Article • Correlation of Anisometropia with Axial Length and Corneal Curvature: An Institution-Based Cross-Sectional Study

Pritam Dutta, M.Optom • Sri Sankaradeva Nethralaya, Guwahati, Assam
Damaris Magdalene, DO • Sri Sankaradeva Nethralaya, Guwahati, Assam
Henal Javeri, DNB Ophthalmology • Sri Sankaradeva Nethralaya, Guwahati, Assam
Sheesham Singh, DNB Ophthalmology • Sri Sankaradeva Nethralaya, Guwahati, Assam

Damaris Magdalene, DO
Sri Sankaradeva Nethralaya, Guwahati, Assam

Senior Consultant and HOD of Pediatric Ophthalmology Department of Sri Sankaradeva Nethralaya Guwahati, India Assam

Trained in strabismus, low vision, and contact lens

Research on stem cells and extraocular muscles and also one on amblyopia in collaboration with ICMR

ABSTRACT

Background: A difference of >1.00 dioptre (D) is the widely accepted criteria for anisometropia. An analysis of binocular characteristics in the anisometropic eye revealed that the most critical component was axial length (AL). The purpose of this study was to determine the correlation between AL and corneal curvature in anisometropes.

Methods: This was a prospective institution-based observational study. One hundred subjects with >1 dioptre anisometropia were included. All of the subjects underwent a comprehensive eye examination followed by corneal curvature (CR) measurement with a manual keratometer and axial length measurement using the Carl Zeiss IOL Master 500.

Results: The mean ± SD of spherical equivalent refraction (SER) was 3.52±2.08 D. A positive correlation was found between SER and AL difference between both eyes (r=0.61; p=<0.001) and between SER and AL/CR ratio between both eyes (r=0.57; p=<0.001).

Conclusions: AL is a relevant factor in anisometropic eye dioptric power disparities, with no significant relationship between CR and dioptric power.

Keywords: Anisometropia, corneal curvature, axial length

Introduction

Anisometropia is generally defined as a difference of one dioptre or more in the spherical equivalent refraction.[1] It is relatively common, with an incidence of 4-35 %.[2] The incidence is higher in adult populations over 40 years of age (>18%), as age-related conditions such as cataracts frequently cause anisometropia.[1] In children, the imbalance between the various refractory components (i.e., corneal curvature, anterior chamber depth, lens status, vitreous cavity length, and axial length [AL]) has been implicated as a cause and explored. Anisometropia in children has substantial implications on vision, resulting in decreased stereopsis and amblyopia.[2] While the cornea mediates 2/3 of the refractive power of the eye, the interocular difference in AL has been suggested as a major factor in literature.[3] Other population-based studies highlighted an interplay between the corneal curvature and AL measurements as the major factor and that the corneal curvature by AL ratio has a better correlation with the refractive status.[4,5] When considering the cause of refractive errors, it is crucial to remember that emmetropization is just one of many homeostatic or disruptive processes that affect eye development from conception to adulthood.[6] The refractive correction at birth and the degree of emmetropization that happens in the years that follow are the two main refractive factors by the age of six. At the age of six, the presence of a considerable refractive correction necessitates one of the following scenarios: an initial refractive error too large to be rectified by emmetropization, an initial refraction within the normal range but insufficient emmetropization, or a combination of both.[7] Until the age of 12–15, the level of anisometropia increases in lockstep with the difference in refraction.[7] Anisometropia is also linked to the magnitude of refractive correction, with the occurrence of anisometropia increasing as myopia, hyperopia, and astigmatism increase.[1] During the process of emmetropization, anisometropia tends to decrease in early childhood.[8,9] It was discovered that anisometropia appears and disappears during the emmetropization process, with a low risk of

Table 1. Mean ± SD of All Variables

	Mean ± SD [Range]
Spherical equivalent difference	3.52 ± 2.08 [1.00-8.88]
Axial length difference	1.59 ± 1.38 [0.05-6.29]
Mean k difference	0.15 ± 0.42 [0-2.93]
AL/CR difference	0.25 ± 0.27 [0.01-1.97]

amblyopia.[10] The process of emmetropization is generally completed during this age of early life. The development of myopia in older children is linked to the later development of increasing anisometropia.[1,11] This shows that the majority of persistent hyperopia is caused by an initial failure of emmetropisation, while myopia is caused by a failure to sustain emmetropia.[6] Therefore, the aim of this study was to determine relationship of AL and corneal curvature in anisometropes, ages 6-16, attending the paediatric outpatient department of a tertiary eye care hospital.

Methods

This was a prospective, hospital-based observational study. The study was approved by the Institutional Review Board and adhered to the tenets of the Declaration of Helsinki. Informed consent from the parents of all of the participants was taken as per Indian Council of Medical Research (ICMR) ethical guidelines for biomedical research on human subjects. One hundred subjects, age 6-16 and diagnosed with >1 dioptre of anisometropia, were included. Subjects with any other ocular pathology, a history of ocular surgery or trauma, or manifest squint were excluded from the study.

Every subject underwent a comprehensive ophthalmic evaluation, which consisted of:

- Documentation of best-corrected visual acuity (BCVA) for distance and near
- Measurement of ocular motility
- Measurement of refractive correction using retinoscopy, both before dilation (dry refraction) and after dilation (cycloplegic refraction) using cyclopentolate hydrochloride 1%
- Measurement of intraocular pressure (IOP) using non-contact tonometry
- Dilated fundus examination using indirect ophthalmoscopy
- Measurement of AL using optical biometry technique based on the dual laser beam partial coherence interferometry principle (Carl Zeiss IOL Master 500). The subject was asked to fixate at the inner fixation target of the instrument, readings were noted three times, and their mean values were calculated.
- Measurement of corneal curvature (CR) using manual keratometer

Results

Among the 100 subjects in the study, 61 were males. The mean age was 11±3 years [range: 6-16]. The mean ± SD of the SER was 3.52±2.08 D (Table 1), with all of the subjects being myopic anisometropic in nature. A positive correlation was found between SER and AL difference between both eyes (Figure 1: $r=0.61$; $p<0.001$) and between SER and AL/CR ratio between both eyes (Figure 3, $r=0.57$; $p<0.001$).

Discussion

Anisometropia is a condition in which there is a significant discrepancy in the refractive status between the two eyes.[12,14] A previously conducted study indicated that the AL was a substantial factor in anisometropia, as well as parameters such as CR, anterior chamber depth, corneal power, and lens power.[12] The current study indicates a moderate positive correlation between anisometropia and AL. A positive correlation is further shown between anisometropia and AL/CR ratio. However, the findings showed no correlation between anisometropia and corneal power.

In accordance with the current study, previous studies have also shown a positive correlation between the difference in the spherical equivalent and AL. Anisometropic myopia occurs as a result of faster myopic progression of one eye compared to the fellow eye (i.e., longer AL in the more myopic eye).[13] A significant difference in AL between eyes of the same subject implies axial elongation as a vital factor in the development of myopic anisometropia; breaking down the association of CR changes and crystalline lens thickness in anisometropic development as insignificant.[14] Moreover, Khanal and Kandel assessed ocular parameters in anisometropic amblyopes and found that anisomyopic amblyopic eyes had longer ALs than fellow eyes, whereas anisohyperopic amblyopes had shorter ALs; thus, AL was the major factor influencing the spherical refractive errors.[15] These reports correlate with the findings of the current study. We established a moderate correlation with changes between-eye difference in AL and changes between-eye difference in SER, similar to the study by Tong et al.[16] This confirms the axial nature

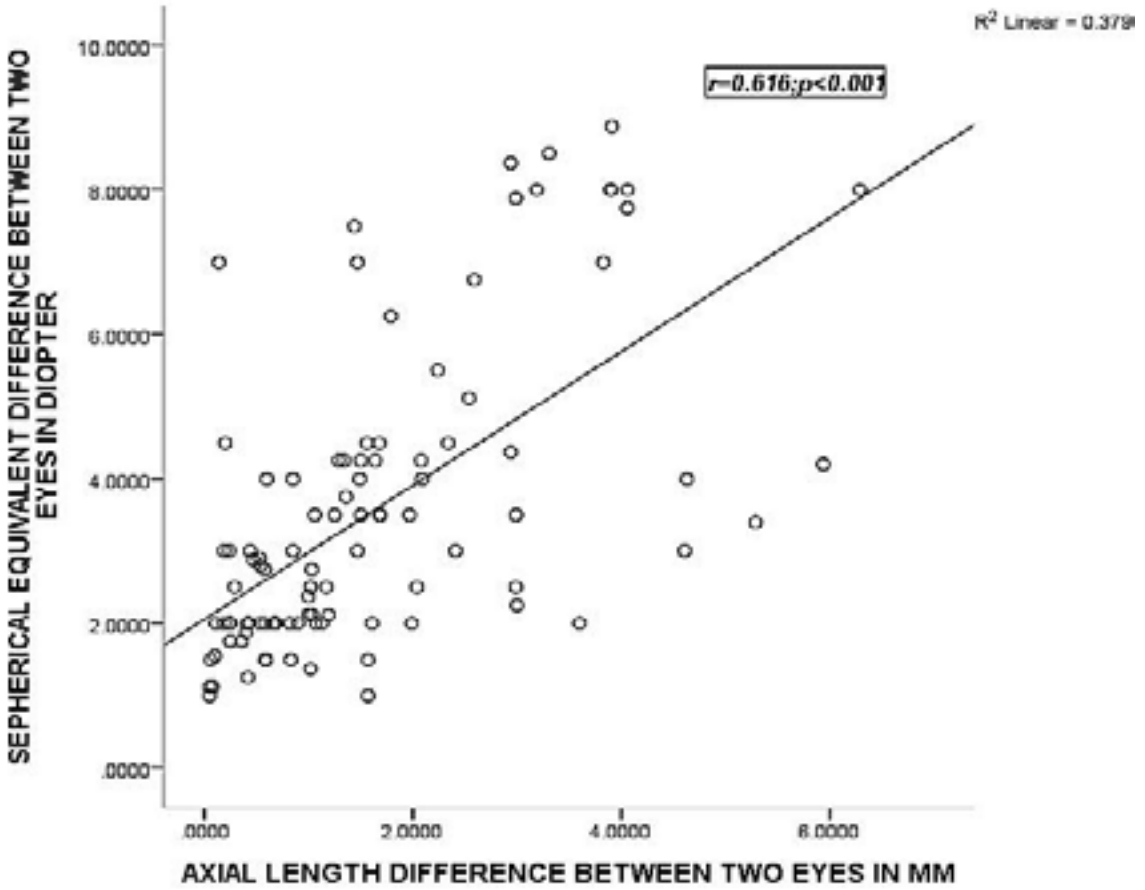

Figure 1. *Correlation between SER and difference in axial length between the two eyes*

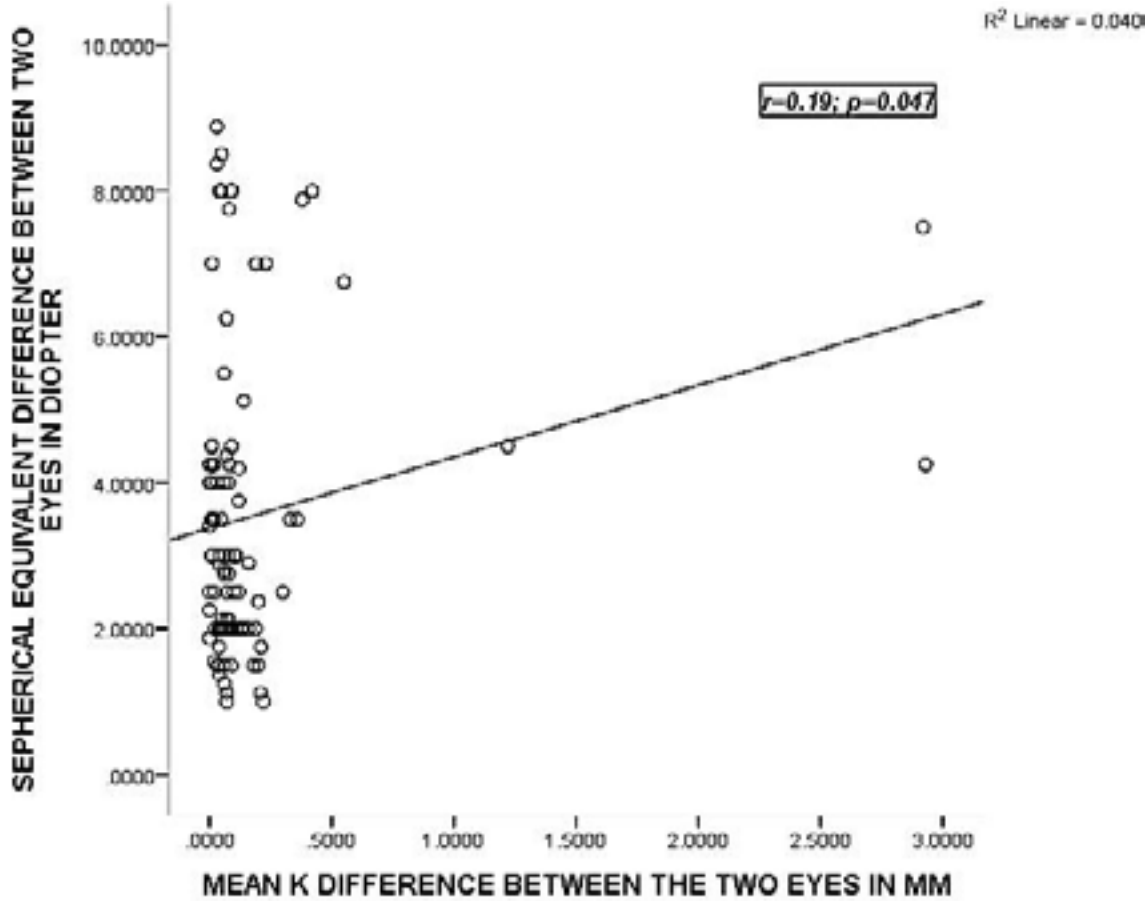

Figure 2. *Correlation between SER and difference in mean K between the two eyes*

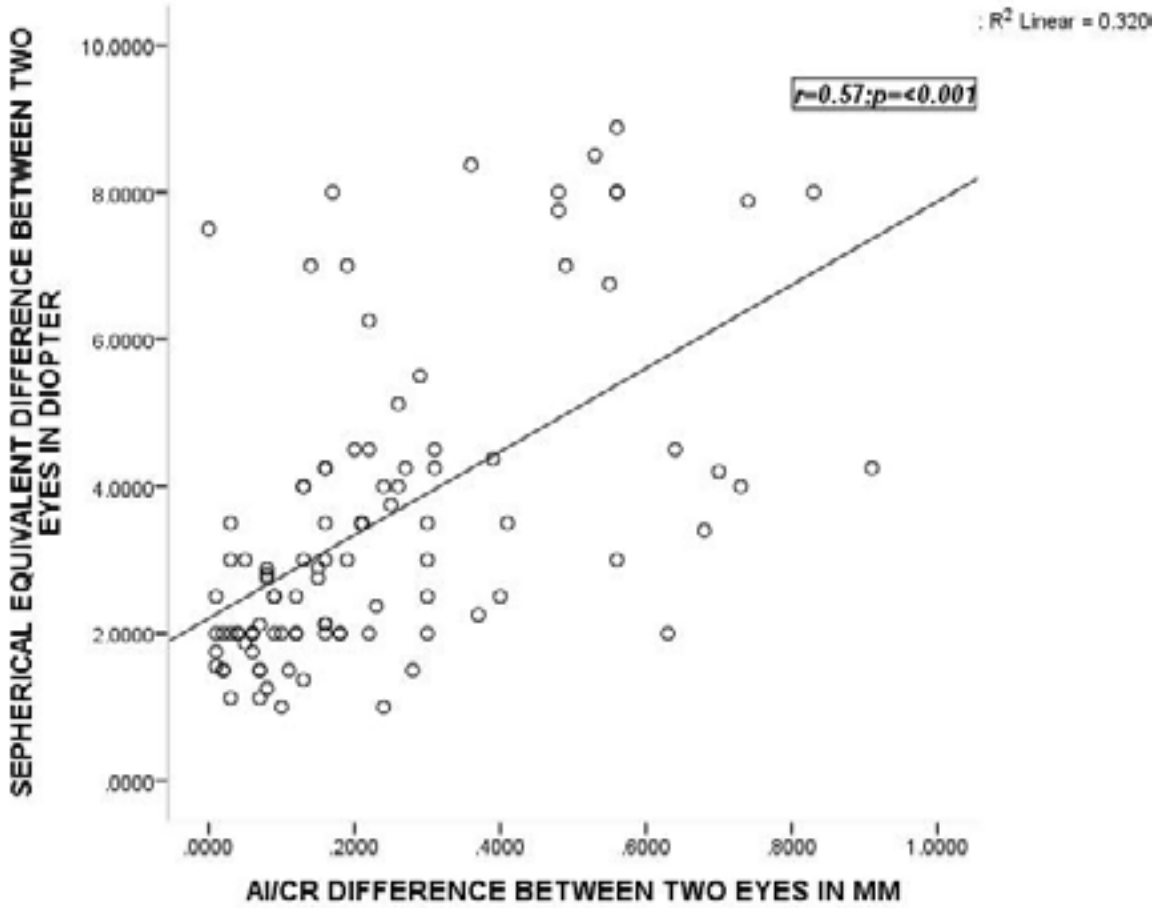

Figure 3. *Correlation between SER and difference in AL/CR between the two eyes*

of anisometropia in a younger group yet again. Interocular changes in ocular components other than AL, such as CR, lens, or anterior chamber depth, may also contribute to anisometropia, although this correlation is not substantial.

The results by Zeng et al. are in line with the current results, suggesting a positive correlation between anisometropia and AL/CR ratio.[2] They suggested that with axial growth, there is a degree of corneal compensating effect (increased radius of curvature resulting in flattened cornea) in order to establish binocular equilibrium.[2] Anisometropia may result due to corneal changes and unbalanced axis (irregular astigmatism) in the event of corneal compensation outside of normal emmetropization ranges. These results are on par with previous studies that suggest that the AL/CR ratio is the best indicator of emmetropization. The AL/CR ratio could be used as an observational indicator to monitor anisometropia and its progression due to the effect it has on refractive errors. Similar to the current study, Zeng et al. found minimal impact of corneal refractive power on the degree of anisometropia.[2] However, Khandal and Kandel found the corneal curvature to be a significant factor responsible for aniso-astigmatic amblyopia.[15]

Although various research studies have been undertaken to investigate the association between myopia and CR, there have been few that have focused on cases of anisometropia.[17,18] Chang et al. observed that as the eyeball elongates in myopia progression, the CR becomes flatter, but the spherical equivalent does not correlate with CR.[17] In high anisometropic patients, we obtained similar results: the anterior corneal surface was flatter in eyes with longer AL, but there was no difference in CR between the two eyes.

Conclusion

Axial length an important component in dioptric power differences in anisometropic eyes, with no significant correlation between CR and dioptric power.

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Correspondence regarding this article should be emailed to Damaris Magdalene, DO at ldrmaggie01@gmail.com.

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