Myopia control: the time is now

For over a century parents have asked clinicians if anything can be done to slow the progression of myopia in their children. Most practitioners shrug their shoulders, add another −0.50 DS to the child’s prescription and see him or her in a year. The tide has now turned. A number of treatments have been shown to cut progression rates in half and a motivated clinician could expand his or her practice to incorporate myopia control.

Optical methods of myopia control

Progressive addition spectacle lenses (PALS) produce a statistically significant but clinically irrelevant 11–13% slowing of myopia progression based on 2 and 3 year randomized clinical trials. Other clinical trials of PALS and flat-top bifocals in hypothetically high-risk groups have found similarly modest treatment effects. Larger treatment effects from spectacle lenses have been reported recently using executive bifocals. Myopic Chinese Canadian children were randomly assigned to one of three treatments: single-vision lenses, executive bifocals, or executive bifocals with base-in prism in the near segment of each lens. After 3 years the treatment effect was 39% and 51% for bifocals without and with prism, respectively, although the axial elongation was similar for each of the two bifocal treatment groups. The aforementioned studies of multifocal spectacle lenses have been predicated on the hypothesis that myopia progression may be slowed by the reduction in accommodative lag by a reading addition. Based on this hypothesis, one might expect that all multifocal modalities would produce similar effect sizes, but PALS have the smallest effect and executive bifocals the largest, with flat-top D-segments falling in between. In other words, the larger the near portion, the greater the treatment effect. Taken together, these studies support an alternative mechanism, that a reduction in peripheral retinal hyperopic defocus slows myopia progression and that interventions that reduce peripheral hyperopic defocus should be developed. Indeed, a number of treatments based on this hypothesis have already been evaluated. These are discussed below, but first the compelling evidence from animal models of myopia is reviewed.

Evidence for optical methods from animal studies

In his 2010 Prentice Award Lecture at the Annual Meeting of the American Academy of Optometry, Earl Smith reviewed over a decade of careful research demonstrating the viability of optical methods of myopia control. Refractive development is regulated by visual feedback and the process can be manipulated by optical interventions. Because of the prominence of central vision in primates, it has generally been assumed that signals from the fovea determine the effects of vision on refractive development, however, experiments in laboratory animals demonstrate that ocular growth and emmetropisation are mediated by local retinal mechanisms and that foveal vision is not essential for many vision-dependent aspects of refractive development. The peripheral retina, in isolation, can effectively regulate emmetropisation and mediate many of the effects of vision on the eye’s refractive status. Moreover, when there are conflicting visual signals between the fovea and the periphery, peripheral vision can dominate refractive development. Collectively, these results suggest that optical treatment strategies for myopia that manipulate peripheral vision offer promise.

Myopia control using peripheral retinal hyperopic defocus

Sankaridurg et al. reported the impact of novel spectacle lens designs intended to reduce peripheral hyperopic defocus. Myopic Chinese children were randomised to wearing either one of three novel spectacle lens designs or conventional, single-vision spectacle lenses for 1 year. For the entire group, no statistically significant reduction in myopia progression was observed with the novel designs although, in children under 12 years with a parental history of myopia, progression was 30% lower than with control spectacles. With spectacles the eye moves behind the lens and this may diminish the effectiveness of the treatment. If the peripheral hyperopic defocus is manipulated with an optical device whose position remains essentially fixed relative to the visual axis, greater benefits may be accrued.

Modern overnight corneal reshaping or orthokeratology (Ortho-K) is effective for temporary myopic reduction and there was anecdotal evidence that these lenses may slow myopia progression in children. Cho et al. and Walline et al. both conducted 2-year case series with historical controls (soft lenses and spectacles, respectively) and found that wearing overnight corneal reshaping contact lenses significantly slowed axial elongation by 46% and 56%, respectively. These preliminary findings were validated by Cho and Cheung who reported a 43% treatment effect in a 2 year randomised clinical trial. Overnight corneal reshaping contact lenses produce a flattening of the central cornea, leaving the peripheral cornea largely unchanged.
effect of this is a change in corneal spherical aberration resulting in foveal vision being corrected to near emmetropia while the peripheral retina is relatively myopic. Thus the retardation of myopia progression produced by overnight corneal reshaping contact lenses provides serendipitous support for the peripheral hyperopic defocus theory.

Sankaridurg et al. reported intriguing results with a novel contact lens designed specifically to reduce relative peripheral hyperopia. Progression was 34% less than for single-vision spectacles. Walline et al. recently reported that daily wear distance-centre multifocal soft contact lenses slowed myopia progression by 50% in a 2 year study, although this was with respect to a historical control group and the reduction in axial elongation was only 29%. Thus two contact lens modalities, that produce similar peripheral optical profiles, offer promise for myopia control, although practitioners will want to make their own assessment of the low but finite risks associated with wear.

Pharmacological interventions

Atropine is probably the most effective treatment to slow myopia progression with a mechanism of action that is retinal or scleral and not accommodative. It is used extensively in Asian countries, but there has been general resistance to its widespread adoption in the West given its side effects of cycloplegia and photophobia. A recent clinical trial has demonstrated that the lower concentrations of 0.1% and 0.01% can slow progression by 68% and 59%, respectively. At a concentration of 0.01% accommodation is relatively unaffected and symptoms absent making this an attractive option that is gaining traction in the US. The effect size of low dose atropine is equal or larger than that reported for selective muscarinic antagonists which, combined with the expense associated with drug development, will likely inhibit the commercialisation of new anti-myopia drugs.

Behavioural approaches

Slowing myopia by changing a child’s behaviour has a dubious history including the SeeClearly Method and the Bates Method and recent attempts to control myopia by vision training have failed. Furthermore, in spite of widely held beliefs that near work causes myopia, several well-designed large-scale studies have failed to find a compelling association between the amount of near work undertaken by a child and the incidence or progression of myopia. In contrast, recent studies have found a strong evidence that more time spent outdoors lowers the risk of developing myopia. Time spent outdoors in childhood is not associated with rates of myopia progression, nor does it appear to be related to myopia stabilisation. A preliminary clinical trial in China has suggested that the incidence of myopia can be lowered by a program of outdoor activity, although, even with incentives, children may be reluctant to persist with such a program. Regardless, practitioners should encourage parents to have their young children spend more time outdoors. This can be part of a broader public health message in the light of increasing rates of childhood obesity.

The future is now

Readers should anticipate additional evidence on clinical myopia control to be forthcoming. Optical therapies will be refined, particularly for contact lenses, and additional clinical trials will enhance our understanding of the underlying mechanisms. Given the effectiveness of atropine, commercial development of designer myopia drugs has likely stalled, although a sustained release device would be an attractive alternative to daily drug installation. Finally, the mechanism underlying the benefits of outdoor activity remain unclear with Vitamin D, light levels and spectral composition all potentially playing a role. The latter could prompt changes in classroom lighting—perhaps representing the ocular equivalent of fluoride for teeth. In the meantime, now is the time for clinicians to offer treatment options to their young patients. Depending on your scope of practice, overnight corneal reshaping contact lenses, multifocal soft lenses, executive bifocals, or atropine are all worthy of consideration. The children deserve something other than an additional –0.50DS.

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