eOftalmo

The need for interventions to delay the onset and slow the progression of myopia in children

A necessidade da adoção de intervenções para controlar o início e a progressão da miopia em crianças

Milton Ruiz Alves[1], Keila Monteiro de Carvalho[2]

1. Faculdade de Medicina da Universidade de São Paulo, São Paulo, SP, Brazil.
2. Faculdade de Medicina da Universidade Estadual de Campinas, Estado de São Paulo, Brasil, Brazil.

"Life cannot be saved for tomorrow. It always happens in the present."
Rubem Alves

The prevalence of myopia and high myopia continues to increase worldwide[1,2]. The association between high myopia, pathologic myopia, and vision-threatening eye diseases imposes the need to implement health policies to limit eye elongation and minimize its adverse visual consequences[3-5]. Recent interventions that can delay the onset and slow the myopia progression in children and teenagers fall into the categories: of environmental (behavioral), pharmacological, and optical[6,7]. In addition, a better knowledge of how to detect the risk of myopia and how to manage its progression makes relevant the choices of therapeutic intervention and the most appropriate time to intervene and initiate myopia management in children and teenagers[8].

All children under 9 should be encouraged to adopt good visual hygiene habits. Children with hyperopia of less than +0.75 D and those with myopic parents deserve special attention. The guidelines on screen time of the World Health Organization recommend that children aged from 5 to 17 have no more than 2 hours of recreational screen time daily and that preschoolers have only 1-hour daily[9]. Increased screen time reduces sleep and school performance[10], whereas outdoor activities were shown to inhibit myopia progression in myopic children aged 6-7 years by 30% in 1 year[11]. Myopia present at age [13] was related to children who had hyperopia less than +0.75 D at age 6-7 years[12]. A study showed a negative association between outdoor time and myopia where additional time outdoors in the 3-9-year age group was associated with reduced incidence of myopia from 10 to 15 years[13]. Furthermore, another study found 7 independent parameters associated with accelerated eye elongation in 6-9-years-old children, , which are as follows: parental myopia; reading one or more books weekly; time spent reading; not playing sports; non-European

Corresponding author: Milton Ruiz Alves. E-mail: miltonruizcbo@gmail.com
Received on: Jan 24, 2023. **Accepted on:** Jan 26, 2023.
Funding: No specific financial support was available for this study. **Conflict of interest:** None of the authors have any potential conflict of interest to disclose.
How to cite: Alves MR, Carvalho KM. The need for interventions to delay the onset and slow the progression of myopia in children. eOftalmo. 2023;9(2):50-3.
DOI: 10.17545/eOftalmo/2023.0014

ethnicity; less time spent outdoors; and axial length--to-corneal radius ratio. Based on these results, the authors pointed out that behavioral changes are of major importance in these children and that preventive measures should be considered[14]. Emmetropic children with one myopic parent have a threefold increased risk of becoming myopic; if both parents are myopic, they have a sixfold increased risk[15]. Having siblings who are already nearsighted also increases the risk, regardless of parental myopia[16].

Implementation of interventions to delay the onset and slow myopia progression in children and teenagers follows identifying risk factors and diagnosing myopia progression. The following are considered risk factors: age under 9 years, parenteral myopia, time spent outdoors ≤1.5h/day; time spent with near vision activities >3h/day, hyperopia <+0.75D at 6-7 years of age, and anteroposterior diameter ≥23.6 mm[17]. In addition, myopia progression is identified when the refractive error under cycloplegia increases >-0.50D in 1 year, when the annual rate of eye elongation is ≥0.3 mm/year until age 10, or >0.2 mm/year from age 11 onward[17].

Regarding pharmacological intervention for managing myopia progression in children, up to now, topical atropine, which is now widely used as an approved or off-label product, has dominated both clinical trials and practice[18]. There are two trends regarding the choice of the initial dose of atropine[19]. In the first trend, treatment begins with the lowest concentration (0.01%), and the child is followed for 1 year; if control is not achieved, the dose is increased to 0.025% and, if necessary, to 0.05% after 1 year, according to the same criteria. In the second trend, the concentration is decided according to pre-established criteria of myopia progression in the child and adolescent population, i.e., age, annual progression rate (APR), refraction, and anteroposterior diameter (APD). For ages between 5 and 8 years, the dose of 0.025% atropine should be started, while for ages between 9 and 15 years, if APR is >0.50D/year, refraction is <-4D and APD is <24.5 mm, 0.01% atropine should be started. If these criteria exceed the above values described above, the dose of 0.025% atropine should be started. Furthermore, for patients over 15 years of age, 0.01% atropine is suggested.

Cunha et al.[20] showed that the use of 1 drop of 0.025% atropine at night for 2 years was effective in decreasing myopia progression by 65% in Brazilian children aged 6-12 years with spherical equivalent (SE) between -1.00 and -6.00 D, and APR ≥-0.50D. The control of myopia progression with atropine is dose dependent. The most frequent side effects of low-concentration atropine are photophobia, blurred near vision, and allergic conjunctivitis. At 2 years of age, photophobia was experienced by 8.6%, 4.7%, and 5.5% of children using atropine at concentrations of 0.05%, 0.025%, and 0.01%, respectively[21].

Concerning optical intervention in the management of myopia progression, we currently rely on orthokeratology, 1-day disposable contact lenses (MiSight®1-day), and spectacle lenses that correct peripheral hyperopic defocus (Hoya's MiyoSmart® and Essilor's Stellest®).

Orthokeratology uses specially designed contact lenses to reshape the cornea temporarily. It is an effective and promising treatment option to control myopia in children. Generally, the 2-year inhibitory effect on axial elongation ranges from 30% to 55% compared with single-vision spectacles and contact lenses[22,23]. However, a rebound phenomenon in myopia progression occurs after discontinuing orthokeratology and the duration of treatment for maximum effect remains unknown[23].

MiSight® 1 day (Cooper Vision) is a multizone soft contact lens indicated for controlling myopia progression in children 8-12 years of age at the start of treatment24. The center of the lens focuses on distance error correction, while alternating rings around the center create myopic defocus to slow eye elongation[24]. For 3 years, there was a 59% reduction in myopia progression (SE) and a 52% reduction in eye elongation (mm)24. Over 6 years, children using MiSight® 1 day contact lenses progressed by an average of less than 1.00 D[25].

MiyoSmart® (Hoya) spectacle lenses feature a 9.4-mm central area for distance error correction surrounded by a treatment area composed of 396 spherical lenses with dioptric power of +3.50D that creates a myopic defocus surface in front of the retina to slow eye elongation (Defocus Incorporated Multiple Segments Technology)[26]. The results of a 3-year clinical trial showed a reduction in myopia progression (SE) and axial elongation (mm) of 86% and 61%, respectively[27].

Stellest® (Essilor) spectacle lenses feature a 9.0-mm central zone for distance error correction surrounded by a treatment area composed of 11 rings containing 1021 highly aspherical lenslets with dioptric

power varying from +3.50D to +5.00D that creates a myopic defocus volume in front of the retina to slow eye elongation (Highly Aspherical Lenslet Technology)[28]. The results of a 2-year clinical trial with these lenses compared to the historical control group (single-vision lenses) showed a reduction in myopia progression (SE) and axial elongation (mm) of 67% and 60%, respectively[29].

Considering that no intervention strategy (behavioral, pharmacological, or optical) effectively inhibits myopia progression in children, we need to explore combination therapies as an approach to improve treatment efficacy[7]. For example, during the 2-year follow-up period, the combination of orthokeratology and 0.01% atropine was more effective in slowing axial elongation than orthokeratology alone in children with myopia, especially in the first year and children with low initial myopia[30].

The current epidemic of myopia shows no signs of abating. Despite the limited effectiveness of the available interventions and the potential for recovery, the projected decrease in the risk of complications later in life provided by even moderate reductions in myopia progression suggests that treatment should be considered for young people with myopia, especially those aged 12 years or younger[31]. Bullimore and Brennan[32] showed a 67% increase in the risk of myopic macular degeneration (MMD) with each 1.00D increase in myopia. Even a 0.25D reduction in myopia progression (equivalent to 0.1mm) decreases the risk of MMD by approximately 10%. Given the relatively modest effect size expected for the interventions discussed in this editorial, we recommend that eye doctors educate children to practice good visual hygiene to delay the onset of myopia and to be bold in implementing pharmacological and/or optical therapies aimed at slowing the progression of the condition in myopic children[31].

REFERENCES

1. Holden BA, Fricke TR, Wilson DA, Jong M, Naidoo KS, Sankaridurg P, et al. Global Prevalence of Myopia and High Myopia and Temporal Trends from 2000 through 2050. Ophthalmology. 2016;123(5):1036-42.
2. Resnikoff S, Jonas JB, Friedman D, He M, Jong M, Nichols JJ, et al. Myopia - A 21st Century Public Health Issue. Invest Ophthalmol Vis Sci. 2019;28;60(3):Mi-Mii. Erratum in: Invest Ophthalmol Vis Sci. 2019;60(6):1888.
3. Alves MR, Louzada RN. Efeitos da educação online na saúde ocular dos estudantes durante a pandemia da Covid-19. eOftalmo. 2020;6(4):68-70.
4. Fang Y, Yokoi T, Nagaoka N, Shinohara K, Onishi Y, Ishida T, et al. Progression of Myopic Maculopathy during 18-Year Follow-up. Ophthalmology. 2018;125(6):863-77.
5. Yan YN, Wang YX, Yang Y, Xu L, Xu J, Wang Q, et al. Ten-Year Progression of Myopic Maculopathy: The Beijing Eye Study 2001-2011. Ophthalmology. 2018;125(8):1253-63.
6. Walline JJ, Lindsley KB, Vedula SS, Cotter SA, Mutti DO, Ng SM, et al. Interventions to slow progression of myopia in children. Cochrane Database Syst Rev. 2011 Dec 7;(122):CD004916.
7. Wildsoet CF, Chia A, Cho P, Guggenheim JA, Polling JR, Read S, et al. IMI - Interventions for Controlling Myopia Onset and Progression Report. Invest Ophthalmol Vis Sci. 2019;60(3):M106-M131.
8. Brennan NA, Toubouti YM, Cheng X, Bullimore MA. Efficacy in myopia control. Prog Retin Eye Res. 2021 Jul;83:100923.
9. Chaput JP, Willumsen J, Bull F, Chou R, Ekerlund U, Firth J, et al. 2020 WHO guidelines on physical activity and sedentary behaviour for children and adolescents aged 5-17 years: summary of the evidence. Int J Behav Nutr Phys Act. 2020;17(1),141.
10. Gentile DA, Reimer RA, Nathanson AI, Walsh DA, Eisenmann JC. Protective effects of parental monitoring of children's media use: a prospective study. JAMA Pediatr. 2014;168(5):479-84.
11. Wu PC, Chen CT, Lin KK, et al. Myopia Prevention and Outdoor Light Intensity in a School-Based Cluster Randomized Trial. Ophthalmology. 2018;125(8):1239-1250.
12. Jones LA, Mitchell GL, Mutti DO, Hayes JR, Moeschberger ML, Zadnik K. Comparison of ocular component growth curves among refractive error groups in children. Invest Ophthalmol Vis Sci. 2005 Jul;46(7):2317-27.
13. Shah RL, Huang Y, Guggenheim JA, Williams C. Time Outdoors at Specific Ages During Early Childhood and the Risk of Incident Myopia. Invest Ophthalmol Vis Sci. 2017;58(2):1158-1166.
14. Jones LA, Sinnott LT, Mutti DO, Mitchell GL, Moeschberger ML, Zadnik K. Parental history of myopia, sports and outdoor activities, and future myopia. Invest Ophthalmol Vis Sci. 2007;48(8):3524-32.
15. Tideman JWL, Polling JR, Jaddoe VWV, Vingerling JR, Klaver CCW. Environmental Risk Factors Can Reduce Axial Length Elongation and Myopia Incidence in 6- to 9-Year-Old Children. Ophthalmology. 2019;126(1):127-136.
16. Guggenheim JA, Pong-Wong R, Haley CS, Gazzard G, Saw SM. Correlations in refractive errors between siblings in the Singapore Cohort Study of Risk factors for Myopia. Br J Ophthalmol. 2007;91(6):781-4.
17. Klaver C, Polling JR, Erasmus Myopia Research Group. Myopia management in the Netherlands. Ophthalmic Physiol Opt. 2020; 40(2):230-240.
18. Alves MR, Ogassavara NC, Victor G. O uso terapêutico do colírio de atropina para retardar a progressão de miopia em crianças é reconhecido cientificamente e possui eficácia comprovada?. e-Oftalmo. 2017;3(1):1-7.
19. Ejzenbaum F, Shaefer TMC, Cunha C, Rosseto JD, Godinho IF, Nakagami CR, et al. Diretrizes Brasileiras para o Tratamento da Miopia (SOBLEC/SBOP). Disponível em: https://sbop.com.br/diretrizes-brasileiras-para-o-tratamento-da-miopia-soblec/ Acessado em 29/12/2022.

20. Cunha CM, Correia RJB, Cunha JT. Diminuição da progressão da miopia com atropina 0,025%. Rev Bras Oftalmol. 2018;77(2):72-5.
21. Yam JC, Li FF, Zhang X, Tang SM, Yip BHK, Kam KW, et. Two-Year Clinical Trial of the Low-Concentration Atropine for Myopia Progression (LAMP) Study: Phase 2 Report. Ophthalmology. 2020;127(7):910-919.
22. Cho P, Tan Q. Myopia and orthokeratology for myopia control. Clin Exp Optom. 2019;102(4):364-377.
23. Hiraoka T. Myopia Control With Orthokeratology: A Review. Eye Contact Lens. 2022;48(3):100-104.
24. Chamberlain P, Peixoto-de-Matos SC, Logan NS, Ngo C, Jones D, Young G. A 3-year Randomized Clinical Trial of MiSight Lenses for Myopia Control. Optom Vis Sci. 2019;96(8):556-567.
25. Chamberlain P, Bradley A, Arumugam B, Hammond D, McNally J, Logan NS, et al. Long-term Effect of Dual-focus Contact Lenses on Myopia Progression in Children: A 6-year Multicenter Clinical Trial. Optom Vis Sci. 2022;99(3): 204-212.
26. Carlà MM, Boselli F, Giannuzzi F, Gambini G, Caporossi T, De Vico U, et al. Overview on Defocus Incorporated Multiple Segments Lenses: A Novel Perspective in Myopia Progression Management. Vision (Basel). 2022;6(2):20.
27. Lam CS, Tang WC, Lee PH, Zhang HY, Qi H, Hasegawa K, et al. Myopia control effect of defocus incorporated multiple segments (DIMS) spectacle lens in Chinese children: Results of a 3-year follow-up study. Br J Ophthalmol. 2022;106(8):1110-1114.
28. Bao J, Yang A, Huang Y, Li X, Pan Y, Ding C, et al. One-year myopia control efficacy of spectacle lenses with aspherical lenslets. Br J Ophthalmol. 2022;106(8):1171-1176.
29. Bao J, Huang Y, Li X, Yang A, Zhou F, Wu J, et al. Spectacle Lenses With Aspherical Lenslets for Myopia Control vs Single-Vision Spectacle Lenses: A Randomized Clinical Trial. JAMA Ophthalmol. 2022;140(5):472-478.
30. Kinoshita N, Konno Y, Hamada N, Kanda Y, Shimmura-Tomita M, Kaburaki T, et al. Efficacy of combined orthokeratology and 0.01% atropine solution for slowing axial elongation in children with myopia: a 2-year randomised trial. Sci Rep. 2020;10(1):12750.
31. Brenam NA, Toubouti YM, Cheng X, Bullimore MA. Efficacy in myopia control. Prog Retin Eye Res. 2021 Jul;83:100923.
32. Bullimore M, Brennan N. Myopia Control: Why Each Diopter Matters. Optom Vis Sci. 2019;96(6):463-465.

AUTHOR'S INFORMATION

» **Milton Ruiz Alves**
https://orcid.org/0000-0001-6759-5259
http://lattes.cnpq.br/6210321951145266

» **Keila Monteiro de Carvalho**
http://lattes.cnpq.br/0606513121982929
https://orcid.org/0000-0002-7976-8017