1. Introduction

Cenk Zeki Fikret

Recognized as a serious global public health concern, myopia is predicted to grow in prevalence during the ensuing decades.

Highly myopic eyes may develop pathologies including myopic maculopathy and optic neuropathy, which can result in considerable, irreversible vision loss and blindness.

In addition, myopia raises the likelihood of other pathological ocular alterations such glaucoma, cataract, and retinal detachment, all of which can result in permanent vision loss.

Even at low and moderate levels of myopia, significant illness connections are present. According to latest studies, none of the known ocular illnesses associated with myopia have a safe threshold myopia level.

The significance of the rise in myopia prevalence and its consequences has been well-documented, notably in East Asian nations where the prevalence of myopia has increased the sharpest. As a result, East Asia has more experience in stopping the growth and progression of myopia in children and teenagers. In the 25- to 29-year-old age range, myopia prevalence increased in Europe over the past few decades and now stands at 45 to 50%.

As a result, myopia is now recognized throughout Europe as a serious economical burden and a public health concern.

Recently, a number of white papers on the pathogenesis of myopia, including the findings of experimental studies, as well as the findings of clinical studies, including the results of randomized controlled trials, were published by the International Myopia Institute (IMI), a group of 85 multidisciplinary experts in the field.

This article's primary goal, which is to raise awareness and offer advice for European ophthalmologists to stop the onset and progression of myopia in children and adolescents, is based on the IMI White Papers.

Holden et al., who were cited in the World Report on Vision released by the World Health Organization (WHO) in October 2019, estimated that 2620 million individuals worldwide will have myopia in 2020, with a further increase forecast to 3361 million by 2030. A significant rise in the number of people with high myopia was also anticipated, from 399 million in 2020 to 516 million by 2030.

World Health Organisation. World report of vision. Geneva, Switzerland: WHO, 2019, p. 42.

Both of these estimations presuppose that efforts to halt the growth of myopia will have no effect.

This implies that pathological myopia is expected to overtake other conditions such as diabetes and hypertension as the most prevalent cause of irreversible vision loss and blindness worldwide. As a result, myopia reduction strategies are crucial to lowering the burden of myopia globally.

By 2050, it is expected that 65% of people in Asia, 56% of people in Western Europe, 54% of people in Central Europe, and 50% of people in Eastern Europe would have myopia.

Holden BA, Fricke TR, Wilson DA, et al. Global prevalence of myopia and high myopia and temporal trends from 2000 through 2050. Ophthalmology 2016;123:1036–1042.

Resnikoff S, Jonas JB, Friedman D, et al. Myopia- a 21st century public health issue. Invest Ophthalmol Vis Sci 2019;60: Mi–Mii.

Fricke T, Holden B, Wilson D, et al. Global cost of correcting vision impairment from uncorrected refractive error. Bull World Health Org 2012;90:728–738.

Haarman AEG, Enthoven CA, Tideman JWL, et al. The complications of myopia: a review and meta-analysis. Invest Ophthalmol Vis Sci 2020;61:49.

Grzybowski A, Kanclerz P, Tsubota K, et al. A review on the epidemiology of myopia in school children worldwide. BMC Ophthalmol 2020;20:27.

Troilo D, Smith EL, III, Nickla DL, et al. IMI-experimental models of emmetropization and myopia. Invest Ophthalmol Vis Sci 2019; 60: M31–M88.

Tedja MS, Haarman AEG, Meester-Smoor MA, et al. IMI-myopia genetics report. Invest Ophthalmol Vis Sci 2019; 60: 89–105.

Wolffsohn JS, Flitcroft DI, Gifford KL, et al. IMI-myopia control reports overview and introduction. Invest Ophthalmol Vis Sci 2019; 60: M1–M17.

2. Definition and Classification of Myopia

Cenk Zeki Fikret

International Myopia Institute (IMI)

Term	Definition
Qualitative definitions	
Myopia	A refractive error in which rays of light entering the eye parallel to the optic axis are brought to a focus in front of the retina when ocular accommodation is relaxed. This usually results from the eyeball being too long from front to back, but can be caused by an overly curved cornea and/or a lens with increased optical power. It also is called nearsightedness.
Axial myopia	A myopic refractive state primarily resulting from a greater than normal axial length.
Refractive myopia	A myopic refractive state that can be attributed to changes in the structure or location of the image forming structures of the eye, that is, the cornea and lens.
Secondary myopia	A myopic refractive state for which a single, specific cause (e.g. drug, corneal disease, or systemic clinical syndrome) can be identified that is not a recognized population risk factor for myopia development.
Quantitative definitions	
Myopia	A condition in which the spherical equivalent refractive error of an eye is ≤ – 0.50 D when ocular accommodation is relaxed.
Low myopia	A condition in which the spherical equivalent refractive error of an eye is ≤ – 0.50 and >–6.00 D when ocular accommodation is relaxed.
High myopia	A condition in which the spherical equivalent refractive error of an eye is ≤ – 6.00 D when ocular accommodation is relaxed.
Pre-myopia	A refractive state of an eye of ≤ +0.75 D and >–0.50 D in children where a combination of baseline refraction, age, and other quantifiable risk factors provide a sufficient likelihood of the future development of myopia to merit preventative interventions.

Term	Definition
Descriptive definitions	
Pathologic myopia	Excessive axial elongation associated with myopia that leads to structural changes in the posterior segment of the eye (including posterior staphyloma, myopic maculopathy, and high myopia-associated optic neuropathy) and that can lead to loss of best-corrected visual acuity.
Myopic macular degeneration (MMD)	A vision-threatening condition occurring in people with myopia, usually high myopia that comprises diffuse or patchy macular atrophy with or without lacquer cracks, macular Bruch's membrane defects, CNV, and Fuchs spot.
Diagnostic subdivisions of MMD	
Myopic maculopathy	Category 0: no myopic retinal degenerative lesion. Category 1: tessellated fundus Category 2: diffuse chorioretinal atrophy. Category 3: patchy chorioretinal atrophy. Category 4: macular atrophy. "Plus" features (can be applied to any category): lacquer cracks, myopic choroidal neovascularization, and Fuchs spot.
Presumed myopic macular degeneration	A person who has vision impairment and vision acuity that is not improved by pinhole, which cannot be attributed to other causes, and: • The direct ophthalmoscopy records a supplementary lens <−5.00 D and shows changes such as "patchy atrophy" in the retina or, • The direct ophthalmoscopy records a supplementary lens <−10.00 D.
Specific clinical conditions characteristic of pathologic myopia	
Myopic traction maculopathy (MTM)	A combination of macular retinoschisis, lamellar macula hole and/or foveal retinal detachment (FRD) in eyes with high myopic attributable to traction forces arising from adherent vitreous cortex, epiretinal membrane, internal limiting membrane, retinal vessels, and posterior staphyloma.
Myopia-associated glaucoma-like optic neuropathy	Optic neuropathy characterized by a loss of neuroretinal rim and enlargement of the optic cup, occurring in eyes with high myopia eyes with a secondary macrodisc or peripapillary delta zone at a normal IOP.

6. Accomodation, Intraocular Pressure fluctation causes progression of Axial Myopia and Glaucoma? Do we have to say don't read and work long hours in 45 cm distances?

Cenk Zeki Fikret

Myopia's beginning and progression have been the subject of numerous theories that attempt to explain their mechanism. Animal models have demonstrated that the retina and sclera likely contain a growth-regulating cascade, in which numerous neuronal channels, neurochemicals, and their receptors have been implicated, including the retinal ON-pathway and the regulation of dopamine.

Retinal visual growth signals are known to be carried by peripheral defocus and an accommodation lag, which ultimately results in axial elongation.

These theories inform the creation of multifocal soft contact lenses, which are intended to slow the progression of myopia.

Since the researchers noticed that the decreases in choroidal thickness and choroidal blood perfusion driven by visual signals in myopes can generate scleral hypoxia connected to the HIF-1α pathway, the notion on the hypoxic microenvironment in the sclera has recently been put out.

Extracellular matrix (ECM) remodeling in the sclera, which causes a reduction in scleral strength, scleral thinning, and axial elongation, is widely considered to be a downstream process in myopia.

The function of accommodation and intraocular pressure (IOP) in the putative biomechanical mechanisms of myopia has not been clarified despite the great number of studies on the condition.

Typically, the underlying genetic susceptibility in myopia is probably connected with the ongoing accommodation demands of increased near-work activity.

Anomalies of accommodative responses and reaction times during near work have been proposed as a causative factor in the development of myopia .

The lens's shape varies during accommodation as a result of the ciliary body's contraction and relaxation, which affects the lens' surface curvature and refractive power.

Axial elongation occurs as a result of persistent pressure that may be produced during the high frequency of lens shape changes and transferred to the ocular wall. To ensure normal near-work activity, the pupil's near reflex, which consists

of accommodation, convergence, and miosis, should maintain a particular level of coordination. However, one of the most popular explanations for the etiology of myopia holds that excessive convergence during close work results in thicker extraocular muscles and higher IOP.

Additionally, a recent cross-sectional observational study found a favorable correlation between high myopia and intraocular pressure.

IOP may be a cofactor, and it appears worthwhile to consider its potential impact on axial myopia, even if it is unclear whether the change in IOP is the source or the effect of the progression of myopia.

Zhou X, Pardue MT, Iuvone PM et al. Dopamine signaling and myopia development: what are the key challenges. Progress in Retinal and Eye Research. 2017;61: 60–71.

Chen S, Zhi Z, Ruan Q et al. Bright light suppresses form-deprivation myopia development with activation of dopamine D1 receptor signaling in the on pathway in retina. Investigative Ophthalmology & Visual Science. 2017;58(4):2306-2017.

Chakraborty R, Ostrin VA, Perez AB, et al. Optical mechanisms regulating emmetropisation and refractive errors: evidence from animal models. Clinical and Experimental Optometry. 2020;103:55–67.

Zhu Q, Liu Y, Tighe S, et al. Retardation of myopia progression by multifocal soft contact lenses. International Journal of Medical Sciences, vol. 2019;16(2):198–202.

Wu H, Chen W, Zhao F, et al. Scleral hypoxia is a target for myopia control. Proceedings of the National Academy of Sciences of the United States of America, 2018;115(30):E7091-E7100.

Wen LB, Cao YP, Cheng Q et al. Objectively measured near work, outdoor exposure and myopia in children. British Journal of Ophthalmology, 2020;104(11):1542–1547.

Abbott ML, Schmid KL, Strang NC. Differences in the accommodation stimulus response curves of adult myopes and emmetropes. Ophthalmic and Physiological Optics, 1998;18(1):13–20.

Kaur S, Sukhija J, Khanna R, et al. Diplopia after excessive smart phone usage. Neuro-Ophthalmology 2019;43(5):323–326.

de Jong PTVM. Myopia: its historical contexts. British Journal of Ophthalmology. 2018;102(8):1021–1027.

Mori K, Kurihara T, Uchino M, et al. High myopia and its associated factors in JPHC-NEXT eye study: a cross-sectional observational study. Journal of Clinical Medicine. 2019;(8):1788.

Pruett RC. Progressive myopia and intraocular pressure: what is the linkage? a literature review. Acta Ophthalmologica. 1988;185:117–127.

7. If We Lower Intraocular Pressure in Myopic Patients without Glaucoma, Can We Occlude Myopia Ascension to High Myopia Progression so the Risk of Glaucoma Decreases?

Cenk Zeki Fikret

The aberrant extension of AL in very myopic eyes causes a variety of anatomical abnormalities, including retinoschisis, atrophy of the retina and choroid, distortion of the optic nerve, and posterior staphyloma, which will permanently impair vision.The precise pathogenesis and biological causes of severe myopia are still unknown, however new loci related with the condition are continuously being found. Additionally, it has been proposed that the nerve system plays a significant part in the etiology of this highly inherited condition. Scleral remodeling and mechanical property weakening have been proposed as two possibilities that may explain how high myopia and posterior staphyloma arise.

Additionally, the axial elongation of high myopia is regulated by Bruch's membrane opening, and high myopia may also be affected by choroidal circulation abnormalities.

High myopia is regarded as an irreversible eye degeneration in the absence of appropriate treatments, according to current medical knowledge.

There is mounting evidence that glaucoma and extreme myopia are closely connected disorders. Although a few research have suggested that they are unrelated, the majority of investigations have shown that patients with high myopia have a twofold to fourfold greater risk of developing open-angle glaucoma.

The pooled odds ratios of the connection with glaucoma were 1.77 for low myopia and 2.46 for extreme myopia, according to a meta-analysis.

The mean intraocular pressure (IOP) before myopia onset was found to be significantly higher (P 0.001) than that of emmetropes in children, according to the Collaborative Longitudinal Evaluation of Ethnicity and Refractive Error study. However, the IOP difference (0.57 mm Hg) was too small to infer that IOP played a part in the development of myopia.

The substantial genetic link between refractive error and IOP has been further investigated at the genetic level by a meta-analysis of genome-wide association studies (P = 1.04 1012). In order to show that, on average, every 1-mm Hg increase in IOP predicts a 0.05- to 0.09-D loss in spherical equivalent, a Mendelian randomization model was created. This suggests that exposure to higher IOP may unintentionally increase the prevalence of myopia.

IOP has a role in glaucoma as well as myopic optic neuropathy by helping to control the retinal and choroidal microcirculation and deform the optic disc.

The evidence presented above suggests that IOP may contribute to the pathophysiology of high myopia. Researchers suggest that decreasing IOP can stop the growth of high myopia based on the responses of the scleral and choroidal layers when combined with prior animal and clinical investigations.

Jonas JB, Ohno-Matsui K, Panda-Jonas S. Myopia: anatomic changes and consequences for its etiology. Asia Pac J Ophthalmol (Phila) . 2019; 8(5): 355–359.

Jonas JB, Wang YX, Dong L, Guo Y, Panda-Jonas S. Advances in myopia research anatomical findings in highly myopic eyes. Eye Vis (Lond). 2020; 7: 45.

Meguro A, Yamane T, Takeuchi M, et al. Genome-wide association study in asians identifies novel loci for high myopia and highlights a nervous system role in its pathogenesis. Ophthalmology. 2020; 127(12): 1612–1624.

Tedja MS, Haarman AEG, Meester-Smoor MA, et al... IMI—myopia genetics report. Invest Ophthalmol Vis Sci. 2019; 60(3): M89–M105.

McBrien NA, Gentle A.. Role of the sclera in the development and pathological complications of myopia. Prog Retin Eye Res. 2003; 22(3): 307–338.

Wu Q, Chen Q, Lin B, et al. Relationships among retinal/choroidal thickness, retinal microvascular network and visual field in high myopia. Acta Ophthalmol. 2020; 98(6): e709–e714.

Shen L, Melles RB, Metlapally R, et al. The association of refractive error with glaucoma in a multiethnic population. Ophthalmology. 2016; 123(1): 92–101

Chao DL, Shrivastava A, Kim DH, et al. Axial length does not correlate with degree of visual field loss in myopic Chinese individuals with glaucomatous appearing optic nerves. J Glaucoma. 2010; 19(8): 509–513.

Marcus MW, de Vries MM, Junoy Montolio FGJ, et al. Myopia as a risk factor for open-angle glaucoma: a systematic review and meta-analysis. Ophthalmology. 2011; 118(10): 1989–1994.e2

Manny RE, Mitchell GL, Cotter SA, et al. Intraocular pressure, ethnicity, and refractive error. Optom Vis Sci. 2011; 88(12): 1445–1453.

Hysi PG, Choquet H, Khawaja AP, et al. Meta-analysis of 542,934 subjects of European ancestry identifies new genes and mechanisms predisposing to refractive error and myopia. Nat Genet. 2020; 52(4): 401–407.

Shin JW, Kwon J, Lee J, Kook MS. Relationship between vessel density and visual field sensitivity in glaucomatous eyes with high myopia. Br J Ophthalmol. 2018; 103: 585–591.

Tan NYQ, Sng CCA, Ang M. Myopic optic disc changes and its role in glaucoma. Curr Opin Ophthalmol. 2019; 30(2): 89–96.

8. Intense Outdoor Light Protects Against Myopia

Cenk Zeki Fikret

Spending time outside has been linked to a decreased risk of myopia development in recent years, and this benefit does not appear to depend on the level of physical activity.

The mechanisms through which outdoor light might protect against myopia are yet unknown, but some ideas are that it might:

A) Stimulate intensity- or wavelength-dependent anti-myopia systems in the retina

B) Cause sustained pupillary constriction via the melanopsin system – thus improving retinal image quality by reducing longitudinal aberrations

C) Increase the production of vitamin D in the skin

D) Increase the average viewing distance of objects outdoors compared to indoors, thereby reducing accommodative fatigue, or;

E) Increase the activation of spatiotemporal image-response mechanisms in the retina, which inhibit myopia development.

For an up-to-date review on the roles each of these enlisted factors may contribute to in myopia, please refer to "The role of luminance and chromatic cues in emmetropization" by Frances Rucker.

Read SA, Collins MJ, Vincent SJ. Light Exposure and Eye Growth in Childhood. Invest Ophthalmol Vis Sci. 2015;56(11):6779–87.

Rucker FJ. The role of luminance and chromatic cues in emmetropisation. Ophthalmic Physiol Opt. 2013;33(3):196–214.

High Intensity Illumination

Children who spent more time outdoors had lower associated myopic refractive errors than kids who spent the majority of their time indoors, even after adjusting for near-work, parental myopia, and ethnicity, according to research by Rose et al. on the effects of time spent outdoors on the development of myopia in Australian children. Exercise versus leisure did not affect associated levels of myopia.

9. Muscarinic Acetylcholine Receptors, Dopamine and Nitric Oxide are Strongly Implicated in Regulation of Eye Growth

Cenk Zeki Fikret

Muscarinic Acetylcholine Receptors (mAChRs)

The pupillary constrictor muscle and the ciliary muscle, which regulate accommodation, are both contracted by muscarinic receptors in the eye. As was previously mentioned, it was once believed that accommodative fatigue blocking may be used to suppress myopia. The failure of COMET and other clinical trials, as well as experimental data from animal models, refute the idea that mAChR antagonists (blockers) only work to reduce myopia by paralyzing the ciliary muscle. For instance, chicks can respond to therapy with medications like atropine or pirenzepine, which block muscarinic receptors, or they can develop experimentally induced myopia.

Atropine and pirenzepine do not target nicotinic receptors, which are responsible for controlling their ciliary muscles. For example, monkeys, tree shrews, and chicks are just a few of the many animal species that pirenzepine prevents from developing myopia. Even though it has unremarkable effect on iris and ciliary musculature.

Finally, ciliary nerve damage has little effect on the development of form-deprivation myopia or myopia brought on by lenses. Myopia development in chicks with damaged ciliary nerves is comparable to that in controls with healthy nerves.

These findings have generally ruled out accommodating activity and the ciliary muscle as significant eye growth regulators, leading us to speculate that the retina, choroid, or sclera may be potential target tissues for mAChR antagonist myopia-inhibition. Muscarinic receptors can be found in the choroid, retina, RPE, and sclera.

By locating the chick mAChR orthologues (cM2, cM3, and cM4) in chick eye tissues, Fischer et al. demonstrated the presence of immunoreactive sites in the ciliary body, retinal pigment epithelium (RPE), and choroid in addition to the inner retina (cholinergic amacrine cells and ganglion cells).

Similar to those observed in the chick, expression patterns have also been observed in the tree shrew and the rabbit. Although there is proof that mAChRs exist in the eye's tissues, it is yet unknown precisely which ocular organs, cells,

10. We must have a full understanding of optic nerve head anatomy in myopia and glaucoma, including parapapillary zones alpha, beta, gamma and delta, histology and clinical features

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The optic nerve head can morphologically be dissimilated into the optic disc with the lamina cribrosa as its basis, and the parapapillary region with zones alpha (abnormal and irregular pigmentation due to abnormalities of the retinal pigment epithelium (RPE) and peripheral location), beta zone (total RPE loss while Bruch's membrane (BM) is present), gamma zone (absence of BM), and delta zone (elongated and thinned peripapillary scleral flange) within gamma zone and located at the peripapillary ring. Alpha zone is seen in almost all eyes. Beta zone is associated with glaucoma and may develop due to a IOP rise-dependent parapapillary uppiling of RPE. Gamma zone may progress due to a shift of the nonenlarged BM opening (BMO) in moderate myopia, while in highly myopic eyes, the BMO enlarges and a circular gamma zone and delta zone formation. The ophthalmoscopic shape and size of the optic disc is markedly and remarkably affected by a myopic shift of BMO, usually into the temporal direction, leading to a BM overhanging into the intrapapillary compartment at the nasal disc border, a secondary lack of BM in the temporal parapapillary region (leading to gamma zone in non-highly myopic eyes), and an ocular optic nerve canal running obliquely from centrally posteriorly to nasally anteriorly. In highly myopic eyes (cut-off for high myopia at approximately −8 diopters or an axial length of 26.5 mm), the optic disc area enlargens, the lamina cribrosa thus enlarges in area and decreases in thickness, and the BMO increases, leading to a circular gamma zone and delta zone in highly myopic eyes. The optic nerve head (ONH) is the structure in the posterior ocular fundus that permits the exit of the retinal ganglion cell axons and the entry and exit of the retinal blood vessels. It is located at a distance of about 4–5 mm (mean: 4.76 ± 0.34 mm) from the fovea (in emmetropic eyes) in nasal slightly superior direction (mean disc-fovea angle: 7.76 ± 3.63°).

From an anatomical perspective, the ONH canal can be thought of as having three layers: the inner layer is represented by the opening in Bruch's membrane (BM), the middle layer is represented by the opening in the choroid, and the outer layer is represented by the opening in the peripapillary scleral flange.

The latter is covered by the lamina cribrosa, which permits the passage of

11. Peripapillary arterial circle of Zinn-Haller

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The peripapillary arterial circle of Zinn-Haller is situated at the peripheral end of the peripapillary scleral flange, roughly where the optic nerve dura mater merges with the posterior sclera. The lamina cribrosa, which is nourished by the arterial ring, is farther away from the arterial circle due to the elongation of the peripapillary scleral flange caused by myopia. Another potential explanation for the increased glaucoma susceptibility of very myopic eyes is the lengthening of the scleral flange with the consequent widening of the gap between the artery circle and the lamina cribrosa.

Morphological differentiation between glaucomatous optic neuropathy and non-glaucomatous optic nerve damage

Any optic nerve damage, whether from glaucoma or another cause, is accompanied by a widespread and focused decrease in the diameter of the retinal arterioles as well as a loss in the thickness and ophthalmoscopical visibility of the peripapillary retinal nerve fiber layer. The loss of retinal nerve fiber layers and other metrics reflecting the degree of optic nerve damage are correlated with the retinal arteriolar thinning. The neuroretinal rim area decreases and the shape of the rim alters in GON compared to non-glaucomatous optic nerve damage, the optic cup deepens (and enlarges), the parapapillary beta zone develops and enlarges, and disc hemorrhages are possible. In contrast, the neuroretinal rim is largely unaffected in non-glaucomatous optic nerve damage, with the exception of a slight decrease in height caused by the loss of the nerve fiber layer. This decrease in rim height also causes the optic cup to become shallower, while the parapapillary region remains unaffected.

Some patients with intrasellar or suprasellar tumors may be an exception to this rule since they have glaucoma-like optic disc morphology in eyes with normal IOP. It has been suggested that in these patients, a tumor that was close to the inner aperture of the ocular optic nerve canal may have prevented CSF from reaching the orbit, causing the orbital CSF pressure to be unusually low and increasing the trans-lamina cribrosa pressure difference. The findings do not apply to giant cell arteritis-induced optic nerve damage, in which the optic cup deepens and enlarges along with an infarct in the lamina cribrosa and subsequent disruption of the structure, as well as a transfer of vitreous into the optic nerve tissue.

12. Diagnostic problems in detection optic nerve damage in a myopic ONH

Cenk Zeki Fikret

The following factors make it challenging to find an optic nerve injury in an extremely myopic ONH:

- The spatial contrast between the neuroretinal rim height and optic cup depth is reduced since the myopia-related stretching of the lamina cribrosa develops a flattening of the optic cup; - that longer axial length makes the optic cup to appear to be flattened; - that the color contrast between the pinkish neuroretinal rim and the pale optic cup is decreased; - that the ophthalmoscopical examination of the retinal nerve fiber layer thickness is cramped due to the bright underground in the parapapillary region; - that the OCT-based decision of the peripapillary retinal nerve fiber layer thickness often is untrustworthy because of abnırmalities in the parapapillary region in profile and color.
- Visual field defects can frequently be caused by conditions other than optic nerve injury, including as myopia, macular alterations, and inconsistencies in the shape of the globe.

If the retinal ganglion cell-inner plexiform layer thickness is determined by OCT outside of macular patchy atrophic zones, some of these issues might be avoided. The retinal surface area is increased within the patchy atrophic regions, which often have a smaller BM defect and a bigger RPE layer and photoreceptor layer defect. This could perhaps cause the retinal ganglion cell layer and inner plexiform layer to thin, which is geometrically described. The evaluation of the retinal nerve fiber layer texture and the OCT-angiography of the radial peripapillary capillary network are two more potential methods.

The obstacles in detecting an optic nerve damage in highly myopic eyes is aligned with an even more substantial problem in detecting progression of optic nerve damage in high myopia. It may be discovered in future research whether the assessment of the outer isopters of the visual field and whether the measurement of the retinal ganglion cell-inner plexiform layer thickness outside of macular patchy atrophic areas are in utility to detect a continuance of the optic nerve damage in highly myopic eyes.

Tan NYQ, Sng CCA, Jonas JB, et al. Glaucoma in myopia: diagnostic dilemmas. Br J Ophthalmol. 2019;103(10):1347-1355.

Process of axial elongation

The process of axial elongation in myopia and its morphological aftereffects could be the source of alterations in the ONH associated to myopia. Although the mechanism causing myopic axial elongation has not yet been fully understood, one theory contends that the BM is the primary structure that lengthens the globe during the process of emmetropization, which occurs when moderate hyperopia in children older than two years turns into emmetropia in adolescents and young adults. Myopization could be an overshooting of the emmetropization process.

The hypothesis assumes that the globe gets axially elongation by the enlargement (and new production) of BM in the equatorial and retro-equatorial region while the foveal region is primarily unspoiled. Such a mechanism would explicate the histologic observations that the retinal thickness and the RPE cell density dwindle in the equatorial and retro-equatorial region with longer axial length, that the RPE cell density, retinal thickness and choriocapillaris thickness in the macular region are uninfluenced by axial length, that the overall choroidal thickness in the macula decreases with longer axial length, and that the best corrected visual acuity is free of axial length (if eyes with maculopathy and optic neuropathy are excluded) .

Such a mechanism would include the backward movement of the posterior BM, leading to shift of the BMO of the ONH into the direction towards the fovea, and the thinning of the posterior choroid by a compression effect between the posterior BM being pushed backward and the sclera.

The enlargement of BM in the equatorial and retro-equatorial region would also result in a slight increase in the horizontal and vertical globe diameters, increasing the tension (or strain) within BM at the posterior pole, according to the hypothesis. This increase in strain is also implied by the enlargement of BM in the equatorial and retro-equatorial region. If the BMO enlargement was insufficient to ease the strain on the BM, it can result in the first stage of myopic maculopathy, which is an enlargement of the BMO in the ONH, and the second stage, which is the development of further BM abnormalities in the macular region. The BMO enlargement would occur mostly in highly myopic eyes, with a cut-off value of an axial length of approximately 26.0–26.5 mm.

Panda-Jonas S, Holbach L, Jonas JB. Choriocapillaris thickness and density in axially elongated eyes. Acta Ophthalmol. 2021;99(1):104-110.

Zhang Q, Xu L, Wei WB, et al. Size and Shape of Bruch's Membrane Opening in Relationship to Axial Length, Gamma Zone, and Macular Bruch's Membrane Defects. Invest Ophthalmol Vis Sci. 2019;60(7):2591-2598.