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The Neurological and Developmental Implications of the Treatment of Myopia in Children by Means of Orthoculogy

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Abstract

To deal with the myopia epidemic, orthoculogy (or ortho C) which denotes treating the whole eye is an improvement to an existing method on the market called orthokeratology (or ortho K) which denotes manipulating just the cornea. Treating pediatric myopia by means of ortho C, which is a modified and improved version of ortho K, has neurological, developmental, and genetical implications.

The 8 myopic pediatric participants treated at different occasions were assigned different follow-up appointments with progressively longer intervals. A visual acuity measurement was taken prior to the intervention. Then they would wear the lenses for about 5 minutes and performed the intervention on the first day of each follow-up period, and a visual acuity test was conducted to record the results. Another test was performed at the end of each period to determine their ability to retain the improvement in visual acuity experienced on the first day. The 8 follow-up appointments were scheduled 1 week apart, then 2 weeks apart, and finally 3 weeks apart.

All of the participants experienced an improvement in visual acuity by the end of the assigned follow-up periods. They only performed the intervention on the first day of each scheduled follow-up periods. They were still able to maintain the improvement in visual acuity by the end of each follow-up period. The developmental process of the eye during those periods seems to assist in the treatment. It was severed when the eye became myopic. Ortho C may have restored it during the intervention.

Keywords: *Myopia, Nearsightedness, Pediatric Myopia, Orthoculogy, Othokeratology*

Introduction

Myopia is a visual condition where near objects appear clear, but distant objects are blurry. By 2050, the prediction is that 50% of the global population will be myopic[7]. In China, about 90% of adolescents leaving school are myopic, and 20% have high myopia[9]. To deal with the myopia epidemic, the existing methods on the market attempt to stem the progression of myopia. According to the industry, there is no cure for myopia. There are only ways to prevent myopia from getting worse. The following are the four main methods to prevent myopia from getting worse: MiSight contact lenses, orthokeratology, low-dose atropine drops, and multifocal contact lenses[10].

Orthoculogy (or ortho C) is an improved version of orthokeratology (or ortho K). Ortho K denotes manipulating just the cornea: ortho + keratology. Ortho C denotes treating the whole eye: ortho + oculus. It does not just prevent myopia from getting worse. It also attempts to correct the myopia. Ortho C does not force the cornea to change mechanically. Instead, it alters the myopic shape of the crystalline lens and eyeball neurologically and developmentally[14].

After ortho C relaxes the oblique muscles, it seems to reset the proper neurological response to a blur distant object[14]. It may also restore the developmental synchronization of the lens and eyeball in children and adolescents[15]. It was severed when it became myopic[11].

By reinstating the development of the eye, it may assist in the treatment. It was demonstrated by assigning different scheduled follow-up appointments and having the participants wear the lenses and perform an intervention (which takes about 5 minutes) only on the first day of each period. Each successive period was progressively longer to examine the extent the improvement in visual acuity can be maintained despite the stress experienced by the participants in the classroom at school during those periods.

The phenomenon also has genetical implications. It is possible for the developmental process to restore the eye to its premyopic shape despite the adverse effect of familial genetical influence.

Literature Review

The Problem

Before seeking a treatment for myopia, one needs to know the etiology of the problem. There is a high correlation between near-point stress and myopia[4]. Near-point stress is due to adopting the habit of looking at something very close for an extended period or to wearing a minus lens (a lens prescribed for myopia to bring blur objects far away into focus) for close-up work (which produces the condition of looking at something very, very close). It causes the ciliary muscle to become more tense (and thus become thicker). The increase in tension induces a rounder (or more bulged) crystalline lens[14], but the focal point still ends up behind the retina instead of on the retina.

The proposed theory of the problem is that the excessive tension of the ciliary muscle due to near-point stress, in turn, forces the oblique muscles to tighten up. The oblique muscles are the two external muscles that runs across the top and bottom width of the eye. (See Figure 1.) The tension of those muscles causes the eye to elongate to assist in very near focusing by attempting to bring the focal point back onto the retina, but the eyeball will become stuck in that shape if very near work was prolonged. Once that occurs, myopia had set in[15]. There is a relationship between the bulging of the ciliary muscle and the excess tension of the oblique muscles which causes the elongated eye[3, 5]. A potential treatment would be to loosen the ciliary muscle[11]. The elongated crystalline lens as well as the elongated eyeball contributes to myopia.

After the excess tension of the oblique muscles causes the eye to elongate, it initiates an incorrect neurological response. The motor response ignores the neurosensory message from a blur distant object even though the subject knows that it is far away. The brain responds as if though the eye was in near focus mode. The tension of the ciliary muscle increases instead of becoming relaxed to flatten the lens for distant focusing. The excess effort further increases the tension of the oblique muscles to maintain the elongated shape of the eye. It is similar to what takes place during near-point stress[15].

The excessive tension of the oblique muscles also neurologically restricts how much the lens can flatten for distant focusing even though spasticity of the ciliary muscle, the muscle that controls the shape of the lens, did not set in. Myopes with mild or moderate myopia can demonstrate that the ciliary muscle did not spasm; the lens can still bulge some more for near focusing[15]. A treatment needs to include a neurological as well as a physiological application since the deviation of the eye also induced an incorrect neurological response.

How It Works

There is a gap between the flange of an ortho C contact lens and the cornea since the lens is slightly flatter. The “flatness” of a rigid contact lens refers to its curvature being less curve than the curvature of the cornea as in Figure 2. The flatter lens does not cause the cornea to change because it is only slightly flatter compared to ortho K. The adhesion to the tears and contact lens solution closes the gap between the flange of the lens and the cornea. The lens is flexible enough to wrap around the cornea instead of collapsing it. The lens bends like a bow, and the adhesion holds it taut[15].

The bending of the lens produces a “contact lens draw”. It is a reactionary draw against the cornea not just along a single meridian but all around the lens due to the uniform adhesion. The draw is primarily outwards in the direction of the arrows as in Figure 3. The ortho C lens is still firm enough to transmit the draw to the cornea. The cornea in turn acts like a large contact lens. The draw of the cornea is outwards and upwards in the direction of the arrows as in figure 3. The draw is then transmitted to the eyeball. The centre of the eye tends to expand slightly in the direction of the arrows as in Figure 3 to offset the tension of the oblique muscles[15].

The relaxation of the muscles resets the proper neurological message. It neurologically activates a "focal point draw". Unlike a contact lens draw, a focal point draw is produced neurologically. A focal point projected from a distant object at a certain proximity from the retina would draw on it. It tends to close the gap to reduce the elongated myopic eye as in Figure 4. The reduced tension of the oblique muscles allows that to take place[15].

Reinstating the correct neurological message allows the ciliary muscle to sufficiently relax to allow the crystalline lens to flatten to bring a blur object far away into focus. The regulation of the lens for distant focusing is handed back to the ciliary muscle. The elongated eye cannot retract until that occurs. The retraction of the myopic eyeball takes place as follows: the crystalline lens can only flatten so much; the eye needs to retract to assist in distant focusing. Ortho C induces the reverse of near-point stress[15].

How It is Different from Ortho K

Ortho C is an improvement of an ortho K lens. An ortho K lenses must be worn every night to reset the improvement. When the child forgets to wear the lenses for a night, the cornea creeps back to its original shape. The myopia would return. By comparison, the wearing duration of an ortho C lens is about 5 minutes, and the goal for the wearing frequency for children is once every 3 to 6 months. The improvement is permanent[14].

Wearing a hard contact lens overnight to reshape the cornea subjects the eye to the risk of abrasion and keeping the lens clean. There is the risk of an infection called microbial keratitis which can cause blindness[10]. By comparison, the reduced wearing time of an ortho C lens reduces the risk of infection.

An ortho K lens is only intended to reduce myopia progression. An ortho C lens is meant to correct myopia up to -2.50 D. If the myopia is more severe, ortho C will still reduce it significantly. It also addresses progressive myopia which is more prevalent in children during development[15].

Ortho C is More Effective in Treating Pediatric Myopia

Ortho C is more effective in correcting children and adolescent myopia compared to adult myopia. Unlike adults, children tend to have less of other types of problems adults have in addition to myopia. Those other types of problems tend to offset the effect of ortho C[15].

The eyes of children are also more resilient. Prior to the onset of myopia, their development assist in the tendency to achieve normal vision. According to the National Institutes of Health, about 23% of children from 6 months to 1 year of age have astigmatism, but they tend to grow out of it by the time they reach school age around 5 or 6 years of age. (Astigmatism is the uneven curvature of the cornea. Its severity is determined by the difference between the curvature of the horizontal and vertical curvature. The symptoms are similar to myopia) Of the 6 children with anisometropia of 1 D or more and less than 2 D at 2 ½ years, only 1 child was anisometropic at 10 years of age. Of the 7 children with high anisometropia of 2 D or more at 6 months of age, 6 continued to have high anisometropia greater than 2 D[8]. (Anisometropia is the difference in prescription between the right and left eye of 1 D or more).

Aims of The Study

The study intends to demonstrate that a treatment for myopia based on ortho C has neurological, developmental, and genetical implications. It also considers the resilience of the eyes of children and adolescents compared to adults. The tendency for the myopic eye of the former to take on the proper shape dictated by the ortho C lens to achieve better vision is higher compared to the latter.

Hypotheses

First Hypothesis

By reinstating the ciliary muscle to function on its own to regulate the lens for distant focusing without any interference from another muscle (such as the oblique muscles in the case of myopia), it is possible to restore the developmental of the eye in the synchronization process (which was severed when the eye became myopic). The development of the eye is restored by initiating the lens to synchronize with the elongated eye and the elongated eye to synchronize with the lens. The development of the eye can assist with reversing the myopia.

Second Hypothesis

It is possible for ortho C to reduce the myopia of children whose parents are myopic. The restored development of the eye tends to prevent the reoccurrence of myopia and thereby overrides the familial genetical etiology of myopia.

Sample

My sample consists of the following 8 participants who I treated at different times. They are categorized according to the type of problem: myopia, severe myopia, astigmatism, and hyperopia plus astigmatism. Astigmatism is the uneven curvature of the cornea. Its severity is determined by the difference between the horizontal and vertical curvature. Hyperopia is a condition where the eye is too short from front to back compared to the normal eye. Other refractive errors are included in addition to myopia to demonstrate that children are more resilient than adults after applying ortho C.

It is interesting to note that it is very difficult for ortho C to reduce the astigmatism of adults—if astigmatism was the major contributor of the refractive error. Their astigmatism would be the major problem if the myopia was mild or moderate and the astigmatism was higher. It is also difficult to treat adults with moderate or midrange myopia and a disparity between the right and left eye of -0.50 D or higher[14].

The present study is still in reference to myopia. The visual acuity (or v/a) of those participants displayed characteristics of different types of myopia in the sense that their combined refractive errors simulated residual myopia. The focal point of all the participants was in front of the retina. Their v/a was less than 20/20 (or line 8 on the Snellen chart which indicates normal vision). For example, prior to applying ortho C, the binocular v/a of Participant G with hyperopia and high astigmatism of +2.00 D and -1.50 D was line 4 on the Snellen chart. She could only see the 20/50 line and therefore her visual acuity was 20/50. The symptom was similar to someone with myopia. Therefore, the treatment is similar.

Included also are the corresponding refractive errors of both parents when the participants were born. One of the parents may have presbyopia while the other may have myopia, or both parents may have myopia. Presbyopia is a visual condition where near objects are blurry, but distant objects appear clear.

Methodology

Research Design

I adopted a pretest-posttest design. Its effectiveness was demonstrated by the researcher Hans Eysenck who summarized the results of 24 such studies and compared the results with archival data from state hospital and insurance company records. The results were similar[6]. In a similar manner, the outcome of the present research can be validated without setting up a control group. By comparing the present results to data derived over the decades in the treatment of pediatric myopia by means of ortho C, the results were similar.

I did not conduct an experimental design because I can expect with a reasonable amount of certainty the outcome if I gave the control group ortho K lenses and the experimental group ortho C lenses and had the participants in each group wear the lenses and perform the recommended drill for 5 minutes. I would know that the participants in the experimental group would register an improvement in visual acuity after removing the lenses while those in the control group would not register any change in visual acuity after removing the lenses. The knowledge is derived from previous research with different variations of ortho K.

The variation of ortho K for the above experimental design would be according to the version where the patient would wear the ortho K lenses for the entire day. If they were worn for just 5 minutes instead while performing a specific drill looking into the distance, there would not be an improvement in visual acuity after removing the lenses. Not enough time was allotted to alter the shape of the cornea. On the other hand, if the ortho C lenses were worn for 5 minutes while performing a specific drill looking into the distance, there would be an improvement in visual acuity after removing the lenses. It is easier to alter the shape of the crystalline lens than the cornea.

The drawbacks of a pre-test post-test design are history and regression to the means[13]. To attend to the problem of history, or the problem that there could be something else in the interim to cause the participant to lower their myopia, the post-interventional data of the participants was immediately acquired after the ortho C intervention. The problem of regression to the means was attended to in the same way. Before the possibility of the participants' reduction in myopia can be attributed to spontaneous remission (lowered on its own accord), the post-intervention data was immediately acquired after the ortho C intervention.

Scheduled Follow-Ups

The following are the scheduled 8 follow-up periods:

- We would meet weekly for 3 times.
- The next schedule is 2 weeks apart. We would meet on the first day and the last day of that period. (The last day of that period is the first day of the next follow-up schedule.) We would meet for 3 times.
- The next schedule is 3 weeks apart. We would meet on the first day and the last day of that period. (The last day of that period is the first day of the next follow-up schedule.) We would meet 2 times.
- Afterwards, I would collect further data once every 3 to 6 months.

Informed consent was obtained from each participant. The above schedule was generally designed to treat pure myopia from -0.50 D to -2.50 D. Certain conditions may arise to extend the treatment period: if the participant had severe myopia (beyond -2.50 D), if the prescription is incorrect, if the keratometer (which measures the curvature of the cornea to determine the curvature of the ortho C contact lens) is not calibrated properly, or if the participant needs to adapt to the lens first.

Method

To establish a benchmark, a "before" and "after" visual acuity test was performed on each participant before the intervention during the first follow-up visit. It determined the degree of myopia based on what the participant can read on a standard Snellen eye chart. Another v/a test was conducted immediately after the intervention to determine the improvement in visual acuity. Another v/a test was also conducted at the end of the scheduled period of each scheduled follow-up to determine the ability to retain the improvement.

The Intervention

The participant would wear the lens designed for the better eye first. A distant drill is performed by looking outside and tracing an object about 300 feet away for 30 seconds. A Snellen chart drill is then performed immediately afterwards with the better eye without any lens on. A specific line, depending on the prescription of the eye, is read 5 times at 8 feet away. The same drills would be conducted on the other eye.

The intervention cannot be performed too often. It is not necessary to keep resetting the correct neurological response once it is reset. Otherwise, the participant would see blur. An indication of this is by performing the intervention on a normal eye. The participant would see blur just after one application. Ortho C cannot overcorrect the normal eye with the intention of acquiring “high-definition vision”. It can only correct how much the eye deviated[15].

The intervention was only performed once at the start of each period to boost the developmental process of the eye after subjecting the eye to stress for the duration of the previous period (especially during those periods before the eye regained normality). The visual acuity test performed at the end of each scheduled follow-up period would determine the participant’s ability to maintain the improvement in visual acuity during that period and the ability of the restructured eye to handle the stress experienced by the participants in the classroom at school. The assumption is that the progressive increase in stress during each successive period tends to offset the synchronizing process and promote a regression. Therefore, the v/a test also checked for signs of progressive myopia.

The phenomenon also has genetical implications. It is possible for the developmental synchronizing process to restore the eye to its premyopic shape despite the adverse effect of familial genetical influence.

Data Collection Tools

A phoropter is an instrument used to test the eye for refractive errors. The results are given in diopters. A diopter is a unit of measurement that represents the optical strength of a lens. A phoropter may induce instrument myopia by causing the lens of the eye to bulge too much when it is placed over the eye. The lens is supposed to flatten for distant focusing instead of becoming rounded or bulged (which is the shape it assumes for near focusing). Instrument myopia can occur when an instrument such as a binocular, telescope, or even a phoropter is placed over the eye[1, 12]. Conventional optometry does not take instrument myopia seriously because the intention is to bypass the lens of the eye. Myopia is attributed strictly to the elongated shape of the eye. But the lens of the eye should also be considered as well as the eyeball when treating myopia[11]. Myopia affects not just the eyeball but also the crystalline lens.

A Snellen eye chart is preferred over a phoropter. The results are given in visual acuity (or v/a) measurements. It represents the specific line that can be seen on the chart. The 20/20 line is line 8 on the standard Snellen chart. Ortho C causes the lens of the eye to flatten as well as the eyeball to retract for distant focusing due to the synchronization of the lens to the myopic eyeball as well as the synchronization of the myopic eyeball to the lens. A Snellen chart does not cause instrument myopia and thus takes into account the improved shape of the lens.

Results

By applying an ortho C lens according to protocol, 6 participants corrected their visual acuity to 20/25, 20/20, or 20/10. There were 2 participants with high myopia who managed to reduce their myopia. Since a Snellen eye chart was used instead of a phoropter, the before and after results are in visual acuity measurements. The corresponding line number on the standard Snellen chart is also provided. (The visual acuity measurements can be converted to diopters according to a conversion chart).

Correcting and Reducing Their Refractive Errors

Just by applying an ortho C lens in a certain way (how long it should be worn and what to do with the lens on), 6 participants managed to correct their refractive errors and 2 participants with high myopia managed to reduce it. The term "correct" referred to the participants who were able to improvement their binocular visual acuity (what they can see with both eyes) to 20/25, 20/20, or 20/10 on the Snellen chart. The term "reduce" referred to the participants who were able to lower their myopia to the extent that they were able to rely on a lower prescription to enable them to see 20/25 or 20/20. All the participants' binocular visual acuity showed a progressive improvement by the end of all the scheduled follow-ups compared to their binocular v/a prior to ortho C.

An improvement in visual acuity to 20/25 (or line 7 on the Snellen chart) was classified as a correction even though 20/20 (or line 8 on the Snellen chart) is the usual standard measurement to indicate normal vision. The participants who improved their v/a to 20/25 were still able to see the blackboard at school, and the parents did not report squinting when they were watching television. If they were squinting while watching TV, it is an indication that they were applying an excessive "effort to see". Participants F and G who improved their v/a to 20/10 (or line 11 on the Snellen chart) were able to see better than what is considered normal. The designation meant that people with normal vision can see line 11 at 10 feet away from the chart while the participants in this category can see line 11 at 20 feet.

The final reading on the Snellen eye chart at the end of the 8 follow-up periods was taken before applying any drills. Participant B, for example, can see the 20/20 line (or line 8) at the end of the scheduled follow-up periods before applying the intervention. During the last 3 follow-up periods, if the intervention was performed, he would be able to see the 20/10 line (or line 11); but his vision would gravitate to the 20/20 line by the end of 3 weeks at each of those periods. Participants F and G, however, were still able to see the 20/10 line (or line 11) at the end of the follow-up period prior to applying the intervention. They were able to retain any improvement in their visual acuity after performing the drills at the beginning of the follow-up period.

It is not unusual for each eye to see one line lower compared with their binocular vision[15]. For example, Participant A can see the 20/20 line (or line 8 on the Snellen chart) with both eyes, and she can see the 20/25 line (or line 7 on the Snellen chart) with each eye. In some cases, only the weaker eye may read one line less than the binocular visual acuity, but the better eye would be equivalent to the binocular visual acuity. For example, before Participant B balanced the v/a of each eye, he can see the 20/20 line (or line 8) with both eyes; the better eye can also see the 20/20 line (line 8) while the weaker eye can see the 20/25 line (line 7).

Time It Takes to Achieve Maximum Improvement

There were 7 participants who achieved maximum improvement within the above schedule. It is possible to achieve it weeks before the end of the follow-up periods. It depends on the type of refractive error (while bearing in mind that children and adolescents are more resilient than adults after applying ortho C). In general, mild or moderate astigmatism seem to experience the quickest recovery followed by mild or moderate myopia; but most parents do not usually consider myopia control for their children until it reaches the midrange (-2.00 D to 2.75D) or severe stage (-3.00 D and over).

Participant F with astigmatism of R -0.75 D and L -1.75 D corrected her vision by the second week. Participant B with myopia of R -2.00 and L -1.50 corrected his vision by the fifth week. Participant A with myopia of R -1.25 D and L -1.00 corrected her vision by the eighth week. She was ill on several occasions and had to reschedule. Participant H had compound hyperopia and astigmatism. His hyperopia was in the mild range. Although he had very high astigmatism, it was corrected in about 2 months (or half of the duration of the scheduled follow-up periods).

Participants G did not correct her vision until near the end of the follow-up periods. She had compound hyperopia and astigmatism. Her astigmatism was also considered high. Although it was not as high as Participant H, it would have been difficult to treat if she was an adult. Her refractive error took longer to correct compared to Participant H because her hyperopia was higher. It seems to put up more resistance compared to her astigmatism. Participant C with myopia of R-2.25 D and L -2.50 D also did not correct his vision until near the end of the follow-up periods due to difficulty in inserting and removing the lenses. Participant D with severe myopia of -7.25 D in both eyes was able to reduce her eyeglasses prescription to -3.50 D within the above schedule. However, she was not able to continue with the treatment. She did not give a reason.

Participant D with severe myopia of R -6.25 D and L -7.25 D took longer than the scheduled follow-up periods before achieving maximum improvement. It took 1 years before her prescription stabilized to -1.75 D. Prior to the treatment, she wore her glasses all the time even when she was reading. If she was an adult, she would have been difficult to treat. The spasticity of her ciliary muscle would have set in.

At university, she relied on her glasses only to see the blackboard. Her courses involved a lot of close work on the computer and distant work taking notes in the classroom. After university, her vision remained at -1.75 D. She was able to see the 20/20 line on the Snellen chart with those glasses.

Discussion

Neurological Perspective

Neurology was involved in the treatment due to the following phenomenon:

- A “contact lens draw” is necessary to reset the neurological message in response to a blur distant object.
- A “focal point draw” is necessary to initiate the retraction.
- Both draws needs to be combined.

A contact lens draw seemed to relax the oblique muscles to reset the correct neurological message of a blur distant object. It reinstated the proper neurological response, and that was indicated by making it possible for a focal point draw to occur. When a distant object projected a focal point at a certain proximity in front of the retina, it was able to coax the eye to retract. The outcome is the reverse of the effect of near-point stress where the focal point was behind the retina[15].

A focal point draw needs to be combined with a contact lens draw. The projection of a focal point by itself cannot stimulate the curvature of the crystalline lens or eyeball to change to bring a distant image into focus. Otherwise, an ortho C lens is not required to relax the oblique muscles. All you would need is a weaker minus lens (i.e., a weaker pair of glasses) to project a focal point within a reasonable distance in front of the retina. However, it is difficult for a “focal point draw” by itself to cause a change in visual acuity because the oblique muscles are still too tight. A neurological intervention is necessary before a focal point draw can be activated.

Most of the research done on treating myopia naturally are applications of a focal point draw without the assistance of a contact lens draw—such as wearing progressively weaker and weaker glasses to improve one’s vision. Any positive results are not as quick or as pronounced as ortho C due to the absence of a contact lens draw. It is difficult for a focal point draw by itself to entice the eyeball to retract. The excess tension of the oblique muscles tends to increase the “effort to see”[15]. That was why it was found in some trials that the axial length of the eye can further elongated due to wearing undercorrected glasses. The researchers had to discontinue the research when the glasses made their vision worse instead of enhancing it[2].

Developmental Perspective

The development of the eye in reference to the synchronization between the lens and eyeball was severed when it became myopic[11]. The lens was not able to synchronize with the elongated eye. Its myopic shape took place for a different reason other than development. By reinstating the correct neurological response, it seemed to also restore the developmental synchronizing process during each of the scheduled periods. It is likely that it contributed to the treatment since all the participants were able to retain the improvement in their visual acuity by the end of each of the scheduled periods.

When treating myopic children and adolescents during development, the intention behind increasing the period of each follow-up session is to give the crystalline lens and eyeball enough time to synchronize in each eye and to allow one eye to synchronize with the other eye despite the presence of an incremental increase in stress. The stress encountered by the eye when the participants were at school would tend to offset the synchronization process and promote progressive myopia if there was constantly an excess “effort to see” something far away (such as the blackboard). The intervention was performed at the beginning of each follow-up period to boost the development of the eye to counter any residual stress. Progressive myopia was not present when a visual acuity check was conducted at the end of every period. The participant’s myopia was sufficiently reduced during each period to prevent an excessive “effort to see”.

The study included participants with other types of refractive errors in addition to myopia: participants with astigmatism, participants with a disparity of -0.50 D in the moderate myopic range, and participants with severe myopia. These types of refractive errors found in adults were difficult to treat by means of ortho C; but during the developmental stage, the eye responded more favorably.

Genetical Perspective

Children are more likely to be myopic if their parents are myopic. Having two myopic parents pose a higher risk than having only one[9]. The genetical etiology of myopia presupposes that the eye would get worse if it was left unattended, but none of the participants had a relapse. The visual acuity of all the participants still improved despite the presence of familial genetical influence. The participants with severe myopia, for example, still had traces of myopia during every stage of the treatment, but ortho C was still able to avert progressive myopia. The residual myopia became less and less after each successive scheduled period. It seems that the restored developmental synchronizing process overrides the possibility of a relapse due to familial genetics.

Conclusion

During development, the eye was able to synchronize with the lens and eyeball prior to myopia. The lens was able to flatten to compensate for the growing eye to maintain proper distant focusing[11]. By restoring the developmental process, it assists in the treatment. The extent of the resiliency of the myopic eye of children and adolescents is demonstrated by the ability for ortho C to treat other types of refractive errors in addition to myopia such as severe astigmatism which is more difficult to treat in adults by means of ortho C. Progressive myopia was thought to have a genetical disposition, but it did not take place during any of the scheduled periods. The reinstated development of the eye seemed to override it.

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Table 1: Sample Section – Participant A

Age	Gender	Type of Problem	Prescription of Right Eye	Prescription of Left Eye	Refractive error of Father	Refractive error of Mother
8	F	Myopia	-1.25 D	-1.00	Myopia	Myopia

Table 2: Sample Section – Participant B

Age	Gender	Type of Problem	Prescription of Right Eye	Prescription of Left Eye	Refractive error of Father	Refractive error of Mother
11	M	Myopia	-2.00 D	-1.50 D	Myopia	Myopia

Table 3: Sample Section – Participant C

Age	Gender	Type of Problem	Prescription of Right Eye	Prescription of Left Eye	Refractive error of Father	Refractive error of Mother
15	M	Myopia	-2.25 D	-2.50 D	Presbyopia	Myopia

Table 4: Sample Section – Participant D

Age	Gender	Type of Problem	Prescription of Right Eye	Prescription of Left Eye	Refractive error of Father	Refractive error of Mother
13	M	Severe Myopia	-7.25 D	-7.25 D	Myopia	Normal Vision

Table 5: Sample Section – Participant E

Age	Gender	Type of Problem	Prescription of Right Eye	Prescription of Left Eye	Refractive error of Father	Refractive error of Mother
17	F	Severe Myopia	-6.25 D	-7.25 D	Myopia	Normal Vision

Table 6: Sample Section – Participant F

Age	Gender	Type of Problem	Prescription of Right Eye	Prescription of Left Eye	Refractive error of Father	Refractive error of Mother
17	F	Astigmatism	-0.75 D	-1.75 D	Presbyopia	Myopia

Table 7: Sample Section – Participant G

Age	Gender	Type of Problem	Prescription of Right Eye	Prescription of Left Eye	Refractive error of Father	Refractive error of Mother
5	F	Hyperopia plus Astigmatism	+2.00 D and -1.50	+2.00 D and -1.50	Presbyopia	Myopia

Table 8: Sample Section – Participant H

Age	Gender	Type of Problem	Prescription of Right Eye	Prescription of Left Eye	Refractive error of Father	Refractive error of Mother
11	M	Hyperopia plus Astigmatism	+0.75 D and -3.75	+0.50 D and -3.00	Presbyopia	Myopia

Results: The following participants improved their visual acuity to 20/25:

Table 9: Results Section – Participant H

Age	Gender	Type of Problem	V/A Prior to Ortho C	V/A at the end of 8 follow-up periods
11	M	Hyperopia plus Astigmatism	20/50 Or Line 4	20/25 Or Line 7

Table 10: Results Section – Participant C

Age	Gender	Type of Problem	V/A Prior to Ortho C	V/A at the end of 8 follow-up periods
15	M	Myopia	20/70 Or Line 3	20/25 Or Line 7

Results: The following participants improved their visual acuity to 20/20:

Table 11: Results Section – Participant A

Age	Gender	Type of Problem	V/A Prior to Ortho C	V/A at the end of 8 follow-up periods
8	F	Myopia	20/50 or Line 4	20/20 or Line 8

Table 12: Results Section – Participant B

Age	Gender	Type of Problem	V/A Prior to Ortho C	V/A at the end of 8 follow-up periods
11	M	Myopia	20/40 or Line 5	20/20 or Line 8

Results: The following participants improved their visual acuity to 20/10:

Table 13: Results Section – Participant F

Age	Gender	Type of Problem	V/A Prior to Ortho C	V/A at the end of 8 follow-up periods
17	F	Astigmatism	20/25 or Line 7	20/10 or Line 11

Table 14: Results Section – Participant G

Age	Gender	Type of Problem	V/A Prior to Ortho C	V/A at the end of 8 follow-up periods
5	F	Hyperopia plus Astigmatism	20/40 or Line 5	20/10 or Line 11

Results: The following participants were able to reduce their myopia:

Table 15: Results Section – Participant D

Age	Gender	Type of Problem	V/A with -3.50 D Glasses Prior to Drills	V/A with -3.50 glasses 2 months later
13	M	Severe Myopia	Cannot see any letters on the chart	20/25 or Line 7

Table 16: Results Section – Participant E

Age	Gender	Type of Problem	V/A with -1.75 D glasses Prior to Drills	V/A with -1.75 glasses 1 year later
17	F	Severe Myopia	Cannot see any letters on the chart	20/20 or Line 8

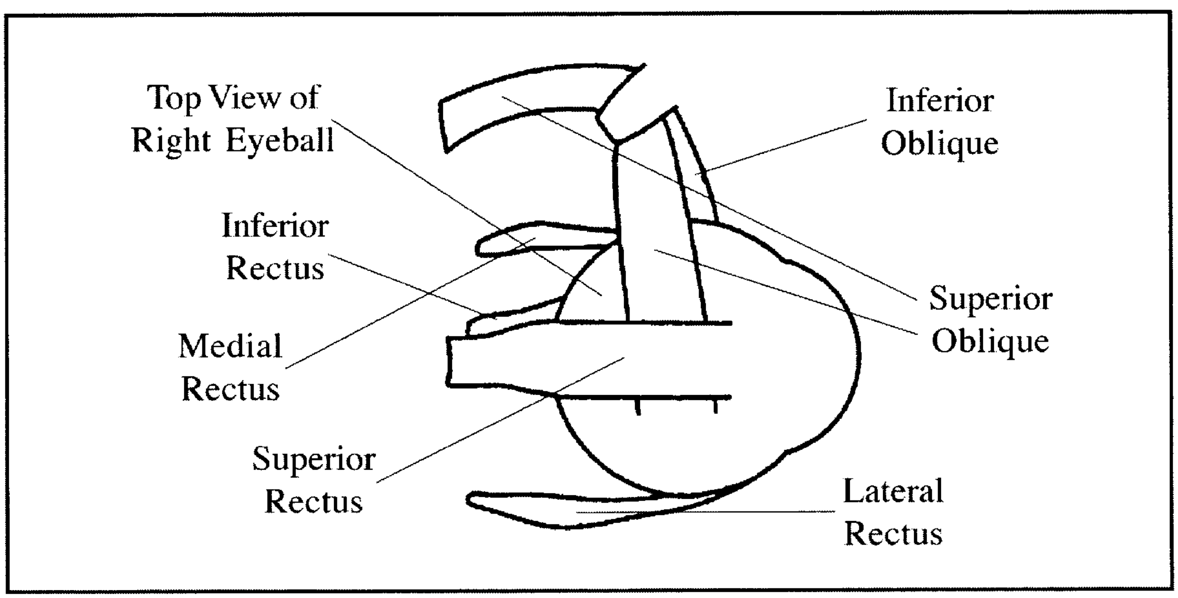

Figure 1: Top View of Right Eye

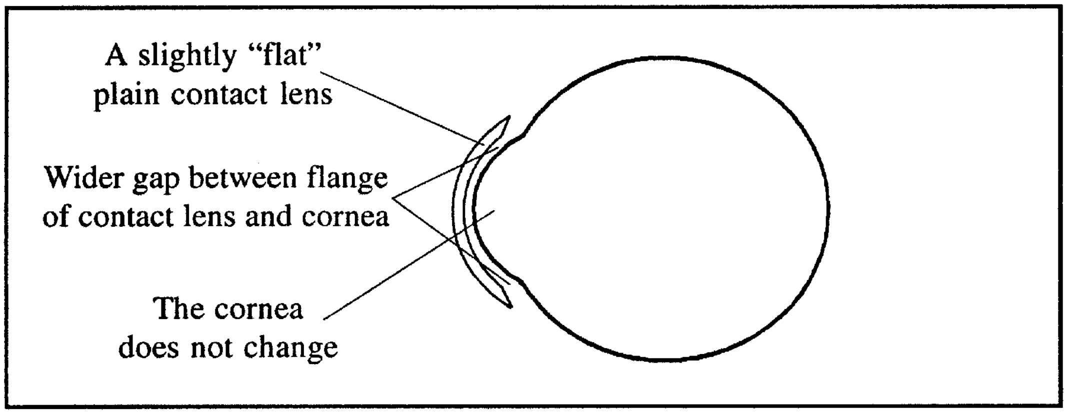

Figure 2: A Slightly Flatter Lens

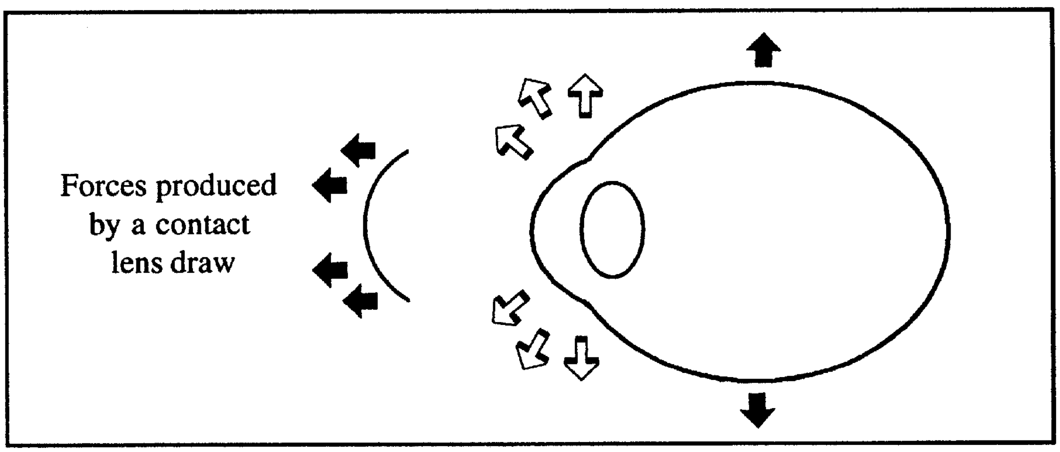

Figure 3: A Contact Lens Draw

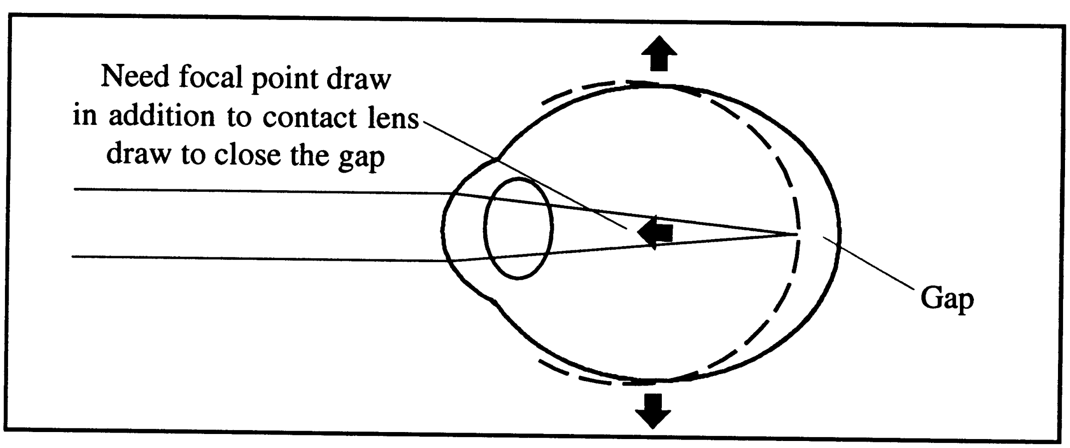

Figure 4: A Focal Point Draw