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Ocular Biometrics: Study of Myopia, Using A-Scan and Keratometer

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ABSTRACT

In this study we analyzed the degree of myopic error (corneal curvature and axial length.) in patients admitted to ocular ophthalmology department. The most common age group amongst study population was 10-18 years (38%) followed by 19-26 years (25%), 27-33 years (21%) and 34-40 years (16%). Keratometer reading were taken using Appaswamy keratometer. AL: CRC ratio was calculated after converting the keratometer reading from diopters to millimeters. Statistical analysis showed the following results; percentage of the study population that had low degree of myopia : < -3D (40%) followed by moderate degree of myopia: -3D to -6D (35%) and high degrees of myopia : >-6D (26%). Mean axial length amongst study population was 25.84 ± 1.43 mm. However, in the present study, low myopia: < -3D had a mean axial length of 23.90 ± 1.15 mm, moderate myopia: -3D to -6D had mean axial length of 24.77 ± 1.29 mm and high myopia: > 6D had mean axial length of 26.66 ± 1.90 mm.

Keywords: Corneal curvature, Mean axial length, Myopia, Keratometer, Vision impairment

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INTRODUCTION

The term myopia is derived from Greek word "myein" means to shut and "ops" means eye. Also known as short sightedness, people frequently close their eye lids trying to look at distant objects, to gain the advantage of a pin hole (Wojciechowski, 2011).

Myopia is a class of refractive error which is a chief cause of visual disability in the world. In India, refractive errors which are uncorrected are the most common origin of visual impairment and second major source of blindness that can be avoided (Morgan et al., 2012). Among many of the complication related to high myopia, a common complication is myopic retinopathy, which is a major cause of irreversible vision loss and blindness (Sihota et al., 2015). Other pathologic conditions that cause vision impairment are associated with high myopia, including retinal damage, cataract and glaucoma. For these reasons, there is an extreme need to control the onset and progression of myopia (Yu et al., 2011).

The refractive status of human eye is a complex variable. It is determined by the stability of the optical powers of the cornea and the lens as well as axial length of the eye. Children are born hyperopic mostly (Doyle, 2013). During the initial 1 to 2 years after birth, there is an active process shaping the distribution of refraction, known as emmetropization. After that period, the cornea is relatively stable throughout development, while axial length (AL) increases and lens power decreases (Iomdina et al., 2013).

RESEARCH OBJECTIVES

This cross-sectional study was aimed to:

- Study the optical and anatomical factors in patients with myopia viz. corneal curvature and axial length.
- Evaluate optical and anatomical factors in patients with myopia.
- Determine the correlation of axial length (AL) and corneal curvature (CC) in various degrees of myopia.
- Determine the correlation of axial length and corneal curvature ratio (AL: CRC) in various degrees of myopia.

LITERATURE REVIEW

Aristotle was the first to discuss refractive errors which are old citations explaining the name and concept of myopia. This was the first time, the word "myopes" was encountered in the literature, a word which even today is used in the same sense. Galen used the specific term myopia and apparently understood symptoms associated with this error of refraction (Backhouse, 2013).

Pan et al., (2012) prepared the way for later studies of the geometrical optical functioning of the eyes and the optical and physiological understanding of refractive errors and refraction. Accordingly, Johannes Kepler was the first to explain about the optics of myopia. Tron studied measurements of the optics of myopic eyes and his judgement of axial length. He stated that changes in axial length seemed to be a factor in causing the higher degrees of both myopia and hypermetropia.

Sivak (2012) employed a prism in place of glass plates, objects in place of original flames, diffused light reflected from white surfaces called mires. These mires are circular which could be rotated round the axis of the instrument. The more accurate technique of keratometry makes use of the first Purkinje image. The principle of visible doubling, was embraced for the ophthalmometer devised by Jesse Ramsden; and was perfected by von Helmholtz. The image is doubled by refraction through two rotating glass plates. This is then adjusted so that the lower edge of one image coincides with the upper edge of the other. The ophthalmometer of von Helmholtz is undoubtedly accurate in the scientific work, but several modifications have been introduced to facilitate its use as a clinical instrument for measuring corneal astigmatism.

Xiangui and others (2015) studied myopia in Chinese school children from age 6 to 12 years and found the axial length to be <-3D was 24.99±0.85, >-3D was 23.93±0.77, which is not in correlation with our study. Majumder and Tan (2015), studied comparison of ocular biometry & corneal curvature among Malaysian emmetropes and myopes, from age 18-35 and found the axial length to be 24.12 ± 0.70 in low myopia, 24.82 ± 0.65 in moderate myopia and 25.50 ± 0.42 in high myopia. This study was parallel to our study. It was found that axial length was more in high degree than that of low degree of myopic eyes.

Azura et al., (2012) studied Ocular Biometric Measurements in Emmetropic and Myopic Malaysian Children aged 7 8 years. This study reported that vitreous depth in emmetropes was 15.73± 0.02mm and myopics was 16.32 ±0.07mm.

MATERIALS AND METHOD

Sample Collection

This study included 200 eyes of 100 patients belonging to different age groups varying from 10 to 40 years of age and both sexes. We studied various degrees of myopia varying from-2D and above in which variation in ocular biometrics were studied and analyzed.

Patients attending ophthalmology OPD in Krishna Institute of Medical Sciences, Karad fulfilling the inclusion criteria were examined.

Sample Size

100 patients who satisfied the selection criteria.

$n = 4pq/l^2$

Where, p is prevalence, q is 1-p, l is allowable error.

Study Period: 18 months (Nov 2016 to May 2018)

Methods of Study and Data Collection

Following ethical committee clearance, informed written consent was obtained from patients in their preferred language (marathi, hindi) after explaining them about the purpose & procedure of examination. Patients were explained about adverse affects of dilatation. Two hundred eyes of one hundred patients complaining of diminution of vision or asthenopic symptoms, attending the outpatient department of ophthalmology were selected based on inclusion criteria and exclusion criteria.

A detailed history regarding their complaints, the onset, duration of symptoms, family history, history of previous glasses, history of any ocular surgery or ocular trauma and any known case of any systemic illness. Examination of visual acuity for distance was determined using a well-lit snellen's chart with pinhole improvement. Aided and unaided vision was taken separately. Auto refractometer readings was taken. Vertical (KV) and horizontal (KH) keratometry values using Appaswamy Keratometer were taken and the average was calculated in dioptres (D) to get the corneal curvature. This value was converted to millimetres (mm) using the formula 337.7/D = mm.

Every patient underwent retinoscopy with appropriate cycloplegic and mydriatric according to age, in a dark room. Patients were reviewed later for post mydriatic refractive correction. Patients under the age of 18 years underwent retinoscopy with cyclopentolate (1%) eyedrops, whereas those above the age of 18 years underwent retinoscopy with tropicamide (0.8%) + phenylephrine hydrochloride (5%) eye drops. The retinoscopy was done according to appropriate working distance. A detailed examination was performed using slit-lamp biomicroscopic and fundus examination using direct and indirect ophthalmoscope respectively.

Figure 1: Keratometer

Figure 2: A-scan used for the study

Figure 3: A-scan readings

RESULTS

Table 1: study population according to age group.

AGE GROUP	FREQUENCY	PERCENTAGE
10 to 18 years	38	38
19 to 26 years	25	25
27 to 33 years	21	21
34 to 40 years	16	16
TOTAL	100	100

As seen in the table, the most common age group amongst study population was 10 to 18 years (38%) followed by 19 to 26 years (25%), 27 to 33 years (21%) and 34 to 40 years (16%)

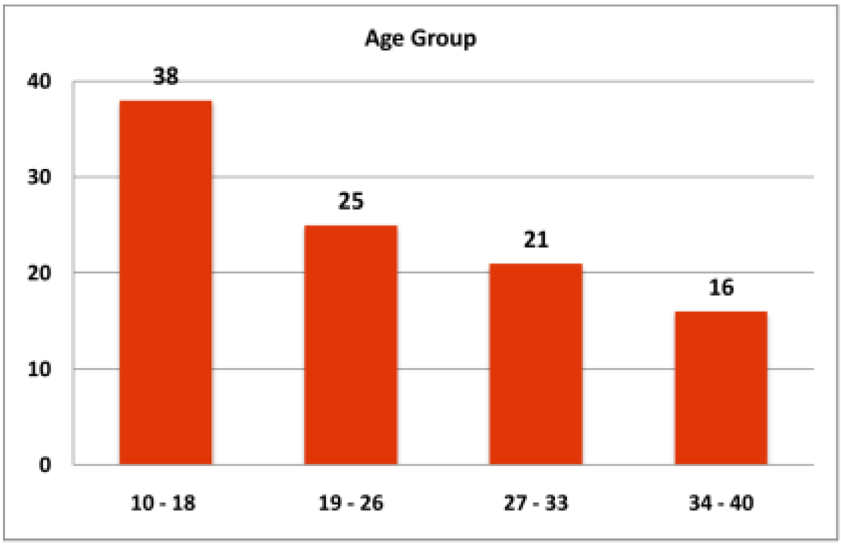

Figure 4: Age group of the study patients

As seen in the Table 1, there was males predominance (61%) amongst study population as compared to female (39%).

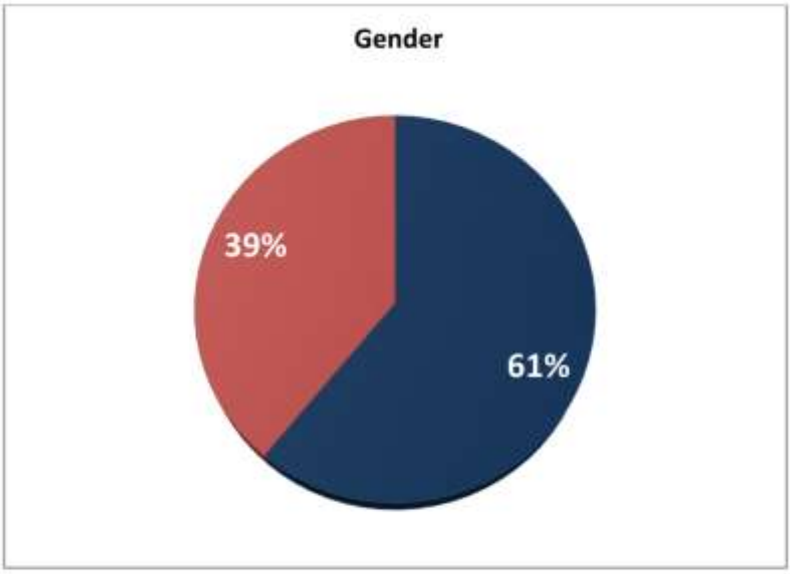

Figure 5: Gender-wise distribution of patients

Table 2: study population according to family history

FAMILY HISTORY	FREQUENCY	PERCENTAGE
POSITIVE	67	67
NEGATIVE	33	33
TOTAL	100	100

As seen in the table 2, family history was positive in 67% of study population.

Table 3: study population according to various degrees of myopia

DEGREE OF MYOPIA	FREQUENCY	PERCENTAGE
LOW : <-3D	80	40
MODERATE : -3D TO -6D	69	35
HIGH : >-6D	51	26
TOTAL	200	

As seen in the Table 3, most of the study population had Low : <-3D myopia (40%) followed by Moderate: - 3D to - 6D myopia (35%) and High : >-6D myopia (26%)

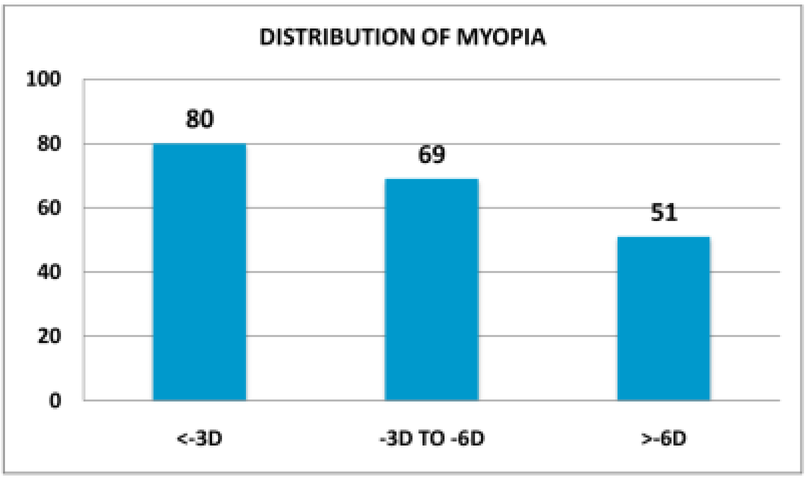

Figure 6: study population according to various degrees of myopia

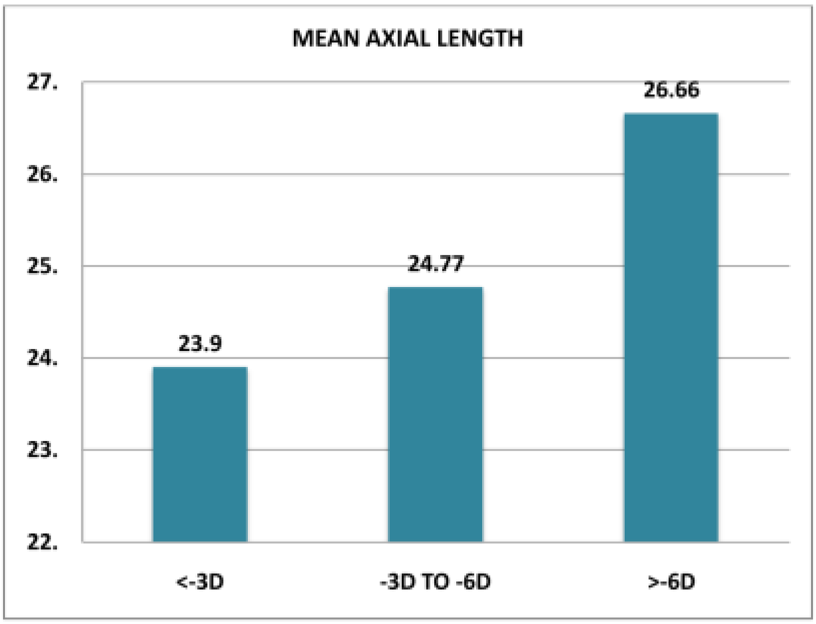

Figure 7: Variations in axial length with various degrees of myopia

Table 4: Variations in corneal curvature with various degrees of myopia

DEGREE OF MYOPIA	NUMBER OF CASES	CORNEAL CURVATURE(MEAN ± SD)
LOW : <-3D	80	7.65 ± 0.71
MODERATE : -3D TO -6D	69	7.71 ± 0.81
HIGH : >-6D	51	7.80 ± 0.84
TOTAL	200	

As seen in the Table 4, low myopia: < -3D had mean corneal curvature of 7.65 ± 0.71 mm, moderate myopia: -3D to -6D had mean corneal curvature of 7.71 ± 0.81 mm and high myopia: >-6D had mean corneal curvature of 7.80 ± 0.84 mm. The variant was statistically insignificant. ANOVA test , P value is 0.5627 (Table 5 and Table 6).

Table 5: P Value of corneal curvature

P Value ANOVA test	0.5627	Insignificant

Table 6: Mean and standard deviation of corneal curvature

	MEAN	SD
CORNEAL CURVATURE(mm)	7.64	0.79

As seen in the table 6, mean corneal curvature amongst study population was 7.64 ± 0.79 mm.

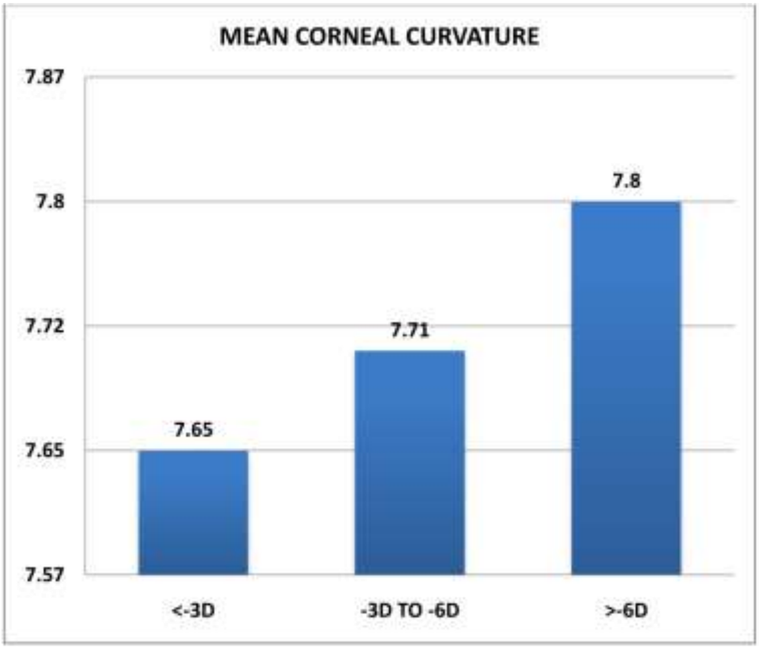

Figure 8: corneal curvature with various degrees of myopia

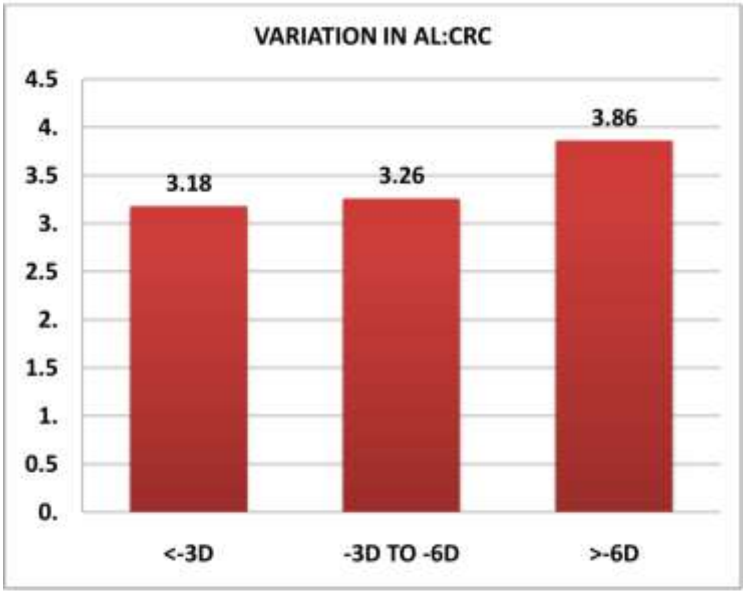

Figure 9: variations in AL: CRC ratio with various degrees of myopia

Table 7: Variations in lens thickness with various degrees of myopia

DEGREE OF MYOPIA	NUMBER OF CASES	LENS THICKNESS(MEAN ± SD)
LOW : <-3D	80	3.59± 0.5
MODERATE : -3D TO -6D	69	3.51 ± 0.6
HIGH : >-6D	51	3.49 ±0.9
TOTAL	200	

As seen in the Table 7, low myopia: < -3D had mean lens thickness of 3.59 ± 0.5 mm, moderate myopia : -3D to -6D had mean lens thickness of 3.51 ± 0.6 mm and high myopia : >-6D had mean lens thickness of 3.49 ± 0.9 mm. The variant was statistically insignificant. ANOVA test, P value was 0.6378.

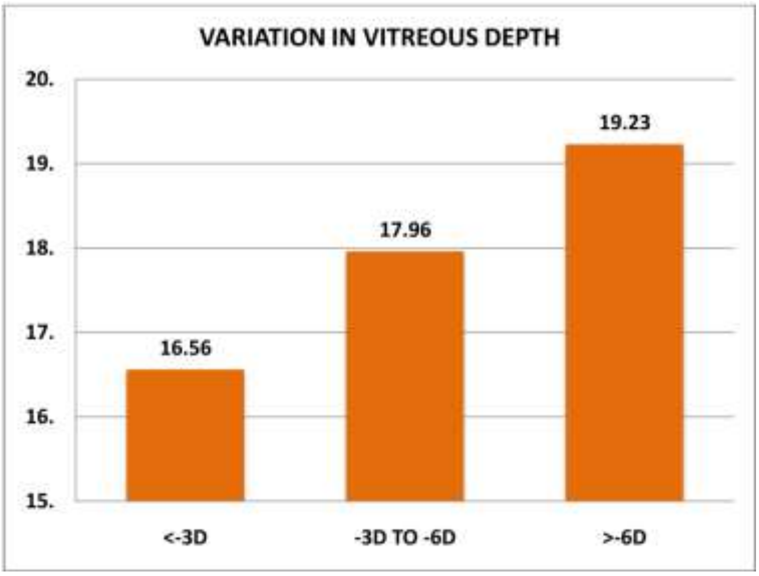

Figure 10: **Variations in vitreous depth with various degrees of myopia**

CONCLUSION

As a result of combined efforts of multiple optical elements of the eye, refractive error is determined, axial length being one of the most important component related to myopia. The function of the cornea seems to compensate the possible myopizing effects of a slight increase in the axial length. When increase in the axial length is excessive, the effect of cornea tends to disappear. Axial length to corneal curvature ratio (AL:CRC) which was 3.86 ± 0.7 in high myopia was a better index of categorization of myopia followed by axial length as a single component. This ratio can be considered as a cutoff point to categorize myopia into degenerative myopia. It can also be used to regularize the follow ups of these patients to check for degenerative changes. To further authenticate this mathematical ratio a larger sample size would have been helpful, including hereditary and environmental factors. The association between AL:CRC and refraction is linear; the ratio is highest in high myopia and lowest in high hyperopia. However, this ratio can be used to use for evaluation of degenerative myopia.

CONFLICT OF INTEREST

None

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