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RESEARCH ARTICLE

Are the biometric parameters predictors of refractive and accommodative status of the eye?

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ABSTRACT

Background: Refractive error is a complex interaction of the biometric parameters depending on both genetic and environmental factors. The amplitude of accommodation (AA) varies with refractive error, and hence, changes in biometric parameters on accommodation also vary with refractive status. **Aims and Objectives:** The objective of our study was to find out the relationship between various refractive errors and biometric parameters. We also compared the changes in the biometric parameters during accommodation in different refractive states. **Materials and Methods:** Our study included 126 subjects of both the sexes. The patients included were between 12 and 35 years of age. The patients were categorized into three groups based on spherical equivalent refraction (SER). SER was calculated by adding spherical refraction and half of cylindrical refraction. Patients with SER ≤±0.5 D were categorized as emmetropia, with SER ≥+0.5 D were categorized as hypermetropia, and patients with SER ≥−0.5 D were categorized as myopia. Various biometric parameters were measured by Nidek echo scan US 800 A - scan biometer for both distant and near focus. **Results:** There were 51 myopic subjects: 37 emmetropes and 38 hypermetropes. The axial length and anterior chamber depth were found to be highest in myopes followed by emmetropes and lowest in hypermetropes. On accommodation, the changes in biometric parameters occurred maximally in myopes ($P < 0.005$), and minimal changes were documented in hypermetropes. **Conclusion:** We concluded that there exists a strong association between the status of refraction and biometric parameters. There also exists a positive correlation between AA and changes in biometric parameters. The axial elongation in myopes during near work suggests a possibility that near work can lead to development and progression of myopia.

KEY WORDS: Refraction and Amplitude of Accommodation; Refractive Errors and Biometric Parameters; Myopia and Near Work

INTRODUCTION

The ocular biometric parameters are chief determinants of refractive status. The anterior-posterior axial length, radius of curvature of cornea, thickness and curvature of lens, and depth of anterior chamber are a few biometric parameters, which determine the refraction.[1] The biometric parameters are dynamic and keep changing in growing age. The final refractive state is determined by the net balance of these changes.[2] The complex interaction of the anatomical factors depends on both genetic and environmental factors.[3] In myopia, with accommodation at rest parallel rays coming from infinity are focused in front of retina while in hypermetropia, the rays are focused behind the retina.[3] Emmetropia or normal refractive status is achieved when light rays are focused on the retina directly.[4]

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Accommodation can be defined as the inherent property of the eyes to change the power of the crystalline lens to focus near objects clearly on the retina. It is a biophysical phenomenon having neural, motor, and sensory components. The complex interaction brings out change in lens power and objects at various viewing distances are focused accurately on retina.[5] The AA varies with refractive error, and hence, changes in biometric parameters on accommodation also vary with refractive status. It has been reported that myopes have higher amplitude of accommodation (AA) as compared to emmetropes.[6] The magnitude of accommodation exerted to change the focus from near viewing point to distant point is known as the amplitude of accommodation (AA the value of AA regresses with increasing age.[7]

Multiple studies in the literature correlate etiopathogenesis of myopia and accommodation. The increase in axial length beyond the normal limit is the prime etiology of myopia and important determinant of its progression.[8] The etiopathogenesis of myopia is not clear and a major issue of debate in the field of optometry. Myopia is mostly diagnosed and progresses during the school going age. Hence, it has been suspected that there exists a correlation between myopia and reading.[9,10] One possible mechanism of eye elongation during accommodation can be attributed to ciliary muscle contraction leading to forward traction on choroid.[11,12] Although the exact mechanisms involved in the development of increased axial length are still unknown, there exists a significant correlation between refraction and amount of near work.[3] Whether near work and accommodation are responsible for development and progression of myopia is still a question of debate.

Through this study, we have made an attempt to understand the relationship between biometric parameters and changes in them during accommodation in various refractive errors.

Aim and Objectives

1. The aim of our study was to observe whether there exists any relationship between various biometric parameters and refractive status of the eye.
2. We compared the changes in various biometric parameters in different refractive errors during accommodation.

The objective of the study is to find out whether ocular biometric parameters are predictors of refractive status and is there any relationship between progressions of refractive errors, especially myopia with prolonged near work.

MATERIALS AND METHODS

This was observational, prospective and cross-sectional study conducted in the Department of Physiology in collaboration with the Department of Ophthalmology between October 2015 and February 2016. The study was duly approved by the Institutional Ethics Committee and Departmental Research Committee. Our study included 126 subjects of both the sexes. The patients included were between 12 and 35 years of age. The patients with any ocular anomaly, infection, or medication were not included in the study. The patients were categorized into three groups based on spherical equivalent refraction (SER). SER was calculated by adding spherical refraction and half of cylindrical refraction.[12] Patients with SER $\leq \pm 0.5$ D were categorized as emmetropia, with SER $\geq +0.5$ D were categorized as hypermetropia, and patients with SER ≥ -0.5 D were categorized as myopia. The patients underwent routine ocular examination including anterior segment examination under slit lamp, and posterior segment examination with indirect ophthalmoscope. Various biometric parameters such as axial length, anterior chamber depth (ACD), and lens thickness were measured by Nidek echo scan US 800 A - scan biometer for both distant and near focus. The recordings were first obtained for distance, and then, accommodation was stimulated by asking the patients to read 12 point font size at 25 cm distance for 30 min. The royal air force rule was used to measure AA.[14,15] Statistical analysis was done using SPSS version 18.5 using one-way ANOVA.

RESULTS

The study included total 126 subjects of both the sexes. The patients included were between 12 and 35 years of age. Out of the total 126 subjects, there were 51 myopic patients 37 emmetropes, and 38 hypermetropes. The mean AA of the three groups has been described in Table 1. The mean axial length of emmetropes myopes and hypermetropes on distant (D) and near focus (N) has been described in Table 2. The mean lens thickness of the three groups on diatant (D) and near (N) focus is described in Table 3. The mean ACD of emmetropes, myopes, and hypermetropes on distant (D) and near (N) focus has been described in Table 4.

DISCUSSION

The results of our study showed that refractive error and biometric parameters are significantly correlated with each other. The mean axial length of myopes was significantly higher than emmetropes and hypermetropes ($P < 0.001$). The mean ACD of mypoes was also higher than that of hypermetropes and emmetropes. Chromosomes carrying genes of high axial length and myopia have been identified in various genetic studies.[2] Out of all the biometric parameters, axial length remains the most significant parameter identified by researchers as being associated with refractive errors. In the study done by Warrier et al., high axial length and lens thickness were correlated with myopic refractive error.[11] Shufelt et al. in their study also found axial length as a most significant predictor of refractive error. Myopic

Table 1: Mean AA in three groups

Refractive status	Number of patients	Mean AA
Emmetropia	37	10.56±1.45
Myopia	51	13.11±0.44
Hypermetropia	38	8.98±1.86

AA: Amplitude of accommodation

Table 2: Comparison of mean AL in three groups

Refractive status	AL (D)	AL (N)	*P* value
Emmetropia	22.67±1.24	22.70±1.56	>0.005
Myopia	24.89±0.40	25.01±0.82	<0.005
Hypermetropia	21.77±0.8	21.78±0.82	>0.005

AL: Axial length, N: Near, D: Distance

Table 3: Comparison of mean LT of three groups

Refractive error	LT (D)	LT (N)	*P* value
Emmetropia	3.68±0.33	3.72±0.37	>0.005
Myopia	3.90±0.46	4.10±0.23	<0.005
Hypermetropia	4.2±0.29	4.22±0.15	>0.005

LT: Lens thickness, N: Near, D: Distance

Table 4: Comparison of mean ACD of three groups

Refractive error	ACD (D)	ACD (N)	*P* value
Emmetropia	3.56±0.37	3.60±0.16	>0.005
Myopia	3.86±0.44	3.99±0.51	<0.005
Hypermetropia	3.22±0.62	3.20±0.57	>0.005

ACD: Anterior chamber depth, N: Near, D: Distance

shift of refraction with aging is also correlated with nuclear opalescence and increased lens thickness.[12] Iyamu et al. in their study on Nigerian population associated high axial length, corneal radius of curvature, and the ratio of axial length and corneal radius of curvature with myopia.[16]

In our study, in response to accommodation axial elongation was maximum in myopes, i.e., +0.12 mm as compared to 0.04 mm in emmetropes and +0.01 mm in hypermetropes. The mean increase in lens thickness and decrease in ACD during accommodation were also found to be maximum in myopic patients and minimum in hypermetropic patients, which were also linearly correlated with the AA. The highest AA was observed in patients with myopia. The hypermetropes had least AA. Emmetropes had higher AA as compared to hypermetropes but lesser than myopes, the findings of previous investigators suggest that AA is higher in myopes and also demonstrated a decrease in ACD and increase in lens thickness during accommodation.[14] It has been hypothesized that increase in axial length in myopia during accommodation could be a contributory factor in etiopathogenesis of myopia in susceptible patients.[17] Drexler et al. and Mallen et al. in their study hypothesized that increase in axial length during accommodation is due to the ciliary muscle contraction. Myopic patients having decreased ocular rigidity transmits greater force of contraction of ciliary muscles to the choroid and sclera.[8,9] Mallen et al. in their observed a 0.037 mm increase in axial length in emmetropia and 0.058 mm increase in myopia during accommodation. The researchers also observed that during a short period of accommodation axial elongation was seen in both myopic and emmetropic patients. While greater increase in axial length was observed in myopia as compared to emmetropia in higher level of accommodative stimulation.[10] Read et al. also found that found that the axial length of eye increases with short duration of accommodative effort. The magnitude of change depends on the demand of accommodation. However, the magnitude of elongation is irrespective of the refractive error.[18] Woodman et al. in their study demonstrated choroidal thinning associated with accommodation which contributes to some part of axial elongation during accommodation.[19] Researchers have observed increased lens thickness and decreased ACD with ocular coherence tomography of long scan depth.[20]

Our study reconfirms the findings of previous investigators that there occurs a transient increase in axial length during accommodation. It has been hypothesized that a high near-accommodation lag induces abnormal axial growth of the eye, though many studies have not found an association between accommodation and myopic progression.[21] The question of debate remains that those born with myopic genes naturally tend to become academicians or more of near work leads to development of myopia.

Limitation

Our sample size was small further studies on larger sample size are needed to study the effect of accommodation on refractive errors. Longitudinal study to see the progression of susceptible eyes to final refractive state will definitely find an answer to the query.

CONCLUSION

Observing our results in the light of available literature, we conclude that biometric parameters and refractive errors are significantly associated with each other. The AA and changes observed in biometric parameters during accommodation are also positively related with each other. As there occurs axial elongation during accommodation to a greater magnitude in myopic patients, there exists a possibility that prolonged near work can lead to development of myopia. Although it requires further longitudinal study to find out whether prolonged near and myopia progression are correlated with each other or not.

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