A STUDY OF THE RELATIONSHIP BETWEEN AXIAL LENGTH, ANTERIOR CHAMBER DEPTH AND CORNEAL CURVATURE IN DIFFERENT REFRACTIVE STATES

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ABSTRACT

PURPOSE

The purpose of the present study is to describe the relationship between refractive errors, axial ocular dimensions, anterior chamber depth and corneal curvature, specifically to determine whether the refractive associations of these biometric variables are mutually related.

METHODS

We have conducted a prospective case study in patients attending the Outpatient Department of Ophthalmology, in Government General Hospital, Kakinada, during the period of October 2012 to December 2014. The study was done in 250 patients in order to evaluate refractive errors are determined by axial length of the eyeball.

RESULTS

It was observed that maximum number of myopics 18.8% are in 10-19 years' age group followed by 12.8% in 20-29 years' age group. However, hypermetropia is seen at little higher age, maximum of 16.4% in the age group of 20-29 years. It is also observed that hypermetropia make up the maximum number i.e. 45.2% followed by myopia 34.4%.

CONCLUSION

We came to conclusion that most of the refractive errors are determined by axial length of the eye ball.

KEYWORDS

Myopia, Hypermetropia, Astigmatism & Axial length.

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INTRODUCTION: Uncorrected refractive error is a leading cause of visual impairment and second largest cause of treatable blindness after cataract. As age of people increases, the refractive status of their eyes also changes. This is attributable to the changes in the crystalline lens, genetic, environmental influences like near work, night lighting, and UV exposure.

The refractive status of a person above 40 years changes with age, predominately due to the changes in the crystalline lens. Genetic and environmental influences are also believed to play a role in determining the refractive status of the eye.[1]

The aetiology of refractive error cannot be fully understood without examination of biometric data such as axial length (AL), corneal power (CP), anterior chamber depth (ACD) as well as indices of lenticular power.

In human eyes, axial length, refractory power of the cornea and lens, and anterior chamber depth are interrelated determinants of optical function. Changes in each of ocular parameters accompany not only various refractory errors but also cataract, glaucoma, retinal disease, and other oculopathies.[2]

The purpose of the present study is to describe the relationship between refractive errors, axial ocular dimensions, and anterior chamber depth and corneal curvature, specifically to determine whether the refractive associations of these biometric variables are mutually related or not. Common refractive errors studied here are hypermetropia, myopia and astigmatism.

AIM OF THE STUDY: The aim of the study is to estimate the refractive status of the patients by cycloplegic refraction, subjective verification and by post mydriatic test and to see any influence of axial length (AL), anterior chamber depth (ACD) and corneal curvature (CC) on the refractive errors and to establish the relationship among these variable by correlation coefficients.

MATERIALS & METHODS: This was a prospective study conducted on the patients attended to the Department of Ophthalmology, Government General Hospital, Kakinada, during the period of October 2012-December 2014.

A total of 250 patients with the complaints of defective vision, headache and asthenopia are studied. Cycloplegic refraction with Homatropine 2% eye drops has been done in all these 250 cases and the eyes are refracted with streak

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retinoscope, and subjective verification has been done immediately to confirm the findings of refraction. Post mydriatic test is performed for these patients after the pupil attaining its normal size and shape, preferably after 72 hours.

The determinants of refraction, i.e. corneal curvature, axial length, anterior chamber depth for both eyes are recorded, using Keratometer and A-Scan Biometry. Data on right and left eyes were analysed separately.

Inclusion Criteria:

- Younger individuals.
- Literates.
- Those who are less likely to have diabetes or hypertension.
- Those who are less likely to be smokers.

Exclusion Criteria:

- Aphakia.
- Pseudophakia with AC and PC IOLs.
- Nuclear sclerosis.
- Posterior subcapsular cataract.

OBSERVATION AND RESULTS:

Age Incidence in The Present Study: It was observed that maximum number of myopics 18.8% are in 10-19 years' age group followed by 12.8% in 20-29 years' age group. However, hypermetropia is seen at little higher age, maximum of 16.4% in the age group of 20-29 years. It is also observed that hypermetropia make up the maximum number i.e. 45.2% followed by myopia 34.4%.

Age group in years	Emmetropes		Myopes		Hypermetropes		Total	
	No.	%	No.	%	No.	%	No.	%
0 – 9	1	0.40%	2	0.80%	5	2%	8	3.20%
10 -19	21	8.40%	47	18.80%	32	12.80%	100	40%
20 -29	22	8.80%	32	12.80%	41	16.40%	95	38%
30 -39	7	2.80%	5	2%	35	14%	47	18.80%
Total	**51**	**20.40%**	**86**	**34.40%**	**113**	**45.20%**	**250**	**100%**

Table 1

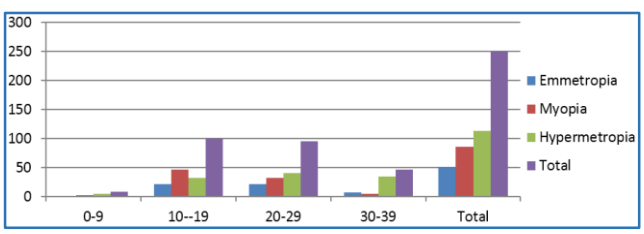

Fig. 1

Prevalence of Various Refractive Errors: It was observed that the prevalence of hypermetropia is more when compared to myopia in this study.

Type of refractive error	No. of cases
Emmetropes	51
Myopes	86
Hypermetropes	113
Total	**250**

Table 2

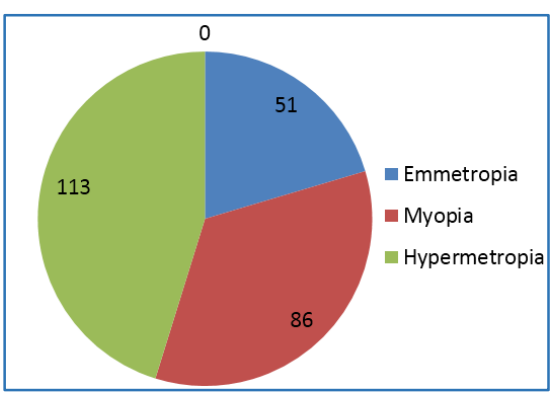

Fig. 2

Sex Incidence of Refractive Errors: It was observed that incidence of refractive errors is more in females when compared to males.

Sex	Total
Male	99
Female	151
Total	**250**

Table 3

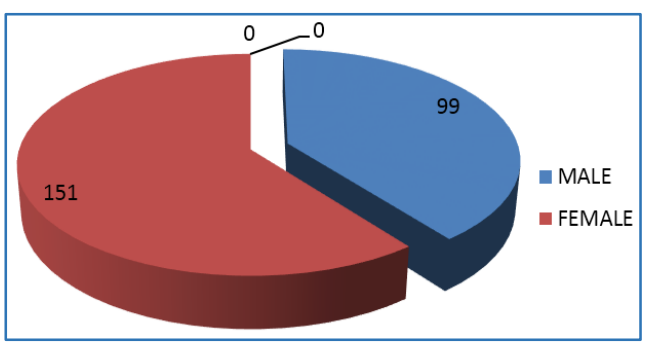

Fig. 3

Mean Axial Length of The Eye Ball: It was observed that as the axial length of the eye ball increases myopic refractive error increases. The reverse is seen in hypermetropia.

Refractive Error	Axial length of Right eye	Axial length of Left eye
Emmetropia	22.50±0.16	22.41±0.17
Myopia<3.00D	22.99±0.28	22.96±0.40
Myopia< 6.00D	24.72±0.75	25.55±1.51
Myopia>6.00D	27.60±1.43	27.32±1.44

Hypermetropia <2.00d	22.12±0.19	21.99±0.22
Hypermetropia >2.00d	21.51±0.62	21.63±0.51

Table 4

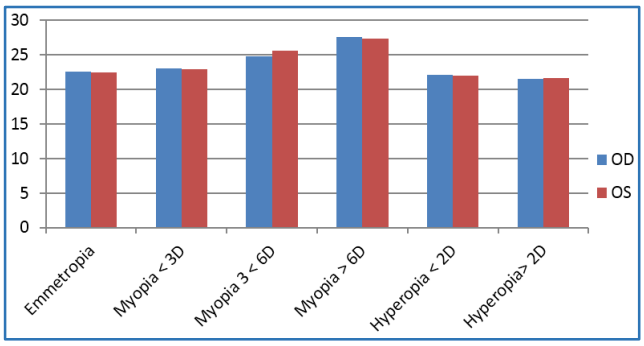

Fig. 4: Axial length Distribution in various refractive states

Mean Anterior Chamber Depth (ACD) Of the Eye Ball: It was observed that as the anterior chamber depth increases the myopic refractive error increases especially in high myopia and the same decreases in hypermetropia. The normal anterior chamber depth is 2.73±0.04 mm in this study.

Refractive Error	ACD of Right eye	ACD of left eye
Emmetropia	2.73±0.04	2.75±0.03
Myopia <3.00d	2.88±0.05	2.85±0.04
Myopia<6.00d	3.22±0.13	3.37±0.27
Myopia>6.00d	3.60±0.29	3.61±0.31
Hypermetropia<2.00	2.54±0.05	2.65±0.21
Hypermetropia>2.00	2.51±0.33	2.61±0.45

Table 5

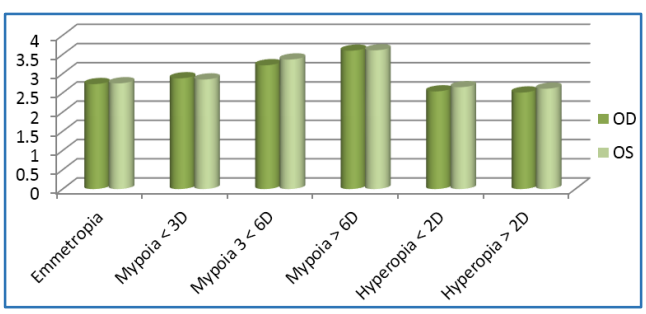

Fig. 5: Mean ACD (in mm) of the eye ball

Mean Values of ACD, AI & C. Curvature in Determination of Astigmatism: It was observed that the anterior chamber depth, and axial lengths in simple myopic astigmatism of less than 2.00D are normal, without much deviation from emmetropes. However, there is marginal increase in the radius of curvature of cornea indicating the condition is purely a curvature aberration. Same is the case with simple hypermetropic astigmatism and there is slight decrease in radius of curvature.

Component	Emmetropia	Simple hypermetropic Astigmatism	Simple myopic Astigmatism
K1 (OD)	7.81±0.06	7.72±0.10	7.82±0.13
K2(OD)	7.83±0.07	7.71±0.09	7.84±0.13
K1 (OS)	7.83±0.07	7.72±0.10	7.85±0.16
K2(OS)	7.84±0.07	7.73±0.09	7.86±0.12
Axial length (OD)	22.4±0.16	22.04±0.22	22.76±0.22
Axial length (OS)	22.41±0.17	21.87±0.21	22.65±0.24
ACD (OD)	2.73±0.04	2.62±0.05	2.75±0.06
ACD (OS)	2.75±0.03	2.63±0.05	2.77±0.04

Table 6

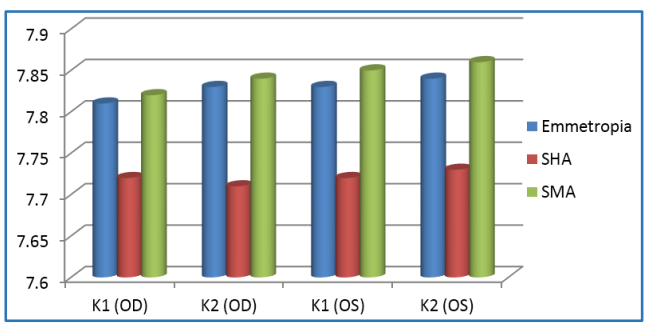

Fig. 6. Corneal curvature in astigmatism

DISCUSSION: In the present study, 136 patients out of 250 are found to be having refractive errors with a prevalence of 34.40% and 45.20% for myopia and hypermetropia respectively. In the 10-19 years' age group, 18.8%, 12.8%; in the 20-29 years' age group, 12.8%, 16.40%; and in the 30-39 years' age group 2%, 14%.

Hypermetropia was the most common refractive error in both Asian and non-Hispanic white children. Myopia showed relatively stable prevalence across age groups, while hypermetropia prevalence decreased after infancy and then increased again in older age groups; however, longitudinal studies are needed to evaluate refractive changes over time in individual children.[3]

It was observed that females are more affected with hypermetropia (38%) than males (34.4%) in all age groups with a sex ratio of 1: 1.53. This finding may be related to the fact that women have shorter axial length than men. This female preponderance can be attributed to increased asthenopia and headache in female population. There was a linear increase in the frequency of hypermetropia with age, with a steeper gradient in women than in men in all ethnic groups.[4]

In the present study, changes in the corneal curvature caused astigmatism and the radius of curvature correlated well with amount of astigmatism. In myopic astigmatism, there is increase in the radius of curvature making the cornea flat. Similar decrease is noticed when the shift of refraction towards hypermetropia and the mean values ranges from 21.87±0.21 to 22.04±0.22. The shape of cornea was the major cause of total astigmatism. The

influence of lens on the total astigmatism was different. The reasons for the change of the total astigmatism from regular to irregular with the increase of age were the changes of the power of corneal refraction, particularly the increase of the power of horizontal corneal refraction and lenticular irregular astigmatism. The comparison between observed and calculated values both for corneal shape and physiological astigmatism suggested that at least in the foetal eye, the relative deformation of the cornea is applicable in terms of tensile forces in the ocular globe.[5,6]

In the current study, the ACD (anterior chamber depth) correlated well with the type and amount of refraction. It is deepest (3.6±0.29) in myopia of >6.00D, and shallow (2.51±0.33) in hypermetropia especially >2.00D. Different studies suggested that anterior chamber depth decreases with increasing age. In fact, anterior chamber depth has been found to vary with both age and sex. In this perspective of change of axial length, anterior chamber depth and lens thickness with age, there is an interesting finding of one study which stated that during school age axial length and anterior chamber depth increased with severity of myopia in contrast the lens thickness decreased. Whereas after age of 20 anterior chamber depth decreased with ageing and lens thickness increased with ageing.[7]

It was also observed that there was a statistically significant sex difference in axial length and refraction, where women had shorter axial lengths and were more hypermetropic than men. It was observed in our study that myopes tend to have longer axial length and hypermetropes tend to have a shorter axial length comparing to that with emmetropes and astigmatics up to certain age group.[8]

The present study reaffirms that net refraction of the eye is a summary of various biometric components of eye, like axial length, corneal curvature and anterior chamber depth. The determination of the same is crucial in planning surgery and treating them with visual aid is essential to improve patient's visual disability.

Obtaining accurate ACD measurements is critical for success with cataract surgery and intraocular lens implantation when using the Haigis, Holladay 2 or Olsen formulas, or ray tracing for IOL power calculation. The type and magnitude of the refractive error of an eye are determined by the relationships between the dimensions of its optical components. The relevant optical components include the corneal power and radius of curvature, the anterior chamber depth (ACD), the lens thickness (LT) and the power, the vitreous chamber depth (VCD), and the axial length (AL).[9, 10]

CONCLUSIONS:

- Axial length of the eye ball determines the refraction many times.
- Corneal curvature (Radius of curvature of the cornea) is important in causing astigmatic error.
- Anterior chamber depth determination is important as it modifies the postoperative refraction.
- There is a good correlation between axial length (AL) and corneal radius (CR) and the ratio is approximately equal to ACD.
- However, each of these determinants does not cause the ammetropia, but is a sum effect of all these biometric components.

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