

Original Research Article

A cross sectional clinical study on correlation between myopia and intraocular pressure and ocular biometric values among adults in tertiary eye care in Palakkad, Kerala, India

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ABSTRACT

Background: To find out whether there is a correlation between intra ocular pressure and ocular biometric values like corneal curvature, anterior chamber depth, lens thickness and vitreous chamber depth in myopic eyes.

Methods: A cross sectional clinical study was conducted in karuna medical college hospital Palakkad Kerala, India from September 2015 to August 2017. 1000 eyes of 500 myopic patients attending the ophthalmology OPD were included in this study. Goldman applanation tonometry was used to measure intra ocular pressure. Bausch and Lomb keratometer was used to measure corneal curvature and Biometer A scan machine was used to measure anterior chamber depth, lens thickness, vitreous chamber depth and axial length.

Results: In this study majority of the patients age group was 16-20 years. The overall mean intra ocular pressure was 15mmhg and mean radius of corneal curvature was 44.12D. In this study average anterior chamber depth was 3.55mm and mean lens thickness was 3.56mm. Mean vitreous chamber depth was 18.40. In this study mean axial length was 24.60mm.

Conclusions: Amount of myopia and variation in corneal curvature was not statistically significant. There was no correlation between intra ocular pressure and degree of myopia. But anterior chamber depth, lens thickness, vitreous chamber depth and axial length were statistically very significant with amount of myopia.

Keywords: Anterior chamber depth, Corneal curvature, IOP, Myopia

INTRODUCTION

The Roman Emperor Nero Claudius Drusus was seeing Rome burn by blurred picture through his narrowed lids, as contemporary historians told his eyes were “dull and weak”.

Since he was committed suicide at the age of 31 years it was not likely that weakness was presbyopia ;thus Nero Claudius was the most infamous of myopes.¹ Galen used the specific term myopia and apparently understood symptoms associated with this error by refraction.²

Physiologically in normal eye parallel rays of light converge upon the retina to form a circle by least diffusion when eye was at rest, this condition is called emmetropia and the opposite condition termed as ametropia in which parallel rays of light is not focussed at retina when eye was at rest.³ Basically ametropia or refractive error has three types like myopia, hypermetropia and astigmatism. In myopia light rays were focussed in front of the retina and in hypermetropia light rays were focussed behind the retina when eye was at rest. Astigmatism is a type of refractive error in which focal lines are formed instead of focal points.^{4,3}

Myopia (short sightedness) optics was first explained by Johannes Kepler, the founder of dioptric's during the 17th century. In his initial clarification of ophthalmic dioptrics, he correctly assumed that in myopia the incident light was brought to focus in front of the retina.⁵ Myopia (short sightedness) was the most common refractive error in the world. In India prevalence of myopia was 6.9% in general population.^{6,7} Roughly 25% of the individuals between the ages of 12 and 54 years were myopic in United states.⁸

Etiologically myopia can be classified as axial myopia (due to increase in antero posterior length of eyeball), curvatural myopia (due to increase in curvature of cornea, lens or both), positional myopia (due to anterior placement of the lens) and Index myopia (due to increase in refractive index of lens in nuclear sclerosis).⁹ American Optometric Association (AOA) has classified myopia into low myopia when the power was $\leq -3D$ to $-6D$, and High myopia when the power was $\geq -6D$. Clinically myopia has classified into Simple myopia and Pathological myopia. Simple myopia is a physiological error and not associated with any eye diseases. It results from normal biological variation in the development of eye which may or may not be genetically determined. Genetics play some role in biological variation in the development of eye and prevalence of myopia which is more in children with both parents who are myopic (20%) than in children with one parent myopic. Defective vision for distance (short sightedness) and half shutting of the eyes were common symptoms in simple myopia. Anterior chamber was slightly deeper than normal and fundus examination was normal in simple myopia.¹⁰

Pathological or degenerative myopia is a rapidly progressive refractive error which starts in childhood at the age of 5-10 years and results in high myopia (power $>6D$) during early adult life which is usually associated with degenerative changes of retina, choroid and vitreous. Genetic factors play a role in the etiology of pathological myopia. Autosomal dominant pathological myopia has been linked to genes 18p11 31 and 21 23 12q. Other than defective vision, muscae volitantes (floating black opacities) in front of the eye and night blindness are the main symptoms. Signs were prominent eye balls, large cornea and deep anterior chamber. Fundus examination shows temporal crescent, chorio retinal atrophy, foster fuchs spots in the macula, latticedegeneration, posterior staphyloma and posterior vitreous detachment. Retinal detachment, Complicated Cataract, Corneal neovascularisation were some common complications of pathological myopia.¹¹

Intra Ocular Pressure (IOP) is measured by Schiottz tonometer, applanation tonometer, Perkins hand held tonometer, and non contact tonometer. Goldmans applanation tonometer is the gold standard method for measuring IOP. Intra ocular pressure in normal individual is 10-21mmHg. Raised intra ocular pressure leads into Glaucoma which is due to blockage in the trabecular

meshwork out flow pathway or excessive secretion of aqueous humour. Incidence of primary open angle glaucoma (POAG) was slightly higher in myopes.^{11,9} Axial length or antero posterior diameter of eye ball in normal individual is 22-24mm. Axial length is measured by A scan Biometry. About 1mm shortening of antero posterior diameter of the eye results in 3 dioptrics of myopia.^{11,10} Corneal curvature is measured by keratometer. Two types of keratometers are Javal-schiottz keratometer and Bausch and lomb keratometer. Keratometer measures the radius of curvature of cornea in horizontal meridian and vertical meridian separately, then calculating total corneal curvature by using this formula

$$K=0.5[K1+K2]$$

Where, K= total corneal curvature,
K1 =horizontal curvature,
K2= vertical curvature.

About 1mm increase in radius of curvature results in 6 dioptrics of myopia.^{11,10,9}

METHODS

This cross-sectional study was conducted in the department of ophthalmology karuna medical college hospital, Palakkad, Kerala. One thousand eyes of 500 myopic patients from various parts of Palakkad district, Kerala who were attending ophthalmology outpatient department were included in this study. Details including age, sex, duration and amount of myopia were noted. Visual acuity in both eyes were measured by Snellen's chart. Other materials used were

- Slit lamp examination for anterior segment examination,
- Goldmann's applanation tonometer for measuring intra ocular pressure in both eyes,
- Bausch and lomb keratometer for measuring corneal curvature of both eyes,
- Biometer Ultrasound A machine with digital display was used to assess the anterior chamber depth, axial length, lens thickness and vitreous chamber depth,
- Direct and Indirect ophthalmoscope were used for fundus examination.

Inclusion criteria

- Simple myopia,
- Pathological myopia,
- Myopic between 7-35 years.

Exclusion criteria

- Congenital myopia,
- Compound myopic astigmatism,
- Presbyopia with myopia.

RESULTS

Majority of the patients (28.6%) were from the age group of 16-20 years in this study. The 137 patients (27.4%) in the age group of 21-25 years were participated in this study (Table 1).

Table 1: Age distribution.

Age	No. of patients
7 -10 yrs	21 (4.2%)
11-15yrs	47 (9.4%)
16-20 yrs	143 (28.6%)
21-25yrs	137 (27.4%)
26-30 yrs	122 (24.4%)
31-35 yrs	30 (6%)

Table 2: Gender distribution.

Male	Female
224 (44.8%)	276 (55.2%)

Table 3: Percentage of patients.

Amount of myopia	No. of patients
0-2	88 (17.6%)
2.25-4	223 (44.6%)
4.25-6	108 (21.6%)
6.25-8	59 (11.8%)
8.25-10	14 (2.8%)
>10	8 (1.6%)

Table 4: Variations of intra ocular pressure (IOP) and amount of myopia.

Amount of myopia	No. of patients	IOP
0-2	88	18
2.25-4	223	16
4.25-6	108	12
6.25-8	59	14
8.25-10	14	10
>10	8	20
P-value	P >0.05	
Significance	Not significant	

Table 5: Variations of radius of corneal curvature (k reading) and amount of myopia.

Amount of myopia	No. of patients	K reading
0-2	88	43.25
2.25-4	223	43.75
4.25-6	108	45
6.25-8	59	43.25
8.25-10	14	45
>10	8	44.50
P-value	P > 0.05	
Significance	Not significant	

Minimum age group was 7 years and maximum were 35 years for this study. Out of the 500 patients 276 patients were females and 224 were males (Table 2). In this study majority (44.8%) of the patients were having myopia between -2.25 to -4 Diopter value. Around 81 patients were having myopic power more than 10 Diopter (Table 3). Around 223 patients (44.6%) were having 16mmHg intra ocular pressure (IOP). The 14 patients were having IOP 14mmHg and 8 patients were having 20mmHg IOP (Table 4). Around 223 patients were having 43.75D radius of corneal curvature value, 147 patients were having corneal curvature value 43.25D and 122 patients were having 45D corneal curvature value (Table 5).

Table 6: Variations of anterior chamber depth (ACD) and amount of myopia.

Amount of myopia	No. of patients	ACD
0-2	88	3.04
2.25-4	223	3.36
4.25-6	108	3.57
6.25-8	59	3.65
8.25-10	14	3.73
>10	8	3.96
P-value	P <0.05	
Significance	Significant	

Table 7: Variations of lens thickness (LT) and amount of myopia.

Amount of myopia	No. of patients	LT
0-2	88	3.56
2.25-4	226	3.43
4.25-6	108	3.58
6.25-8	59	3.74
8.25-10	14	3.63
>10	8	3.46
P-value	P <0.05	
Significance	significant	

Table 8: Variations of vitreous chamber depth (VCD) and amount of myopia.

Amount of myopia	No. of patients	VCD
0-2	88	16.66
2.25-4	223	17.34
4.25-6	108	18.56
6.25-8	59	18.82
8.25-10	14	19.34
>10	8	19.72
P-value	P <0.001	
Significance	Highly significant	

The minimum value of anterior chamber depth obtained in this study was 3.04mm and the maximum value obtained was 3.96mm. Majority of the patients anterior

chamber depth was 3.36mm (Table 6). Maximum lens thickness value obtained in this study was 3.74mm and the minimum value obtained in this study was 3.43mm. The mean value of lens thickness for all eye was 3.56mm (Table 7). The minimum value of vitreous chamber depth obtained in this study was 16.66mm and maximum value was 19.72mm. The mean value for the whole range in vitreous chamber depth value was 18.40mm (Table 8). Around 8 patients were having high 19.72mm vitreous chamber depth value. The minimum value of axial length obtained in this study was 21.74mm and the maximum value was 26.74mm. The mean value of axial length for all the eyes were 24.60mm (Table 9).

Table 9: Variations of axial length and amount of myopia.

Amount of myopia	No. of patients	Axial length
0-2	88	23.74
2.25-4	223	23.91
4.25-6	108	24.36
6.25-8	59	25.90
8.25-10	14	26.51
>10	8	26.91
P-value	P <0.001	
Significance	Highly significant	

DISCUSSION

Prevalence of myopia in general population in India has been reported to be 6.9%.^{12,13} Roughly 25% of individuals between the ages of 12 and 54 years in US were myopic. In this study majority (28.6%) of the patients were participated in the age group of 16-20 years. The 55.2% female patients and 44.8% male patients were participated in this study. The prevalence of the pathological myopia may involve 1.7 to 2.1% of Caucasian population.^{13,12} In this study 419 patients (83.8%) were having simple myopia (power <6D) and 81 patients (16.2%) were having pathological myopia (power >6D). The overall mean intraocular pressure (IOP) in myopia was 15mmHg in this study. The mean IOP in myopic eye was similar to that of the present study in most of the previous studies. Becker et al, in their study reported that mean IOP was 15.35mmHg. In this study the mean IOP increases with the age.^{14,13} The study conducted by Abdulla MI and Hamdi M, also agreed that intra ocular pressure increases in older myopes.¹⁴ In this study, the mean IOP was found high (15.33mmHg) in simple myopia than pathological myopia (14.66mmHg). But there was no correlation between degree of myopia and intra ocular pressure in this study. Abdulla MI and Hamdi M, had similar observation in their studies. Brien Mc and Millodot M, found that the values of both horizontal and vertical corneal radius of curvature between myopes and emmetropes were identical.¹⁵ Normally radius of corneal curvature was 43.25 D in emmetropes but in this study mean radius of corneal curvature was 44.12D.

Tien yin Wong et al, concluded that there was no significant variation in corneal curvature between emmetropia and refractive error.¹⁶ Grosvenor T and Scott R, found that mean corneal power was significantly greater for myopes than for emmetropes. Corneal power as well as axial length increases significantly with increase amount of myopia.¹⁷ Any corneal steepening (increased corneal power or increased corneal curvature) in a myopic eye occurs very early in development of myopia. Bai-chuan Jiang and Woessner WM, found that changes in keratometer powers with spherical equivalent changes for the two meridians are not statistically significant. They hypothesized that corneal steepening occurs early in development of myopia or even as a precursor to myopia but progression of myopia was caused mainly by axial elongation.¹⁸ In this study 370 patients had radius of corneal curvature less than 44 D and 130 patients had radius of curvature more than 44D. The variation of radius of corneal curvature was not found to be statistically significant. Calmettes L et al, suggested that depth of anterior chamber increases regularly up to 20 yrs of age and reaches its maximum of 3.76mm between 20 and 30 years and decreased afterwards slowly with age to attain the maximum of 3.23mm.¹⁹ He found that mean value of anterior chamber depth was 3.62mm in myopic eyes compared to 3.58mm of anterior chamber depth in emmetropes.

However, the values obtained were not statistically significant. They found a positive correlation between depth of anterior chamber and diameter of cornea. Stenstrom in examining his dispersion diagram remarks that a maximum value for anterior chamber depth was found for myopia of the order of 5D. Beyond this the depth of anterior chamber ceases to increase.²⁰ But in this study mean anterior chamber depth was 3.55mm. McBries and Adams, found that the main change in the ocular components in eyes showing progression was increased axial length and the other components including anterior chamber depth and lens thickness were remained same.²¹

Erickson pointed the effect of change in anterior chamber depth and refractive error depends on the causative structure. If 0.1mm in anterior chamber depth results from the growth of cornea away from the lens, then 0.14D of myopia results.²² But if increase was due to lens shifting posteriorly then 0.13D of hypermetropia occurs. The mean anterior chamber depth was 3.55mm for all myopes in this study. Deeper anterior chamber was seen in myopia in the range of 8-9D in this study.

Normal thickness of human crystalline lens was 4mm at the age of 20 years, 4.3mm at the age of 40 years, 4.45mm at the age of 50 years and 4.7mm at the age of 60 years.²³ Kenneth J and Hoffer, found that the eyes with axial length <23mm has mean lens thickness of 4.76mm, while those with axial length of 24mm or more had mean lens thickness of 4.54mm. The minimum lens thickness was variable in all axial length groups but maximum

value decreased as axial length increased.²⁴ McBrien et al, found that myopes have significantly thinner crystalline lenses, usually thinner lens implies a weaker power lens. This explanation proposed by them is that myopic eyes underwent zonular dysplasia and reduces lens development.²⁵ Sanjeeva et al, suggested that lens thickness is more influential than anterior chamber depth in determining refraction.²⁶

Fledelius HC et al, suggested that thicker lens does not per se imply higher lens power because continued lens thickness throughout life does not lead to much refractive change in general.²⁷ Zadnik K et al, found that myopic eyes were associated with excessive axial length, steep cornea and thin and less powerful crystalline lens.²⁸ Fledelius HC and Stubgaars M, found that lens thickness increases and AC depth decreases with age. Barbura E et al, found that the lens thickness was strongly related to the age of adults showing an increase within age.²⁹ The mean value of lens thickness in this study for all myopic eyes were 3.56. Thicker lens were observed in lower and moderate degrees of myopia and higher degrees of myopia had thinner lens.

A statistically significant thinner lens was seen in higher degrees of myopia in this study. Sanjeeva et al, noticed that axial length and vitreous chamber depth are the strongest determinants of the refractive error.^{29,26} Tien Yin Wong et al, found that myopes had longer axial length, deep anterior chamber depth and long vitreous chamber depth than hypermetropes.^{29,16} Grosvenor T and Scott R, concluded that myopia develops as a result of antero-posterior elongation of eye with the result that myopic eye has a cornea that is significantly steeper, vitreous chamber that is deeper, axial length that is longer and lens that differs little. They suggested that it is increase in axial length that is not fully compensated by a decrease in lens power that determines myopia.^{29,17} Bai-Chuan-Jiang and WM Woessner, found a high correlation between refractive error and axial length. The axial elongation is a consequence of change in vitreous chamber depth.^{29,18} The mean value of axial length for all the eyes were 24.60mm in this study. Mc Brien and Adams DW, concluded that the only difference in ocular component dimension changes for myopic eye was elongation of vitreous chamber depth.²⁹ Goss DA et al, concluded in their study that vitreous depth was greater in myopes than in emmetropes.³⁰ The mean value for vitreous chamber depth was 18.40mm in this study. Tanja RM et al, observed that axial length in myopic eye was 4mm longer than in emmetropes. They found that anterior chamber depth in emmetropic eye was average 3.61mm but in myopic eye was 3.73mm.³¹ But in this study mean anterior chamber depth was 3.55mm and mean axial length was 24.60mm.

CONCLUSION

Refractive error cannot be determined by a simple optical component, it was a result of combined interactive effect.

Based on our findings there were no correlation between corneal curvature, intra ocular pressure and amount of myopia. But axial length, lens thickness, anterior chamber depth and vitreous chamber depth were the strongest determinants of refractive error.

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