Myopia management

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With the growing prevalence of myopia at epidemic levels in some countries and increasing number of research publications on myopia control, there is a lot of controversy regarding the management of myopia. As none of them are at present available in the NHS, there is a lot of anxiety among parents and younger patients. The aim of this article is to provide guidance on key issues including how myopia should be defined, options available for reducing prevalence of myopia, interventions to slow progression of myopia and research evidence available to support it.

Epidemiology of myopia

Myopia currently is widely recognised as a significant public health issue causing visual loss and a risk factor for a range of other serious ocular pathologies [1]. The prevalence of this condition is increasing on a global basis for reasons that are not understood fully [2]. The prevalence has markedly increased in East and South-East Asia and pathologic consequences of myopia including myopic maculopathy and myopic optic-neuropathy are some of common causes of irreversible blindness.

It is affecting 85-90% of young adults in some Asian countries and between 25-50% of older adults in the United States and Europe. The prevalence of myopia ranges from three percent amongst school children in Sub-Saharan African countries to approximately 80-90% amongst senior high school students in East and South-East Asia [3-5]. The economic cost of myopia is estimated at an annual US$268 billion worldwide.

Defining myopia

The World Health Organisation (WHO) international classification of disease (ICD-10) defines myopia as a refractive error in which rays of light entering the eye parallel to the optic axis are brought to focus in front of the retina when accommodation is relaxed. This results from an overly curved cornea or from the eyeball being too long from front to back. It is also called near-sightedness.

High myopia as defined in the WHO report indicates the threshold of high myopia to be ≤ -5.00D [6]. This was chosen because uncorrected myopia of -5.00D gives an estimated distance visual acuity of 6/172, a level which meets the threshold for blindness (<3/60 in the better eye). However, based on epidemiologic studies the International Myopia Institute (IMI) classifies high myopia as a condition in which the spherical equivalent refractive error is ≤ -6.00D when ocular accommodation is relaxed [7].

Interventions to reduce prevalence of myopia

1. Time outdoors

It has been shown that low prevalence of myopia and more hyperopic mean refraction is associated with increased time spent outdoors, with implications of a protective effect of outdoor activity in studies conducted on children of Chinese ethnicity in Singapore and Australia, as well as children from all ethnicities in Sydney [8,9]. Results from clinical trials for outdoor intervention programs to reduce incident myopia have shown promising results.

The underlying reasons to explain why time spent outdoors is associated with lower incidence of myopia have not completely been understood so far but proposed reasons include: higher light intensities, variations in chromatic light compositions, less near work and decrease in accommodative demand.

2. Near work

Several reports have indicated that a school curriculum consisting of greater near work demands is associated with a higher rate of myopia and a faster rate of myopia progression [10,11]. It has also been suggested that the intensity of near work i.e., sustained reading at close distance (less than 30cm) with fewer breaks may be more important than total hours of near work.

Interventions to slow the myopia progression

1. OPTICAL INTERVENTION

1.1 Under correction (does not work)

Studies as summarised in recent Cochrane reviews have shown that under correction of myopia either increases or has no effect on myopia progression [12,13]. Hence, under correction should no longer be recommended.

1.2 Bifocal lenses and progressive additional lenses (PALs) (probably does not work)

The aim of these therapeutic interventions is to reduce the accommodation associated with near-viewing tasks thereby eliminating the delay in accommodation and the consecutive hyperopic defocus at the fovea [14].

Randomised clinical trials in the US, Denmark and Finland demonstrated that bifocals alone do not significantly slow myopia progression. The only study that yielded promising results of 40% reduction of myopia progression was conducted on a group of Canadian-Chinese children by Cheng et al., but these results are yet to be corroborated.

Regarding PALs, the largest study has been the Correction of Myopia Evaluation Trial (COMET) study which aimed to evaluate whether PALs limit the evolution of myopia versus conventional single vision lenses. It concluded that the overall adjusted three-year treatment effect was statistically significant but not clinically meaningful. Three-year treatment effects decreased further after five years [15].

1.3 Rigid gas permeable (RGP) lenses and soft contact lenses (probably does not work)

Randomised clinical trials have shown that soft contact lenses and RGP lenses are not effective in slowing myopia progression. In the Contact Lens and Myopia Progression (CLAMP) study, the RGP contact lenses slowed the progression of myopia more than the soft contact lens in young myopic children over the first year of contact lens wear, and the effects seemed to be primarily due to corneal reshaping and not true slowing of myopia. However, three-year axial elongation was not significantly different between the treatment groups.

1.4 Orthokeratology (might work)

Orthokeratology (OK) is a technique whereby specially designed reverse geometry RGP contact lenses are worn overnight to reshape the cornea by flattening the corneal centre and steepening the corneal periphery. As the cornea maintains its reshaped form

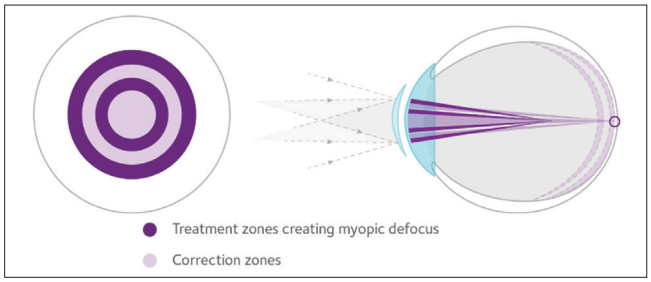

Figure 1: MiSight contact lens.

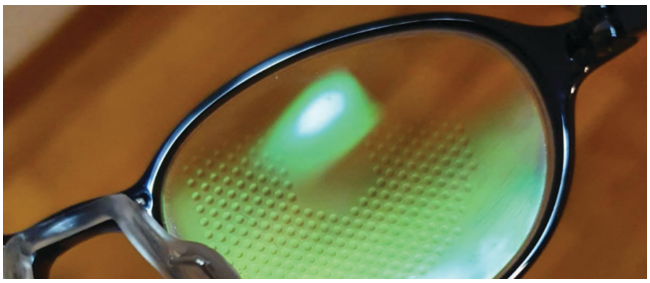

Figure 2: MiYOSMART Spectacles.

throughout the day, a reduction of up to -6.00D can be achieved without wearing any refractive correction during the day. OK may additionally slow myopic progression by causing peripheral myopic blur due to steepening of the mid peripheral corneal surface. Two randomised control trials: "The Retardation of Myopia in Orthokeratology" (ROMIO) and the High Myopia-Partial Reduction Orthokeratology (HM-PRO) study revealed that axial elongation was reduced by 43-63% [16,17]. Microbial keratitis is a serious complication that needs to be considered when prescribing these lenses. The risk of keratitis in OK wearers is similar to extended wear soft contact lenses.

1.5 MiSight contact lens and MiYOSMART spectacle lenses (might work)

According to the literature, peripheral retina and peripheral vision are both associated with the development of myopia [18]. Induction of peripheral myopic defocus has become the mainstay of several current myopia control strategies including MiSight contact lens and MiYOSMART spectacle lenses.

MiSight contact lenses available from CooperVision in the UK are daily disposable soft contact lenses which are FDA-approved for use in slowing of myopia progression. These types of lenses with a centre-distance dual focus concentric ring design, contain a central treatment area of the full myopic correction and two peripheral treatment "rings" containing defocus of +2.00D (Figure 1). It has been demonstrated in studies that myopic evolution is reduced by this contact lens [19]. Although the risk of microbial keratitis is significantly reduced in daily disposable contact lenses compared to RGP contact lenses, the risk must still be considered when prescribing.

In the past a soft contact lens called a "defocus incorporated soft contact" (DISC) lens was created for myopia control. Based on the same myopic defocus mechanism the "defocus incorporated multiple segment" (DIMS) spectacle lens was designed providing the same optical stimulus as the DISC lens. This is available in the UK as Miyosmart spectacle lenses from Hoya (Figure 2).The MiYOSMART lens contains a central treatment area to the patient's full myopic correction surrounded by a ring of multiple DIMS which provides a ring of defocus. Patients using DIMS spectacle lenses had 52% lower myopic progression and 62% lower axial growth over a two-year period compared to single vision lenses. This treatment is easy to apply and is least invasive when compared to pharmacological interventions and contact lenses [20]. However, the importance of accurate frame fitting must be emphasised as a loose, ill-fitting frame could lead to the patient potentially looking directly through the area of defocus in primary gaze, rather than the clear centre.

2. PHARMACOLOGICAL INTERVENTION (DOES WORK)

Topical atropine has shown statistically and clinically significant reductions in myopia progression, demonstrated by many studies. Atropine blocks the muscarinic receptors (found in human ciliary muscle, retina, and sclera) non-selectively. Though the exact mechanism of how atropine works is unknown, it is believed that atropine acts directly or indirectly on the retina or sclera, inhibiting stretching of sclera and hence eye growth.

In the atropine for treatment of childhood myopia 1 (ATOM1) study conducted by Chua and et al. in 2006 showed that 1% atropine eye drops nightly in one eye over a two-year period slowed progression by 77% and reduced the axial length elongation (mean axial length increase of 0.39mm in controls versus no growth in atropine group) [21]. The limitation of this study design was that the high concentration atropine was associated with a marked rebound effect after the application of the eye drops was stopped [22].

Subsequently, the ATOM 2 study published in 2012 showed a dose-related response with 0.5%, 0.1% and 0.01% atropine slowing myopia progression by an estimated 75%, 70% and 60% with spherical equivalent change of 0.30D, 0.38D and 0.48D respectively over a two-year period. However, when atropine was stopped, the rebound effect was considerably smaller in the group with 0.01% atropine eye drops than in 0.1% and 0.5% groups [23]. The limitation of ATOM 2 study was lack of a placebo control group. The side-effects of these drops include slightly reduced amplitude of accommodation, slight mydriasis, and risk of an allergic reaction. However, based on the ATOM 2 study, the application of 0.01% atropine eye drops has become widely used as a medical prevention of myopia progression.

Conclusion

In summary, spending time outdoors is the safest strategy compared to other interventions. Useful clinical measures to reduce progression of myopia include atropine eye drops ranging in concentration between 0.01% and 0.05%, multifocal spectacle design, contact lenses with power profiles to produce peripheral myopic defocus and orthokeratology. Though there is evidence that these treatments work in slowing myopia progression, many questions are still unanswered. Much of the current research is based on children from East Asian or South Asian backgrounds, and we need more research to understand how myopia management will affect children from other backgrounds. None of these treatments are available on the NHS at present and we would have to wait for the results of ongoing UK trials for these interventions to be approved by NICE and then funded by the NHS. Until then, optical interventions are available from high street opticians in the UK for which patients will have to be prepared to pay.

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Additional resources

- WSPOS Myopia Consensus Statement – 2016: https://www.wspos.org/wspos-myopia-consensus-statement/
- Myopia Management – Guidance for optometrists: https://www.college-optometrists.org/category-landing-pages/clinical-topics/myopia/myopia-management-%E2%80%93-guidance-for-optometrists
- Ocumension trial: https://clinicaltrials.gov/ct2/show/NCT04770610

LEARNING POINTS

- Lot of research has been undertaken regarding interventions to slow myopia, but many questions still remain unanswered.
- The two main treatments to try to reduce myopia progression are wearing special glasses / special contact lenses or using eye drops.
- None of these treatments are available on the NHS.
- Information for glasses / contact lenses can be obtained from high street opticians.
- Increasing daylight exposure and reducing intense periods of near work are currently the safest strategy.

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