Ophthalmic A - Scan ultrasonography studies in myopia

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Abstract

Background: Refractive errors are a common cause of visual disorders, of which myopia (short sightedness) is the most common; one that usually occurs in isolation from other eye and systemic disorders. Axial myopia is the most common type of myopia. Higher degrees of axial myopia are commonly associated with increased incidence and severity of complications.

Objectives:

1. To establish a correlation between axial length, degree of myopia, degenerative changes and visual acuity.
2. To determine differences in axial lengths in the two genders and different age groups.

Methods: Axial lengths of 400 myopic (786 eyes) were determined using A scan ultrasonography. Informed consent was obtained from the subjects after explanation of the nature and possible consequences of the study and this study was approved by ethical committee.

Results: 53.5% of subjects were males and 46.5% were females in the present study. Studies revealed a wide range of axial lengths varying from 21.45 mm to 32.94 mm. Subjects having <–6D constituted 69% of the cases. Axial lengths progressively increased with the degree of myopia that was particularly valid in case >–6D. Myopia >–6D (25.5mm) was commonly associated with degenerative changes, the severity increasing progressively with increase in axial lengths with all eyes >–15D (>28mm) having severe complications. Lesser degrees of myopia with normal axial lengths had best uncorrected and corrected visual acuities. In general, higher degrees of myopia > –15D (29 mm) had poor uncorrected and corrected visual acuities.

Conclusion: Statistical correlation between axial lengths and degree of myopia was seen. Correlation was obtained between axial lengths, degree of myopia, fundus changes and visual acuity, implying higher grades of myopia with increased axial lengths had greater retinal degenerations and complications, resulting in less than normal visual acuity. No correlation was established between axial lengths in different age groups.

Keywords: Axial myopia; A scan biometry; Ultrasonography; Visual acuity; Myopia complications; Axial length.

Introduction

Refractive errors are a common cause of visual disorders, of which myopia is the most common; one that usually occurs in isolation from other eye and systemic disorders[1]. It is a condition occurring as a result of increased global axial length or increased refractive power of the anterior segment or both. The word myopia comes from the Greek - “myein” (to close) and “ops” (Eye) and describes the behaviour of a short sighted person attempting to focus on objects far away from him by using the stenopaeic, that allows him to narrow the palpebral tissue[1, 2]. In the majority of cases, myopia is of axial type; due to increase in the antero-posterior diameter of the eye. Higher degrees of myopia are known to be associated with higher axial lengths and higher incidence and severity of complications. This study was taken up with the following objectives:

1. To measure the axial length of myopic eyes using A-Scan USG and to establish a correlation between the axial length and the degree of myopia.

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2. To determine any differences in axial myopia in the two genders.
3. To determine any differences in axial length of myopic eyes in the different age groups.
4. To establish a correlation, if any, between the degree of myopia, axial length, the degenerative changes and complications of myopia.
5. To establish a correlation if any between the degree of myopia, axial length and the visual acuity.

Materials and Methods

The present study was carried for a period of 2 years from February 2014 to March 2016 on all patients (above the age of 6 years) attending the ophthalmology OPD at Basaveshwar Teaching and General Hospital, Gulbarga for diminution of vision.

By using the formula for prevalence rates (19.4%) $4pq/L^2$, a total of 400 cases were selected by simple random sampling on the basis of complaints of diminution of vision.

All the patients underwent the following procedures: Detailed history; Distant Visual acuity was determined with Snellen's chart; Dry retinoscopy was performed in adults; Wet Retinoscopy readings in children were done using cyclopentolate (1%) E/D and were called on next day for post mydriatic test correction; Slit lamp bio microscopy; Fundus examination with direct and indirect ophthalmoscopy; Keratometry; and A–scan Biometry.

Results

In the present study, carried out for a period of two years, axial lengths of 400 myopic subjects (786 eyes) were measured using the A scan ultrasonography.

–0 to –3D constituted the largest number of myopic eyes examined i.e., 43% followed by –3 to –6D (26.34%). A progressive increase in the mean axial length with increase in the dioptric power was seen. A wide range of axial lengths were seen ranging from 21.45mm to 32.94 mm.

Table 1: Proportion of Myopia in the two genders

Gender	No. of Cases	Percentage
Male	214	53.5
Female	186	46.5
Total	400	100

Males constituted 53.5% of the total cases seen while females constituted 46.5% of the total cases (Table 1).

Table 2: Range of axial lengths in different age groups

Age group (years)	No. of myopic eyes observed	No. of cases observed	Percentage of cases	Mean axial length (mm)
6 – 10	24	12	3.00	22.24 – 26.33
11 – 20	225	115	28.75	21.45 – 32.94
21 – 30	270	138	34.5	22.38 – 31.83
31 – 40	124	63	15.75	22.76 – 31.86
41 – 50	71	36	9.00	22.85– 28.38
51 – 60	40	20	5.00	23.36 – 30.98
> 60	32	16	4.00	22.72 – 29.88
Total	786	400	100. 00	

The above table shows a wide range of axial lengths that can be observed in any age group. 11-20 years age group constituted the largest range of axial length i.e., 21.45 to 32.94 mm.

Table 3. Correlation between fundus changes, degree of myopia and axial lengths

Degree of myopia	No. of eyes examined	Percent of cases	Range of axial length (mm)	Mean axial length (mm)	Degenerative changes and complications
0 to –3.0	338	43.00	21.45 to 25.89	23.29	Phy, Int
–3.0 to –6.0	207	26.34	22.38 to 26.58	24.30	Phy, Int, Path
–6.0 to –9.0	89	11.32	24.81 to 26.72	25.52	Int, Path
–9.0 to –12.0	51	6.49	25.81 to 26.72	26.51	Int, Path
–12.0 to –15.0	34	4.33	27.00 to 27.92	27.45	Int, Path
–15.0 to 18.0	30	3.82	28.04 to 29.26	28.45	Path
–18.0 to –21.0	13	1.65	29.14 to 30.26	29.32	Path
–21.0 to - 24.0	14	1.78	30.12 to 31.24	30.52	Path
>–24.0	10	1.27	31.32 to 32.94	31.81	Path

The myopic fundus changes seen have been classified into Physiological (Phy), Intermediate (Int), Pathological (Path) (Duke-Elders classification)

The above table shows that lesser degrees of myopia (<-3D) with mean axial length 23.29mm had physiological or intermediate type of myopic fundus changes.

Table 4. Correlation between degree of myopia, axial lengths and visual acuity

Degree of myopia	No. of eyes examined	Percent of cases	Range of axial length (mm)	Mean axial length (mm)	Range of uncorrected visual acuity	Range of corrected visual acuity
0 to –3.0	338	43.00	21.45 to 25.89	23.29	6/6 to 6/60	6/6 to 6/9
–3.0 to –6.0	207	26.34	22.38 to 26.58	24.30	6/24 to 1/60	6/6 to 6/12
–6.0 to –9.0	89	11.32	24.81 to 26.72	25.52	6/60 to 1/60	6/9 to 6/18
–9.0 to –12.0	51	6.49	25.81 to 26.72	26.51	6/60 to 1/60	6/9 to 6/24
–12.0 to –15.0	34	4.33	27.00 to 27.92	27.45	6/60 to CF2’	6/9 to 6/24
–15.0 to 18.0	30	3.82	28.04 to 29.26	28.48	5/60 to CF1’	6/12 to 6/36
–18.0 to –21.0	13	1.65	29.14 to 30.26	29.32	4/60 to CF2’	6/12 to 6/36
–21.0 to 24.0	14	1.78	30.12 to 31.24	30.52	3/60 to CF1’	6/12 to 6/36
>–24.0	10	1.27	31.32 to 32.94	31.81	4/60 to CF1’	6/18 to 6/60

The above table shows that the lower degrees of myopia with shorter axial lengths had the best uncorrected and corrected visual acuities. The higher degrees of myopia with larger axial lengths had the worst uncorrected and corrected visual acuities. It is seen that as the dioptric power and axial lengths increase, the visual acuity decreases.

Table 5. Number and Percentage of myopic eyes showing fundus changes

Myopic Fundus Changes	No of eyes seen	Percentage
Myopic crescent	365	46.44
Tesselated fundus	339	43.12
Vitreous changes	191	24.30
Nasal supertraction crescent	122	15.52
Chorioretinal degenerative patches	125	15.90
Peripheral retinal degenerations	251	31.93
Fuchs spot	28	3.56
Choroidal hemorrhage	32	4.07

Myopic crescent was the most common finding seen in 46.44% of myopic eyes; tesselated fundus was the next common finding observed in 43.12% of myopic eyes; and peripheral retinal degenerations (LD, WWP, PSD, PD, RB) were seen in 31.93%.

Table 6. Myopic eyes with peripheral retinal degenerations seen in each age group

Age (years)	LD	WWP	PSD	PD	RB
6 – 10	3	2	0	0	0
11 – 20	60	38	5	3	25
21 – 30	54	44	7	2	24
31 – 40	4	3	30	0	3
41 – 50	0	2	14	4	0
51 – 60	0	0	0	9	0
> 60	0	0	0	12	0
	121	89	56	30	52

The above table shows that lattice degeneration (LD) and white without pressure (WWP), commonly occur in 11-20 and 21-30 age groups. Paving stone degeneration (PSD) occurs in 31-40 and 41-50 age groups. Pigmentary degeneration (PD) is commonly seen in 51-60 and >60 age groups. Retinal breaks (RB) commonly occurred in 11-20 and 21-30 age groups.

Table 7. Axial lengths at which peripheral retinal degenerations were seen

Peripheral retinal degeneration	Range of Axial length (mm)	Mean Axial length (mm)
LD	25.7-32.94	27.75
WWP	24.62-32.33	26.71
PSD	24.36-31.86	26.36
PD	23.89-30.98	26.20
RB	25.70-32.94	29.02

The above table shows that peripheral retinal degenerations were seen in axial lengths ranging from 23.89 to 32.94 mm.

Discussion

The axial lengths of 400 myopic subjects (786 eyes) were measured using the A scan ultrasonography in the present study carried out over a period of 2 years.

Table 8 shows the results of four studies measuring the range of axial lengths in different degrees of myopia.

Table-8. Range of axial length in low and high myopia

	Axial length (mm)	
	Low myopia (< –6D)	High myopia (> –6D)
Tron[3] (Computation)	22.19 – 28.08	24.88 – 38.18
Deller [4] (Radiologic)	20.5 – 26.0	25.5 – 28.5
Stenstrom[5] (Radiologic)	22.0 – 28.0	23.5 – 29.50
Sorsby et al [6] (computation)	22.01 – 28.0	25.01 – 37.0

Yang J, Song X, Wang Y[7] in their paper published in 1997 observed that ultrasound biometry to be the best method of axial length measurement.

Reports by Hauff W[8], using 10 MHz sound probe for A scan biometry enabled measurements of the axial lengths of the eye to within an accuracy of 0.1mm.

Subjects having 0 to –3D of myopia and –3 to –6D of myopia accounted for 69% of the subjects in this study and their average axial lengths were 23.29 mm and 24.30mm respectively.

In the present study, it was noted that in general the axial lengths progressively increased with the degree of myopia especially in cases having greater than –6D of myopia. The highest degree of myopias had the largest axial lengths. The same however could not be said in lesser degrees of myopia (<–6D) where even eyes with smaller axial lengths than normal (23-24 mm) had considerable degrees of myopia in some subjects.

Beyond –6D of myopia, a definite relationship between the axial length and degree of myopia was seen. Every degree of myopia corresponded to approximately an increase by 0.39 mm in the axial length. This was however, found to be valid only for myopias of greater than –6D.

Nicolcescu AM[9] concluded that axial myopia is by far the most frequent form of myopia. In these cases, the increase in axial length was proportional with the degree of myopia.

In this study of axial myopia, 53.5% of the subjects were males and 46.5% were females. This probably signifies an increased incidence of axial myopia in males than in females

Studies conducted by Wang et al[10] reveal a higher prevalence of myopia in females compared to males in all age groups (Table 9). This was attributed to the higher educational exposure in this sample.

Table-9: Gender difference in refraction (%) Wang et al[10]

Age group (years)	Gender (%)	
	Female	Male
43 – 54	47.50	37.80
55 – 64	26.50	23.40
65 – 74	15.90	13.30

It could also be as per Krause et al[11] hypothesis that if the onset of myopia is late, males are more myopic compared to females.

The least number of myopic patients in this study were in the age groups of 6-10 years, hence these age groups also had the smallest range of axial lengths. The age groups 11-20 and 21-30 years constituted 63.25% of the subjects, showing the high incidence of axial myopia in these groups. Similar findings have been reported by Saunders [12] in his description of age related changes in refraction. He reports a progression to myopia reaches a maximum around the 30s and then regresses towards hypermetropia.

In the present study, the majority of cases having myopia of less than –6D, also had smaller axial lengths and showed mainly a physiological myopic fundus. All eyes greater than –15D had a pathological myopic fundus. The incidence and severity of complications showed an increase in the axial lengths and the degree of myopia. It was noticed that in cases having myopia over –15D, the degenerative changes were severe and the complications were common. The axial lengths of these subjects usually exceeded 28 mm

Similar findings have been reported by Curtin BJ[13]. He reports an increased frequency of crescents with increase in axial lengths. Curtin BJ[13] also assessed the relationship between different axial lengths (from 21 mm to 36.6 mm) and peripheral lesions. He concluded that in general eyes of greater axial lengths (26.5 mm) had a higher incidence of peripheral retinal lesion.

Table-10: Axial length range and retinal lesions

Axial length (mm)	Total eyes		Eyes with one or more lesions		Eyes with no lesions	
	No.	Percent	No.	Percent	No.	Percent
24 – 24.9	37	7.20	13	4.78	24	9.96
25 – 25.9	30	5.80	17	6.25	13	5.39
26 – 26.9	59	11.6	30	11.03	29	12.03
27 – 27.9	66	12.9	34	12.5	32	13.28
28 – 28.9	73	14.2	32	11.76	41	17.01
29 – 29.9	68	13.3	35	12.8	33	13.69
30 – 30.9	60	11.7	37	13.6	23	9.54
31 – 31.0	38	7.40	23	8.46	15	6.22
32 – 32.9	50	9.7	33	12.13	17	7.05
> 33	32	6.2	18	6.62	14	5.81
Total	513	100	272		241	

The above table shows the frequency of one or more lesions is significantly more in the higher axial length ranges except in >33 mm where it was found to be low by the author Pierro L[14].

Similarly, in the present study, peripheral retinal degenerations were more common in the higher mean axial lengths.

In the present study, optic disc crescent was found to be the most common posterior pole findings, lattice degeneration was found to be the most common peripheral fundus findings.

Optic disc crescents were commonly seen in axial lengths >25 mm (i.e., >-6D) in the present study. Lattice degeneration was commonly seen with a mean axial length >27.75 mm (i.e., >-15D). (range 25.7 to 32.94mm). Similar findings have been reported by Karlin DB[15]. They reported that the frequency of crescents increased with the axial length until all eyes larger than 29 mm had crescents.

Increased frequency of lattice degeneration has been reported in the 2nd decade by Curtin BJ[10] and an increased frequency of pigmentary and paving stone degeneration in the 5th and 6th decade. Similar findings were obtained in the present study. Lattice degeneration and white without pressure commonly occurred in 11-20 and 21-30 age groups. Paving stone degeneration commonly occurred in 31-40 and 41-50 age groups. Pigmentary degeneration was seen commonly in 51-60 and >60 age groups. Retinal breaks commonly occurred in 11-20 and 21-30 age groups.

Conclusion: A statistical correlation between the degree of myopia, axial length and the degenerative changes and complications of myopia was seen. Axial lengths correlated best with the degenerative changes and complications. Lower degrees of myopia has good uncorrected and corrected visual acuities while the higher grades of myopia having larger axial lengths had the worst visual acuities, both uncorrected and corrected.

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