A Clinical Study on the Correlation Between Axial Length, Intraocular Pressure and Central Corneal Thickness in Myopic Eyes

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ABSTRACT

Introduction: Myopia or short sightedness, is that form of refractive error wherein parallel rays of light come to a focus in front of the sentient layer of the retina when the eye is at rest; the eye is thus relatively too large, and the condition is the opposite to that of hypermetropia**.** Aims and objectives of the research were to find out whether there is a correlation between axial length, intraocular pressure and central corneal thickness in myopic eye and to find out whether the degree of myopia can be correlated with axial length, intraocular pressure and central corneal thickness in myopic eye.

Material and Methods: A prospective study was conducted in Silchar Medical College and Hospital, Assam for 1 year. Total of 200 eyes of 100 myopic patients attending the Outpatient department of Ophthalmology were included in the study.

Result: Overall mean (SD) myopic refractive error was found to be -4.41±3.23D with range of -1.00 D to -17.00 D. The overall mean axial length was 24.06±1.74 mm. The overall mean intra ocular pressure in the patient was found to be 15.50±2.00 mm of Hg with range of 12-20 mm Hg. The overall mean (SD) central corneal thickness in myopic eyes was found to be 0.509±0.026 mm.

Conclusion: The effect of myopia on the axial length, the intraocular pressure and the corneal thickness are interrelated and are important determinants of myopia.

Keywords: Axial length, Intraocular pressure, Central corneal thickness, Myopia

INTRODUCTION

When Nero (Nero Claudius Drusus Germanicus, The Roman Emperor, 37AD68AD) watched Rome burn, the chances are he was seeing a blurred picture through narrowed lids, as contemporary historians tell us his eyes were "dull and weak." Since he committed suicide at 31 yrs of age, it is not likely that the weakness was presbyopia; thus Nero is the most infamous of myopes.[1]

Myopia or short sightedness, is that form of refractive error wherein parallel rays of light come to a focus in front of the sentient layer of the retina when the eye is at rest; the eye is thus relatively too large, and the condition is the opposite to that of hypermetropia.[2] Myopia is measured by the spherical power in diopters of the diverging lens needed to focus light onto the retina, which can be expressed as the spherical equivalent or refraction in the least myopic meridian.[3,4] Myopia is one of the most common refractive error.Normally the total refractive power of the eye, which is the additive power of the cornea and lens modified slightly by the depth of the anterior chamber, maintains a relationship with axial length of the globe such that their overall impact renders the refractive state of the eye to be emmetropic.

Myopia results when there is an excess of corneal power or lens power or both or when the axial length of the globe is longer than that which is compatible with the total refractive power of the eye.Myopia may be simple or pathological. In simple myopia the refractive changes are brought about by variations within the optical system, an increased Curvature of the cornea or the lens surface, a high refractivity of the lens, or a greater axial length of the globe.[5] Simple myopia is considered as physiological error not associated with any disease of the eye. Poor vision for distance, asthenopic symptoms, half shutting of the eyes are the usual complains and prominent eyeballs,deep anterior chamber, slightly large and sluggishly reacting pupils, normal fundus, refractive error usually not exceeding -6 to -8 D are found on examination.

Pathological myopia is that type of myopia which is accompanied by degenerative changes occurring particularly in the posterior segment of the eye. It is usually associated with lengthening of the antero-posterior length of the eyeball. The presenting symptoms are defective vision, muscaevolitantes, and night-blindness. The signs are prominent eyeball, large cornea, deeper anterior chamber, slightly large pupil with sluggishly reacting to light. The fundus changes are large and pale optic discs, myopic crescent, degenerative changes in retina, choroids, macula and fovea (eg.Foster-Fuch's spot, cystoid degeneration)posterior staphyloma, degenerative changes in vitreous.[6]

Other varieties are curvature myopia, index myopia, and traumatic myopia.

Etiologies of myopia have been attributed partially to hereditary and partially to environmental factors and both are believed to have a substantial impact on the magnitude of the myopic problem. In majority of cases, myopia is axial and it is certain in higher degree. That is due to an increase in the anterior-posterior diameter of the eye.[2] It has been stated that per millimeter change in axial length, the refractive state of the eye varies by 3 diopters and per millimeter change in radius of curvature of the cornea the refractive change is 6 diopters.[7]

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Intraocular pressure is the pressure maintained inside the eyeball in normal condition which is exerted by the volume of solid and liquid contents of the eye and elasticity of its coat. The normal range of the intraocular pressure in human is 10-20mm Hg. Myopia is considered to be a risk factor for primary open angle glaucoma. Myopes tend to have slightly higher intraocular pressure as compared to emmetropes.

The normal cornea has a central thickness of approximate 0.52mm and peripheral thickness of approximate 0.67mm.[8] In myopia there is enlargement of the globe which is associated with corneal thinning. Myopic cornea is 0.018mm thinner than the normal. Optical treatment of myopia constitutes prescription of appropriate (concave) lenses, contact lenses; meanwhile surgical treatment of myopia is becoming more popular nowadays. LASIK (Laser in-situ Keratomileusis) is one of the most popular and effective surgical techniques used especially to correct myopia. Corneal thickness is an important factor for refractive surgeries such as RK, PRK and LASIK. LASIK is a refractive surgery in which central corneal thickness is reduced by excimer laser.[9,10] Correction of high myopia usually causes loss of corneal thickness which may induce corneal ectasia. Hence, central corneal thickness is an important determinant in myopia.

The axial length, the intraocular pressure and the central corneal thickness are interrelated and are important determinants of myopia. As the myopia is more common and universal, it is necessary to know the correlation of these factors in myopic eyes, which will increase our understanding, and knowledge and its further management.

In the present study an attempt has been made on the group of myopic patients attending the Department of Ophthalmology, Silchar Medical College and Hospital, Assam, to evaluate whether there is a correlation between axial length, intraocular pressure and central corneal thickness in myopic eyes and whether the degree of myopia can be correlated with axial length, intraocular pressure and central corneal thickness in myopic eyes.

MATERIAL AND METHODS

A total of 100 subjects visiting Department of Ophthalmology, Silchar Medical College and Hospital, Assam, were included in the study (based on inclusion and exclusion criteria), for the period of 1 year. Study was conducted after due approval of ethical committee. Patients were informed about the study and written consent was taken prior to their inclusion in the study.

Criteria for selection of cases: Patients with equal and more than 1 diopter of myopic refractive error (refraction in the least myopic meridian) and age group of 5 years and more were selected in this study.

Sample calculation: The Assumed Population Prevalence (P) = 25%[11], CI 95%, Precision of +/- 0.09, Sample Size was estimated at 100.

Exclusion criteria: Congenital or acquired ocular anomalies; History of surgery or trauma; Systemic or other ocular diseases of the posterior segment of eye.

The cases were evaluated in detail by History taking; Ocular examination; Visual acuity testing with Snellen's chart; Retinoscopy and post mydriatic test; Keratometry; A - scan biometry (Axial length measurement); Tonometry (Goldman applanation tonometer); Pachymetry (Central corneal thickness measurement) and Fundus examination.

STATISTICAL ANALYSIS

Microsoft excel, Student t-test were used for statistical calculations and P value was corrected with Bonferonni adjustment where required. P value less than 0.05 was taken as statistically significant.

RESULTS

Out of 100 patient 51 were male and 49 were female. Overall mean (SD) myopic refractive error was found -4.41±3.23D with range of -1.00 D to -17.00 D.

The overall mean axial length was 24.06±1.74 mm. Axial length of male was greater than that of the Female but it was not statistically significant. Older age group was seen to have lesser axial length than younger age group. It was found that axial length was more in high degree than that of low degree of myopic eyes. There was statistically significant negative correlation of axial length with myopic error.

The overall mean intra ocular pressure in the patients was found to be 15.50±2.00 mm of Hg with range of 12-20 mm Hg. Intraocular pressure of Male was greater than that of the Female but it was not statistically significant. There was positive significant correlation of age and intraocular pressure. There was statistically significant negative correlation of intra ocular pressure with myopic error.

In the study the overall mean(SD) central corneal thickness in myopic eyes was found to be 0.509±0.026 mm. Central corneal thickness of Male was greater than that of the Female but it was not statistically significant. In the study it was found that the central corneal thickness was greatest in 15-24 years and was lowest in 5-14 years. Central corneal thickness was found less in high degree myopia (0.479±0.022 mm) than that of moderate (0.518±0.017 mm) and low degree (0.518±0.022 mm) myopia.

DISCUSSION

The mean age of the patients was 28.48±12.29 years, range 6-54 years. Overall mean (SD) myopic refractive error was found -4.41±3.23D with range of -1.00 D to -17.00 D. Mean myopic refractive error in male was -4.46±3.42 D where as in female it was found to be -4.35±3.05 D.

In the current study overall mean axial length was found to be 24.06±1.74 mm (range 21.01 to 31.53). It was 24.15±1.80 in male and 23.96±1.67 in female. Meanwhile, it is well agreed that women tend to have a shorter axial length.[12]

In the current study it was seen that the mean axial length in older (45-54 years) age group was 23.38±0.72 mm which was less than that (24.86±1.89) of the younger group (5-14 years). Older people were likely to have shorter axial length than young participants.[13]

It was found in the present study that the axial length was more in high degree than that of low degree myopic eye (Table - 1).

The Difference in mean axial in the three groups (low degree, moderate degree and high degree) was found statistically sig-

Degree of myopia	Axial length (in mm)
Low Degree(≤3 D)	23.16±1.14
Moderate Degree(-3D to -6D)	23.77±0.88
High Degree(≥6 D)	26.40±1.70

Table–1: Axial length and degree of myopia

nificant. There were also found statistically significant negative correlation (correlation coefficient r= -0.823878331, p value <0.001) of axial length with myopic error. The refractive status of the eye is mainly dependent on the axial length. In general, the higher the myopia is, the longer the eyeball.[14] There were also similar significant correlation of the axial length with myopia was found in previous studies as per with present study. [Shu-wen Chang et al (2001).[15]

In the current study the overall mean intra ocular pressure in myopia found was 15.50±2.00 mm of Hg (range 12-20 mm Hg). The mean intra ocular pressure in myopic eye was similar to that of the present study in most of the previous studies. Becker et al. in their study reported a mean intra ocular pressure of 15.35mm Hg.[16]

It was seen in the current study that the mean intraocular pressure increases with the age. The study conducted by Abdulla MI and Hamdi M[17] also agreed that the intraocular pressure increases in the older myopes.

In the present study the mean intraocular pressure was found less in low degree (14.69±1.92 mm Hg) of myopic eye than that of moderate (16.12±1.64 mm Hg) or high degree (16.27±2.07 mm Hg) myopia, which was statistically significant. There were also found statistically significant negative correlation (Correlation Coefficient r=-0.222104148,p value <0.05) of intra ocular pressure with myopic error. Though there was no such type of correlation seen while degree of myopic error was considered. Abdulla MI and Hamdi M[17] had similar observation in their studies.

In the current study the overall mean central corneal thickness in myopic eye was found to be 0.509±0.026(range of 0.442-0.578 mm). The mean value in the current study was lower than the value of most of the past studies for myopic eye except that of Nazim Yacoub Mohamed et al.[18] whose values were lower than our value. It was difficult to comment whether the mean central corneal thickness was thinner than normal population as no control was recruited in the current study. Central corneal thickness was higher in males (0.510±0.031 mm) than females (0.508±0.020 mm) but was statistically significant. In the current study it was found that the mean central corneal thickness was greater in 15-24 years age group (0.527±0.016 mm) and lowest in 5-14 years age group (0.497±0.033 mm).

In the present study the mean (SD) central corneal thickness was found less in high myopia (0.479±0.022 mm) than that of moderate (0.518±0.017 mm) and low degree (0.518±0.022 mm) myopia. The difference in the mean central corneal thickness in between low degree and high degree and between moderate degree and high degree were found statistically significant however between low degree and moderate degree it was not significant. Statistically significant positive correlation (correlation coefficient, r=0.6398762, p value <0.001) were also found between central corneal thickness and myopic error. While the degree of myopia was considered, the correlation was found to be stronger on shifting from low degree to high degree.

The effect of myopic error on central corneal thickness has been reported by many investigators but results are conflicting. Some found that myopic subject have a thicker [Kunert et al. 2003[19]] others a thinner central corneal thickness [Von Bahr (1948)[20]] While yet others found no correlation between central corneal thickness and myopia [Ehlers and Tanaka et al. 1996[21]].

In the current study it was found that the axial length was not correlated with the intraocular pressure(correlation coefficient, r=0.13246706, p value>0.01),while degree of myopia was considered negatively correlated in low degree(correlation coefficient,r=-0.223532526, p-value<0.01) but not correlated in moderate degree (correlation coefficient, r=-0.070705173, p-value>0.10) and high degree (correlation coefficient, r=0.069433832, p value > 0.10) Lee AJ et al, (2004)[22] also found that the intraocular pressure was not correlated with the axial length (r=0.030). On the other hand Parssinen (1990)[23] found positive correlation between IOP and axial length among the boys.

In the current study it was found that the intraocular pressure was not correlated with the central corneal thickness, though positive value was found (Correlation Coefficient, r =0.016554215, p-value >0.10). While degree of myopia was considered, though positive values were found in all groups of myopia, but it was again statistically insignificant. The correlation Coefficient was 0.176762006 (p-value >0.05) in low degree, 0.178167601 (p-value >0.1) in moderate degree and 0.237887392 in high degree (p-value >0.1) respectively, the correlation of the intraocular pressure and the central corneal thickness has been reported by many investigators, majority of them found positive correlation.

Foster PJ (1998)[24] in a Mongolian population aged 10-87 years found significant positive correlation between intraocular pressure and the central corneal thickness. Andrew J. Morgan et al. (2002)[25] found that IOP was correlated significantly with central corneal thickness (r = +0.374, p = 0.010), such that a change of 10 micro meter in Central Corneal Thickness was equivalent to a 0.30mmHg change in measured IOP.

On the other hand Nemesure B et al. (2003)[26] in there study among the predominantly black population found the intraocular pressure was not associated with Central Corneal Thickness in this population.

Roomasa Channa et al. (2009)[27]also reported no statistically significant correlation between Central Corneal Thicknessand IOP (r = 0.158, p = 0. 12). In the present study it was found that the axial length was negatively correlated with the central corneal thickness (Correlation Coefficient, r = -0.430533391, p-value <0.001). While degree of myopia was considered it was also negatively correlated in high degree (Correlation Coefficient, r=-0.48585669 p-value <0.001). But in low degree it was positively correlated (Correlation Coefficient, r= 0.288438522p-value <0.01) and in moderate degree it was not correlated (Correlation Coefficient, r = 0.12916611, p-value>0.10). Shu-wen Chang et al. (2001)[28] also found that the cornea tend to be thinner in eyes with longer axial length.

CONCLUSION

The effect of myopia on the axial length, the intraocular pressure and the corneal thickness has been reported by many investigators and these are interrelated and are important determinants of myopia. Based on our findings, it can be concluded that the myopic refractive error and the axial length seem to have a significant correlation as such that with the increase of myopic refractive error there was increase of the axial length and it was evident in all the degrees of myopia.

The myopic refractive error and the intra-ocular pressure seem to have a significant correlation as such that with the increase of myopic refractive error there was increase of the intra-ocular pressure, however there was no such type of correlation seen while the degrees of myopia was considered. The intra-ocular pressure also correlated with the age of the patient as such that with the increase of age there was increase of the intra-ocular pressure.

The myopic refractive error and the central corneal thickness seem to have a significant correlation as such that with the increase of myopic refractive error there was decrease of the central corneal thickness. While the degrees of myopia were considered, this correlation was found to be stronger on shifting from low degree to high degree.

The intra-ocular pressure did not seem to have any correlation with the axial length and the central corneal thickness in myopic eyes.

There seem to have a significant correlation between the axial length and the central corneal thickness in higher degree of myopia, as such that more the axial length thinner the central corneal thickness.

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