Progressive myopia: an update

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Progressive myopia is a major concern to eyecare professionals all over the world. A simple search on popular search engines for “myopia progression” yields over 380,000 results. A Pubmed search yields. Myopia is a global health problem associated with not only vision impairment but also binding complications. It is a significant economic burden too. In Singapore mean annual cost of myopia for a child 7–9 years of age is $148. In US annual direct cost of correcting distance vision impairment due to refractive errors is between US $3.9 and US$7.2 billion.

Myopia also poses a significant medical burden with increased incidence of glaucoma and cataracts in those myopic individuals. There is also a higher incidence of blinding retinal complications due to choroidal neovascular membranes, not to mention the impaired quality of life.

Prevalence

Studies in adults have found myopia prevalence ranging from 19.4% in Taiwan to 41.8% in Japan with figures from Singapore and China falling in between. The population-based studies in children have found myopia prevalence ranging from 1.2% in Nepal to 42.4% in China. Studies from the early 2000s from India have quoted prevalence figures of 7.4% by Murthy et al. and 4.1% by Dandona et al.

A recent study by Saxena et al. looked at prevalence of myopia in Delhi. Amongst a total of 9884 school children screened the prevalence of myopia was 13.1% with only one-fourth of those wearing appropriate spectacles. A look at figures from Asian countries have shown a sharp increase in prevalence in the last 20 years.

Risk factors for myopia progression

In this section, various risk factors that have been studied will be discussed.

Outdoor activities

Rose et al. in an Australian study found that children with low outdoor time and high near work were two to three times more likely to be myopic compared to those performing low near work and high outdoor activities. Dirani et al. found a significant negative association between myopia and outdoor activity. For each hour increase in outdoor activity per day, spherical equivalent (SE) increased by 0.17 D and axial length (AL) decreased by 0.06 mm. The Orinda Longitudinal Study of Myopia (OLSM) found that children who became myopic by the eighth grade spent less time in sports and outdoor activity (hours per week) at the third grade compared to those who did not become myopic. More recently, the Guanzhou Outdoor activity longitudinal study results provided proof of principle that increasing the amount of time children spent outdoors through the school system can decrease the number of children who become myopic.

Researchers have also found that it is not the sports but the exposure to the outdoors that appears to be protective. Chicks reared in less ambient light became myopic. Higher light intensity outdoors could make the depth of field greater and reduce image blur. Studies have also shown that there is release of dopamine from the retina when stimulated by light and dopamine is known to inhibit eye growth. Spectral composition of the light rather than the intensity seems to be a more important factor.

Near work

The summary of findings regarding near work and myopia increase as found in The Sydney Myopia Study (SMS) and the Singapore Cohort Study for the risk factors for myopia (SCORM) are as follows:

Children who read continuously for more than 30 min had a higher incidence of myopia. Children who performed near work at <30 cm distance were 2.5 times likely to be more myopic. Children who read more than two books per week were also three times likely to have higher myopia. Children who read more than 2 h per day were 1.5 times likely to have higher myopia. For every book read per week the AL elongation was more by 0.04 mm. However, several other studies failed to find any significant correlation between near work and myopia.

Education

Higher educational level, higher achievement and earlier schooling were also found to be associated with an increase in myopia prevalence. It is unclear if this can be considered as implying that it is the near work that was more important than the education itself.

Parental myopia

The SMS reported that children with one or both parents myopic had to two and eight times higher risk of developing myopia compared with children who had no myopic parents. SCORM cohort showed that having one and two myopic parents

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Alteration peripheral defocus was the focus of 3. A meta-analysis by Li et al. COMET 2 Trial looked at a separate cohort of 2. OLSM assessed peripheral refractive error in 822 children aged 5–14 years. This study indicated that myopic children had greater relative hyperopia in the periphery, compared to emmetropes and hyperopes. 1. The rationale for the use of bifocals or progressive addition lenses (PAL) is that they optimize accommodative accuracy for near tasks and minimize the retinal blur. Bifocals seem to slow the myopia progression in children with nearpoint esophoria but not necessarily in children with exophoria. The Correction of Myopia Evaluation Trial (COMET) was a multicenter randomized study involving 469 ethnically diverse subjects where participants were randomized to wearing single vision lenses (SVL) or PALS. Mean 3-year increases in myopia were −1.28 D in the PAL group and −1.48 in the SVL group, which was statistically significant. Mean myopic progression in the PAL group with nearpoint esophoria was −1.18 D compared to −1.39D in SVL group.

2. COMET 2 Trial looked at a separate cohort of children with near esophoria and high accommodative lag and placed them in PALS. The overall reduction in myopia over 3 years was only 0.28 D.

3. A meta-analysis by Li et al. showed that PALS slowed myopia progression by 0.25 D/year and reduced AL by 0.12 mm/year. Patients that appeared to benefit the most from PALS were those with moderate myopia, Asian ancestry, Near point esophoria and high accommodative lag.

4. Altering peripheral defocus was the focus of work by Sankaridurg et al. In their study, 210 Chinese children aged 6–16 years were fitted with one of three novel spectacle lens forms. After 12 months, no statistically significant difference between SE refraction or AL in the control group wearing SVL versus children wearing the novel spectacle lenses was found. In younger children (6–12 years old), with a parental history of myopia 30% less myopia progression in children wearing one of the lens designs than in children wearing control SVD lenses was found. These novel lenses however are limited in their availability.

Peripheral refraction
Theories of peripheral refraction state that due to the oblong shape of the eyeball the peripheral rays of light do not focus on the retina. This resultant hyperopic defocus serves as a stimulus for growth of the eyeball. While this process may be important in emmetropization, it also appears to contribute to eyeball elongation. OLSM assessed peripheral refractive error in 822 children aged 5–14 years. This study indicated that myopic children had greater relative hyperopia in the periphery, compared to emmetropes and hyperopes.

Control of myopia progression
Spectacles
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Contact lenses
Extending the idea of peripheral refraction to contact lenses, the Dual Focus contact lenses were studied and found to show effectiveness similar to spectacle dual focus lenses.

Orthokeratology
Orthokeratology involves temporarily reshaping the cornea with rigid gas permeable lenses. It involves wearing the lenses overnight. While meta-analysis of all studies using Orthokeratology showed a definite slowing of progression, the use of these lenses is also associated with a slight increase in incidence of epithelial defects and corneal infections. There is also a higher rebound increase in myopia progression after cessation of lens wear. These lenses are of limited availability in India.

Pharmacological therapy
Muscarinic receptor antagonists Atropine and Pirenzpine have been studied for myopia control, the former extensively. The rationale behind the use of these agents is the theory that excessive accommodation leads to myopia. The other mechanisms postulated are affecting the release of neurotransmitter dopamine and synthesis of glycosaminoglycans in the sclera and thereby reducing AL elongation.

The ATOM (Atropine treatment of Myopia) 1 and 2 studies have studied the daily application of Atropine in various concentrations from 1 to 0.01% through various phases. Atropine 1% was the first to be studied. There were concerns about these children needing PALs due to the accommodative difficulties, UV toxicity and rebound progression after cessation of the treatment. Typically, the atropine was administered for 2 years and stopped. The children were followed for a washout period of 1 year following which the atropine was reinstituted for 2 more years. Both AL elongation and cycloplegic refraction were closely followed as indicators of myopia progression. Children were also monitored for side effects such as photophobia and difficulties with accommodation. The recently published 5 year results of the ATOM 2 study shows the efficacy of Atropine 0.01% in the retardation of myopia progression and its safety.

- Pirenzpine which is a selective M1 receptor antagonist was also studied in a randomized control trial in the US Pirenzpine study. 174
children, aged from 8 to 12 years (mixed ethnicity/73% were Caucasian) were enrolled in the study. The mean increase in myopia was –0.26 D/year in the pirenzepine group versus –0.53 D/year in the control group.

Myths and traditional therapies
Undercorrection of myopia and giving plus glasses and withholding minus lenses are harmful practices with no evidence.

Chinese eye Exercise, Acupuncture, Qi-gong ocular exercise, Electrophotomagnitostimulation, eye massage and Drishti Doshya, Triphala, Saptamrita Lauha, Amla, Fennel, Licorice, Yoga eye exercises, one dose one globule Rhus Tox 1M and splashing water, while mentioned in various articles and websites, do not have a place in scientific literature.

Clinical practice
The ideal age to start treatment is between 6 and 8 years. Children with one or two myopic parents, whose myopia started early, who live in an urban environment, with less chance for outdoor play, perhaps more near work, intense school curriculum, perhaps females, shorter working distance with prolonged reading, with near esophoria and/or accommodative lag maybe good candidates for intervention.

If progression of more than 0.5 D SE in last 1 year as per a cycloplegic autorefraction, then these patients may be considered for intervention. A baseline testing for near esophoria and accommodative lag, a cycloplegic autorefraction and AL measurement using a non-contact method such as an IOL master are basic requirements prior to initiation of therapy.

Choice of therapy has been covered in detail earlier. It may be guided by the availability of certain therapies too. Six monthly monitoring is needed. Increase in outdoor activity may be achieved by public health measures and interventions by school authorities through education of teachers and parents.

In conclusion, progression of myopia is a major public health burden.41 The control of progression continues to be an area of debate and research.

References


