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Editorial

Explore the underdiscovered—the choroid of the eye

The choroid of the eye is primarily a vascular structure containing large membrane-lined lacunae, nonvascular smooth muscle cells, and intrinsic choroidal neurons.[1] It lies between the retina and sclera, extending from the ora serrata anteriorly to the optic nerve posteriorly, and is composed of three layers: the choriocapillaries, the medium vessel layer, and the large vessel layer. Choroidal blood flow constitutes 75–85% of the total blood flow that perfuses the eye, which is responsible for vascular support and temperature modulation of the outer retina. More than 90% of the oxygen delivered to the retina is consumed by the photoreceptors, which are extremely metabolically active in order to maintain ion homeostasis. A normal choroidal vasculature is essential for the health of retinal pigment epithelium (RPE) and photoreceptors, and an abnormal choroidal vasculature plays a critical role in the pathophysiology of a variety of retinal diseases such as diabetic retinopathy and age-related macular degeneration.

In a clinical setting, choroidal vasculature often is assessed with fluorescein angiography and indocyanine green angiography that evaluate the time sequence and distribution pattern of the injected dye that fills the choroid. However, these technologies have limitations in that they provide neither quantitative blood flow data nor structural information of the RPE and choroid, and patients may develop adverse reactions to the injected dye. Laser Doppler flowmetry has been used by some researchers to measure choroidal blood flow, but the device is not available in most areas of the world. In recent years, various versions of spectral-domain optical coherence tomography (SD-OCT) that use an interferometer with a high-speed spectrometer to simultaneously measure light echoes from all time delays, have become available on the market. Coupled with improvement in the quality of light sources, the cross-section image with an axial resolution of 5–7 μm of the choroid can be assessed noninvasively under normal and pathologic conditions. However, the outer limit of the choroid abutting against the sclera cannot usually be reliably identified using standard SD-OCT. In order to more accurately measure the choroidal thickness (CT), techniques such as image averaging, mechanical eye tracking, or enhanced depth imaging usually have to be adopted.[2] Assessment of CT by SD-OCT may play a role in the differentiation of age-related maculopathy from polypoidal choroidal vasculopathy, of central serous chorioretinopathy from other causes of serous retinal detachment, and may help in the determination of disease activity and evaluation of treatment effect for a certain follow-up period.[2]

The prevalence of high myopia (refractive error < −6.0 diopter) in schoolchildren has doubled from 10.9% (in 1983) to 21% (in 2000) in Taiwan in recent decades.[3] As compared with eyes without myopia, high myopic eyes have a higher risk for a variety of vision-threatening diseases that may cause irreversible blindness, including glaucoma, retinal detachment, and myopic maculopathy. Myopic maculopathy tends to occur earlier in life when patients are still at a productive age, so the expected person-years of blindness for patients with this disease is 7–12 years more than that of other common blinding diseases such as glaucoma and age-related maculopathy. In this issue of the *Journal of the Chinese Medical Association*, Hsu et al[4] report that thinner subfoveal CT measured by SD-OCT and longer axial length of the eye are two factors significantly associated with myopic maculopathy. These findings are not surprising as Saka et al[5] have shown that increased severity of maculopathy is associated with increased axial length and age in patients with myopia. Wang et al,[6] based on their study findings, even suggested that CT could be used to predict the development of lacquer cracks in patients with high myopia. Lacquer crack represents breaks in the Bruch's membrane–RPE–choriocapillaris complex secondary to posterior segment elongation of the eye, which may lead to the subsequent deterioration of the fundus, including patchy chorioretinal atrophy and choroidal neovascularization in the macula.

What is unexpected, based on the authors' hypothesis, is that systolic blood pressure (BP) is not a factor associated with myopic maculopathy in their study. This is inconsistent with the findings of a previous population-based Shihpai Eye Study reported by Chen et al,[7] in which patients with high myopia with maculopathy had higher systolic BP than those without maculopathy in multivariate analysis. It should be noted that in the Shihpai Eye Study, only 44 out of 1058 participants had high myopia; among them myopic maculopathy was present in 32 individuals and absent in 12 individuals. Furthermore, ocular variables relevant to the development of myopic maculopathy, such as axial length and refractive error, were not taken into consideration in the multivariate analysis in Chen et al's[7] study. Thus, the small sample size and omission of relevant factors in the statistical analysis could have biased the study results reported by Chen et al.[7] However, it should be

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kept in mind that, being a retrospective chart review study, the study by Hsu et al[4] itself has inherent limitations. Specifically, BP measurement and fundus photography used to define myopic maculopathy were conducted on the same day for one particular participant in the Shihpai Eye Study; however, in Hsu et al's[4] retrospective study, the authors did not mention the time point during BP measurement when the reading was collected and used to evaluate its association with myopic maculopathy. Thus, whether there is an association between systolic BP and myopic maculopathy remains inconclusive.

Hsu and his colleagues[4] are to be commended for their efforts to explore a possible link between a modifiable systemic variable and a vision-threatening disease. Having the highest blood flow per unit tissue weight among all tissues in the body, choroid has attracted increasing attention in research regarding the impact of systemic hemodynamic changes on its blood flow or thickness.[8–10] The conventional perception is that choroid vasculature has no autoregulation, but recent studies suggest that choroidal blood flow exhibits baroregulation similar to that seen in the cerebral circulation.[11] Meanwhile, studies have shown that, in addition to the functions of nourishment and thermoregulation of the retina, choroid works to adjust the position of the retina by changing its thickness and secretion of growth factors.[1,12] These findings highlight the importance of further investigation of the mechanisms through which the choroid affects elongation of the eyeball with subsequent development of myopia. An ounce of prevention is better than a ton of treatment; it would be manifestly more worthwhile to prevent the development of high myopia than to treat its dreadful complications such as myopic maculopathy.

Conflicts of interest

The author declares that there are no conflicts of interest related to the subject matter or materials discussed in this article.

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