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Comparison between Atropine Medication and Orthokeratology in Suppressing Myopia Progression in Children: a systematic review

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Myopia, Childhood, Infant, Progressivity, Orthokeratology, Atropine 0.01%, Medical Therapy, Axial Elongation, Diopter, Subfoveal, Choroid, Thick,

ABSTRACT
Background: The progression of myopia in children is mainly caused by near-work activities and diminishing time outdoors. These increase the risk of high myopia, resulting in retinal detachment or macular degeneration. There are several alternative interventions to slow myopia progression, such as Orthokeratology (Ortho-K) and Atropine Eyedrop. Objectives: Systematically compile current evidence from relevant peer-reviewed publications to assess children's myopia progression efficacy between Atropine Eyedrop and Orthokeratology. Method: A literature search was conducted on Cochrane®, Pubmed®, and ProQuest® then selected based on inclusion (randomized controlled trial, cohort, myopic children under 18 years old, cycloplegic refraction, publication year between 2010 - 2022) and exclusion (conference abstracts, case reports, duplicate publications) criteria. Primary outcomes are mean changes of axial elongation and spherical equivalent refraction in diopters. The secondary outcome is the mean changes in the sub-foveal choroidal thickness. Furthermore, critical appraisal will be done on selected articles. Results: Two prospective RCTs (187 subjects) revealed: axial elongation and spherical equivalent refraction significantly reduced in both treatment groups. However, axial length reduction was better in the Atropine Eyedrop compared to the Ortho-K group (0.20 ± 0.03 mm vs. 0.28 ± 0.03 mm). Another study also revealed that AL increased in Atropine compared to the Ortho-K group (0.24 ± 0.06 mm vs. 0.32 ± 0.07 mm). Moreover, spherical equivalent refraction reduction was better in Atropine compared to the Ortho-K group (−0.30 ± 0.07 D vs. −0.41 ± 0.08 D). Nevertheless, sub-foveal choroidal thickness was greater in Ortho-K compared to the Atropine group (19.33 ± 2.63 μm vs. 8.09 ± 1.47 μm). Conclusion: Atropine Eyedrop is potentially a better option in controlling myopia progression in children than Orthokeratology with minimal changes in sub-foveal choroidal thickness.

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INTRODUCTION

Prevalence and progressivity of myopia in children becoming a serious health problem in the world, especially in Asia (Muhiddin et al., 2022). Near-work activities are inevitable in children nowadays, and time for outdoor are diminishing. This phenomenon is associated with myopia progression in children(Medina, 2022a). Myopia in childhood increases the risk of high myopia, results in retinal detachment or macular degeneration thus can lead to permanent vision loss (Bullimore et al., 2021).

Axial elongation and thickening sub-foveal choroidal thickness are the main causes of myopia progression (Jonas et al., 2023). Therefore, myopia control is crucial in early childhood. With advances in technology, there are several alternative interventions to slow the myopia progression, such as optical intervention, medication, and behavior modification. Orthokeratology (Ortho-K) is one of the optical intervention options (VanderVeen et al., 2019). Ortho-K is a custom-made rigid contact lens that placed overnight, results in cornea reshaping to reduce refractive error; hence during the day, patients would not need vision aid. Several studies show that Ortho-K is effective in inhibiting axial elongation and myopia progression (Wang et al., 2022).

Meanwhile, atropine eyedrop has also been proven to be effective in preventing myopia in early childhood. Atropine eyedrops have a direct effect and thus could prevent myopia progression by stopping the axial elongation, affecting the remodeling of the sclera, and reducing vitreous chamber growth (Pugazhendhi et al., 2020a). Its indirect effect is relaxing the eye muscle.

The aim of this study was to systematically compile current evidence from relevant peer-reviewed publications to assess children's myopia progression efficacy between Atropine Eyedrop and Orthokeratology (Kochik, 2019).

The research aims to systematically review current evidence from peer-reviewed publications to evaluate the efficacy of two interventions, Atropine Eyedrop, and Orthokeratology, in controlling myopia progression among children (Long et al., 2023). This investigation is crucial due to the rising prevalence and seriousness of myopia among children globally, particularly in Asia, where near-work activities are prevalent and outdoor time is decreasing. Myopia in childhood increases the risk of severe complications like high myopia, retinal detachment, and macular degeneration, leading to permanent vision loss. The main mechanisms contributing to myopia progression are axial elongation and thickening sub-foveal choroidal thickness.

This research distinguishes itself from previous studies by systematically compiling current evidence from relevant peer-reviewed publications to specifically assess the efficacy of myopia progression control in children between Atropine Eyedrop and Orthokeratology (Yanoff et al., 2017).

METHODS

Types of Studies

The review included data from all types of relevant randomized controlled trials and cohort studies. The focus of the review was on the efficacy of Atropine Eyedrop and Ortho-K. Because the review focuses on the efficacy between Atropine Eyedrop and Ortho-K in children's myopia, hence there is a limitation of the primary objective of the studies, the treatment is used for myopia control, not for correction.

Search Strategy for Identification of Studies

A literature search was done by selecting the publication type restricted to randomized controlled trials and cohort studies. We included studies with criteria such as myopic children under 18 years old, cycloplegic refraction, and publication years between 2010 and 2022. The exclusion criteria were conference abstracts, case reports, and duplicate publications. Then, titles were assessed, and summarized, and obtained a complete copy of all potential related or definitive related studies was to determine if the study met the criteria for inclusion and exclusion in this review. References to all included publications were also checked.

In between groups on different articles, will find out the mean changes of axial elongation and spherical equivalent refraction in diopters for the main outcome (Chen et al., 2021). While on secondary outcome would be the mean changes of the sub-foveal choroidal thickness.

RESULTS and DISCUSSION

Axial Elongation

Axial length (AL) elongation affects children's myopia progression, hence proper treatment that could reduce the axial elongation would be effective in controlling myopia in children such as atropine eyedrop or Ortho-K (Zhang et al., 2024). Two randomized control studies revealed a similar population with several refractions of myopia, gender, and a group of ages ranging from 8 to 14 years old as shown in Table 2. Hao Q et al revealed that atropine eyedrop is better in controlling myopia in children compared to Ortho-K. As shown in Table 3, the increase in axial elongation by the atropine group was 0.20 ± 0.03 mm compared to the Ortho-K group by 0.28 ± 0.03 mm. Zhao Q et al also revealed that axial elongation increased in atropine compared to the Ortho-K group, 0.24 ± 0.06 mm vs. 0.32 ± 0.07 mm.

Spherical Equivalent Refraction

Spherical equivalent refraction is the most common measurement for children's myopia progression, the test's outcome usually shows in diopters (D). Clearly seen in Table 3, Zhao Q et al proved that atropine eyedrop and Ortho-K could effectively reduce the spherical equivalent. However, the reduction was shown better in Atropine compared to the Ortho-K group, −0.30 ± 0.07 D vs. −0.41 ± 0.08 D.

Sub-foveal Choroidal Thickness

Thickening of sub-foveal choroidal has often been reported as a side effect result of atropine eyedrop and Ortho-K usage, Hao Q et al revealed that sub-foveal choroidal thickness was greater in Ortho-K compared to the Atropine group as shown in Table 3, 19.33 ± 2.63 μm vs. 8.09 ± 1.47 μm.

Table 1.
Study Characteristics

	Hao Q et al1	**Zhao Q et al2**
Subjects	67 children	120 children
Age	8-12 years old	8-14 years old

Table 2.
Outcomes Parameters

PARAMETERS	**Hao Q**			**Zhao Q**		
	Atropine	**Ortho-K**	**P values**	**Atropine**	**Ortho-K**	**P values**
Axial Elongation	0.20 ± 0.03mm	0.28 ± 0.03mm	<0.0001	0.24 ± 0.06mm	0.32 ± 0.07mm	<0.0001
Spherical Equivalent Refraction	−3.62 ± 0.57D	−3.66 ± 0.60D	0.293	−0.30 ± 0.07D	−0.41 ± 0.08D	<0.05
Sub-foveal Choroidal Thickness	8.09 ± 1.47μm	19.33 ± 2.63μm	<0.0001	N/A	N/A	N/A

DISCUSSION

Myopia is a refractive error, where the refractive power is too great for the axial length of the eye and uncorrected refractive error is the main cause of visual impairment (Hashemi et al., 2020). Atropine eyedrop and Ortho-K might be the treatment option for slowing the myopia progression in children. Controlling myopia is very important nowadays due to the drastic increase in myopia prevalence worldwide. This method becoming popular as myopia appears at earlier onset (Medina, 2022b). With the advances in technology, still, there are still some side effects of the treatment.

Axial Elongation

There is still no clear mechanism for how myopia develops, however axial length elongation plays a role in myopia progression in children (Pugazhendhi et al., 2020b). As children's time outdoors diminishes nowadays, near work-induced transient myopia (NITM) is also related to axial length elongation and affected sclera remodeling. Current theories have been proposed for the atropine mechanism towards AChR antagonist, thus blocking M1 and M4 receptors in the sclera and retina. This results in axial elongation restriction and prevents sclera remodeling (Pugazhendhi et al., 2020c). However, one study shows that atropine 0.01% has no effect on lens and cornea. Hence, can be concluded that atropine has almost no side effects (Yam et al., 2019). Another study also revealed that the adverse effects of 0.01% atropine were not significantly related. Hence, axial elongation was better with 0.01% as it could control the axial length elongation.

Spherical Equivalent Refraction

Ortho-K is a method of contact lens worn at night allowing epithelial of the cornea to redistribute by using reverse geometry-designed rigid oxygen-permeable contact lens. The study has different ages and different refractions among patients and found that reduction of spherical equivalent was better in the atropine group compared to the Ortho-K group for myopia less than 6.00D (Lau, 2020). Conversely, the Ortho-K lens was better for children with spherical equivalent refractions of more than 6.00D. Clinicians also must consider for children aged less than 11 years old, compliance with Ortho-K might be harder.

Sub-foveal Choroidal Thickness

One study demonstrated that myopia mechanism was related to axial elongation and thinning of sub-foveal choroidal thickness (Read et al., 2019). Atropine medication and Ortho-K itself effectively slow the myopia progression in children. However, the study also revealed that sub-foveal choroidal thickness changes were greater in the Ortho-K group due to lack of oxygen and negatively associated with axial length elongation.

This research has some limitations. There were few numbers of studies available, and the articles were based on the same researcher. The research found only two RCTs that met the requirements. Despite a thorough search of the database, there were relatively few high-quality RCTs. Higher quality, larger sample RCTs can lead to more reliable conclusions (Spieth et al., 2016). Secondly, myopia control in children needs long-term follow-up, while both studies were 12 months in duration.

CONCLUSION

Atropine Eyedrop might be a better option in controlling myopia progression in children compared to Orthokeratology. It is more applicable to children and toddlers. Complications and side effects are also minimal compared to Ortho-K thus resulting in sub-foveal choroidal thickened, which has a negative effect on axial length elongation.

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