Detecting glaucoma in eyes with moderate or no myopia is similar, because the appearance of their optic nerves is more or less the same (Figure 1).¹ In highly nearsighted eyes, diagnosing glaucoma is difficult, because the visual field is likely to be abnormal due to myopic irregularities of the fundus irrespective of additional glaucomatous field changes. Furthermore, the IOP in highly myopic eyes with open-angle glaucoma (OAG) is more likely to be in the normal range than in glaucomatous eyes without high myopia. For that reason, clinicians often must rely on an examination of the optic disc in order to diagnose glaucoma in high myopes.

The ophthalmoscopic appearance and histology of the optic nerve head differ markedly between eyes with and without high myopia (Figure 2).²⁻⁵ These abnormalities have to be differentiated from and may complicate the identification of glaucomatous damage. Because the contour of the retinal vessels on the disc is often the sole indicator of the surface topography, it may be the only means of identifying the width of the neuroretinal rim at a given disc segment. As a result, clinicians must assume each highly myopic optic disc to be glaucomatous until proven otherwise.

**INTRAPAPILLARY CHARACTERISTICS**

The size of the optic disc varies among individuals from approximately 0.80 to almost 6.00 mm² or about 1:7 in a normal, white population.¹ Within a range of -5.00 to +5.00 D of ametropia, the optic disc’s size is almost independent of the refractive error of the eye, or it may grow slightly by 1.2% ±0.15% for each 1.00 D increase toward myopia, according to a recent epidemiological study.⁶⁻⁷ Beyond +5.00 D of refractive error, the optic disc is significantly smaller than in emmetropic eyes, whereas it is significantly larger beyond -8.00 D.⁶⁻⁷

In severely nearsighted eyes, including the highly myopic form of primary open-angle glaucoma, the globe stretches and becomes larger. Correspondingly, the optic disc is abnormally large in the sense of an acquired macrodisc due to the degree of ametropia.²⁻³ Additionally, the optic disc in highly myopic eyes is oval, elongated, and obliquely oriented to a significantly greater degree than in any other group.³ The cup is also remarkably shallow. The abnormal shape of the optic disc is much more pronounced in eyes with a myopic refractive error of more than -12.00 D than in those with ametropia ranging from -8.00 to -12.00 D. This difference suggests that the myopic stretching leading to the secondary macrodisc in highly myopic eyes pulls the optic disc...
more strongly in some directions than others.

The myopic elongation of the globe stretches the optic disc and thins the lamina cribrosa. The same pressure difference between the intraocular and retrobulbar spaces is therefore distributed over a shorter length, resulting in a steeper pressure gradient across the lamina cribrosa. A continuous drop in the pressure difference between the intraocular and extraocular spaces in the lamina cribrosa would produce the same effect as an increase in IOP if the lamina cribrosa were of normal thickness. One can hypothesize that some similarities exist between the stretching of the optic disc in highly myopic eyes and the abnormal deformation and thinning of the lamina cribrosa in glaucoma. In severe myopia, the increased susceptibility for glaucomatous optic nerve fiber loss may be present mainly in eyes with large, abnormally shaped, optic nerve heads.

It is possible that the secondary enlargement and irregular stretching of the optic disc in highly myopic eyes are predisposing factors to glaucomatous optic nerve damage, even in the presence of statistically normal IOP measurements. That idea is corroborated by the results of a recent study that compared glaucomatous eyes with myopia in excess of -8.00 D with glaucomatous eyes that had a moderate refractive error. The neuroretinal rim in the highly myopic glaucoma group was significantly smaller than in the subgroup of glaucomatous eyes with a moderate refractive error when adjusted for optic disc size. As a corollary, a subgroup of the highly myopic glaucomatous eyes with especially large optic discs had significantly lower IOP measurements compared with the subgroup of glaucomatous eyes with a moderate refractive error. These two groups did not differ significantly in neuroretinal rim area.

In addition, the IOP measurements were lower, although not significantly so, in the highly myopic group. This finding suggests that, at the same level of IOP and with both subject groups adjusted for optic disc area, the neuroretinal rim area was significantly smaller in the high myopes. The idea that severely myopic eyes are more susceptible to developing glaucoma than eyes with smaller refractive errors may fit with the aforementioned histomorphometry of the lamina cribrosa in highly myopic eyes and with the pathophysiologic role that the anatomy of the lamina cribrosa may play. Correspondingly, moderately myopic eyes with chronic OAG and normally sized optic discs do not differ in neuroretinal rim area from eyes that are not myopic.

**PARAPAPILLARY CHORIoretinal ATROPHY**

The secondary macrodiscs in highly myopic eyes differ from the primary macrodiscs in eyes with low-to-moderate myopia or hyperopia. The latter exhibit deep and large physiologic cupping and unremarkable parapapillary atrophy. Eyes with the highly myopic type of chronic OAG and highly myopic eyes without glaucoma do not vary remarkably in the size of parapapillary atrophy. The large parapapillary atrophy in highly myopic eyes with glaucoma may result mainly from nonglaucomatous causes such as the myopic stretching of the globe.

Ophthalmoscopically and histopathologically, parapapillary atrophy may be divided into a peripheral alpha zone and a central beta zone. The former is characterized by an irregular hypopigmentation and hyperpigmentation of the retinal pigment epithelium and slight thinning of the chorioretinal tissue layer. The beta zone is characterized by a complete loss of the retinal pigment epithelium, marked atrophy of the retinal photoreceptor layer and the choriocapillaris, clear visibility of the large choroidal vessels and sclera, and round boundaries to the adjacent alpha zone on its peripheral side and to the peripapillary scleral ring on its central side. Parapapillary atrophy is significantly larger, and a beta
zone occurs more often in eyes with glaucomatous optic nerve atrophy than in normal eyes.\textsuperscript{1,13-15} In a recent longitudinal study, the enlargement of the beta zone occurred significantly more frequently in progressive versus stable glaucoma.\textsuperscript{20} That finding suggests that, in the higher myopic range, glaucomatous progression as well as the myopia itself may have contributed to the enlargement of the parapapillary atrophy. In contrast, in moderately myopic and hyperopic eyes, the progression of glaucoma alone may have produced an enlarged beta zone.

Clinicians must differentiate the alpha and beta zones from the myopic scleral crescent in eyes with high myopia and from the inferior scleral crescent in eyes with ‘tilted optic discs.’”

Clinicians must differentiate the alpha and beta zones from the myopic scleral crescent in eyes with high myopia\textsuperscript{4} and from the inferior scleral crescent in eyes with “tilted optic discs.” In the region of the myopic crescent, only the inner limiting membrane and the underlying retinal nerve fiber layer or its remnants cover the sclera.\textsuperscript{4} In contrast, in the glaucomatous beta zone, Bruch’s membrane and the choroid are interposed between the remnants of the retina and the sclera.\textsuperscript{21-23} The alpha and beta zones may also be present in an eye with high myopia. Both zones are significantly larger in highly myopic eyes with glaucoma than in glaucomatous eyes that are not.

CONCLUSION

Clinicians do not need special techniques for examining the optic discs of eyes with moderate myopia for glaucomatous damage. In high myopia, however, they must take into account the secondary enlargement of the disc. In a macrom disc, one may expect to observe a large cup. If neuroretinal rim is present around the optic disc and the shape of the rim follows the ISNT rule, the presence of a large cup may not be an indicator of glaucoma. If the neuroretinal rim cannot be distinguished due to shallow cupping or if the course of a retinal vessel indicates a gap in the neuroretinal rim, glaucoma may be assumed. Evaluating the parapapillary atrophy in myopia will not assist in the diagnosis of glaucoma.

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