DOI: 10.7860/JCDR/2026/82736.22410

Original Article

Ophthalmology Section

Retinal Degenerative Changes and Complications in Pathological Myopia: Cross-sectional Study from a Tertiary Care Centre

ATHIRA AJAYGHOSH[1], GANDAVARAPU ASRITHA[2], SHARON MARY GEORGE[3], RUTHRA[4]

ABSTRACT

Introduction: Higher degrees of pathologic myopia are more frequently associated with degenerative changes which occur in the posterior segment of an eye with high myopia. Early identification of the complications due to pathological myopia will help in the identification of patients with high-risk and the need for frequent follow-up and screening of the fundus.

Aim: To study the presence of degenerative changes in the fundus among patients with pathological myopia, and to compare these fundus changes among the various categories of pathological myopia.

Materials and Methods: This is a cross-sectional study conducted in the Outpatient Department (OPD) of Ophthalmology, SRM Medical College Hospital and Research Centre, Chennai, Tamil Nadu, India, from July 2023 to June 2024. Based on predetermined inclusion and exclusion criteria, 144 patients with high myopia (≥–6.00 dioptres (D); axial length >26 mm) who were seen in the Ophthalmology OPD were enrolled. Following informed consent, demographic information and a thorough examination of the eyes, including a history, evaluation of the anterior and posterior segments (fundus examination), and a visual acuity test were conducted. Refractive error was used to stratify patients into three groups: >-14D, -14D to -10D, and -6D to -10D. Retinal degenerations, tessellated backgrounds, tilted discs, myopic crescents, peripapillary atrophy, lacquer cracks, posterior staphylomas, foster fuchs spots, chorioretinal atrophy, retinal tears/breaks, and retinal detachment are among the degenerative changes linked to high myopia that were recorded and compared across categories. Data was recorded in MS Excel sheet and analysis was done using Statistical Package for Social Sciences (SPSS) software version 16.0. A p-value less than 0.05 was considered a cut-off for statistical significance.

Results: The study involved 288 eyes (144 patients). The mean age among the subjects was 43.93 (±16.99) years, ranging from 13 to 89 years. Among the subjects, 75 (52.08%) were females, and 69 (47.92%) were males. Among the subjects, 107 eyes (37.15%) had 6-10D followed by 93 eyes (32.29%) had >10 - 14D and least 88 eyes (30.56%) had >14D. Most common abnormalities observed in the study was tessellated background among 254 eyes (88.19%), 143 eyes (49.7%) had peripapillary atrophy, 41 eyes (14.2%) had chorioretinal atrophic patch, 40 eyes (13.9%) had retinal tear, 22 eyes (7.6%) had tilted disc, 18 eyes (6.3%) had lattice degeneration, 16 eyes (5.6%) had staphyloma. Subjects with greater myopia (>14D) had a significantly higher proportion of peri-papillary atrophy, tessellated background, retinal tear, tilted disc, lattice degeneration, chorioretinal atrophic patch, staphyloma, lacquer cracks, atrophic retinal hole, and retinal detachment.

Conclusion: Tessellated background, peripapillary atrophy, myopic crescent, chorioretinal atrophic patch, retinal tear, tilted disc, lattice degeneration, and staphyloma are common abnormalities observed in high-grade myopia. Hence, early screening of these abnormalities and effective control of myopia can prevent these abnormalities.

Keywords: Categories of high myopia, Fundus degenerations, Papillary atrophy, Refractive error, Retinal pathology, Short-sightedness

INTRODUCTION

The importance of the retina is ever-increasing not only in the field of science, but also in the field of ophthalmology for its unique anatomy, organisation, and physiology. The retina is primarily responsible for the visual function of an eye. The knowledge which is providing more accurate and detailed information about the topography of the retina, its anatomical relationships, and the variations in the development of the different degenerations of the retina, helps in providing the proper information for the understanding of findings [1-3].

Myopia (short-sightedness or near-sightedness) is a kind of refractive error resulting from the excessive axial elongation [4,5]. Myopia is one of the causes of impairment in visual acuity, not only among school-going children, but also in adults. The prevalence of myopia is increasing globally by 2050 high-grade myopia will be affecting 9.8% of the global population, especially among the young adults of urbanised East and Southeast Asian countries [6-8]. High-grade myopia is one of the common causes of social blindness [9].

Myopia can be corrected by optical glasses, contact lenses, and refractive correction surgeries. Myopia is associated with complications such as Myopia-related Macular Degeneration (MMD), Detachment of the Retina (RD), cataract, and glaucoma of open-angle [10]. The global expansion of the eye is a slower process that happens during the life of a human, resulting in the complication of blindness [11].

Pathologic myopia arises when there is a high myopia or severe form of myopia (described as an eye with an error of refraction of >-6.0 dioptres), which is usually associated with specific degenerative changes arising in the choroid, sclera, and Retinal-pigment Epithelium (RPE) coupled with decreased vision [12-14]. Pathologic myopia is usually an isolated condition without associated co-morbidities. Pathological changes due to myopia, occurring in the retina, are one of the causes of irreversible blindness [15].

Eyes with myopia exhibit elongation of the axial length with increased expansion of the sclera, dehiscence, cataract formation and formation of posterior staphyloma. Most commonly, retinal tears of the peripheries, macular hole with or without retinal degeneration and retinal-detachment are seen in myopic patients [9].

Pathological myopia represents a major global cause of irreversible vision loss, with its prevalence on a significant rise [7]. The progressive elongation of the ocular globe leads to a spectrum of degenerative changes, including chorioretinal atrophy and lacquer cracks, which can predispose patients to vision-threatening complications. These complications, such as myopic choroidal neovascularisation and myopic foveoschisis, are the primary drivers of severe visual impairment [16]. A deeper understanding of the prevalence and progression of these complications within specific populations is essential for developing effective screening and management strategies.

The present study aimed to establish the association between various degrees of myopia and the severity of retinal changes in pathological myopia, by evaluating and comparing fundus changes across various categories of high-grade myopia to aid in early identification of high-risk patients and determine the need for frequent follow-up.

MATERIALS AND METHODS

This cross-sectional study was conducted in the Department of Ophthalmology at SRM Medical College Hospital and Research Centre, Kattankulathur, Chennai, Tamil Nadu, India, over one year, from July 2023 to June 2024. Institutional Ethical Committee (IEC) clearance approval, from SRM Medical College, Hospital and Research Centre, Kattankulathur, Chennai (2407/IEC/2021) was acquired before the commencement of the study. Written informed consent was acquired from each subject. They were given the option to quit the study if they desired them at any point in time. All data were kept confidential. The

Inclusion criteria: A total of 144 patients with high myopia (≤–6.00D) and an axial length greater than 26mm, attending the Ophthalmology OPD at SRM Medical College Hospital and Research Centre, Kattankulathur, Chennai, were selected for this study. Patients having refractive error of ≤–6.00 dioptres and an axial length ≥26 mm were selected for the study.

Exclusion criteria: Patients with visual impairment due to cataract, a history of ocular surgery, congenital retinal degenerations or dystrophies (such as retinitis pigmentosa, Stargardt disease, or cone dystrophies), a refractive error greater than –6.00 dioptres (i.e., not meeting the high-myopia criteria), other ocular diseases (including glaucoma, diabetic retinopathy or retinal detachment), and those with systemic co-morbidities such as hypertension or diabetes mellitus were excluded from the study.

Sample size calculation: According to Saw SM et al., study, considering the occurrence of retinal changes in pathological myopia as 14% with an absolute precision of 5.67% and 95% interval, the required sample size for this study is calculated as [17],

$$N = \frac{Z21\text{-}a/2^{*}p^{*}\ (1 - p)}{d^{2}}$$

Z1-a/2 - two-tailed probability for 95% confidence-interval = 1.96

p (%) - occurrence of retinal changes in pathological myopia = 0.14

d (%) absolute precision for Retinal changes in pathological myopia = 0.0567

$$N = \frac{1.96^{2*}\ 0.14\ ^{*}\ (10.14)}{0.0567^{2}}$$

N = 143.87

Thus, the total minimum required sample size for the study is 144.

Study Procedure

After obtaining informed consent from the participants in both English and their Vernacular language, demographics (age, race, and gender) will be recorded, and a complete ocular examination will be performed for each patient with high myopia. This includes the detailed history of the patients, visual acuity evaluation, followed by detailed anterior and posterior segment examination.

High-grade myopia is described as an axial length of 26.5mm or more, or refractive error of at least -6.00D [5]. Patients with high myopia are divided as three categories based on the degree of myopia as:

1) -6D to -10D
2) 2)-10D to -14D
3) >14D

Degenerative changes are noted and followed-up in each high myopia category and compared.

Expected degenerative changes in cases of high myopia:

- Retinal degenerations
  - Tessellated background
  - Tilted disc
  - Myopic crescent
  - Peripapillary atrophy
  - Lacquer cracks
  - Posterior staphyloma
  - Foster fuchs spots
  - Chorioretinal atrophy
- Retinal detachment
- Retinal tear or break

STATISTICAL ANALYSIS

Statistical analysis was performed using both descriptive and inferential methods. While qualitative factors, such as fundus changes and the degree of myopia were expressed as percentages and frequencies, numerical variables, such as age and length of sickness, were summarised using mean, standard deviation, and median. The SPSS software version 16.0 was used to analyse the data, which were entered into an MS Excel sheet. When it came to inferential statistics, numerical variables were compared using the Chi-square test and Fisher's-exact. A p-value of less than 0.05 was considered the threshold for statistical significance.

RESULTS

Results of the study, on fundus changes in patients with degenerative myopia, is described under the following headings:

Age

The mean age among the subjects was (43.93±16.99) years, ranging from 13 to 89 years. Among the subjects, 75 (52.08%) were females, and 69 (47.92%) were males [Table/Fig-1].

Age (years)		Gender n (%)	
Mean±SD	43.93±16.99	Males	69 (47.92)
Median (Range)	43.5 (13-89)	Females	75 (52.08)
		Total	144 (100)

[Table/Fig-1]: Age and gender distribution among study participants.

Axial Length

The mean axial length of the right eye was (27.84±1.12) mm and (27.84±1.07) mm for the left eye [Table/Fig-2].

	Side	N	Mean±SD
Axial length (in mm)	Right eye	144	27.84±1.12
	Left eye	144	27.84±1.07

[Table/Fig-2]: Axial length of each eye among study participants.

K reading

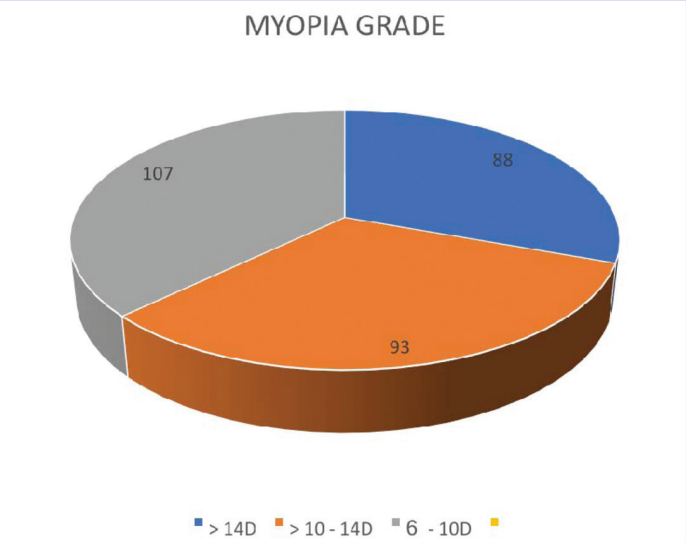
The mean K reading of the right eye was (45.10±1.08) and (45.11±1.08) for the left eye among the study participants [Table/Fig-3].

	Side	N	Mean±SD
K reading	Right eye	144	45.10±1.08
	Left eye	144	45.11±1.08

[Table/Fig-3]: K reading of each eye among the study participants.

Myopia grade

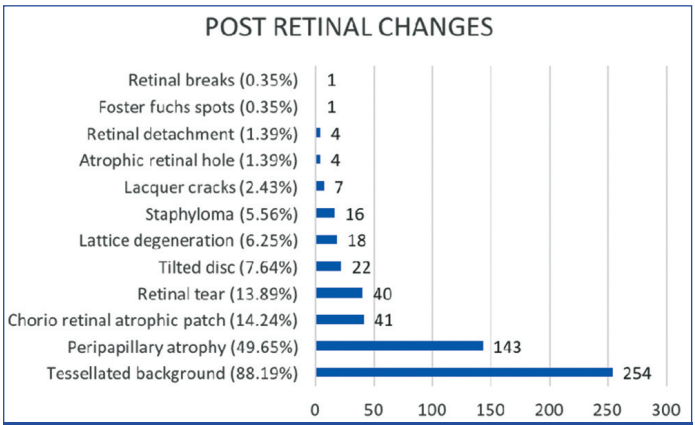
Among the subjects, 107 (37.15%) had 6-10D followed by 93 (32.29%) had >10 14D and least 88 (30.56%) had >14D [Table/Fig-4].



[Table/Fig-4]: Myopia grade among study participants.

Postretinal Changes

Among the 144 subjects (288 eyes), 254 eyes (88.19%) had tessellated background, 143 eyes (49.7%) had peripapillary atrophy, 41 eyes (14.2%) had chorioretinal atrophic patch, 40 eyes (13.9%) had retinal tear, 22 eyes (7.6%) had tilted disc, 18 eyes (6.3%) had lattice degeneration, 16 eyes (5.6%) had staphyloma, 7 eyes (2.4%) had lacquer cracks, 4 eyes (1.4%) had atrophic retinal hole, 4 eyes (1.4%) had retinal detachment, 1 eye (0.3%) had foster fuchs spots, 1 eye (0.3%) had retinal break [Table/Fig-5].



[Table/Fig-5]: Postretinal changes.

Comparison of different grades of myopia with a tessellated background

Comparing the myopia with tessellated background distribution, >14D myopia had a higher proportion of tessellated background with 100% followed by >10-14D myopia with 95.69% and least in 6-10D myopia with 71.96%. There was a statistically significant association between the different grades of myopia and the presence of tessellated background (p-value ≤0.001**) [Table/Fig-6].

Myopia	Tessalated background		Total	Chi- square value	Chi-sq. p-value
	Yes n (%)	No n (%)			
>14D	88 (100)	0	88 (100)	43.83	<0.001**
>10-14D	89 (95.69)	4 (4.43)	93 (100)		
6-10D	77 (71.96)	30 (28.04)	107 (100)		
Total	254 (88.19)	34 (11.81)	288 (100)		

[Table/Fig-6]: Comparison of different grades of myopia with tessellated background.

Comparison of different grades of myopia with peripapillary atrophy

Comparing the myopia with peripapillary atrophy distribution, >14D myopia had a higher proportion of peripapillary atrophy with 61.36% followed by >10-14D myopia with 50.53% and least in 6-10D myopia with 39.25%. There was a statistically significant association between different grades of myopia and the presence of peripapillary atrophy (p-value=0.0087*) [Table/Fig-7].

Myopia	Peripapillary atrophy		Total	Chi-square value	Chi-sq. p-value
	Yes n (%)	No n (%)			
>14D	54 (61.36)	34 (38.63)	88 (100)	9.49	0.0087*
>10-14D	47 (50.53)	46 (49.46)	93 (100)		
6-10D	42 (39.25)	65 (60.74)	107 (100)		
Total	143 (49.65)	145 (50.34)	288 (100)		

[Table/Fig-7]: Comparison of different grades of myopia with peripapillary atrophy.

Comparison of different grades of myopia with a chorioretinal atrophic patch

Comparing the myopia with chorioretinal atrophic patch distribution, >14D myopia had a higher proportion of chorioretinal atrophic patch with 23.86% followed by >10 14D myopia with 16.12% and least in 6-10D myopia with 4.67%. There was a statistically significant association between different grades of myopia and the presence of chorioretinal atrophic patch (p-value ≤0.001**) [Table/Fig-8].

Myopia	Chorioretinal atrophic patch		Total	Chi-square value	Chi-sq. p-value
	Yes n (%)	No n (%)			
>14D	21 (23.86)	67 (76.13)	88 (100)	14.99	<0.001**
>10-14D	15 (16.12)	78 (83.87)	93 (100)		
6-10D	5 (4.67)	102 (95.32)	107 (100)		
Total	41 (14.23)	247 (85.76)	288 (100)		

[Table/Fig-8]: Comparison of different grades of myopia with chorioretinal atropic patch.

Comparison of different grades of myopia with retinal tear

Comparing the myopia with retinal tear distribution, >14D myopia had a higher proportion of retinal tear with 21.59% followed by 6-10D myopia with 11.21% and least in >10-14D myopia with 9.67%. There was a statistically significant association between different grades of myopia and the presence of retinal tear (p-value=0.041*) [Table/Fig-9].

Myopia	Retinal tear		Total	Chi-square value	Chi-sq. p-value
	Yes n (%)	No n (%)			
>14D	19 (21.59)	69 (78.4)	88 (100)	6.39	0.041*
>10-14D	9 (9.67)	84 (90.32)	93 (100)		
6-10D	12 (11.21)	95 (88.78)	107 (100)		
Total	40 (13.88)	248 (86.11)	288 (100)		

[Table/Fig-9]: Comparison of different grades of myopia with retinal tear.

Comparison of different grades of myopia with tilted disc

Comparing the myopia with tilted disc distribution, >10-14D myopia had higher proportion of tilted disc with 12.9% followed by >14D Myopia with 6.8% and least in 6-10D myopia with 3.7%. There was a statistically significant association between different grades of myopia and the presence of tilted disc (p-value = 0.0487*) [Table/Fig-10].

Myopia	Tilted disc		Total	Chi-square value	Chi-sq. p-value
	Yes n (%)	No n (%)			
>14D	6 (6.8)	82 (93.2)	88 (100)	6.07	0.0487*
>10-14D	12 (12.9)	81 (87.1)	93 (100)		
6-10D	4 (3.7)	103 (96.3)	107 (100)		
Total	22 (7.6)	266 (92.4)	288 (100)		

[Table/Fig-10]: Comparison of different grades of myopia with tilted disc.

Comparison of different grades of myopia with lattice degeneration

Comparing the myopia with lattice degeneration distribution, >14D myopia had higher proportion of lattice degeneration with 11.36% followed by >10 14D myopia with 7.52% and least in 6-10D myopia with 0.93%. There was a statistically significant association between different grades of myopia and the presence of lattice degeneration (p-value=0.0093*) [Table/Fig-11].

Myopia	Lattice degeneration		Total	Chi-square value	Chi-sq. p-value
	Yes n (%)	No n (%)			
>14D	10 (11.36)	78 (88.63)	88 (100)	9.53	0.0093*
>10-14D	7 (7.52)	86 (92.47)	93 (100)		
6-10D	1 (0.93)	106 (99.06)	107 (100)		
Total	18 (6.25)	270 (93.75)	288 (100)		

[Table/Fig-11]: Comparison of different grades of myopia with lattice degeneration.

Comparison of different grades of myopia with staphyloma

Comparing the myopia with staphyloma distribution, >14 D myopia had higher proportion of staphyloma with 11.36% followed by >10 14 D myopia with 5.37% and least in 6-10 D myopia with 0.93%. The difference in staphyloma distribution between different grades of Myopia has statistical significance (p-value=0.0091*) [Table/Fig-12].

Myopia	Staphyloma		Total	Fisher-exact p-value
	Yes n (%)	No n (%)		
>14D	10 (11.36)	78 (88.63)	88 (100)	0.0091*
>10-14D	5 (5.37)	88 (94.62)	93 (100)	
6-10D	1 (0.93)	106 (99.06)	107 (100)	
Total	16 (5.55)	272 (94.44)	288 (100)	

[Table/Fig-12]: Comparison of different grades of myopia with staphyloma.

Comparison of different grades of myopia with lacquer cracks

Comparing the myopia with lacquer cracks distribution, >14D Myopia had higher proportion of lacquer cracks with 6.81% followed by 6-10 D myopia with 0.93% and least in >10-14D Myopia with 0%. The difference in lacquer cracks distribution between different grades of Myopia has statistical significance (p-value=0.0038*) [Table/Fig-13].

Myopia	Lacquer cracks		Total	Fisher-exact p-value
	Yes n (%)	No n (%)		
>14D	6 (6.81)	82 (93.18)	88 (100)	0.0038*
>10-14D	0	93 (100)	93 (100)	
6-10D	1 (0.93)	106 (99.06)	107 (100)	
Total	7 (2.43)	281 (97.56)	288 (100)	

[Table/Fig-13]: Comparison of different grades of myopia with lacquer cracks.

Comparison of different grades of myopia with atrophic retinal hole

Comparing the myopia with atrophic retinal hole distribution, >14D myopia had highest proportion of atrophic retinal hole with 3.4% followed by >10-14D myopia with 1.07% and the least in 6-10D myopia with 0%. The difference in atrophic retinal hole distribution between different grades of myopia has statistical significance (p-value=0.0365*) [Table/Fig-14].

Myopia	Atrophic retinal hole		Total	Fisher-exact p-value
	Yes n (%)	No n (%)		
>14D	3 (3.4)	85 (96.59)	88 (100)	0.0365*
>10-14D	1 (1.07)	92 (98.92)	93 (100)	
6-10D	0	107 (100)	107 (100)	
Total	4 (1.38)	284 (98.61)	288 (100)	

[Table/Fig-14]: Comparison of different grades of myopia with atrophic retinal hole.

Comparison of different grades of myopia with retinal detachment

Comparing the myopia with retinal detachment distribution, >14D myopia had a higher proportion of retinal detachment with 3.4% followed by >10-14D myopia with 1.07% and least in 6-10D myopia with 0%. The difference in retinal detachment distribution between different grades of myopia has statistical significance (p-value=0.0365) [Table/Fig-15].

Myopia	Retinal detachment		Total	Fisher's-exact test p-value
	Yes n (%)	No n (%)		
>14D	3 (3.4)	85 (96.59)	88 (100)	0.0365
>10-14D	1 (1.07)	92 (98.92)	93 (100)	
6-10D	0	107 (100)	107 (100)	
Total	4 (1.38)	284 (98.61)	288 (100)	

[Table/Fig-15]: Comparison of different grades of myopia with retinal detachment.

Comparison of different grades of myopia with foster fuchs spots

Comparing the myopia with foster fuchs spots distribution, >14D myopia had a higher proportion of foster fuchs spots with 1.13% followed by >10-14D myopia with 0% and least in >10-14D myopia with 0%. The difference in foster fuchs spots distribution between different grades of myopia has no statistical significance (p-value >0.05) [Table/Fig-16].

Myopia	Foster fuchs spots		Total	Fisher's-exact p-value
	Yes n (%)	No n (%)		
>14D	1 (1.13)	87 (98.86)	88 (100)	0.306
>10-14D	0	93 (100)	93 (100)	
6-10D	0	107 (100)	107 (100)	
Total	1 (0.34)	287 (99.65)	288 (100)	

[Table/Fig-16]: Comparison of different grades of myopia with foster fuchs spots.

Comparison of different grades of myopia with retinal break

Comparing the myopia with retinal break distribution, >10-14D myopia had a higher proportion of retinal break with 1.07% followed by >14D myopia with 0% and least in >14D myopia with 0%. The difference in retinal break distribution between different grades of myopia has no statistical significance (p-value>0.05) [Table/Fig-17].

Comparison of different grades of myopia with myopic crescent

Comparing the myopia with myopic crescent distribution, 6-10D myopia had a higher proportion of myopic crescent with 22.42% followed by >14D myopia with 18.18% and least in >10-14D myopia with 11.82%. There is no statistically significant association

between different grades of myopia and the presence of myopic crescent (p-value>0.05) [Table/Fig-18].

Myopia	Retinal break		Total	Fisher's-exact p-value
	Yes n (%)	No n (%)		
>14D	0	88 (100)	88 (100)	0.323
>10-14D	1 (1.07)	92 (98.92)	93 (100)	
6 -10D	0	107 (100)	107 (100)	
Total	1 (0.34)	287 (99.65)	288 (100)	

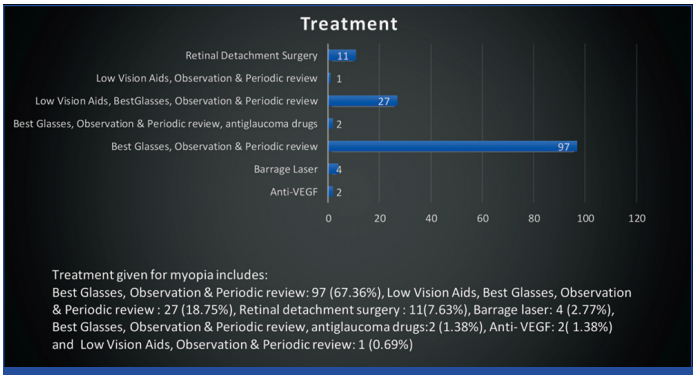
[Table/Fig-17]: Comparison of different grades of myopia with retinal break.

Myopia	Myopic cresent		Total	Chi-sq. p-value
	Yes n (%)	No n (%)		
>14D	16 (18.18)	72 (81.81)	88 (100)	0.145
>10-14D	11 (11.82)	82 (88.17)	93 (100)	
6-10D	24 (22.42)	83 (77.57)	107 (100)	
Total	51 (17.7)	237 (82.29)	288 (100)	

[Table/Fig-18]: Comparison of different grades of myopia with myopic crescent.

Treatment

Among the subjects, 97 (67.36%) had best glasses, observation and periodic review, followed by 27 (18.75%) had low vision aids, best glasses, observation and periodic review and 1 subject (0.69%) had low vision aids, observation and periodic review [Table/Fig-19].



[Table/Fig-19]: Treatment for myopia (non surgical and surgical).

DISCUSSION

In the present study, evaluated 288 eyes of 144 patients for retinal degenerative changes in various grades of pathological myopia. The distribution of myopia severity showed that 37.15% of individuals had -6D to -10D of myopia, 32.29% had >-10D to -14D and 30.56% had >-14D myopia. The most frequent fundus alteration was tessellated background (88.19%), which was followed by staphyloma (5.6%), tilted disc (7.6%), chorioretinal atrophic patches (14.2%), retinal tears (13.9%), peripapillary atrophy (49.7%), and lattice degeneration (6.3%). Subjects with greater myopia (>14D) had a significantly higher proportion of peripapillary atrophy, tessellated background, retinal tear, tilted disc, lattice degeneration, chorioretinal atrophic patch, staphyloma, lacquer cracks, atrophic retinal hole, and retinal detachment.

The prevalence of pathologic myopia, the prevalence and severity of maculopathy increase with advancing age [18]. In the current study, the mean age among the subjects was (43.93±16.99) years, ranging from 13 to 89 years. Xiao O et al., in their study, observed that higher age, higher myopic-refraction, and longer axial length were significantly associated with increased severity of myopic maculopathy [19]. Xiao O et al., observed that the odds of developing Clinically Significant Myopic Maculopathy (CSMM) increased 1.57 times (95% CI: 1.46-1.68) for every unit increase in myopic refraction. Likewise, with an odds ratio of 2.97 (95% CI: 2.50-3.53), the risk was almost tripled for every unit increase in axial length. Another significant predictor was age, with those between the ages of 40 and 70 having 6.77 times the chances of CSMM compared to those between the ages of 12 and 18 (95% CI: 3.61-12.70). These results demonstrate the combined impact of age, axial length, and refractive error on the likelihood of developing more severe myopic maculopathy [20].

In the present study, 75 (52.08%) were females and 69 (47.92%) were males. Various studies have also reported a higher prevalence of myopia among females across the population and different ages [21-23].

High-grade myopia is described as an axial-length of 26.5 mm or more, or a refractive-error of at least -6.00D [5]. Axial length is an important variable associated with maculopathy of myopia. In the present study, the mean axial length among the right eye was 27.84 (±1.12) and 27.84 (±1.07) in the left eye. Curtin BJ et al., observed that crescent formation is directly associated with the higher axial length in both incidence (p-value<0.01) and type and size of fundus changes. Similarly, chorioretinal atrophy is directly associated with the higher axial length (p-value<0.01), however, age can play an essential role in the creation of this deformity (p-value <0.01) [24].

In the present study, participants with high myopia { Spherical Equivalent Refraction (SER) ≥-6.00D} were included. On the other hand, Ohno-Matsui K and Jonas JB in their meta-analysis, observed that even lower levels of myopia such as low (SER<-0.5 to >-3.00 dioptre), moderate-grade (SER <- 3.00 to >-6.00D), and high-grade myopia (SER >-6.00D) were all associated with higher risks of myopic degeneration of macula and detachment of retina [25]. In the current study, 107 (37.15%) had 6-10D, followed by 93 (32.29%) had >10-14D and lastly 88 (30.56%) had >14D.

The results in the present study are similar to the study by Hayashi K et al., who observed that the common pattern among their subjects was tessellated fundus, leading to the progression of diffuse atrophy and lacquer-cracks. They also observed that 40.6% showed signs of myopic maculopathy [26].

Ohno-Matsui K and Jonas JB, in their study, observed tessellated fundus in 20.0%, diffuse Chorioretinal atrophy in 20.2%, 2.6% having patchy chorioretinal atrophy and 0.2% having macular atrophy [27]. Chang L et al., observed that staphyloma and chorioretinal atrophy lesions were the most frequent observations of fundus among the adults with high myopia of the Asian population. The most common finding of the disc associated with high-grade myopia was peripapillary atrophy (81.2%), followed by tilting of the disc (57.4%) [28].

Maheshwari U observed that the majority of subjects in their study group had temporal crescent and tessellated fundus as a common posterior segment pathologies, followed by Posterior-staphyloma-10%, Foster Fuchs spots - 4.16% and Lacquer cracks-2.08% [29].

This study shows, participants with greater myopia (>14D), had a significantly higher proportion of peripapillary atrophy, tessellated background, chorioretinal atrophic patch, retinal tear, tilted disc, lattice degeneration, staphyloma, lacquer cracks, atrophic retinal hole, and retinal detachment. In a study by Saw SM et al., they observed higher risks of the presence of glaucoma among adults with myopia, and hazards of chorioretinal abnormalities such as detachment of retina, chorioretinal atrophy and lacquer-cracks associated with higher grades of myopia and increased axial length [17].

In the present study, no statistically significant association was found between different grades of myopia and variables such as retinal break, foster fuchs spots, and myopic cresent (p-value >0.05).

Yan YN et al., did a ten-year follow-up and observed that the maculopathy of myopia was 35.5% in their aged Chinese population [30]. Similarly, Li Z et al., in their two-year follow-up observed myopic maculopathy was 14.8% in their Chinese population [31]. In the studies by Yan YN et al., and Li Z et al., longer axial length, smaller parapapillary y-zone, pre-existing staphylomata, higher age, and female gender were correlated with higher grades of the myopic maculopathy.

The following complications were significantly associated with the grades of myopia, like tessellated fundus, peripapillary atrophy, chorioretinal atrophic patch, retinal tear, tilted disc, lattice degeneration, staphyloma, lacquer cracks, atrophic retinal hole and retinal detachment.

Tessellated fundus is a marker for the identification of the visual acuity, grade of myopia or risk of advancement of myopia and complications [32]. In this study, subjects with >14D myopia had a significantly higher proportion of tessellated background with 100% followed by >10-14D myopia with 95.69% and least in 6-10D myopia with 72.72%, with a p-value of <0.001.

When progressive RPE thinning surrounds the optic disc, the hypopigmented findings are designated as peripapillary atrophy [33]. In the present study, subjects with >14D Myopia had a significantly higher proportion (p-value = 0.0087) of peripapillary atrophy with 61.36% followed by >10-14D myopia with 50.53% and least in 6-10D myopia with 39.25%.

In the current study, subjects with >14D myopia had a significantly higher proportion of chorioretinal atrophic patches and atrophic retinal holes.

Subjects with pathological myopia (i.e., -8 dioptres) have a higher risk of RD, with a lifetime risk of 15-200 times higher [34]. In this study, subjects with >14D myopia had significantly higher proportion of retinal tear with 21.59% followed by 6-10D myopia with 11.21% and least in >10-14D myopia with 9.67% whereas, subjects with >14D myopia had significantly higher proportion of retinal detachment with 3.4% followed by >10-14D myopia with 1.07% and least in 6-10D myopia with 0%.

Inferonasal tilting of the optic disc is the most common observation in patients with high myopia, which occurs bilaterally [35]. In the present study, subjects with >10-14D myopia had a significantly higher proportion of tilted disc with 12.9% followed by >14D myopia with 6.8% and least in 6-10D myopia with 3.7%.

The proportion of lattice degeneration is significantly increased among the patients with high myopia [36,37]. Celorio JM and Pruett RC, in their study among patients with myopia of -6.00D or more in both eyes, observed a 33.0% prevalence of lattice degeneration of the retina [38]. In the current study, subjects with >14D myopia had a significantly higher proportion of lattice degeneration with 11.36% followed by >10-14D myopia with 7.52% and least in 6-10D myopia with 0.93%.

Staphyloma is a circumscribed out-pouching of the wall of the globe [25]. Posterior staphyloma is a hallmark finding of high myopia, which progresses to maculopathy [39]. In this study, subjects with >14D myopia had a significantly higher proportion of Staphyloma with 11.36% followed by >10-14D myopia with 5.37% and least in 6-10D Myopia with 0.93%.

Prevalence of Lacquer cracks among the high myopic eyes ranges between 4.3% to 9.2% [24]. In the current study, subjects with >14D myopia had a significantly higher proportion of lacquer cracks with 6.81% followed by 6-10D myopia with 0.93% and least in >10-14D myopia with 0%. Ohno-Matsui K et al., patchy atrophy and lacquer-cracks were found to be essential for the progression of choroidal influencing factors for neovascularisation [27].

The identification of the association of different grades of pathologic myopia with the abnormalities warrants the early identification of the complications of pathologic myopia and the need for frequent follow-up and screening of the fundus.

Limitation(s)

In the current study, matched controls were without myopia. However, the study of the association of pathological myopia was possible with complications such as tessellated background, peripapillary atrophy, retinal tear, etc. The study was not designed with an adequate follow-up to study the temporal relationships involved with the associations. Rather, longer follow-ups cannot be possible with the tenure of the study period during the postgraduate course. The associations observed in this study may be influenced by bias from confounding factors- for instance, variations in age, duration of myopia, genetic predisposition or environmental influences such as bear-work habits, which could independently affect the occurrence of complications. This is a hospital-based study in a tertiary-care setting; hence, the study may not reflect the pattern in the community or in the other levels of healthcare. This study was not designed with an adequate follow-up to study the temporal relationships involved with the associations.

CONCLUSION(S)

The study of 288 eyes (144 patients) showed that a tessellated background (88.2%) was the most common fundus abnormality, followed by peripapillary atrophy (49.7%) and myopic crescent (17.7%). Significantly higher proportions of degenerative changes, including peripapillary atrophy, chorioretinal atrophic patches, tessellation, retinal tears, tilted disc, lattice degeneration, staphyloma, lacquer cracks, atrophic holes, and retinal detachment, were linked to higher grades of myopia (>14D). Conversely, fewer tessellations were seen in those with lower myopia (6-10D). There were no statistically significant differences in myopic crescent, retinal fractures, or Foster Fuchs spots amongst myopia classes. The key message from the present study is that increasing severity of myopia is strongly linked with more sight-threatening degenerative fundus changes, underscoring the need for close monitoring of high myopes.

REFERENCES

[1] Normann RA, Guillory KS. Anatomy and physiology of the retina. In: Hung GK, Ciuffreda KJ, editors. Models of the visual system. Boston (MA): Springer; 2002. p. 109-45. Doi: 10.1007/978-1-4757-5865-8_3.

[2] Arslan OE. Anatomy and physiology of retina and posterior segment of the eye. In: Battaglia Parodi M, Bandello F, editors. Drug Delivery for the Retina and Posterior Segment Disease. Cham: Springer; 2018. p. 3-33. Doi: 10.1007/978-3-319-95807-1_1.

[3] Hildebrand GD, Fielder AR. Anatomy and physiology of the retina. In: Lambert SR, Capone Jr A, editors. Pediatric retina. New York: Springer; 2011. p. 39-65. Doi: 10.1007/978-3-642-12041-1_2.

[4] Morgan I, Rose K. How genetic is school myopia? Prog Retin Eye Res. 2005;24(1):1-38. Doi: 10.1016/j.preteyeres.2004.06.004.

[5] Meng W, Butterworth J, Malecaze F, Calvas P. Axial length of myopia: A review of current research. Ophthalmologica. 2011;225(3):127-34. Doi: 10.1159/000317072.

[6] Pan CW, Ramamurthy D, Saw SM. Worldwide prevalence and risk factors for myopia. Ophthalmic Physiol Opt. 2012;32(1):3-16. Doi: 10.1111/j.1475-1313.2011.00884.x.

[7] Holden BA, Fricke TR, Wilson DA, Jong M, Naidoo KS, Sankaridurg P, et al. Global prevalence of myopia and high myopia and temporal trends from 2000 through 2050. Ophthalmology. 2016;123(5):1036-42. Doi: 10.1016/j.ophtha.2016.01.006.

[8] Dolgin E. The myopia boom. Nature. 2015;519(7543):276-78. Doi: 10.1038/519276a.

[9] Ikuno Y. Overview of the complications of high myopia. Retina. 2017;37(12):2347-51. Doi: 10.1097/IAE.0000000000001489.

[10] Flitcroft DI. The complex interactions of retinal, optical and environmental factors in myopia aetiology. Prog Retin Eye Res. 2012;31(6):622-60. Doi: 10.1016/j.preteyeres.2012.06.004.

[11] Baird PN, Saw SM, Lanca C, Guggenheim JA, Smith EL 3rd, Zhou X, et al. Myopia. Nat Rev Dis Primers. 2020;6(1):99. Doi: 10.1038/s41572-020-00231-4.

[12] Coscas G, Soubrane G. Pathologic myopia. In: Retinal Imaging. Elsevier; 2006. p. 164-174. Available from: https://www.sciencedirect.com/topics/medicine-and-dentistry/pathologic-myopia.

[13] Pathologic myopia: an overview [Internet]. ScienceDirect Topics. [cited 2022 Aug 8]. Available from: https://www.sciencedirect.com/topics/medicine-and-dentistry/pathologic-myopia.

[14] Ong SS. Pathologic myopia. In: Levin AV, Enyedi LB, editors. Handbook of pediatric retinal OCT and the eye-brain connection [Internet]. Elsevier; 2019. p. 267-71. [cited 2022 Aug 8]. Available from: https://www.sciencedirect.com/topics/medicine-and-dentistry/pathologic-myopia.

[15] Wong YL, Saw SM. Epidemiology of pathologic myopia in Asia and worldwide. J Asia Pac Ophthalmol (Phila). 2016;5(6):394-402. Doi: 10.1097/APO.0000000000000234.

[16] Ohno-Matsui K. Proposed classification of myopic maculopathy by the International Myopia Institute. Invest Ophthalmol Vis Sci. 2020;61(12):1. Doi: 10.1167/iovs.61.12.1.

[17] Saw SM, Gazzard G, Shih-Yen EC, Chua W-H. Myopia and associated pathological complications. Ophthalmic Physiol Opt. 2005;25(5):381-91. Doi: 10.1111/j.1475-1313.2005.00298.x.
[18] Haarman AEG, Enthoven CA, Tideman JWL, Tedja MS, Verhoeven VJM, Klaver CCW. The complications of myopia: a review and meta-analysis. Invest Ophthalmol Vis Sci. 2020;61(4):49. Doi: 10.1167/iovs.61.4.49.
[19] Ohno-Matsui K, Wu PC, Yamashiro K, Vutipongsatorn K, Fang Y, Cheung CMG, et al. IMI Pathologic Myopia. Invest Ophthalmol Vis Sci. 2021;62(5):5. Doi: 10.1167/iovs.62.5.5
[20] Xiao O, Guo X, Wang D, Jong M, Lee PY, Chen L, et al. Distribution and severity of myopic maculopathy among highly myopic eyes. Invest Ophthalmol Vis Sci. 2018;59(12):4880-85. Doi: 10.1167/iovs.18-24672.
[21] Gong JF, Xie HL, Mao XJ, Zhu XB, Xie ZK, Yang HH, et al. Relevant factors of estrogen changes of myopia in adolescent females. Chin Med J (Engl). 2015;128(5):659-63. Doi: 10.4103/0366-6999.151659.
[22] Czepita M, Czepita D, Safranow K. Role of gender in the prevalence of myopia among Polish schoolchildren. J Ophthalmol. 2019;2019:9748576. Doi: 10.1155/2019/9748576
[23] Ludwig CA, Boucher N, Saroj N, Moshfeghi DM. Differences in anterior peripheral pathologic myopia and macular pathologic myopia by age and gender. Graefes Arch Clin Exp Ophthalmol. 2021;259(12):3511-13. Doi: 10.1007/s00417-021-05282-5.
[24] Curtin BJ, Karlin DB. Axial length measurements and fundus changes of the myopic eye. Am J Ophthalmol. 1971;71(1):42-53. Doi: 10.1016/0002-9394(71)90438-2.
[25] Ohno-Matsui K, Jonas JB. Posterior staphyloma in pathologic myopia. Prog Retin Eye Res. 2019;70:99-109. Doi: 10.1016/j.preteyeres.2018.12.001.
[26] Hayashi K, Ohno-Matsui K, Shimada N, Moriyama M, Kojima A, Hayashi W, et al. Long-term pattern of progression of myopic maculopathy: a natural history study. Ophthalmology. 2010;117(8):1595-611.e1-4. Doi: 10.1016/j.ophtha.2009.11.003.
[27] Ohno-Matsui K, Yoshida T, Futagami S, Yasuzumi K, Shimada N, Kojima A, et al. Patchy atrophy and lacquer cracks predispose to the development of choroidal neovascularisation in pathological myopia. Br J Ophthalmol. 2003;87(5):570-73. Doi: 10.1136/bjo.87.5.570.
[28] Chang L, Ohno-Matsui K, Lin X, Cheung GC, Koh VT, Gazzard G, et al. Myopia-related optic disc and macular changes in Singapore adults with high myopia. Invest Ophthalmol Vis Sci. 2013;54(14):830. Doi: 10.1167/iovs.13-12257.
[29] Uma Maheshwari R. A clinical analysis of 50 cases of pathological myopia [dissertation]. Chennai: Madras Medical College; 2007.
[30] Yan YN, Wang YX, Yang Y, Xu L, Xu J, Wang Q, et al. Ten-year progression of myopic maculopathy: the Beijing Eye Study 2001-2011. Ophthalmology. 2018;125(8):1253-63. Doi: 10.1016/j.ophtha.2018.01.036.
[31] Li Z, Liu R, Xiao O, Guo X, Wang D, Zhang J, et al. Progression of myopic maculopathy in highly myopic Chinese eyes. Invest Ophthalmol Vis Sci. 2019;60(4):1096-104. Doi: 10.1167/iovs.18-26319.
[32] Jagadeesh D, Philip K, Naduvilath TJ, Fedtke C, Jong M, Zou H, et al. Tessellated fundus appearance and its association with myopic refractive error. Clin Exp Optom. 2019;102(4):378-84. Doi: 10.1111/cxo.12822.
[33] Jabbarpoor Bonyadi MH. High myopic peripapillary atrophy: spectral domain optical coherence tomography features. J Ophthalmic Vis Res. 2016;11(1):124-25. Doi: 10.4103/2008-322X.180732.
[34] Moisseiev E, Yiu G. Retinal detachment in severe myopia. Lancet. 2017;389(10074):1133. Doi: 10.1016/S0140-6736(16)31407-6.
[35] Dervisevic E, Ibrisevic N. Tilted optic disc frequency in myopia of different degree. Med Arch. 2019;73(6):391-93. Doi: 10.5455/medarh.2019.73.391-393.
[36] Ho T-C, Ho A. Long-term natural course of lattice degeneration of the retina in high myopic eyes: a ten-year long-term study. Invest Ophthalmol Vis Sci. 2015;56(7):2965-71. Doi: 10.1167/iovs.14-16069.
[37] Semes LP. Lattice degeneration of the retina and retinal detachment. Optom Clin. 1992;2(3):71-91. Doi: 10.1016/0002-9394(74)90804-6.
[38] Celorio JM, Pruett RC. Prevalence of lattice degeneration and its relation to axial length in severe myopia. Am J Ophthalmol. 1991;111(1):20-23. Doi: 10.1016/S0002-9394(14)76891-6.
[39] Curtin BJ. The posterior staphyloma of pathologic myopia. Trans Am Ophthalmol Soc. 1977;75:67-86.

PARTICULARS OF CONTRIBUTORS:
1. Postgraduate, Department of Ophthalmology, SRM Medical College Hospital and Research Centre, Chennai, Tamil Nadu, India.
2. Postgraduate, Department of Ophthalmology, SRM Medical College Hospital and Research Centre, Chennai, Tamil Nadu, India.
3. Postgraduate, Department of Ophthalmology, SRM Medical College Hospital and Research Centre, Chennai, Tamil Nadu, India.
4. Postgraduate, Department of Ophthalmology, SRM Medical College Hospital and Research Centre, Chennai, Tamil Nadu, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Athira Ajayghosh,
Sakunthala Vihar, Kannamba, Varkala P.O., Thiruvananthapuram-695143,
Kerala, India.
E-mail: athiraajayghosh15@gmail.com

PLAGIARISM CHECKING METHODS: [Jain H et al.]
- Plagiarism X-checker: Aug 16, 2025
- Manual Googling: Sep 08, 2025
- iThenticate Software: Nov 20, 2025 (8%)

ETYMOLOGY: Author Origin

EMENDATIONS: 8

AUTHOR DECLARATION:
- Financial or Other Competing Interests: None
- Was Ethics Committee Approval obtained for this study? Yes
- Was informed consent obtained from the subjects involved in the study? Yes
- For any images presented appropriate consent has been obtained from the subjects. NA

Date of Submission: **Aug 13, 2025**
Date of Peer Review: **Sep 17, 2025**
Date of Acceptance: **Nov 23, 2025**
Date of Publishing: **Feb 01, 2026**