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Original Research Article

A Study on Correlation between Axial Length of Eyeball and Degree of Myopia

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Abstract:

Background: Refractive errors are the most common cause of visual disorders. Amongst them, myopia is the most common disorder. In myopia as the axial length increases, the refractive power of the eye changes, causing images of distant objects to appear blurred. Understanding this relationship is crucial for diagnosing and managing myopia, especially in children and adolescents, where the progression of axial length can be rapid. Interventions, such as orthokeratology and pharmaceutical treatments, aim to slow the progression of myopia by targeting axial elongation. The current study aimed to study the correlation between axial length, age, sex, and complications associated with the degree of myopia.

Methods: Anterior segments of 110 eyes of patients were examined using a slit lamp biomicroscope. Visual acuity, cycloplegic refraction, retinoscopy, and fundoscopy were performed on all the selected patients after obtaining informed consent. The axial lengths that were obtained using A-scan were correlated with the degree of myopia. They were further sub-classified based on age, sex, familial factors, and complications.

Results: The results of myopia and axial length revealed a higher prevalence of myopia in females (65.57%) compared to males (34.43%). The majority of cases (50.82%) exhibited mild to moderate myopia (O to -3D), with a positive correlation between myopia degree and axial length. Common ocular complications included myopic crescent (32.73%), tessellated fundus (35.45%), and vitreous changes (16.36%). While less frequent, conditions like retinal detachment (2.73%), posterior staphyloma (1.82%), macular scar (2.73%), and central serous chorioretinopathy (1.82%) were also observed, emphasizing the importance of regular eye examinations for myopic individuals.

Conclusions: Within the limitations of the current we found that most cases of myopia were observed in females. A strong positive correlation exists between axial length and degree of myopia. Longer axial lengths were associated with a higher degree of myopia, and shorter axial lengths were associated with a lower degree.

Keywords: Axial Length, Myopia, Refractive Error, Visual Acuity.

Introduction

Refractive errors are the most prevalent cause of visual disorders, with myopia being the most common cause. Myopia, also known as short-sightedness, is a refractive error in which parallel rays of light from a distant object focus in front of the retina when the eye is at rest [1]. It affects people of all ages, ethnicities, and genders, and is a leading cause of vision impairment and blindness. Myopia is a global health concern due to its association with vision impairment and potentially blinding complications. Numerous studies have examined the prevalence of myopia in Indian populations. A meta-analysis by Agarwal et al. [2] investigated the prevalence of myopia among Indian schoolchildren aged 5-15 over the past four decades. The study found a crude overall prevalence of myopia of 7.5% (95% CI: 6.5-8.5%) in this age group. Notably, urban children exhibited a higher prevalence of myopia (8.5%, 95% CI: 7.1-9.9%) than rural children (6.1%, 95% CI: 4.5-7.7%). In the broader Indian adult population, the Andhra Pradesh Eye Disease Study conducted by Krishnaiah et al. [3] reported a higher age-gender-area-adjusted prevalence of myopia (spherical equivalent ≤ -0.5 D) at 34.6% (95% CI: 33.1-36.1) among individuals aged 40 years in Andhra Pradesh. The study also noted a significant increase in the prevalence of myopia, astigmatism, high myopia, and anisometropia with age. Focusing on specific regions of India, a study by Singh et al. [4] explored the prevalence and associated risk factors of myopia among schoolchildren in Gurugram,

Haryana, India. The research revealed a prevalence of myopia of 21.1% in this population, with higher rates among older children (aged 9-12 years, 27%) and a notable sex disparity, with boys showing a higher prevalence (3 of epidemiology). Studies in adults have found a myopia prevalence ranging from 19.4% in Taiwan to 41.8% in Japan. [5, 6] It is a condition that occurs as a result of increased global axial length or increased refractive power of the anterior segment; however, the former is more important. Various demographic characteristics have been associated with myopia. Factors such as female sex, young age, early onset of myopia, and positive family history have been associated with progressive myopia. Additionally, higher income and educational levels are often correlated with a greater degree of myopia, likely because of the increased amount of near work associated with these factors [7]. A large retrospective study by Grossniklaus and Green highlighted several abnormal posterior pole findings in pathological myopia, including tigroid fundus, tilted optic nerve, peripapillary detachment, chorioretinal atrophy, posterior vitreous detachment (PVD), retinal detachment, Foster-Fuch's spots, lacquer cracks, lattice degeneration, scleral thinning, and choroidal neovascularisation (CNV) [5]. Through the evaluation of axial length by Ultrasonography A A-scan, it is possible to determine the patients who have a high risk of developing myopia and start early treatment to slow the progression of the disease. Understanding axial length is beneficial in coming up with individual treatment plans, including prescribing the correct glasses and possibly a more suitable orthokeratology and atropine therapy for myopia control. Axial length is a major risk factor for myopia-related complications, such as retinal detachment, glaucoma, and cataracts; hence, a longer axial length poses a greater risk [8]. Knowledge of this relationship aids in evaluating risk and applying necessary measures to prevent or mitigate impending risks. Exploring the relationship between axial length and myopia not only deepens our knowledge of the disease but also furthers positive patient experiences and prevents potentially dangerous complications in patients with high myopia. With this background, the current study aimed to investigate the correlation between axial length, age, sex, and complications associated with the degree of myopia.

Material and Methods

This cross-sectional study was conducted in the Department of Ophthalmology, Sarojini Devi Eye Hospital, Hyderabad. Institutional Ethical approval was obtained for the study. Written consent was obtained from all the participants of the study after explaining the nature of the study in vernacular language. Those participants who were voluntarily willing to participate were included in the study.

Inclusion Criteria

1. Aged from 10 – 50 years
2. Males and Females
3. Attending OPD for diminished vision with pseudophakia, diabetes, and hypertension
4. Willing to participate in the study voluntarily

Exclusion Criteria

1. Patients with corneal pathologies,
2. lenticular opacities, glaucoma,
3. retinitis pigmentosa,
4. uveitis.

The study involved patients experiencing blurred vision who were willing to participate. After obtaining written informed consent, a detailed history of their complaints, onset, duration, past use of spectacles, and family history were collected. Patients were screened in the outpatient department, with visual acuity for distance determined using Snellen's chart, and pinhole improvement noted. Cycloplegic refraction was performed for patients aged 10 to 15, and retinoscopy was conducted for all participants. Refraction readings were taken using a retinoscope in a dark room, and subjective correction was provided. Cycloplegic agents like cyclopentolate (0.5 to 1%) were used, and patients were scheduled for post-mydriatic refractive correction after three days. For autorefractometer measurements, three consecutive readings were taken, with the average used for analysis. Patients were reviewed again to assess subjective dioptric refractive acceptance and prescribed appropriate refractive correction. The results of objective refractometry were compared to subjective dioptric acceptance results. The following measurements in dioptres (D) were recorded for analysis: 1. Spherical Power 2. Cylindrical Power 3. Spherical Equivalent (Spherical Power + (0.5× Cylindrical Power) 4. Axis. Patients with myopia were further examined with slit lamp and fundus examinations using direct or indirect ophthalmoscopes. The procedure for measuring axial lengths using an A-scan was explained, and the axial lengths obtained were correlated with the degree of myopia. Patients were further categorized based on age, sex, familial factors, and complications.

Statistical analysis: All the available data was refined organized and uploaded to an MS Excel spreadsheet and analyzed by SPSS version 21 in Windows format. The continuous variables were represented as mean, standard deviation, and percentages, and categorical variables were calculated using the chi-square test for differences between the two groups. The values of p (<0.05) were considered as significant.

Results

In the present study, the axial lengths of 110 eyes were measured using the A-scan ultrasonography. Table 1 depicts the distribution of Myopia by Gender The majority of cases (65.57%) were observed in females, indicating a higher prevalence of myopia in this gender group compared to males. Males accounted for 34.43% of the study population. This suggests a gender disparity in the prevalence of myopia, with females being more likely to develop the condition than males. This finding is consistent with previous studies reporting a higher incidence of myopia in females.

Table 1: Shows the distribution of myopia in gender included in the study

Gender	Frequency	Percentage
Male	21	34.43
Female	40	65.57
Total	61	100

Table 2 depicts the distribution of myopia cases based on the degree of myopia. The majority of cases (50.82%) fall within the O to -3 D range (Mild Myopia), indicating a predominance of lower degrees of myopia in the study population. Moderate Myopia (-4 to -6 D) was 18% of the total patients, indicating a noticeable but less common degree of myopia compared to mild myopia. Moderate to High Myopia (-7 to -9 D) This category was 16.39% of the cases, showing a significant decrease in prevalence as the degree of myopia increases. While few, cases of high myopia (-13D and above) are present in the study. This shows a clear trend where the number of patients decreases as the degree of myopia increases. Mild myopia is the most prevalent, affecting half of the patients, while severe and extreme myopia is rare. This pattern suggests that higher degrees of myopia are less common in our cohort.

Table 2: Correlation Between the Degree of Myopia and Number of Patients

Degree of Myopia	No. of Eyes	No. of Patients	Percentage
O to -3D	62	31	50.82
-4 to -6D	17	11	18.03
-7 to -9D	15	10	16.39
-10 to -12D	6	3	4.91
-13 to -15D	4	3	4.91
-16 to -18D	4	2	3.27
-19 to -21D	2	1	1.64
Total	110	61	100

Figure 1 presents the distribution of myopia cases based on the degree of myopia and corresponding axial length ranges. Correlation between Myopia and Axial Length: The data suggests a positive correlation between the degree of myopia and axial length. As the degree of myopia increases, there is a general trend towards higher axial length ranges. Distribution of Myopia: The majority of cases fall within the lower degree of myopia (O to -3D) with a corresponding axial length range of 21 to 25 mm. Decreasing Frequency with Increasing Severity: As the degree of myopia increases, the number of cases decreases, indicating a lower prevalence of higher degrees of myopia. The data supports the established relationship between myopia and axial length elongation. Eyes with higher degrees of myopia tend to have longer axial lengths

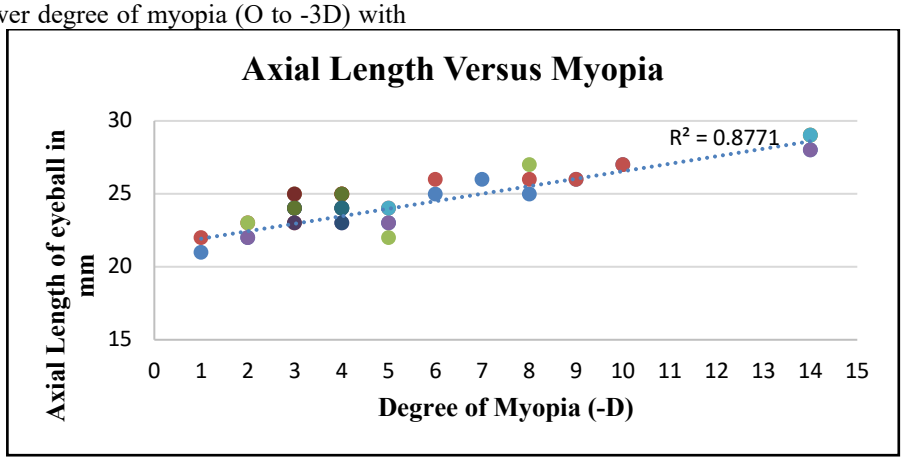

Figure 1: Correlation Between Range of Axial Length and Degree of Myopia

Table 3 presents the distribution of various fundus changes observed in a group of myopic eyes. The important fundus changes observed were myopic crescent and tessellated fundus are the most common fundus changes, together accounting for nearly 70% of the cases. The prevalence of fundus changes decreases progressively from myopic crescent to peripheral retinal degeneration. Vitreous changes represent a significant proportion (16.36%) of the observed fundus abnormalities. This suggests that myopic eyes are prone to specific fundus changes, with myopic crescent and tessellated fundus being the most frequently observed. The presence of vitreous changes, choroid degenerative changes, Fusch's spots, and peripheral retinal degeneration highlight the potential for more severe complications associated with myopia. The findings underscore the importance of regular fundus examination in myopic patients to detect early signs of complications. Early identification of fundus changes can facilitate timely intervention and potentially prevent vision loss.

In this study, a record of family history of myopia was done in which we observed that 15(24.59%) cases had a family history of myopia present and the remaining 46(75.4%) did not have a family history of myopia.

Table 3: Showing the result of Myopic Eyes with Fundus Changes

Fundus Features	Frequency	Percentage
Myopic crescent	36	32.73
Tessellated fundus	39	35.45
Vitreous changes	18	16.36
Choroid degenerative changes	8	7.27
Fusch's spots	6	5.45
Peripheral retinal degeneration	3	2.73
Total	110	100.00

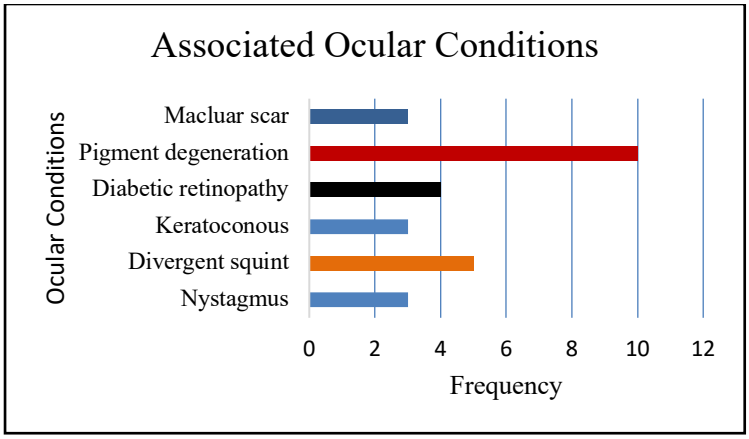

Figure 2: Myopic Cases with Associated Ocular Conditions

Figure 2 shows the frequency and percentage of various ocular conditions observed in patients with myopia. Pigment degeneration is the most frequent ocular condition (10 cases, 9.09%), followed by divergent squint (5 cases, 4.54%) and nystagmus (3 cases, 2.73%). Night blindness was not observed in any of the patients.

Table 4: Degree of Visual improvement with glasses recorded in the cases of the study

Visual Improvement	No of eyes	Percentage
6/6 – 6/9	53	48.18
6/12 – 6/18	23	20.9
6/24 – 6/36	17	15.45
6/60 – CF 3mtrs	10	9.09
CF 2mtrs – CF 1 mt	5	4.54
No improvement	2	1.81
Total	110	100.0

Table 4 presents the distribution of visual improvement achieved with glasses in a group of patients. Majority Achieved Significant Improvement: A significant majority of patients (83.64%) experienced visual improvement of at least 6/60 to CF 3 meters. Best Visual Acuity: The largest group of patients (48.18%) achieved a visual acuity of 6/6 to 6/9 with glasses. Minimal Improvement: A small percentage of patients (1.81%) showed no improvement in visual acuity

with glasses. This indicates that glasses were effective in improving vision for a majority of patients. While a small group experienced minimal or no improvement, the overall trend suggests that corrective lenses were beneficial in enhancing visual function.

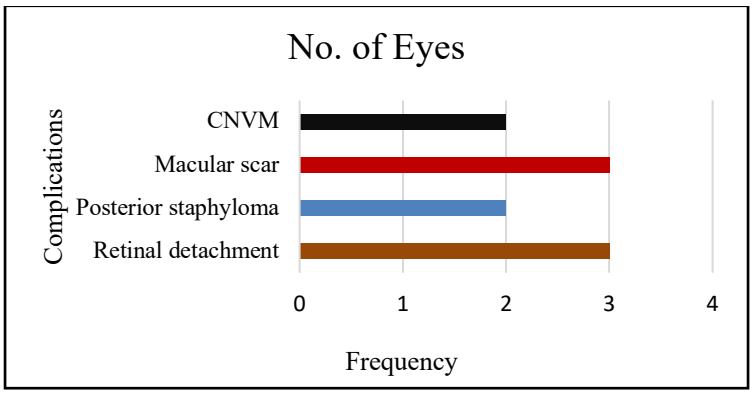

Figure 3: Frequency of Myopic Eyes Showing Complications

Figure 3 presents the frequency and percentage of various complications associated with myopia in a sample population. Low Prevalence of Complications: The overall percentage of complications is relatively low (10.91%). Retinal Detachment and Macular Scar: These complications appear to be the most prevalent, each affecting around 2.73% of the eyes. Posterior Staphyloma and (Choroidal neovascular membrane) CNVM: These complications have a lower incidence, affecting less than 2% of the eyes. The data suggests that while complications associated with myopia are not uncommon, their overall prevalence is relatively low in the studied population. Retinal detachment and macular scar seem to be the most significant concerns.

Discussion

The important findings of the present study show a higher prevalence of myopia in females (65.57%) compared to males (34.43%). The majority of cases (50.82%) exhibited mild to moderate myopia (O to -3D), with a positive correlation between myopia degree and axial length. Common ocular complications included myopic crescent (32.73%), tessellated fundus (35.45%), and vitreous changes (16.36%). While less frequent, conditions like retinal detachment (2.73%), posterior staphyloma (1.82%), macular scar (2.73%), and central serous chorioretinopathy (1.82%) were also observed, emphasizing the importance of regular eye examinations for myopic individuals. Sudhakar et al. [9] in a similar study on one hundred myopic participants (two hundred eyes) with the participants' ages ranged from 6 to 60 years. Axial length was ascertained using A-scan Ultrasonography. The study showed that the mean axial length was positively related to the degree of myopia, with a correlation coefficient of 0.9475. The conclusions of this study were similar to those of the present study. Tideman et al. [10] conducted an extensive population-based study to explore the relationship between axial length and the risk of uncorrectable visual impairment in people with myopia. The results indicated that a longer axial length is linked to an increased risk of visual impairment, highlighting the importance of understanding axial length's role in myopia-related complications. They identified various risk factors, including parental myopia and reduced outdoor activity, associated with faster axial length growth in children aged 6 to 9. These findings emphasize the significance of considering environmental and behavioral factors in understanding the association between axial length and myopia. Saw et al. [11] tracked myopic children aged 7-9 over three years, finding a significant increase of 0.89 mm in axial length. This growth was more evident in younger children, females, and those with a parental history of myopia.

Yang et al. [12] observed that ultrasound biometry was the best method for axial length measurements. Reports by Hauff W,15 using a 10 MHz sound probe for A-scan biometry, enabled measurements of the axial lengths of the eye to within an accuracy of 0.1 mm. In the present study, it was noted that the degree of myopia progressively increased with an increase in axial length, especially >-6D. Beyond, -6D a definite relationship between axial length and the degree of myopia was observed. Each degree of myopia corresponded to an increase of 0.39 mm in the axial length. Nicolcescu et al. [13] concluded that axial myopia is the most frequent form of myopia. In this study of axial myopia, 34.3% of the subjects were males and 65.5% were females. Studies conducted by Wang 17 et al reveal a higher prevalence of myopia in females than in males in all age groups. In the present study, the majority of patients with shorter axial lengths had myopia of less than -6D and mainly showed a physiological fundus. All eyes with >-15D had pathological myopic fundus changes. The incidence and severity of

complications showed an increase in axial length and degree of myopia. Similar findings have been reported by Curtin et al. [14] He reported an increased frequency of crescents with an increase in axial lengths. In the present study, tessellated fundus and optic disc crescents were the most common posterior pole findings. Karlin et al. [15] reported that the frequency of crescents increased with axial length until all eyes larger than 29 mm had crescents. Pigmentary degeneration was commonly in the 51-60 and >60 years age groups.

Conclusions

Within the limitations of the current, we found that most cases of myopia were observed in females. A strong positive correlation exists between axial length and degree of myopia. Longer axial lengths were associated with a higher degree of myopia, and shorter axial lengths were associated with a lower degree of myopia. In addition, high degrees of myopia were associated with complications and compromised quality of life due to poor vision compared to low degrees of myopia associated with fewer complications and good quality of life due to good vision.

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