MYOPIA MANAGEMENT: A PARADIGM SHIFT

From refractive error correction to disease prevention and control

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Once considered a benign refractive error easily corrected by eyeglasses or contact lenses, myopia is now viewed as a public health concern with socioeconomic and national security implications—particularly in East Asia.[1-4] In Singapore and many places in China, Korea, and Japan, about one-third of children in first grade and two-thirds of children in sixth grade are myopic.

The prevalence of myopia is so high in young adults that those countries are facing serious challenges in military conscription and recruitment. For example, in China, the high prevalence of poor, uncorrected visual acuity in the target population is hampering efforts to recruit personnel for military service and other professions, such as commercial pilots, law enforcement personnel, and heavy machinery operators.

In fact, the number of people in the age-appropriate population in China who have uncorrected visual acuity of no worse than 20/50 (previously the minimum requirement for military draft) has drastically diminished. Consequently, in 2014 the government further modified the requirement for military recruitment from monocularly uncorrected visual acuity of 20/50 to best-correctable visual acuity of 20/30 and a refractive error of no worse than –6.00D from a previously lowered requirement in 2004.[5] This was the third time the Chinese government reduced the vision requirement for military enrollment in the past 25 years.

Because of the higher overall prevalence, earlier onset, and faster progression of myopia in East Asia, as well as a higher incidence of complications there, the perception of myopia shifted from a minor refractive problem to a potentially serious health issue much earlier than it did in North America.

In Singapore, myopia has long been considered a priority national health issue, prompting the creation of the National Myopia Prevention Programme (NMPP) in 2001 to develop a comprehensive national registry of the refractive status and ocular biometric profile of all school-age children.

The goal of the NMPP is timely and accurate evaluation of the epidemiological trend of myopia and the effectiveness of public health campaigns and intervention strategies targeting the early onset or rapid progression of myopia.[6]

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More recently, the Singapore National Eye Centre's Myopia Centre was established to focus on initiatives to prevent, control, and treat the condition.[7] Additionally, in China, a consortium was formed in 2018 by eight government agencies, including the National Health Commission and the Ministry of Education, to implement a comprehensive set of public health strategies involving preschool and school-age children and their families, as well as school systems, medical institutions, and other related government agencies.

The aim is to reduce the incidence of myopia by 0.5% per year. This is now one of the key performance indices of the primary school system.[8]

UNIQUE CHALLENGES TO PUBLIC HEALTH

With the exceptions of childhood blindness and several genetic eye diseases, the age of onset of myopia is several decades earlier than that of most other priority eye diseases, such as diabetic retinopathy, glaucoma, cataract, and age-related macular degeneration.[9-11] Considering the recurring expenses for refractive correction, treatment of complications, and visual rehabilitation, the lifetime financial burden of myopia for each patient can be substantial. In addition, blurry vision and dependence on optical corrections in the early developmental age of myopic children may have a profound impact on self-esteem, as well as the lifestyle and career choices of those patients.[12]

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In contrast to the negative risks associated with educational level and socioeconomic status of other common chronic conditions, such as diabetes, hypertension, and heart disease, there is a strong positive correlation between the severity of myopia and educational level, as well as the socioeconomic status of patients and their families. Because the irreversible visual impairment resulting from myopia complications usually occurs bilaterally, the overall impact on productivity at the individual and the population level is tremendous.

DO CONVENTIONAL SINGLE-VISION SPECTACLES DO NO HARM?

Myopia is now being recognized as a potential health risk, and tremendous efforts are underway to identify novel treatment modalities that are safe and effective for myopia retardation. Despite some significant advancement in the development of evidence-based, myopia-control treatments and a set of recently published general guidelines on the clinical management of myopia,[13] we still lack a specific standard of practice or a clinical manual detailing indications, first-line versus second-line treatment considerations, dosing regimens for each option, and the necessity for tapering treatment. This lack of guidance is likely related to the following:

- absence of U.S. Food and Drug Administration approval of myopia control indications
- lack of specific diagnostic and billing codes for progressive myopia in contrast to stable myopia
- limited insurance coverage for myopia control treatments
- inconsistency in the understanding of the etiology of myopia, the efficacy of the myopia-controlling treatments, and the perception of the risks associated with each option.

As a result, many practitioners take a risk-benefit approach to incorporating myopia management, evaluating each case based on the risk for fast progression and the development of related complications. Hence, they are weighing the benefits of myopia control against the potential risks of complications imposed by the treatment options, such as overnight orthokeratology (ortho-k), daytime multifocal contact lenses, and low-dose atropine eye drops.

One common argument against incorporating myopia management into primary care practice is the risk of complications associated with contact lens wear or chronic use of atropine may be unjustified, particularly considering the off-label application of some of these modalities in the pediatric population.

Instead, practitioners choose to conform to the Hippocratic Oath of "First, do no harm" by providing conventional single-vision spectacle correction until more definitive evidence of treatment efficacy and the official approval of this indication become available.

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The next logical question is: Are we really doing no harm to children with progressive myopia by prescribing conventional single-vision eyeglasses? The answer may be surprising to many practitioners.

Based on the converging evidence from experimental myopia models and clinical studies, conventional single-vision eyeglasses may induce significant myopia-stimulating effects and trigger faster progression. Specifically, it is commonly accepted that hyperopic defocus imposed throughout the entire or only in the peripheral visual field while maintaining clear

MINIMIZE THE IMPACT OF MYOPIC CHOROIDAL NEOVASCULARIZATION

Despite major advancements in the treatment of various proliferative retinal disorders, myopic choroidal neovascularization (CNV) remains untreatable, and early intervention is the key to minimizing excessive scleral stretching as well as the risk of serious complications.

Recent anti-vascular endothelial growth factor (anti-VEGF) trials targeting age-related macular degeneration and diabetic retinopathy, as well as other proliferative retinopathies, have shown significant clinical efficacy, either as an anti-VEGF antibody or by receptor blocking; however, its efficacy for treating myopic CNV has been controversial.[18,19]

Although there have been reports of immediate vision improvement after anti-VEGF treatment of myopic CNV cases, the long-term outcome is generally poor, particularly in cases with patchy or diffuse chorioretinal atrophy. Because of the continuous myopia progression and axial elongation, the posterior sclera undergoes excessive stretching and thinning.[20]

As the scleral expansion reaches its decompensating stage, the structural and functional support to the overlying structures, such as the choroid, Bruch's membrane, the retinal pigment epithelium, and ultimately, the outer retina, is dramatically compromised. As a result, the fundamental mechanisms of myopic CNV are somewhat different from those of other proliferative retinal diseases, because the root of the pathologic cascade of myopic CNV originates from the excessive and irreversible scleral stretching, rather than local hypoxia of the outer retina.

Consequently, early interventions that aim to slow the myopia progression and the excessive scleral stretching at its early stage play crucial roles in minimizing the risks of subsequent complications.

central vision may accelerate axial growth and the development of myopia.[14]

Furthermore, multiple clinical studies have demonstrated that myopic eyes experience significant relative hyperopia in the peripheral visual field when fully corrected at the fovea by a single-vision spectacle lens, because of the inherent optical design of conventional eyeglasses and the relative prolate shape of the ocular posterior, particularly in highly myopic eyes.[15,16]

Importantly, the amount of relative peripheral hyperopia is positively associated with the level of on-axis myopia, i.e., the higher the negative single-vision correction, the stronger the associated myopia-stimulating dose imposed on the peripheral field. In other words, by fully correcting myopia with conventional single-vision spectacle lenses, we may have contributed to the continuous progression of the condition.

A GUIDE TO COMPREHENSIVE MYOPIA MANAGEMENT

Comprehensive myopia management entails early education of patients and parents, thorough data collection, continuous and long-term evaluation of disease progression, and timely adjustment of treatment.

Incorporating myopia management into daily practice can be highly rewarding but challenging. Because of the chronic nature of the disease and the long lag period between the onset of myopia and the onset of myopia complications, it is sometimes difficult for practitioners, as well as patients and parents, to appreciate the invisible benefits of myopia control, particularly compared with treatments for more acute conditions with immediately measurable outcomes, such as allergy and infection. As a result, early repeated education is crucial to raise awareness of the disease and to motivate patients to adhere to treatment.

While there tends to be a close association between myopia progression and axial elongation of ocular structure, overall ocular development is highly complicated, making comprehensive data collection before and during myopia-control treatments critical for monitoring treatment efficacy and disease progression. Emerging clinical evidence has shown that normal eye growth does not stop at birth; instead, there is continuous and significant normal ocular enlargement until a child reaches adolescence.

Consequently, the association between myopic refractive progression and axial change is confounded by physiological ocular growth. The younger the

patient, the less the association between the change of refraction and that of axial length.

While cycloplegic refraction provides straightforward measurement of the level of myopia, longitudinal axial length readings provide the most direct measurement of the extent of ocular expansion and scleral stretching. The two measurements are complementary, and both are essential in the long-term management of progressive myopia.

Another major challenge in myopia management is the accurate evaluation of treatment efficacy for myopia control. Because of the confounding effect of physiological axial growth, efficacy outcomes reported in the relative change of myopia and that of axial length are often different in the same clinical trial, making the results more difficult to interpret. What's more, the exact amount of myopia progression is nearly impossible to evaluate in patients undergoing ortho-k treatment, as a complete washout from the treatment is often difficult.

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Finally, despite consistent evidence from clinical studies demonstrating that juvenile myopia is controllable, the significant individual variability in each treatment reported in the trials makes it difficult to predict the effectiveness of those treatments at the individual level.

As a result, a fully informed consent—including the complex nature of myopia development and the scientific interpretation and explanation of the evidence-based myopia control options—is necessary to ensure patients' long-term adherence to the treatments. Timely adjustment of dosing or treatment modality, or implementation of combination therapy, should be considered if evidence suggests suboptimal controlling efficacy from the current treatment regimen.

CONCLUSION

Despite some geographic or ethnic differences in prevalence and severity, myopia is reaching pandemic status and should be viewed as a serious health issue that carries significant risk of irreversible vision loss if left uncontrolled.

Myopic retinopathies originate from irreversible axial elongation and excessive scleral thinning. The earlier myopia control interventions are initiated, the better the cumulative benefit of inhibiting scleral stretching, resulting in a favorable prognosis in myopia complications. **CLS**

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