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Review Article

An Explorative Literature Review on Conservative Treatment of Myopia: A Current Perspective

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Abstract

This is a review of the current literature describing the effect of atropine, bifocals, contact lenses and exercise therapy on retarding the development of short sightedness. Accruing evidence from a number of studies have determined atropine instilled once a day in myopic eyes resulted in a 90% average reduction of myopia progression, as compared to untreated eyes. Bifocals and progressive lenses, which have been used for years to slow the development of short sightedness, have currently been shown to generate, on average, only small, clinically irrelevant treatment effects. Still, their capability is raised in children who are esophoric and have a large lag of accommodation, decreasing short sightedness development to between 0.25 and 0.40 D/year. Classical adjust soft and gas permeable contact lenses, as well as innovative spectacle lens designs, have not been shown to be effective in decreasing myopic development. Under-correction of the refractive error has been shown not only to be inefficient in slowing myopia, but has also been associated with raised rate of myopia development. Orthokeratology, using reverse geometry designed lenses, has been shown to be moderately effective in decreasing the development of short sightedness by between 30 to 50% in a number of short-term, well-controlled studies, decreasing short sightedness development to between -0.25 and -0.35 D/year. Exercise therapies, Yoga reduce the development of myopia and improve the visual health. It reduces the myopia progression to -0.25 to -0.50 D/Year. After following review we concluded that there is extra need of clinical trials to see the effectiveness of eye exercises on myopia.

Keywords: Atropine; Contact Lenses; Exercise Therapy; Myopia; Orthokeratology; Spectacles; Under correction; Yoga.

Introduction

Myopia is the most common refractive error of eye in school going children. one for which the punctum remotum is a short distance off, sometimes only a little inches from the eye", and also says myopia is "one in which the images focus in front of the retina while eye at rest". Available treatment option for myopia are Optical correction, pharmaceutical treatment like cycloplegic promoters, vision therapy, orthokeratology, refractive surgeries like (radial keratotomy, excimer laser photorefractive keratectomy), osteopathy, yoga therapy and exercise therapy. Through this review we can aware about recent available treatment for myopia and its consequences related to it.

Myopia

Myopia is a common refractive condition affecting approximately 100 million people in the United States [1]. Its prevalence has increased over the few past years, noted to a growing concern among the public and scientific society [2,3]. The occurrence of short sightddness varies in different parts of the world

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[4-7]. Generally speaking, myopia is more prevalent in industrialized countries and in cities as compared to rural areas[8-12]. In the United States, the prevalence rate has increased from 25% between 1971 - 1972 to 41.6% between 1999 – 2004 [12]. The prevalence of myopia in Taiwan and Singapore is 20% to 30% in children 6 to 7 years of age, increasing to 60% to 80% in young adults [13,14]. The accelerated improve in the occurrence of shortsightdness gives strong evidence that current environmental factors must have a considerable influence on the development of myopia that cannot be explained by a genetic model [15,16]. Understanding how the environment influences eye growth should be central to preventing the progression of myopia.

The widespread prevalence and rapidly increasing rates of myopia make it a significant public health concern. Persons with higher degrees of myopia have a greater risk of developing sight-threatening complications that is, permanent visual impairment, blindness from macular degeneration (myopic origin), cataract, glaucoma, retinal holes and tears, and retinal detachments [13-18]. Myopia has been implicated as the sixth leading cause of vision loss [19]. Retarding the progression of myopia in children could ultimately impact the lives of approximately 42 million adults in the United States [20]. Thus, finding an effective method of slowing myopia progression is important in decreasing the morbidity associated with this condition.

If myopia is to be controlled during development, the rate of eye growth must be slowed. The rate of myopia progression is highest for young children with an average age for stabilization of childhood myopia at 16 years of age [21]. The concept that myopia evolved from the use and abuse of the eyes during near vision activities has been credited to Cohn in 1886 and has been traced back to Kepler.[22] More recent studies demonstrate a positive correlation between the presence of myopia and the following: intelligence, [23-25] academic advancement, [16,24,26] avocations requiring near vision use,[27,28[after professional school, [29,30] caged versus free-ranging animals[31] and people confined to restricted spaces such as submarines [32]. The implication of most of these studies is that the greater the time spent performing near work results in an increased incidence of myopia [33-35].

The assumption in most use and abuse theories is that accommodation is somehow indirectly liable for axial length expansion. There is some roundabout confirmation for this since myopes exhibit greater lags of accommodation [36,37], higher ACA ratios [38,39], more esophoria even when they are still emmetropic [40], reduced accommodative amplitudes [41], worse accommodative responses [43,43], and deficient positive relative accommodation [45]. However, the difference in accommodative function between emmetropes and myopes is not great enough to explain the development of myopia. Secondly, it is difficult to regulate which came first, the hampered accommodative function or the short sightedness. Abnormal accommodative findings have led to a host of treatment methods including bifocals progressive addition lenses (PALs), base-in prism, atropine, and vision therapy.

The preceding findings have resulted in a renewed interest in orthokeratology and novel spectacle and contact lens designs to correct the hyperopic peripheral defocus in order to eliminate the local retinal signal for elongation (to be discussed later). In addition, the neuro-retinal signal for ocular elongation is thought to have a biochemical footing [19]. Thus, if one can close the signal, then one might slow or stop short sightedness development. Atropine [46-72] and pirenzepine[73-81] have been shown to slow the development of short sightedness myopia via this presumed mechanism.

In summary, there is ample, solid evidence for both genetic and environmental factors producing myopia. It may be presumed that the genetic predisposition for myopia is triggered by environmental factors like dietary, as reading time, occupation, and as of light. Currently, genetic makeup cannot be changed, but the surrounding factors can be. Thus, understanding the methodology of emmetropization is meaningful in developing methods to control myopia. The following studies have been extracted from the data base of pubmed and google scholars.

Treatment: Spectacle Correction

Bifocals and Multifocal Lenses

Optometrists first began using bifocal lenses to attempt to slow myopia progression in the 1940s [82]. The rationale was that if accommodation caused an increase in myopia, then bifocals or multi-focals would reduce the accommodative response and thus slow myopia progression. Goss[83] performed a retrospective analysis of children between 6 and 15 years of age from three optometry practices to assess the effect of bifocal lenses on the rate of myopia progression. Sixty children wore bifocal lenses with an add power that varied between +0.75 D to +1.25 D, and 52 children wore single vision lenses. Children in the bifocal group displayed either esophoria at near, a low amplitude of accommodation, negative relative accommodation (NRA) and positive relative accommodation (PRA) which were more plus and / or less minus than normal values, a subjective refraction showing more minus than static retinoscopy, or a reported symptom of intermittent distance blur. As a group there was no statistically significant difference in progression between the bifocal group (0.37 D / year) and the single vision group (0.44 D / year). However, when Goss looked only at the esophoric children, there was a statistically significant decrease in myopia progression for children wearing bifocal lenses as compared to single vision lenses, 0.32 Diopter / year contrast 0.54 D / year, subsequently.

Grosvenor et al [85] randomly placed 207 children between the ages of 6 and 15 years into three treatment groups; single vision glasses, +1.00 D bifocals, and +2.00 D bifocals. At the end of the three year study they reported that for the 124 children who completed the study, there was no significant difference in myopia progression in children wearing single vision glasses or bifocal lenses.

Under Correction

Under-correction has been a popular method advocated by professionals to slow the development of short sightedness. In two different studies, under-correction was associated with either an increase in the progression of myopia or no change as compared to fully corrected controls [86-87].Thus, under correction is related with a faster development of short sightedness, and should no longer be advocated.

Contact Lenses

Single Vision Contact Lenses

Randomized clinical trials (RCT) comparing soft contact lenses to spectacle lenses to slow the progression of myopia found no significant difference in myopia progression [88]. Walline et al., in the Contact Lens and Myopia Progression (CLAMP) Study, performed a randomized clinical trial to determine if rigid contact lenses (RGPs) would affect short sightedness development [89]. They found that children wearing RGP lenses had less myopia progression as measured by refraction than children wearing soft contact lenses. However, it was found that only the corneal curvature of RGP wearers was flatter than that of soft contact lens subjects; there was no significant difference in axial length in cohort. So, refractive changes were probably due to a temporary compress of the cornea and did not represent a true slowing of myopia.

In another RCT by Katz et al [90]. there was no significant difference in refractive error between RGP lens wearers and spectacle wearers. These studies suggest that RGPs do not reduce the progression of myopia as previously thought.

Orthokeratology

Orthokeratology (corneal refractive therapy or CRT, and vision shaping treatment or VST), first introduced by Jessen in the 1960s, uses reverse geometry rigid gas-permeable contact lenses to reshape the cornea resulting in a temporary elimination of refractive error. There has been a resurgence in prescribing this treatment over the past decade due to better oxygen permeability of lens materials and improvement in the fit of the lenses [91,92].

In 2003, Reim and his associates [93] performed a retrospective chart review of myopia progression in children between the ages of 6 and 18 with myopia between 0.50 D and 5.25 D. These subjects were fit with the DreimLens® orthokeratolgy lens. In his cohort, 253 eyes were examined after one year of wearing the DreimLens®, and 164 eyes were examined after 3 years of wearing the DreimLens®. They reported a mean increase in myopia of 0.39 D over the 3 years, or 0.13 D / year. This was significantly less than the average reported progression of myopia, -0.50 D / year with single vision spectacle lenses.

In summary, Ortho-K results in an approximately 40% reduction in the development of shortsightdness. Its advantages are that it both eliminates the need for daytime contact lens wear and decreases the development of shortsightdness. Its adverse effects include cost, infection, uneasiness, trouble with insertion and removal, and decreased vision as compared to glasses or daily wear contact lenses. In addition, it is crucial to conclude which subjects will demonstrate slowing of their myopia and by how much.

Multifocal Soft Contact Lenses

There have been two types of multifocal contact lens treatment strategies. The first involves the use of multifocal contact lenses, which are like to progressive lenses to decreasing the development of shor tsighteddness. The second, more novel use is that of multifocal lenses that are designed to eliminate the peripheral hyperopia induced with spherically correcting contact lenses [94-96].

Holden et al [97], reported that peripheral visual acuity was better with these lenses and that the improvement in peripheral vision was most likely due to a reduction in peripheral defocus. The authors concluded that these experimental lenses, designed to maintain clear central vision but reduce relative peripheral hypermetropia, "have the capability of fix central vision without blur, decreasing the development, and improving peripheral vision - a relatively unique and beneficial combination of effects".

They reported that after 6 months of the experimental contact lens wear, the development of was 56% less than that with standard sphero-cylindrical spectacles. They also stated that "longer experience with wear of such contact lenses is needed; however the data are promising with regard to a new generation of contact lenses aimed at myopia control".

Atropine

The first report defined the use of atropine to reduces short sightedness development was by Wells in the 19th century [98], during which time atropine was used extensively to slow myopia progression.

During the First International Myopia Conference in 1964, Bedrossian and Gostin reported on the beneficial effect of atropine on slowing myopia progression. This report provided a renewed interest in the treatment of myopia progression with atropine. [21], Seventy-five patients in an A-B cross over design between the ages of 7 and 13 were prescribed one drop of 1% atropine in one eye for the first year and then the other eye for ensuing year. After one year of treatment, the eyes handle with atropine had an average decrease of 0.21 D of myopia, as compared to the control eyes that had an average improvement of 0.82 D of myopia. After two year, the eye that received atropine had an average decrease of 0.17 D of myopia. The control eyes (which one year before were treated with atropine) had an increase in myopia on average of 1.05 D. Of the 150 treated eyes, 112 showed either a slow in shortsightdness or no change, whereas only four eyes that were used as the control had a slow or no change in shortsightdness [48;51].

Chiang et al [99 performed a reflective, un-comparative case series to check the treatment of childhood myopia with the use of atropine and bifocal spectacle correction. Seven hundred and six Caucasian children from 6 to 16 years of age were treated with one drop of 1% atropine once weekly in both eyes for 1 month to 10 years (median 3.62 years). Seventy percent of the children were completely compliant with the regimen and 30% were only partially compliant. The most common reasons stated for the partial compliance were photophobia, inconvenience, or headache. The mean rate of myopia progression in the completely compliant group was -0.08 D / year, as compared to -0.23 D / year in the partially compliant group.

Kennedy et al [63] reported on 214 children aged 6 to 15 years old who were treated with one drop of 1% atropine once daily in both eyes for 18 weeks to 11.5 years (median 3.35 years). The mean myopia progression during atropine treatment was afterwards, Gimbel [49], Kelly et al.[100], Dyer [53], Sampson [50], Bedrossian [48,51,53], Brodstein [52], Brennar [56], and Yen [58], from 1973 to 1989, reported in a number of studies that children using atropine had a reduction in the rate of myopia progression.

In summary, atropine has been used in both myopia control and amblyopia treatment studies with a minimal number of local side effects and no serious side effects. In none of the studies were the local side effects serious enough to cause a large number of patients to discontinue atropine treatment. (Anecdotally, the first author of this paper has used atropine for the last ten years on over 100 patients without any incident of a serious side effect, and notes that most children surprisingly tolerate atropine with minimal complaints.)

Exercises and Myopia

Samia [101] have done a RCT on myopia with 15 female aged between 12 to 15 years in Saudia Arabia and the results of the study showed that there is improvement in visual acuity in subjects with myopia. These results suggest that clinicians should consider the use of eye exercises as a way of improving visual acuity for adolescents suffering from myopia.

Rathod et al [102] have done research work in both gender age raging between 18-25 year on 30 subjects with myopia. Subjects were randomly assign in to two groups, Group A (Experimental Group) and Group B (Controlgroup). Group A receive Eye focusing exercises 10 repetition 3 sets daily for 4 weeks with standard care and control group did not receive any exercises except standard care for myopia for 4 weeks. The results of this study showed that eye exercises are effective in improving NPC in myopia but not as statistical improvement in visual acuity.

Gosewade et al [103] have conducted a study on the effect of eye exercise techniques along with kapalbharti pranayama on Visual Reaction Time (VRT). They received 60 participants with an age group of 18–30 years. The subjects were divided into two equal groups (study group and control group) containing 30 subjects (18 male & 12 female) each.

Visual reaction time for red and green light was recorded from all 60 subjects before the starting study. Study group subjects were trained different eye exercise techniques and kapalbhati pranayama for 8 weeks regularly whereas control group did not practice any eye exercises techniques. After 8 weeks, VRT was measured for red and green light from all 60 subjects. Result of this study showed that there is a significant decrease in the visual reaction time for red and green light after intervention in study group whereas there is no significant decrease in VRT in control group. So according to statistical analysis the conclusion of the study suggest that simple eye exercises along with pranayama helps in improvement of visual reaction time.

Gopinathan et al [104] have performed a research and the aim of the study was to evaluate the role of eye exercises and Trataka Yoga Kriya on Ammetropia and Presbyopia. Total of 66 patients were registered under two main groups with four sub groups of refractive error like shortsightdness, hyperopia, astigmatism, and presbyopia, respectively, (Group A – 32 patients, Group B – 34 patients) by random sampling method. Group A subjects were subjected to perform group of eye exercises once daily for 3 weeks. *In Group B,* A total of 34 patients were registered in this group here subjects were subjected to perform Trataka Yoga Kriya once daily (either in morning or in evening hours) for 3 weeks. Eye exercises are as follows: Sunning, Eye wash, Palming, Candle light reading, Shifting and Swinging, Playing with ball, Vaporization, Cold pad. After taking full therapy session, subjects were investigating for 1 month in order to see any adverse effects of the therapy. By the end of this research the statistical analysis suggest there is Snellen's chart reading one line rectification was noted. It is a promising conclusion that a non-medicinal, inexpensive, relaxation approaches can rectify the quality of vision, by which it discursively review the betterment of the disease status.

Physical Activity

Jones-Jordan et al [105] in his study and they found that the persons diagnosed with myopia spent less time engaged in sports and physical activities (PA) in childhood prior and following the occurrence of myopia in relation to emmetropes. Donovan et al [106] determined that myopia progression is slower during summer than winter, because people spend more time outside during the summer and they are more engaged in sport activities.

Guggenheim et al [107] explore that the time spent in sports / outdoor activity has shown a negative association with incident myopia at childhood. They investigated the correlation between incident myopia with time spent outdoors and physical activity separately. A follower of 14,541 preggers women was rooted; arise in 13,988 babies who were surviving at 12 months of age. The data stockpile has been through different methods, with self-completion questionnaires sent to the mother and her better half, and later age 5 to the child, with direct assessments and interviews in a delving infirmary, biological samples, and connection to school and hospital records. The conclusion of this study was the greater time spent outdoors at age 8–9 years was unite with a reduced incidence of myopia development over the whole study period (ages of 7–15 years), and accurately between the ages of 11 and 15 years.

Lu et al [108] have done a cohort study on Finnish children and reported that myopia was more frequent with girls because boys spent more time in sport activities, and also in Chinese children and youth. Since girls played out more time in reading and doing homework than boys, who played out more time in activities at open space.

Rose et al [109] found that the prevalence of myopia in Chinese children and youth living in Sydney in relation to Chinese children and youth living in Singapore was lower, since children in Sydney spent several hours engaged in open physical activities, and children in Singapore go to school a bit prior and by that, consume lesser time playing outside. Rose study supported the research by Guggenheim et al, who objectively measured physical competence and determined that less time was spent in sports and PA leading to increase of the myopia level.

Mutti et al [110] determined in two studies a "protective" role of external activity on myopia progression, that is, in case of individuals who were engaged in sport and other external PA, myopia did not increase.

Read et al [111] have done study on to investigate the short-term influence of a period of dynamic exercise on axial length (AXL) and intraocular pressure (IOP) in young adult subjects. In all, 20 young adult patients (10 myopes and 10 emmetropes) engaged in. Standard measures of eye biometrics, IOP and ocular pulse amplitude (OPA) were taken following a 20-minute rest time. Patients then carry out 10 minute of reasonable intensity, low impact dynamic exercise (bicycle ergometry). Measures of eye biometrics, Intra ocular pressure and ocular pulse amplitude were again just after, and then five and ten minutes after this exercise work. Systemic BP and PR were also monitored. A small but detectable decrease in AXL was observed following exercise. The largest change in AXL was noted immediately following exercise. IOP and OPA also decreased significantly following PA.

Discussion

The purpose of this literature review is to provide an updated review of the current research in regard to slowing myopia progression and to provide the reader with unbiased information to help make appropriate clinical decisions. Atropine used once a day in both eyes is clearly the most successful treatment to slow the progression of childhood myopia. Cumulative data from a number of studies employing atropine 1% demonstrated up to a tenfold reduction in the rate of myopia progression as compared to untreated eyes, 0.05 D / year verseus 0.50 D / year. Concentrations of less than 0.5% result in a decreased efficacy but still demonstrate a stronger effect on reducing myopia than other treatment regimens.

The most common side effects of atropine include pupillary dilation, which leads to an increased sensitivity to light and UV radiation, and cycloplegia resulting in accommodation paralysis. These problems have been minimized with the use of progressive lenses which incorporate photochromic properties, and UV filtration. The risk of other ocular and systemic consequences is minimal. In the studies admitted in this paper, more than 85% of children were able to tolerate the side effects, and carry on with their accredited treatment protocol. The minimal local effects in most patients were not serious enough to cause discontinuation of atropine treatment.

The exact mechanism of atropine in slowing myopia progression does not involve accommodation; it is presumed to block the signal stimulating the elongation of the globe via receptors at the retina. No study to date has determined how long a child needs to be on atropine to decrease short sightedness development, or how fast the short sightedness will progress after stop of treatment for longer than 2 years.

For those children in whom myopia is progressing more slowly or there is a need to eliminate glasses for either beautifying or functional limitations, the second choice might be orthokeratology, Exercise therapy or Yoga. Orthokeratology has a high acceptance rate with children and provides a “wow” phenomenon, often seen with LASIK. It should be acknowledged that orthokeratology comes with its own risks of discomfort, keratitis, and potential corneal ulceration. Patients are often concerned about the risk of overnight wear of contact lenses.

The progressive addition lenses for esophoric patients. Utilization of progressive lenses in other non-esophoric myopic patients provides minimal benefits, but current status of myopia treatment with either an explanation or literature to clarify the options. Governess and patients should be administered unbiased risks and benefits of each treatment strategy to help make informed decisions. As a general rule, the more sedentary the patient, the earlier the onset, the greater the risk factors (i.e., parents having myopia or family history of retinal holes or tears) the more likely that atropine will be suggested. Atropine dosage can be seasonally varied to reduce photophobia and blur complaints.

On the other hand, patients who develop shortsightdness later, associated with quite progression, and / or are more energetic, the more likely that orthokeratology should be recommended. If the child is esophoric, the use of progressive addition spectacle lenses can be recommended. Patients with myopia that want to slow the process but who require or desire traditional contact lenses should be prescribed UV filtering daily wear contact lenses. In last we all have to focus on Exercise therapy, Yoga and PA all are having good and beneficial therapeutic effects in slowing myopia progression without any side effect but there are very limited clinical trials to prove it.

Conclusion

In considering myopia treatment, remember what the 19thcentury philosopher Arthur Schopenhauer[112] said, “All truth passes through three stages. First, it is humiliate. Second, it is forcibly opposed. And third, it is accepted as being self-evident” [112]. Treatment of myopia with atropine is in the second stage, and orthokeratology is ending the second stage. Atropine, orthokeratology, eye exercises and Yoga will pass to the third stage. A better atropine / orthokeratology, Exercise / Yoga will come in to use. Atropine and orthokeratology are effective methods to slow the progression of myopia. There is extra need of RCT to emphasize the Eye exercises in prevention or controlling the progression of myopia.

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