Different modalities for the myopia progression control – A review

Arbaz, Kritika, Rajeev Trivedi, Harshita pandey, Rama sharma.

M.Optometry Scholar, Assistant professor, Assistant professor, Assistant Professor, M.Optometry Scholar.

Galgotias University, Gautam Buddh Nagar UP, India**.**

Abstract: - Now a day's myopia become more common refractive error in world wide. Globally, myopia is becoming more common. Axial length elongation and the environment are two main causes of myopia. Myopia was once easily treated with spectacles or other modalities. In this article there are different modalities that reduce the growth of eye in myopia condition a number of strategies, including orthokeratology, pharmacological agents, and specially designed contacts and eyeglasses. According to the available scientific research, controlling myopia with a combination of low contraction of atropine and concurrent night time 0rtho-K is efficient and better. If we compare all the treatment modalities then we found the orthokeratology is best one. All different modalities reduce myopia progression up to limit but no single treatment reduce myopia progression hundred percent. To decide which modality could be best suited for a certain kid, parents and eye care professionals should collaborate.

Keywords: - Myopia, myopia control, orthokeratology lens, Atropine, DIMS.

Introduction:

Myopia has become more commonplace all throughout the world [1]. Improved preventative and visual care is required to lower the risk of acquiring eye conditions such as cataracts, retinal degeneration, myopic macular degeneration, and glaucoma, all of which reduce visual acuity [2]. Concerning predictions for myopia and extreme myopia prevalence rates in 2050 [3]. Myopia prevalence has increased by 80–90% in some East Asian nations over the last five years [4]. Myopia is brought on by either a change in the cornea's and lens' ability to focus light or a shift in the eye's axial length [5]. The under correction of myopic refractive error, alignment fit gas-permeable contact lenses, outdoor time, and bifocal or multifocal eyewear are only a few of the methods that have been proved to be inefficient for controlling myopia. Myopia is a common condition, but little is understood about the risk factors that contribute to its onset and progression. The presence or absence of refractive errors in a child appears to be influenced by genetics. Myopia in youngsters is more common than ever and is considered a serious public health issue. This review article gives information on the many techniques used to cure myopia progression.

Risk factor of myopia

Axial length elongation and the environment are the two main causes of myopia. Children who perform more outside activities but less close work have a higher likelihood of developing hypermetropia. Similar to children who engage in more close-up work than outdoor play, myopia is a common condition. [6] In the Sydney study of myopia, which simultaneously examined near and outside activities, it was discovered that near work activities had less of an effect on refraction [7]. A recent study on animal chicks explains how refraction is greatly influenced by light intensity. Myopia development has a significant likelihood of being caused by low light intensity. Myopia and greater education have been linked, according to many scholars. Those with advanced education. The amount of time we spend reading and writing directly correlates with the prevalence of myopia. In comparison to parents who do not have myopia, those who do have myopia have a 2.5-fold greater likelihood of passing on myopia to their offspring. On the basis of dioptric power, various myopia subcategories are differentiated. Additionally, children of myopes have larger axial lengths than their non-myope parents. Zednick et al.

Rose et al.'s [10] hypothesis was that increased dopamine release in the retina as a result of stronger light outdoors during daylight hours prevented axial elongation. Spending more time outdoors may prevent or delay the onset of myopia, and there is good evidence to support a causal link between the two. Although other proposed processes need additional investigation, there is a lot of evidence that the mechanism may entail stimulation of retinal dopamine release in response to stronger light outdoors.

OCULAR STRUCTURE CHANGES ASSOCIATED WITH MYOPIA: -

Myopia, as we all know, is directly related to axial length elongation, but there are other changes that take place in the eye's ocular anatomy that also lead to myopia.

Cornea: According to certain studies, myopia is not significantly correlated with corneal curvature, while some people disagree [11, 12]. Although the corneal thickness has little effect on myopia, the corneal curvature does make a small contribution. [13]

Crystalline Lens: As people age, their lenses get thicker and more curved, which reduces their ability to focus. [14]

Anterior chamber: When an eye is myopic, the anterior chamber is deeper than it is in an emmetropic eye [15].

Sclera: Because of tissue rearrangement, the axial myopia of the posterior pole is the main source of myopia thinning [16].

Increased axial length, which myopia is brought on by, is made possible by modifications to the sclera's biomechanical characteristics.

Vitreous: Using SS-OCT, the present investigation demonstrated pathologic abnormalities in the posterior vitreous associated with extreme myopia. In addition to full PVDs, severely myopic eyes can insidiously develop partial PVDs surrounding the fovea. High rates of residual vitreous cortex with complete PVD were seen in eyes with severe myopia. [17].

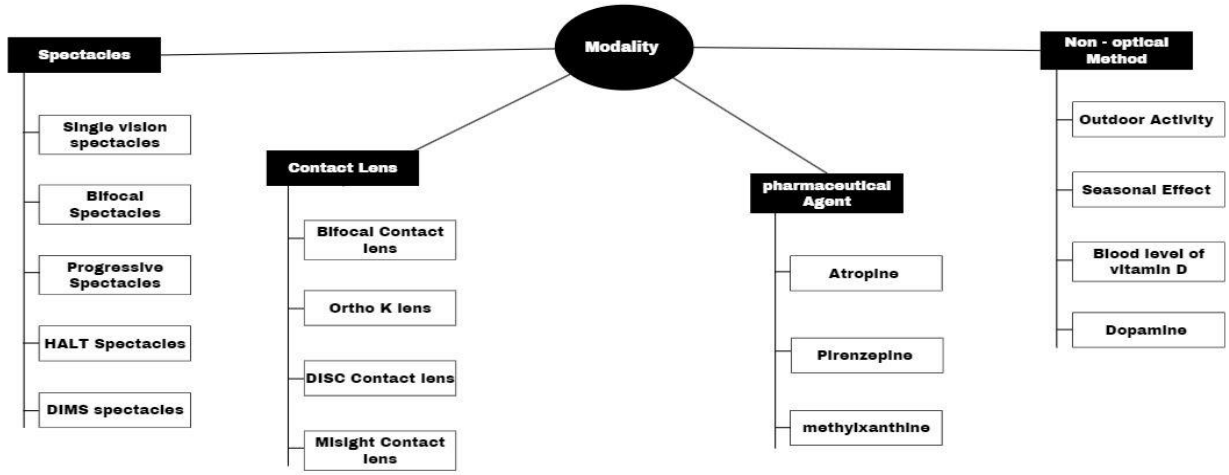
CHOROID: Clinical and histological research have definitely shown that the subfoveal choroidal thickness decreases with greater axial length in addition to an age-related thinning of the choroid. [18].

Retina: Myopia-related issues, such as posterior staphyloma and chorioretinal degeneration, get worse as axial length rises. [19] Thin chorioretinal tissue is associated with poor blood flow, which may encourage VEGF expression and eventually lead to CNV development. [20] Scleral thinning may also cause the posterior pole to bend, which would cause the development of staphylomas with a narrower radius of curvature.

The different modalities for the myopia progression control.

Growing data suggests that specifically created optical therapies, such as SCL, orthokeratology, and glasses , reduce the myopia progression in children. [21] Myopia's progression is currently not addressed by standard clinical care; rather, it is only treated for its optical and medical effects. Studies on humans and animals have significant practical ramifications for the treatment of myopia. They emphasise that decreasing the delay of

accommodation, reducing central and peripheral defocus, and blocking myopiagenic signals in the eye should all be done in order to slow the advancement of myopia.



1-**Spectacle lenses: -** The use of spectacle lenses is a common strategy for treating myopia in children and young adults. When the on-axis refractive defect in myopia is rectified with conventional spherical spectacle lenses, hyperopic defocus in the peripheral retina develops.

The first type of spectacle lenses to be widely used to decrease the progression of myopia were bifocals. The lenses were given with the presumption that myopia resulted from excessive accommodation, which caused visual blur [22,23]. In order to determine how a +2.00 D PAL and a single-vision complete corrective spectacle lens affected the rate at which myopia developed, researchers conducted the Correction of Myopia Evaluation Trial study [24]. Progressive lenses worked best when both parents had myopia since there was a considerable lag in accommodation and/or the kids showed esophoria up close [25]. A study compared the use of high-fitting executive bifocal spectacle lenses with an integrated prism to SV lenses in a population of Canadian Asians. [26]. The studied spectacles slowed the progression of

myopia by 40%. In the past, many eye specialist under corrected myopia in the anticipation that less accommodation would delay the development of myopia. However, this is logically erroneous given the current understanding that blur impacts the eye's capacity to become emmetropic. According to two recent studies, undercorrection actually causes a little acceleration of myopia progression [27]. Recent According to a study, children wearing DIMS glasses had myopia progression dramatically slow down by 52% and axial elongation accelerate by 62% over the course of two years compared to children wearing SV lenses [28].

2- Contact lenses: **-** Traditional optical therapy methods have typically slowed the progression of myopia, largely due to the assumption that visual signals from the fovea control the growth of the eye. In actuality, myopia develops more quickly when under correction occurs [29]. Bifocal and multifocal spectacle lenses have traditionally had minimal effect, despite executive bifocal glasses in some myopia subgroups, contact lens ortho-K, and a variety of bifocal contact lenses having potential.

[30],[31]. Due to the growing need to prevent pathological myopia in adulthood by slowing the evolution of myopia in patients' adolescent growth periods, the use of multiple focal soft contact lenses has grown significantly a short time ago. MFSCLs help myopic patients maintain clearer vision and delay the growth of myopia better than other conventional myopia-controlling techniques. In 1975 it found that RGP contact lenses slow down the myopia progression in the comparison of single vision spectacles [32]. In contrast to spectacles, rigid gas-permeable (RGP) contacts may decrease the advancement of myopia, according to a later study conducted in the 1990s. There is recent advancement in contact lens which is basically based on hyperopic defocus [33] and Multifocal with peripheral add in contact lens [34] . Significantly decrease the evolution of short-sightdness in young generation.

Changes in corneal curvature can result from wearing stiff gas-permeable contact lenses [35]. The initial flat-fitting technique using traditional rigid contact lenses resulted in unsatisfactory and inconsistent results due to issues with the lens's centration on the cornea. A new generation of rigid gas-permeable contact lenses that is orthokeratology [36].Wlodyga and Stoyan made a reverse geometry contact lenses in which secondary curve is more steeper than the central base curve but central base curve in more flatter than the central corneal curvature. At the confluence of the secondary curve, a band of mid-peripheral fluorescein pooled as a result of the contact lens and cornea creating a tear reservoir. Myopia has been reduced more predictably and consistently because of this design, which also enhances the lens's stability and symmetry [37]. Myopia correction using modern orthokeratology is safe up to 6.00 D [38]. A 2-year research described the decrease in power in orthok as compared to the control group as (2.09 +/- 1.34 D). Put on single-vision glasses. 24 months later [39]. Using ortho-K lenses, the cornea's shape can be changed. In a cohort study by Lee et al., myopia increase and orthokeratology are compared for a 1- to 2-year follow-up examination. People with astigmatism greater than or equal to 1.5 D will experience less refractive error when using ortho-K lenses (p 0.001).According to the follow-up exam, corneal curvature change is related to refractive error [40]. Wearing contact lenses is not always advantageous, despite the fact that they are a

promising, practical, and appealing solution to reduce myopia. The main point of contention regarding the usage of contact lenses is care and regimen.

3- **Pharmaceutical agent:** we mainly provide two treatments in pharmaceutical treatment.

Atropine: The (presumed) action of atropine on the accommodative system was the basis for most of its early use. Early investigations employed 1% atropine. [42] Although helpful in decreasing eye growth, atropine-induced cycloplegia had substantial side effects, including photophobia and blurry near vision, which needed to be managed with bifocal and photochromic eyewear. Despite concerns about whether long-term atropine usage causes photic damage or retinal toxicity from drug accumulation, the retinal response and function were unaltered [43]. When giving the treatment SVL alone to 6 to 13-year-olds, Shih et al. [44] indicated that rises in myopia were decreased (p 0.001) until the 18 months as compare to multi-focal glasses alone (1.19 D) and when 0.5% atropine with multifocals was used (1.40 D). This new information has led to an increase in the use of 0.01% atropine, however subsequent examination revealed that while there was a substantial change in spherical equivalent with 0.01% atropine, there was no corresponding significant change in axial length when compared to control eyes [45]. Similar findings were made in a more recent study, which showed that 0.01% atropine dramatically decreased spherical equivalent but not axial length [46].

Atropine concentrations of 0.5%, 0.1%, and 0.01% were tested in the ATOM 2 research on four hundred short-sightness children. The results showed 0.01% was most effective amount with the fewest side effects. Atropine eye drops have since been used all around the world at low concentrations instead of the previous high concentrations. In a recent study, 438 myopic kids were given atropine drop in amount of 0.05%, 0.025%, and 0.01%, as well as a placebo. First, the study demonstrated, using placebo comparisons, the effectiveness of low-amount atropine drops in controlling myopia. Additionally, within the range of 0.01% to 0.05% atropine, both efficacy and adverse effects followed a 0.05% atropine was the most effective dosage for achieving the best efficacy and safety profile among them.

7-methylxanthine :- In a monkey model, it has been shown that the nonselective adenosine receptor antagonist oral 7-methylxanthine reduces axial myopia brought on by hyperopic defocus [47]. In a pilot human clinical investigation with 68 myopic children, the axial length change was less after 12 months (0.35 mm versus 0.38 mm in the placebo group), although it was not statistically significant (P = 0.567) [48]. The thickness of the posterior sclera, as well as the size and number of collagen fibrils, were all found to be increased by 7-methylxanthine. Although the particular mechanism is not yet fully known, it is believed that this strengthens the sclera [49].

Pirenzepine :- Refractive status, axial length, and equatorial diameter of the eyes in the pirenzepine group were significantly lower than those in the form deprivation group (P 0.01), but the parameters were higher than those in the healthy control group, leading to relatively myopic changes being discovered [50]. Pirenzepine is generally safe and decreases the growth of myopia over the course of a year-long treatment regimen [51]. Pirenzepine ophthalmic gel

2% had a clinically acceptable safety profile throughout the course of a two-year treatment period and was superior to a placebo in terms of slowing the progression of myopia [52]. Additionally, 2% pirenzepine gel has been tested on humans to stop the progression of myopia [53]. In a study by Siatkowski et al. and colleagues [54], the mean myopic advancement at 12 months was -0.26 D with pirenzepine and -0.53 D with placebo. The myopic progression was half as fast in the 2% pirenzepine group as it was in the placebo group. Pirenzepine study as a control for myopia is now on hold due to its decreased efficacy and higher frequency of administration.

4- **Outdoor activity:-:** In 6-year-old Chinese study found that those children spent 40 minutes in outdoor activity. They have a lower risk of incidence of myopia[55]. Indian researcher also noticed that outdoor activity and the incidence of myopia is strongly related. Those children Who spent more than 2 hours outside have a lower risk to convert in myopic [56]. The reason is unknown, how outdoor activity control myopia progression. But one reason is that bright light stimulates the release of dopamine from the retina, that why the increase in dopamine inhibits the elongation of axial length[57]. Outdoor activity is very important for school-going children. Each hour that is spent out the door directly affects axial elongation. Parents should encourage their children to play outdoor games and also in every school at least 40 minutes given to every class for outdoor activities. On the other side, there is no significant correlation between myopia progression and outdoor activity, but time spent outside is slow down the incidence of myopia[58].

5-**The combination effect of Pharmaceutical agents and contact lenses:-** Orthokeratology and Atropine are the best way to slow down axial length elongation. In a few research papers, it is found that the combination of pharmaceutical and orthokeratology is very effective to slow down myopia progression[59]. Atropine has better results to control myopia progression in comparison to spectacles[60]. Synergistic combination therapies have recently been looked into as potential new study areas Recently, combinatorial medicines have been considered as promising new research fields. Because the mechanisms underlying orthokeratology and low-dose atropine treatments are almost certainly different, it is possible that their combined efficacy could be greater than the efficacy of either one used alone. Both orthokeratology and low-dose atropine treatments have success rates that are less than 100%. Searches in PubMed and Web of Science were done using the following search terms: (atropine OR low-dose atropine OR 0.01% atropine) and (orthokeratology OR ortho-k) and (myopia control OR myopia progression). 42 articles were found after this search. In the past ten years, 29 of these studies have been completed, and 29 in the past three. Only four articles [59, 60, 61, 62] were clinical studies on the AT and OK combination, per a review of the abstracts and titles. The Chen et al. study [63] was divided into two halves. In the initial study, patients just underwent OK treatment; after a year, 0.01% AT was introduced. They reached to the conclusion that a low dose of AT would be beneficial for people with more severe myopia changes. The most recent research was reported by Tan et al. [64]. Only preliminary findings were available due to the one-month follow-up period, but they found statistically significant differences in AXL between groups that received AT and OK versus groups that received OK alone.

6- **Vitamin D Levels in the Blood:** The current study found no associations between greater blood levels of vitamin D and increased outdoor activity [65] or dietary vitamin D intake [66]. No published research has examined any physiologic connection between myopia and a defense mechanism made possible by vitamin D. You could go down a couple of different avenues.

7- **Seasonal effect:-** Additionally, because of seasonal effects on eye growth, myopia progresses more quickly in the fall and winter when there are less daylight hours and less fast in the spring and summer when it's more sunny [67]. Myopia progression rates decreased more slowly throughout the 6-month periods that spanned the entire summer break than would be anticipated in the absence of a seasonal influence.

8- **Dopamine:** Dopamine has been associated with controlling eye growth and the development of some types of deficient myopia [68]. Interplexiform and retinal dopaminergic amacrine cells release the neurotransmitter dopamine. Several lines of evidence point to the involvement of dopamine (DA), one of the retinal neurotransmitters, in the signalling cascade that controls eye growth by way of vision, A study found that neonatal chicks who were denied visual stimulation had lower levels of dopamine in their retinas. In the same year, the discovery was confirmed in rhesus monkeys [69]. In addition, the dopamine-producing enzyme tyrosine hydroxylase's activity, which is rate-limiting, has decreased [70]. Later, it was shown that retinal dopamine levels in vision-impaired eyes were lower in one-year-old chicks, tree shrews, and guinea pigs [71].

Conclusion: - Myopia can be controlled by postponing its onset, which is currently thought to be possible by spending more time outdoors activity, special spectacles and by postponing its progression with medications such pharmacological agents and special types of contact lenses. Atropine eye drops and orthokeratology lenses are the best treatments for axial elongation and the development of myopia. If a treatment is eventually found to slow progression for more than a year and with few adverse effects, it would be prudent to consider using that therapy for a child who is at risk for developing myopia. School timetables may need to be changed to enable additional time for outdoor activities after school and during school hours. The public and policymakers should be informed of the potential advantages of outdoor activities, and kids should be encouraged to spend more time outside.

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