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CLINICAL PERSPECTIVE:

Optical Control of Myopia Has Come of Age – Or Has It?

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Abstract

This article presents a clinical perspective on recent myopia research related to the development and testing of optical treatments for controlling myopia progression. The perspective is from that of a clinician in private practice and a clinician researcher, both with long term involvement in myopia management and research.

Keywords

myopia control; contact lenses; bifocals; orthokeratology; peripheral refractive error; accommodation lag; spherical aberration

While there has been, and likely always will be, debate over the relative contributions to myopia onset and progression of genetic and environmental influences – why else does myopia tend to run in families. The rapidly increasing prevalence figures are but one piece of evidence forcing a closer look at the role of the environment. The authors of this clinical perspective argue that interventions aimed at slowing and/or preventing myopia warrant serious consideration. In presenting our perspective, we refer readers to key reviews for relevant past literature,^{1–3} including a recent review appearing in *Progress in Retinal and Eye Research* by Ian Flitcroft.⁴

Myopia has shown dramatic increases in prevalence throughout the world over the last thirty years, with a record figure of 96.5% reported for young adult male conscripts in a recent Korean-based study.⁵ The US has not been exempt; the National Health and Nutrition Examination Survey covering the period 1999–2004 found a prevalence figure of 42% compared to 25% for the same 12–54 year age group thirty years earlier.⁶

The debate over the roles of nature and nurture has a long history. While books written at the beginning of the last century linked near work with myopia, offering management strategies for controlling myopia progression – sea voyages without books among them,⁷ many optometrists practicing today will remember being taught that myopia is genetically pre-determined and that nothing can be done to alter the outcome. They may have been further convinced of this “truth” by the modest, clinically insignificant, myopic control effects first reported for the COMET study.⁸ In terms of scientific rigor and scale, there is no

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comparable myopia control study, and thus even when follow-up analyses found positive benefits for myopes with esophoria and dysfunctional accommodation,⁹ the latter results found little traction clinically. For a rigorous analysis of this and other studies attempting to control human myopia progression, the recently published Cochrane review is recommended reading.¹⁰ The authors of this commentary have lesser goals - to convince clinicians to explore optical treatment options with their myopic patients and to call for more, admittedly expensive, supporting human clinical trials.

Why should clinicians attempt to slow myopia progression? Unfortunately data from large-scale clinical trials are currently lacking but the accumulated evidence from multiple smaller trials, mostly involving contact lenses, is very persuasive to us. Here we summarize key findings (many also described in the Cochrane review), starting with the accidental discovery by one of us (TA), working in private clinical practice, that currently available multifocal soft contact lenses, prescribed as an alternative to multifocal spectacle lenses to improve compliance, were also more effective in slowing myopia progression. Supporting clinical data were initially presented as a poster at the American Academy of Optometry,¹¹ but being retrospective in nature, were viewed with great skepticism. They were also the stimulus for our industry-sponsored collaborative controlled clinical study using distance center soft contact lenses (CONTROL), the data from which have never been authorized for release in full by the sponsoring company although a related published abstract has attracted much attention.¹² Nonetheless, the publication of this abstract and a follow-up identical twin case report may have helped to stimulate the on-going, related research investments by many contact lens companies. Indeed, since our randomized clinical trial of bifocal soft contact lenses demonstrated almost 90% less progression as compared with single vision contact lenses, two new soft contact lenses have emerged – a 5-zone dual power MySight design from New Zealand^{10,13} and another based on the Fresnel design from Hong Kong.¹⁴

In considering the role of soft bifocal and multi-zonal contact lenses in myopia management, it is important to recognize the significant variability in outcomes in published studies,^{10,13–16} with reports of up to 50%¹⁴ control of myopia progression – all less impressive than the results of the authors' unpublished CONTROL study.¹² Plausible explanations rest with differences in study designs, including the decision to restrict our CONTROL study to myopes with near associated esophoria and to customize “adds” to correct near eso fixation disparities. The former decision was based on published evidence of effective control for this group with bifocal and multifocal spectacle lenses.^{9,10} Because this subgroup of myopes will likely obtain symptomatic relief of their binocular vision condition from such treatments – in spectacle or contact lens format, it is likely that they are also more compliant, a possible explanation for observed greater myopia control. However, this subgroup is also expected to show larger accommodative lags, a source of hyperopic defocus that is known from animal studies to stimulate myopic growth. Such focusing errors can be eliminated with appropriately prescribed adds, or even replaced with myopic defocus, which is known to inhibit ocular growth.^{1–4,17} The questions raised by such discrepancies in study designs and outcomes are obvious targets for future, large controlled clinical trials.

Results with orthokeratology (ortho-k), may, for some, represent more convincing evidence for the viability of optical strategies of reducing the progression of myopia. Ortho-k or corneal reshaping, designed originally as a mode of lens-free “optical” correction of myopia, represents another “accidental” myopia control treatment. Ortho-k has been shown in several small independent studies to slow ocular elongation, the most trust worthy index of myopia control, by an average of 40 to 50% overall.^{10,18,19} It seems to us no coincidence that optically, ortho-k induces similar overall changes in the optics of the eye to the distance center bifocal contact lenses used in the CONTROL study – noteworthy, both add positive spherical aberration and induce a relative myopic shift in the defocus experienced by the

peripheral retina.²⁰ With ortho-k, the induced changes are directly dependent on the initial myopia and thus variable, providing a potential explanation for the results of several smaller studies reporting greater slowing of progression with higher initial myopia.¹⁰ However, not all studies have addressed this issue and no such relationship between initial refractive error and the degree of control over progression was found in a more recent, randomized controlled study.¹⁹

Clearly, more research is needed to understand the mechanism or mechanisms underlying these “anti-myopia” treatment effects. Some possibilities are alluded to above – reducing or eliminating peripheral hyperopic defocus, correcting on-axis hyperopia associated with lags of accommodation, or using spherical aberration to create myopic defocus.^{3,17,21} Different mechanisms of action may apply to different individuals, perhaps explaining differences in outcomes of studies into the relationship between peripheral refractions, and the development of myopia, the subject of a review by Charman et al.²² For example, a recent study of Singaporean children found peripheral refractions to be not predictive of either myopia onset or progression,²³ yet they were found to be predictive of myopia onset in another US-based study.²⁴ While these studies do not address the question of whether imposed peripheral myopia can slow myopia progression, nonetheless it is important to recognize that the effects for individual patients cannot be reliably predicted. It is also important to remember that ortho-k lenses were not originally designed for ocular growth control. Understanding mechanisms may allow customization of contact lens designs for myopia control as well as for individuals. Researchers have just begun to address such relevant questions.

Besides the question of lens design, there are other critical questions to be addressed, including whether the treatment effects with ortho-k and bifocal contact lenses are limited to the first year, as has been reported in multifocal spectacle lens studies.⁸ The mechanism underlying the latter loss of efficacy is not understood but may reflect adaptation within the accommodative convergence system. Anecdotal data from follow-up examinations of participants in our unpublished CONTROL study suggest a more enduring treatment effect, and a similar conclusion is suggested by results of a recent 2-year ortho-k study.¹⁹ Nonetheless, a three-to-five year prospective study on young children is warranted, to definitively answer this question.

While it is now recognized that even quite young children can manage contact lenses, multifocal spectacles should not be left off the list of possibilities. Specifically, those with near esophorias and dysfunctional accommodation, e.g., increased accommodative lags, were found to benefit significantly in the COMET study, just as reported in much earlier studies by Goss, Grosvenor and others.¹⁰ The good myopia control reported with high-set executive bifocal spectacles prescribed to rapidly progressing Chinese Canadian children suggests that consistent use of the near add during reading may be essential for treatment efficacy.²⁵ For half of the children in the latter study, base-in prisms were included, presumably to help stabilize binocular vision under the induced conditions of reduced accommodation. The greater treatment effect achieved with the high-set, executive lenses compared to that reported in the COMET study may reflect the large area of superior retina subjected to defocus. However, it is also important to recognize that children cannot always be relied on to use multifocal spectacle additions, to reap their benefit, as demonstrated in one Japanese study.²⁶ That study provided direct evidence of the problem of “functional compliance” as an important issue to consider.

Optometry has changed greatly over the last 30 years, advancing into therapeutics and medical care. However, it can hardly afford to abandon its historical reason for existence, the correction of refractive error. Some great things have been accomplished by accident or

serendipity throughout history and we argue that our profession need not wait for the perfect myopia control treatment before attempting to control myopia in our patients. Indeed, it is hard to argue against making myopia management more evidence-based and thus attempting control in all young progressing myopes. If the current standard of care was to prescribe lenses that were either neutral in their effect or reduced myopia progression by 50% and contact lens companies came out with lenses that increased myopia progression by 100%, would anyone prescribe them?

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