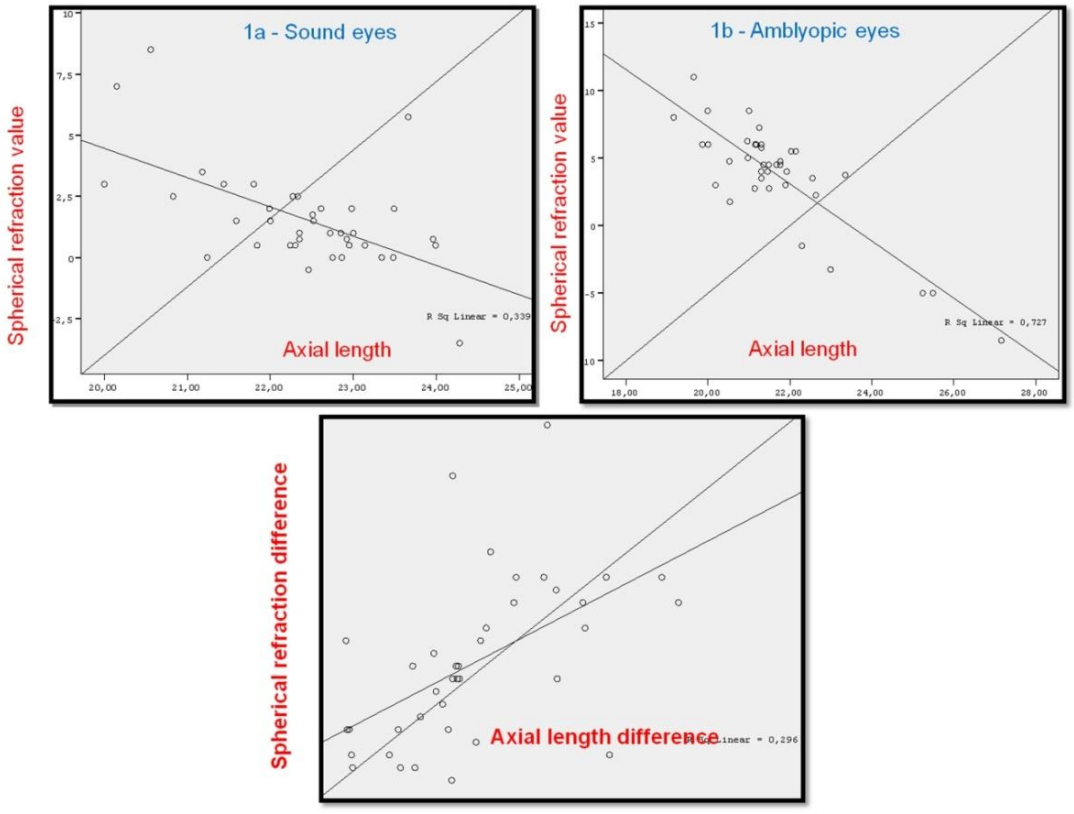

Fig. 1. Graphs showing a positive correlation between axial length and spherical refraction value in both anisometropic sound and amblyopic eyes (a, b), and positive correlation between axial length difference and spherical refraction difference in all anisometropic patients (c)

Table 3. Comparison of depth of amblyopia, anisometropic spherical value and stereopsis between patients with, or without suppression

Parameter	Fusion (n = 24)	Suppression (n = 14)	p
Mean depth of amblyopia, difference in LogMar	0.2	0.5	0.007
Mean anisometropic spherical value, (D)	2.62	4.25	0.009
Median stereopsis, sec arc (Range)	80 (40-800)	300 (80-800)	0.016

In patients with suppression, depth of amblyopia, anisometropic spherical value, and stereoacuity were significantly higher than those of patients with fusion responses (p = 0.007, 0.009, 0.016, respectively). These results were summarized in Table 3.

4. DISCUSSION

Ocular biometric and topographic characteristics play important role in the diagnosis and treatment of various ocular diseases -Axial length is one of these parameters and widely used in cataract surgery in determining the power of intraocular lenses, and also in the recognition of certain eye diseases at risk of retinal detachment [7,8]. In addition, axial length is one of the most important biometric components contributing to refractive errors.

Previously several studies have found a relationship between refractive errors and ocular parameters such as axial length and/or corneal curvature of the eyes [9,10]. Some authors have suggested that there is a significant correlation between anisometropia and axial length asymmetry [11-14]. Similarly, in the present study, we showed that anisometropia degree correlated positively with axial length difference.

In previous studies, it has been reported that axial length is the most important biometric parameter in the etiopathogenesis of anisometropia compared with other ocular parameters such as corneal power, anterior chamber depth, vitreous chamber depth and lens thickness [12,13,15-18]. Similarly, Patel VS et al. reported that in children with anisometropic amblyopia, interocular differences in spherical refractive error was attributed to axial length [14]. In the present study, we have found that axial length has the highest correlation with spherical value supporting previous study results [12,13,17-21].

The literature data on corneal parameter changes in amblyopic eyes are limited. Previously, Aygıt et al. reported that central corneal thickness, anterior chamber depth, horizontal corneal diameter and corneal biomechanical properties did not differ significantly between the sound eye and hyperopic anisometropic eyes [10].

Anisometropia is an important etiological risk factor for amblyopia and binocular vision impairment. Some authors found no relationship between the degree of anisometropia and the depth of amblyopia [22-24] whereas others have found a relationship between [20,24]. Zaka-ur-Rab reported that the depth of amblyopia correlated with the degree of anisometropia in both myopic and hyperopic amblyopic patients [25]. Similarly, Rutstein RP et al. reported that as the degree of anisometropia increases, the depth of amblyopia becomes greater [26]. In the present study, there was no significant relationship between the degree of anisometropia and the depth of amblyopia. However, fusion and better stereopsis values are found to be associated with lower degrees of anisometropia and lower depth of amblyopia.

As a limiting factor, we did not have a control group and instead of this, we compared the two eyes of the same subject on purpose as we would like to consider similar physical characteristics such as age, growth pattern and genetic factors. In future studies, we plan to study the refractive characteristics of cornea and lens as well as anterior chamber depth in anisometropic subjects. The other limitation is; we did not have a comparison in terms of age in our study. No detailed analysis was done between adult and pediatric patients.

5. CONCLUSION

In conclusion, in the present study, we found that there was a significant relationship between the suppression and the axial length in anisometropic subjects. In addition, We have shown that axial length is a significant predictive value in terms of binocular vision functions.

CONSENT

As per international standard or university standard written patient consent has been collected and preserved by the authors.

ETHICAL APPROVAL

As per international standard or university standard written ethical permission has been collected and preserved by the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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