OULUN AMMATTIKORKEAKOULU

Satu Järvinen

MYOPIA MANAGEMENT WITH MIYOSMART LENSES: CASE STUDY-BASED DEVELOPMENT PROJECT

MYOPIA MANAGEMENT WITH MIYOSMART LENSES: CASE STUDY-BASED DEVELOPMENT PROJECT

Satu Järvinen
Master´s theses
Spring 2023
Master of Healthcare, Clinical Optometry
Oulu University of Applied Sciences

ABSTRACT

Oulu University of Applied Sciences
Master of Healthcare Clinical Optometry

Author(s): Satu Järvinen
Title of the thesis: Myopia Management with Miyosmart Lenses: Case Study-based Development Project
Supervisors: Dr. Robert Andersson and Tuomas Juustila
Term and year: Spring 2023
Pages: 57

Purpose: This study aims to evaluate when it is suitable to offer myopia control as management in progressed myopia. This case study-based development project describes the assessment and management of myopia management on daily work at an optometrist's appointment.

Methods: This clinical case study describes assessing and managing a patient with MiOYSMART lenses at a private optical-owned clinic from 2021-2022. A literature review was prepared as background information for the case study discussion. The literature search was made using Springer, Cochrane, and PubMed in January 2023. One hundred twenty-nine (n=129) texts were retrieved, and ninety-nine (n = 99) articles were deemed eligible for full-text review. Seven (n = 32) studies were included in the literature review. The IRB approval was not needed in this case study. The patient´s parents provided consent for participation.

Results: MiYOSMART lenses can provide good myopia management. The case study patient was diagnosed with high myopia. In the case study, the patient´s visual acuity was 20/20 in both eyes with correction and without finger count (distance of 1 meter). This single case study can verify the myopia degrees in one year, as the literature said. The MiYOSMART patient brochure is a tool for patient guidance and follow-up visits. MiYOSMART lenses provide good results for managing myopia, as the literature said. The literature says, if optometrists have wider education and better knowledge of eye health, they can detect myopic defects better than those without wider education.

Conclusion: Myopia progresses quickly and later causes many eye diseases. Optometrists have a wide knowledge of vision-related problems, and with good management possibilities, optometrists can offer wide and good management of myopia. Wider education of optometrists gives an opportunity for professionals and high-quality examinations for myopia patients.

Keywords: myopia, axial myopia, axial elongation, peripheral refraction, myopia management, MiYOSMART, myopia control

CONTENTS

1 INTRODUCTION

It is well-known fact that progressive myopia can lead to poor vision. Untreated and progressive increasing myopia causes low vision and distance vision impairment worldwide. From the year 2000 to 2050 myopia suggest prominent increases in worldwide. This high prevalence means a lot of effects for treating and inhibiting myopia related ocular diseases, and vision impairment. This affects the everyday life of milliards of people (Holden et al., 2016).

According to Brian Holden et al. (2016) "The envisage incidence of near sightedness by 2050 is 56% in West part of Europe, 54% in Central part of Europe, and 50% in East part of Europe" (Figure 1).

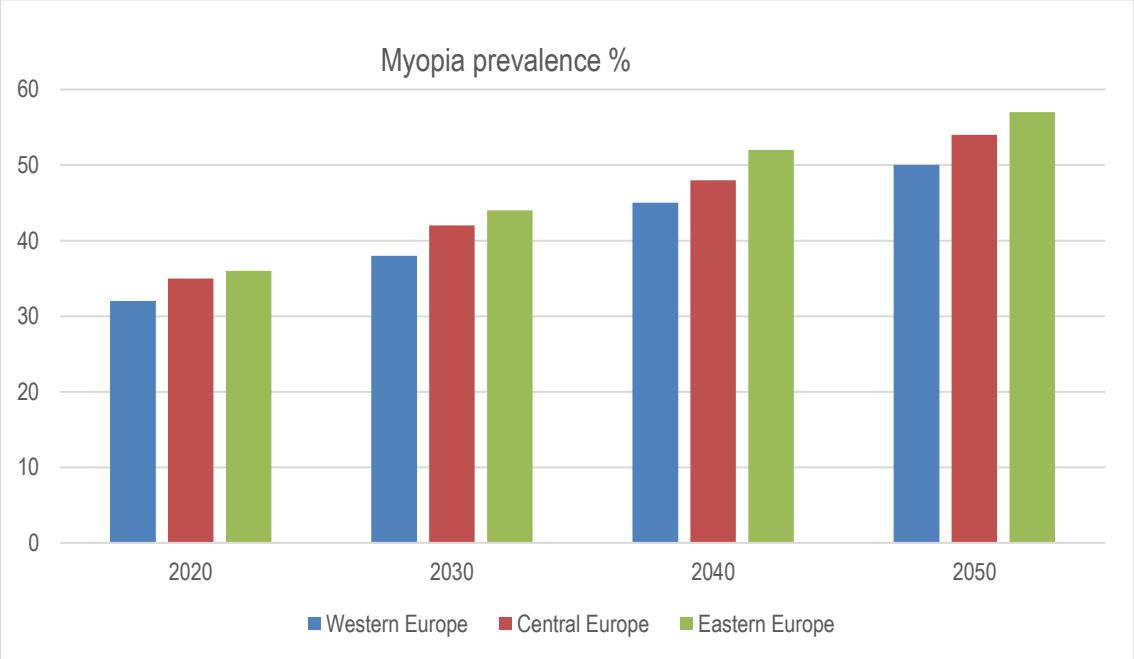


Figure 1. Expected growth in the (%) incidence of myopia in three areas of Europe from years 2020 to 2050 (Holden et al., 2016). Modified figure: Satu Järvinen

The prevalence of myopia has increased rapidly in many Asian countries. Therefore, reproduction and its consequences and effects are well documented. Experiences in preventing myopia's development and myopia's progression in young children and adolescents are extensive. Myopia is also increasing in European countries. Over the past 50 years, it has risen at level of 45-50 percent among young adults aged 25-29 years. Even Europeans have started to realize the meaning of taking care of myopia and it´s management. Growing myopia is a major international health problem and a very important socio-economic problem (Németh et al., 2021a).

Pathological changes in the eye, because of myopia, can cause irretrievable blindness. Slowly progressing optic neuropathy and myopic maculopathy are causing vision impairment and those changes are permanent. Under these circumstances, a plan to reduce myopia prevalence and prevent development to high myopia is warranted. This is the only way to reduce the appearance of pathological myopia (Jonas et al., 2021).

The global growth in myopia and the connection of high myopia with various sight-threatening eye diseases cause the need to study the stimuli causing eye elongation and to search for effective treatments to limit eye elongation. The treatments aim to slow down myopia and reduce the pathological changes in the eye (Wildsoet et al., 2019).

This study shows a way how to examine myopia patient and provide myopia management on daily optometrist appointments. There are different ways to examine early myopia and start myopia management early enough. The study showed also it is worth starting myopia management even if myopia has started developing. It is important to do everything to decrease becoming myopia from the patient’s point of view. It is a relevant health issue and social issue for the patient and the whole society.

2 BACKGROUND

2.1 Myopia Management

According (William J. Benjamin, 2006, p.3) to the definition, myopia is caused because in some reason the eye is starting to get more length and its lens or cornea´s power is unbalanced. Two reasons can affect this, the eye either stretches too long or the eye's refractive power has increased. Thus, myopia can be defined either by the growth of the eyeball or through the amount of its power depending on the etiology, but there are several other classifications.

Years ago, myopia was not thought as a dangerous condition leading to blindness. It was assumed to be just a refractive error with no consequences for eye health. Today, it is considered one of the biggest risk factors for blindness worldwide. In previous years, myopia has been divided only couple of categories depending on the amount of power. This has given the false impression that only people with more than −5.00 D of correction are at risk group of developing a blinding eye disease. Retinal detachment or the development of maculopathy is also a risk with the low degrees of myopia. After an extensive review of the literature, even smaller myopic refractive errors cause morbidity risk compared to the absence of a refractive error (Kang, 2018).

(William J. Benjamin, 2006, p. 6) showed the classification according to early age. This is interesting from a myopia management point of view.

1. Congenital myopia – from birth child is myopic and it will be continued.
2. The myopia of the young – myopia begins about age six and in early teens.
3. Adult myopia – myopia begins at the ages of twenty to forty.
4. Adult myopia - myopia starts later than age forty.

According (Bullimore et al., 2021) myopia has increased significantly in recent years. As known that high myopia is a high risk for increased vision loss. This increased visual impairment is in turn caused by changes in the eye associated with myopia. Myopic maculopathy is more commonly the first cause of deterioration of the quality of vision and eventually its loss. This is because other serious reasons of vision loss, such as macular degeneration (AMD), start at a much later age.

Myopic maculopathy is causing vision loss even more often than diabetic eye disease in both Europe and China. An interesting connection has been found between the possible effects of myopia, glaucoma, and cataracts, myopic maculopathy, and retinal detachment (Bullimore et al., 2021).

It has been established over the years that the progression of myopia can be shared into three different groups:

1. Excessive length growth of the eyeball is axial myopia.
2. The structures, like cornea and lens, that form the image in the eye, transform in design or location; these changes are called refractive changes.
3. Myopia caused by an external factor such as a medication for another illness, a systemic disease or a corneal disease, is called secondary myopia. The resulting increase in near sighted is not a risk for the progress of pathological eye diseases (Ruiz-Pomeda & Villa-Collar, 2020).

As told before myopia can cause blinding difficulties later in life. There can be changes at retina likewise macular degeneration caused by myopia, and retinal tears. Choroidal neovascularization is one of those changes in later years. The diseases mentioned above usually need drugs, surgery, and lifelong medical care. They cause high social costs and lead to vision loss (Ramamurthy et al., 2015).

Even corrected myopia can cause a lot´s of difficulties. Near sighted eye can get cataracts, staphyloma, glaucoma, and retinal detachment. Together, the complications will be a large economic impact on public health. Because of this, many optometrists, ophthalmologists, and researchers have focused on slow down the myopia and find out new treatments for that (Russo et al., 2022a).

(William J. Benjamin, 2006, p.8) Mentioned pseudomyopia and night myopia, those forms don´t belong to myopia management. The spasm of the ciliary muscle causes a pseudomyopia. This can be excluded with cycloplegic refraction. Night myopia is an increased need for minus. The accommodation response is around 0.50 - 1.00 diopters. However, there are some suggestions that changes in chromatic aberration can be combined with this myopic change. The chromatic aberration of the eye results in blue light refracts more than red light.

Various measures are needed to prevent and slow down the development of near sightedness. Measures are needed to inhibit near sighted and its development and to decrease myopia´s improvement. These measures include both teaching patient new lifestyles and medical equipment for eye care. Treating vision with optical devices is easier than influencing the patient's environmental factors. There are several optical methods such as, for example, various eyeglass solutions, contact lens solutions and orthokeratology. A pharmacological alternative can also be used as one method, in which case antimuscarinic eye drops are used locally. There are clear results that different processes retard the growth and improvement of myopia. The efficiency of different procedures is different and depends on the patient (Németh et al., 2021b).

2.1.1 Influence of Lifestyle and Genetic Background on Myopia

As recent epidemiological studies have shown, outdoor activity is a significant environmental factor which can be influenced. Spending time outdoors save young people from nearsighted. The saving mechanism may be involved to the high amount of sunlight outside, and the color of sunlight. There is one option to think the effect of vitamin D regarding growing myopia. A possible protective property has been found in the underlying biological mechanisms. The nicotinic acetylcholine receptors are involved to change the power of refraction error and the mechanism is interesting and should be investigated more. The connection of time which is spent outdoors regarding the development of myopia is important to think. In recent studies, additional information has also been obtained about the influence of other environmental risk factors on changes in myopia. Other studied environmental factors have included, among other things, the share of parental smoking and the genetic frequency of parental myopia and birth order (Ramamurthy et al., 2015).

Parents' myopia has been found to be almost biggest risk factors for near-sightedness. Myopic parents pass on the genetic inheritance to their children and at the same time create a risk factor for their child's myopia. Often, myopic parents are better educated on average, so they pass the myopic lifestyle to their children in addition to their genes (Morgan et al., 2021).

Children whose parents are myopic, spend less time outside and are usually less involved in physical activities. Their interest is more in nearby tasks. If both parents are myopic, their children should spend more time outside. Because it has been found a connection that the growth of near sightedness can slow down by raising daily period outside (Chuang, 2017).

It is assumed that the intensity of light has a big role regarding a growing myopia. It can be stated that the light intensity is significantly higher outside than inside, so the pupil size is smaller outside. By default, the image coming to the retina is more accurate. Secondly, it is known that sunlight increases the amount of dopamine from the retina. A raise in that hormone may reduce the axial length of the eye. A public health measure could be to increase children's outdoor activities, as the apparent protective impact of sunlight and the outdoor time suggests that the development of near sighted would slow down with the help of outdoor activities. Promoting outdoor activities could be encouraged by designing strategies to encourage parents and families to engage their children in various outdoor activities, including sports, and by including more outdoor activities in school curricula (Rose et al., 2008).

2.1.2 The Importance of Sunlight on Myopia Management

The luminance and wavelength of light affect the growth of eye length, and exposure to sunlight slows myopia's progression. The survey results confirm that increasing the time being outdoors is an impressive way to prevent near sighted. Likewise, the wavelength of light can develop into a new effective potential myopia prevention (Zhang & Zhu, 2022).

It has been noticed in the last few years that exposure to blue and violet light could be a way to control myopia. In contrast, red light improves choroidal blood perfusion, and this can be one possibility to control near sightedness in the future. Thus, it can be concluded that the application of light to the management of myopia provides a promising way to develop better public health strategies to prevent myopia and to develop more impressive therapeutic interventions to retard the progression of myopia. Light may be a valuable instrument for managing myopia in the future (Zhang & Zhu, 2022).

2.1.3 Over-Correction or Under-Correction on Myopia Management

Several methods have been sought to prevent the growth of myopia using optical solutions. One of these methods are under correction and overcorrection (Russo et al., 2022a).

There is a need to find out more support in the literature for under- or over-correction to slow progression (Logan & Wolffsohn, 2020).

Many findings due to under-correction are questionable. It seems that under-correction could cause myopia to progress more quickly. Actual evidence of positive results are not found regarding monovision, under-, or over-correction. Because of this, current clinical advice recommends complete correction of myopia. More information is needed to diagnose what amount of myopia can be left uncorrected, which has no effect on the growing myopia, and how it will develop in the future (Logan & Wolffsohn, 2020).

Under-correction or over-correction is not recommended because there is no evidence of their effectiveness for prevent near sightedness (Carlà et al., 2022).

When looking at all the trials that have been done, there is not any proof about refraction which is corrected too little or too much, can reduce the growth of myopia. In the opinion of many pediatricians, it is worth striving to achieve the best possible visual acuity, which can be achieved with full spectacle or contact lens correction (Russo et al., 2022a).

2.1.4 Bifocal Lenses on Myopia Management

Based on research, it can be said that bifocal glasses generally have a little effect on controlling myopia. Prism bifocal lenses may be warranted to correct myopia in patients with low lags of accommodation. Lenses are bifocal glasses with 3 bas in prism in addition of +1.50 D. These seem to work best for myopic children with little adjustment lag. These glasses can be used to dampen convergence and adaptation efforts when working close (Chuang, 2017).

The results of some studies can be explained using prisms. Prisms can reduce the need for the eyes to turn inward and the need to correct exophoria caused by the lens. There is no incontrovertible evidence of the effect of using bifocal glasses for reducing growing myopia (Russo et al., 2022a).

With glasses that have corrected both the far and near side, the user can see well at all distances. In this case, we talk about bifocal and progressive lenses. When the patient can see well at different

distances, it reduces the adaptive strain when working up close. There are many studies where these lenses have improved symptoms and decrease the growth of near sightedness compared to single vision lenses. A greater effect of these lenses was obtained in children with higher myopia, more than three diopters, in addition to accommodation delay or the need for near esophoria correction. Compared to single-power lens corrections, progressive lenses, or bifocal lenses didn´t have a big role in decreasing of near sightedness (Carlà et al., 2022).

2.1.5 MiSight Contact Lenses on Myopia Management

MiSight is the one-day replacement of a hydrophilic contact lens composed of Omafilcon A material. The structure of the lens is called a dual-focus contact lens. FDA (Food and Drug Administration) has accepted MiSight for correcting of near sightedness and slowing its growth in children and young teenagers. MiSight's Activ Control™ technology consists of a ring design. There are alternating rings surrounding the centre and with these concentric rings is made two dioptres of coincident myopic retinal defocus. Two focal planes are produced for correct vision error. MiSight lens simultaneously provide an optical stimulus to prevent the development of near sightedness. MiSight trials have auspicious results in decreasing near sightedness and detecting axial length comparing single vision groups. These results were got from a two-year randomized clinical trial (Russo et al., 2022a).

MiSight soft contact lenses have a 3.36 mm area on the middle of the lens. Around that area there are concentric zones. The contact lens slows down the development of myopia, and it is based on the defocus phenomenon caused by two diopters. There are two correction zones. Patient needs a refractive correction power to see clearly for distance, and at the same time, lens provides for peripheral areas of the retina defocused image. With this defocus image lens restrains growth of eyeball and treat myopia. The patient feels that distance vision accuracy is good due to the sufficiently large size and location of the area for distance zone (Ruiz-Pomeda & Villa-Collar, 2020).

The FDA's approval of MiSight was based on efficacy data and real-world evidence. The functionality of the MiSight lens has been studied in different parts of the world, for example in Portugal, Great Britain, Canada, and Singapore. A randomized, controlled clinical trial lasting three years was completed in these countries. The safety of wearing contact lenses is one of the most important things and using contact lenses should be functional regarding controlling myopia. The

trial investigated those two things. One clinical trial was also made in Spain over a period of two years, in which the function and safety of MiSight were investigated. This survey was also a randomized and controlled clinical trial. The reason of these studies was to measure the potency of MiSight lenses in reduce the development of near-sighted in youngsters and adolescents. The results of both studies confirm that refractive error slowed down and the growth of the eyeball stopped. (Ruiz-Pomeda & Villa-Collar, 2020).

The results obtained from the three-year MiSight study are promising in the management of near sighted. The survey was a randomized and controlled, multicentred survey, but not blinded. As a result of the survey, the eye growth was reduced in about half of the subjects, and the power of the refractive error was reduced by almost 60% in MiSight users when compared to a single-power contact lens user (Dhiman et al., 2022).

During two and three years of follow-up, the MiSight contact lens has been found to be a functional contact lens when talking about the treatment of myopia. The lens has been found to reduce both the increase in power of refraction and the eye's length growth (Carlà et al., 2022).

The findings of a six-year survey of the MiSight lens showed that the use of the lens slows down the growth of myopia. A six-year study gave the results of the increasing effect of the treatment in preventing myopia. In the study, it was noticed that the longer the treatment period is given to the patient, the more effects are positive even in the treatment period started at an older age.
This six-year study is one of the longest studies investigating about wearing soft contact lenses in children to reduce near sightedness. The study paid particular attention to ease of use and safety. During the study, the microscopy findings were at a low level and from this it can be assumed that soft contact lenses do not affect the physiology of the eye. The participants in the study wore the lenses all day, i.e., more than 8 hours, and the lack of clinical changes is important information. Based on research, it is safe to treat myopia with disposable contact lenses.
In addition, the outcome of the survey confirms the assumption that the effectiveness of the treatment is greater if the growth of the eyes was faster before the treatment. Based on the research results, it can be estimated that the treatment is suitable for rapidly progressing myopia, which has a higher risk of future eye diseases (Chamberlain et al., 2022).

2.1.6 Multifocal Contact Lenses on Myopia Management

Contact lenses designed to correct presbyopia have also been developed to curb myopia by reducing the blurring of hyperopia. The behaviour of the eyes affects how these multizone contact lenses manage to eliminate hyperopic blur. The amount of accommodation seems to affect the progression of myopia. If the need for accommodation can be reduced and the eye muscles relax, the blurriness associated with vision can also be reduced (Zhu et al., 2019).

Multi-power contact lenses have different structures. Lens structures include a concentric ring or bifocal lens structure. The lens structure can also be a progressive, peripheral area model. However, both structures affect the imaging of both middle and outer areas on the retina. The structure of these rings allows the lens to produce good visual acuity, where the retina becomes a myopic blur at the same time viewing from a distance and close. The lens has 14 treatment areas, which provide variable distance correction and myopic blurring of the retina.
In progressive lens design, the curvature changes gradually, so that correction of the distance in the central area can be achieved. In addition, more plus intensity is needed for the edge areas in order to achieve the necessary blur. The lens is supposed to produce sharp central vision and meantime it cause a myopic blur in the peripheral areas (Kang, 2018).

With the daily use of more than eight hours of soft multifocal contact lenses, results are achieved. Their use potentially reduces growth of myopia proximately 66% and restrains growth of axial length proximately little bit over 60% among near sighted schoolchildren. The duration of the study was one and a half years. After the results, it can be deduced that multi-power contact lenses provide more powerful treatment in the development of near sighted than single-power contact lenses (Raffa et al., 2021).

Zhu et al. (2019) showed in their review multifocal contact lenses can stop the improvement of near sighted. This can be thought of as one method for controlling myopia with mediocre efficiency. The myopia of school-age children has increased, and further research and development are needed in the design of multi-power contact lenses for younger patients.

Later (Lawrenson et al., 2023) an extensive comparative study was conducted comparing different forms of myopia treatment, mostly pharmacological and optical treatments with an inactive reference preparation. One-year results showed that these measures can slow refractive change

and reduce axial elongation, but in longer-term, wider surveys are needed. There is a need for such surveys which compare myopia management measures alone or in combination, as well as better methods for monitoring and reporting adverse effects.

At first multifocal contact lenses were designed for presbyopia people. It has been found that mid-distance multi-power contact lenses increase the power of the edge, which can eliminate hyperopic unfocused image. At the same time the distance vision will stay quite clear.
Surveys, which were made randomized and controlled, compare the determines the progression of near sightedness between multifocal contact lens users and single vision contact lens users. There was a conclusion that myopia degreased about 38% among multifocal contact lens users. Myopia decreased significantly and axial elongation slowed. As fitting instructions for these lenses when treating myopia, it should be instructed to use the maximum plus – the maximum principle of visual acuity. In this way, the excessive minus of the patients and thus the weakening of the control effect of myopia is avoided. These lenses are instructed to be worn for at least 5 to 8 hours, as effectiveness is observed to decrease with decreasing wearing time (Dhiman et al., 2022).

2.1.7 Orthokeratology (Ortho-K) on Myopia Management

Orthokeratology (Ortho-K) reduces, modifies, and even temporarily removes the refractive error. This goal is achieved with certain types of contact lenses. Wearing a hard contact lens at night time causes a non-permanent change in the shape of the cornea. These results give the possibility of being without a corrective device during the day. As early as the 1950s, Wesley and Jessen observed occasional clouding of the eyes after the removal of contact lenses in those users which were using hard contact lenses. It was later realized that the regeneration of the corneal epithelium caused by hard lenses would allow the use of lenses for therapeutic purposes. The information from these surveys established that Ortho-K lenses change the cornea. The central part flattened, and central-peripheral areas became steeper. All these changes happened in epithelial thickness (Russo et al., 2022b).

Overnight orthokeratology lenses have been approved in several countries for the short term mitigation of near sightedness. Some years ago, an ortho-k contact lens received official status as a means of controlling myopia in the European region.

Orthokeratology lenses on the market today have a remarkable history of correcting corneal curvature. The material of Ortho-K lenses has improved over the years and their oxygen permeability is significantly better today than before. Lenses are used today to restrain the axial elongation and at the same time to slow down the increase in myopia (Bullimore & Johnson, 2020).

Separate studies have also documented promising results of using Ortho-K lenses in elevated near sighted. Lenses have worked fine on both the spherical and astigmatic side. In these cases, we are talking about an amount equivalent to more than -8 diopters, and with ortho-k lens treatment, the young person lives the life on day time without thinking of glasses or contact lenses. This form of treatment is especially suitable for children and young people who play sports.
To achieve the best possible result of the lenses' caring effect, the recommended wearing time of the lenses is at least 8 hours. The benefit is found to be greatest during the first two years of treatment and fades thereafter. Among users of Ortho-k lenses, a high rate of discontinuation was noticed. In the studies, it was noticed that, especially in young people under eight years, the progression of myopia could be restrained. However, it must be remembered that when we talk about contact lenses as a form of treatment, the risk of eye infections must be taken into account (Dhiman et al., 2022).

Several clinical surveys have confirmed that Ortho-K management is efficient in controlling myopia. The lenses affect the axial elongation, and the reduction of the achieved elongation. According to research, the total treatment percentage is significant.
The most important assumption regarding the treatment of near sightedness is that Ortho-K contact lenses cause a different power in the peripheral areas. Another important assumption as a therapeutic effect of the lenses is the acceleration of the ability to adapt. This may be the result from increased in choroidal membrane thickness (Németh et al., 2021c).

There are different theories about how Ortho-K lenses affect the treatment of myopia. At some point, it was noticed that Ortho-K lenses caused myopic accuracy in peripheral areas. In this case, the defocus theory was created, and this theory could also be the basis of function of multifocal contact lenses. However, it is important to search for answers to the causal connection of whether central myopia develops first or peripheral defocus. Currently, it is believed that defocus can be a consequence of the start and progression of near sightedness. The latest theory is connected to binocular vision. Improved adaptive vergence function after Ortho-K may be relevant in the

management of myopia. A reduction in the accommodative delay and thus an improvement in retinal hyperopic acuity and adaptation possibilities have been noticed (Kang, 2018).

The use of contact lenses always involves risks, and it is important to be aware of possible complications. In the study, the most common problem of hard contact lens wearers was corneal staining. Epithelial iron deposition and visible fibrillary lines were also reported. Some biomechanical changes were observed in the cornea, but these were reported to be short-term changes. The research results concluded that the effects on the corneal endothelium did not remain permanent. No matter what kind of contact lenses it is, they must be used carefully. The literature has highlighted the risk of eye infections in connection with overnight contact lenses. In particular, the risk of eye infection increases with contact lenses that shape the cornea overnight. It can be emphasized that contact lenses require careful use for the sake of eye health, because insufficient cleaning or use against the instructions increases the risk of infection (Carlà et al., 2022).

2.1.8 Pharmacological Myopia Management

Atropine

Recently, it has been brought up the possibility to use pharmacological management like atropine in controlling myopia. There are many examples in the literature of the safe and easy use of atropine. This is why the use of atropine has been accepted in many countries as one form of treatment to control myopia (Dhiman et al., 2022).

Atropine belongs to the non-selective muscarinic receptor antagonist group. There are studies that atropine had an accelerating effect on biosynthesis in scleral fibroblast cells. It works exactly to extracellular matrix biosynthesis. This results in a thickening of the dura mater tissue and a decrease in elasticity and reduces its tendency to stretch. Studies have shown that atropine not only affects cell synthesis in the sclera but can also reduce biosynthesis in other tissues. There is at least evidence that it affects the fibroblasts of the choroid, and this results in an improvement in blood circulation in the sclera. This enhancement of cell synthesis appears to moderate progression of myopia (Németh et al., 2021c).

Atropine's ability to suppress myopia has been studied, and it is not possible to say with absolute certainty what the effect is. There are two kinds of assessment of what causes what. The decrease in myopia can be due to either an adaptation effect or a biochemical effect. If we forget the accommodative point of view and look at the activity at the cellular level of the retina, we know that atropine acts on muscarinic receptors. This effect causes biochemical changes that slow down the growth of the sclera and presumably this has a restraining effect on the axial elongation (Dhiman et al., 2022).

The efficacy of this management has been studied for a long time and in the European region it is considered an effective form of treatment when talking about the management of myopia. Atropines use is safe and effective regardless of age, sex, or race. The treatment also has side effects that must be considered. Since the drug affects the ciliary and sphincter muscles of the iris, it leads to mydriasis. For this reason, the patient may experience reduced adaptation to the near area and a greater sensation of glare. In clinical studies, however, it was found that the drug did not cause any serious side effects, and no systemic side effects were noticed (Németh et al., 2021c).

The mild atropine dosage has been established in various studies to be one of effective treatment to curb the growth of near sightedness in terms of refractive error. For refractive error, the treatment has been successful, but it has caused side effects such as photosensitivity, glare, and loss of accommodation (Carlà et al., 2022).

Other agents

There are also other antimuscarinic drugs whose efficacy has been studied. One of the substances studied is pirenzepine, and its use has had good results. It is a selective M1/M4 receptor antagonist and it doesn´t have any significant harmful aftereffects. On the other hand, the effectiveness of the drug remained small, even though the dosage was twice a day, so the studies related to this drug have been stopped at this point. Tropicamide and scopolamine are classified as anticholinergic agents, but the side effects caused by them. Scant follow-up studies have not supported their use in the treatment of myopia. In addition, 7-Methylxanthine adenosine antagonist has been studied to some extent. The development of near sighted has been found to retard with this drug. The slowing of progression is due to the balancing of collagen fibres on the posterior membrane. In Europe, at least Denmark has accepted this medicine in its own treatment program (Dhiman et al., 2022).

Intraocular pressure (IOP) lowering eyedrops like Timolol or Latanoprost has been studied in slowing down myopia. There is still no clear evidence of the effect of eye pressure-lowering drops on myopia at current research (Németh et al., 2021c).

2.1.9 Combination of Optical and Pharmacological Treatment

Over the years, various combination treatments have also been studied as a way to control the growth of myopia. Combined treatments aim to combine optics and pharmacology. The combination treatments of Ortho-K contact lenses and atropine eye drops probably have the most research results at the moment. The idea that one method of treatment works for everyone in the treatment of myopia is probably not the best and most effective way to treat myopia. Every patient needs a treatment plan that takes each patient's needs into account individually (Kang,2018).

2.1.10 Surgical Strategies for Myopia Management

Treatment of myopia with surgical procedures is quite rare. One treatment that has been studied is strengthening the sclera by injection. The common treatment for keratoconus is collagen cross-links, so the treatment is abbreviated CCL. This treatment results in a strengthened cornea. The treatment has been tried on laboratory animals with the aim of stabilizing the sclera and thus preventing the progression of near sightedness, but the results have not been very promising due to side effects (Németh et al., 2021c).

Several different laser correction options have been studied over the years as part of myopia treatment options. Among these, photorefractive keratectomy, PRK, should be mentioned. Newer surgical methods are LASEK, i.e. laser-assisted subepithelial keratectomy, and LASIK (corneal flap surgery). These managements have not really helped to treat myopia, but they can otherwise reduce myopia and anisometropia.

When it comes to children, the biggest problems in the studies have been the effects of anesthesia on the patients. It is also not known what effect the growth of the eye has on the achieved surgical results in the longer term. Talking about the children, the thought arises of how the change in power

of eye affects to the results later. In addition, children's sensitivity to physical injuries and the sufficient endurance of the eye in these situations must be considered. It is difficult to obtain extensive research results, but in any case, more results are needed from surgical procedures regarding the safety of the procedure in the longer term (Russo et al., 2022b)

The surgical procedure permanently changes the structure of the tissue, so these treatments cannot be recommended as the first option for treating myopia. The research results are quite limited on the subject, which in turn supports the idea of avoiding treatments in young people (Németh et al., 2021c).

2.1.11 Defocus Incorporated Multiple Segment (DIMS) MiOYSMART Spectacle Lens

MiOYSMART lenses are manufactured in Hoya. Lenses are made of polycarbonate material and the lens design is unique. The lens design comprises a 9.3 mm in diameter clear area on center of the lens. This area is for distance power and around this clear round area there are several segments with corresponding positive power. It looks like a honeycomb structure and the size of this whole structure is 33 mm. Inside of this structure there are lots of little segments and the diameter of each section is exactly 1.03 mm. The power of these segments is +3.5 diopters in each segment (Figure 2) (Li et al., 2020).

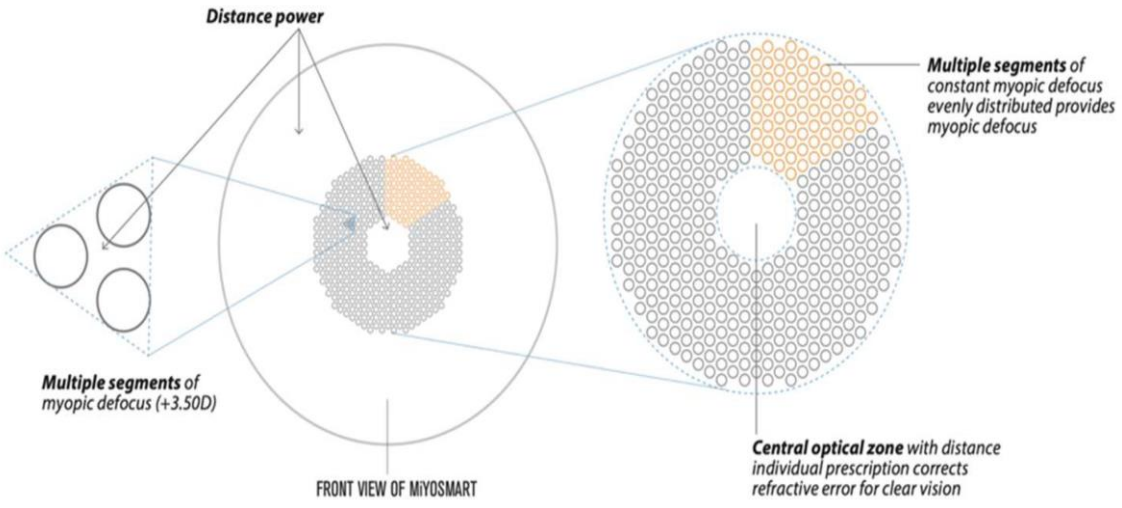


Figure 2. The design of the Defocus Incorporated Multiple Segments (DIMS) MiYOSMART spectacle lens. HOYA Vision Care Center

We know that when we cause the myopic defocus phenomenon with plus lenses in the imaging of the image at the level of the retina (focusing in front of the retina in the vitreous body) (Figure 3,) prevents the growth of eye length, while the hyperopic defocus caused by minus lenses (focusing behind the retina), promotes eye length growth. Correction with conventional eyeglass lenses causes the myopic eye to "focus" on distant objects, the so-called image cortex, moving centrally to the macula, but in most of the retina, in the perifoveal and peripheral parts of the retina, it moves and located behind the retina. This creates hyperopic defocus over a large area, which can stimulate eye length growth. Studies have found that myopic defocusing caused by design on the retina's peripheral areas slows the growth of eye length. This has also been found to work in animal experiments myopia (Kaymak et al., 2021).

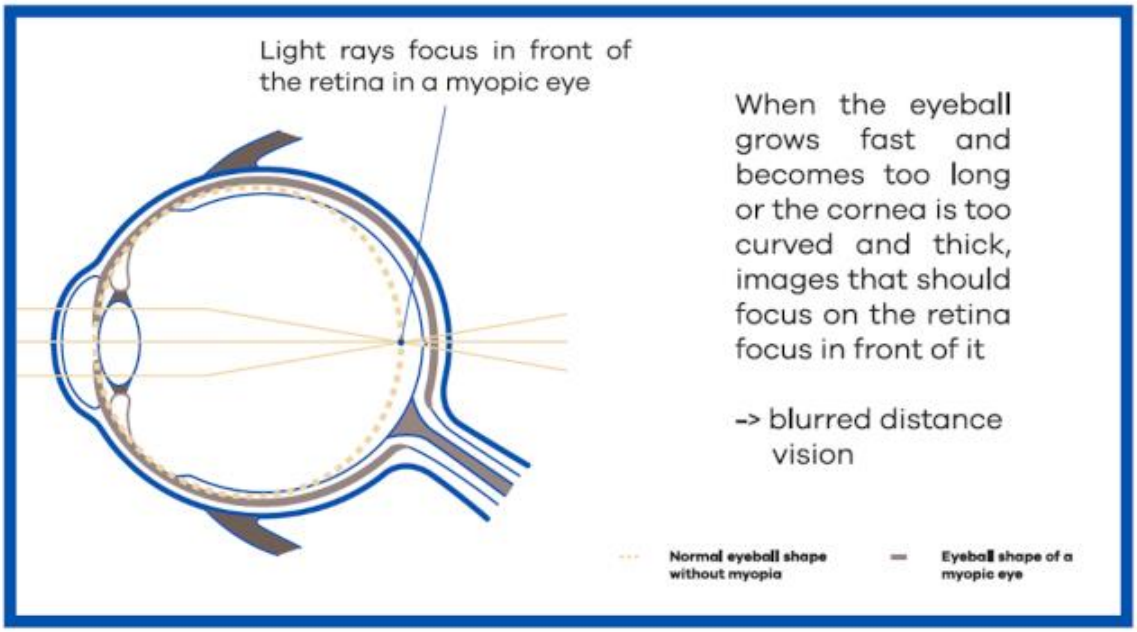


Figure 3. Light rays focus on myopic eye. HOYA Vision Care Center

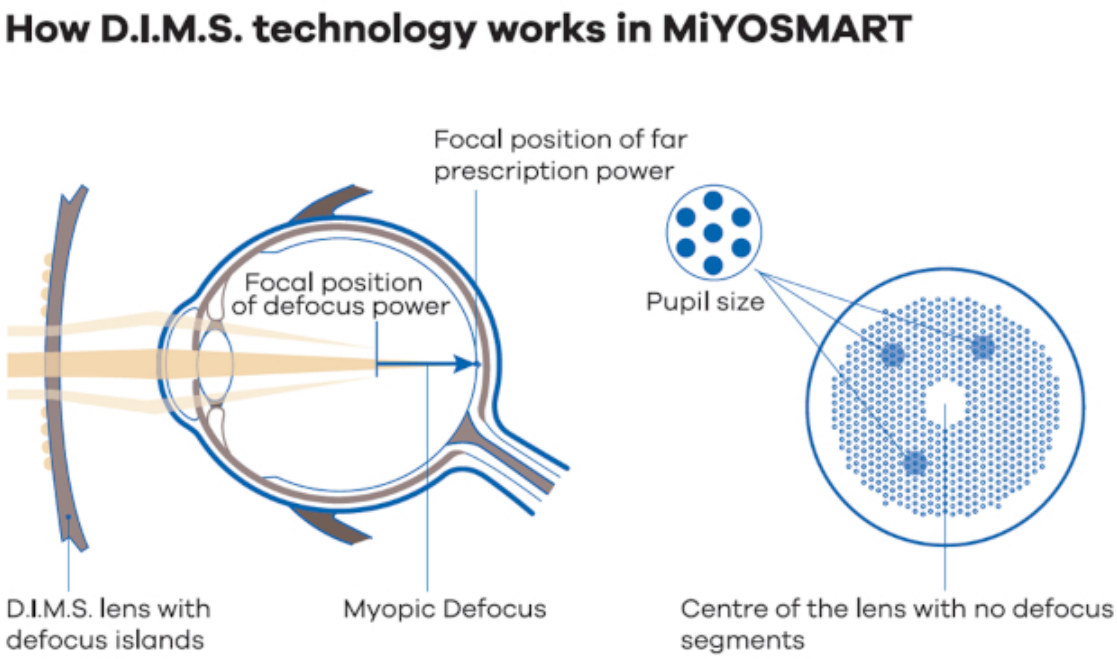


Figure 4. D.I.M.S technology in MiOYSMART lenses HOYA Vision Care Center

Studies have shown that the long-term use of DIMS MiOYSMART lenses significantly prevent the improvement of near sighted and the axial elongation of the eye in near sighted schoolchildren and students compared to using single-power spectacle lenses. With DIMS lenses they were achieved a good vision even there are those treatment areas in the lens. The studies conducted on the use of lenses, it has been found that it is easy to use and get used to. DIMS lenses enable an effective form of treatment to control myopia. If we compare pharmacological alternatives or hard contact lenses, it can be stated that DIMS lenses are the least invasive form of treatment for myopia (Banerjee Srabani & Horton Jennifer, 2021). (Figure 4) Is shown how DIMS technology is working in MiOYSMART lenses.

Figure 5. The image of real lens, HOYA Vision Care Center

The light goes through the lens, we can see the honeycomb structure (Figure 5).

Red arrow shows what is going to happen if it is made a hyperopic defocus to peripheral area. It means the axial length will grow as time passes. The best situation is if the eye will be emmetropic as black colour shows the place of retina image. Green arrow shows what is going to happen if it is made a myopic defocus. This situation can be reached with DIMS lenses or progressive lenses, contact lenses, Ortho-K lenses, or laser refractive surgery (Figure 6).

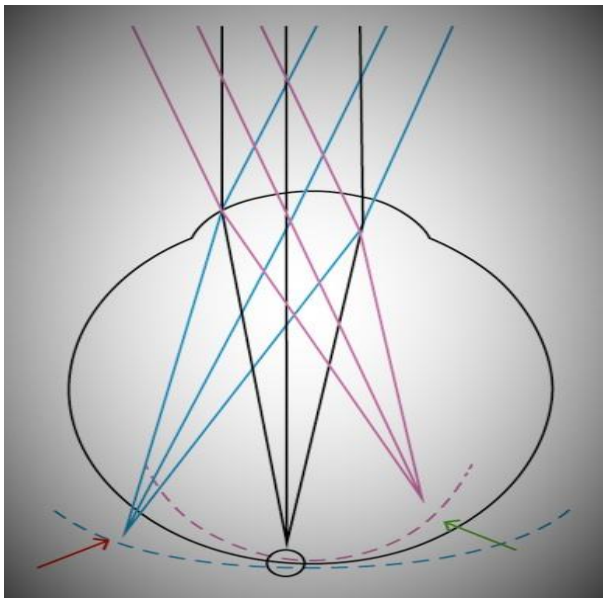


Figure 6. The picture of different myopia management´s effects on retina.

Figure: Satu Järvinen

3 THE PURPOSE, OBJECTIVES, AND TASKS OF THE RESEARCH DEVELOPMENT WORK AND THE DIFFERENT STAGESTABLE OF CONTENTS

3.1 Purpose of the Study Statement

This case study aims to evaluate when it is suitable to offer myopia control as management in progressed myopia.

3.2 Statement of the Research Question

Is it suitable to offer myopia control as management in progressed myopia?

3.3 Summary Description of the Experimental Design

This case study aims to evaluate when it is suitable to offer myopia control as management in progressed myopia. The study describes the assessment and management of myopia management on daily work at an optometrist's appointment. The data of the study was collected anonymously by a single researcher at the private optical owned clinic. This was a single case study and because of that, a separate IBR approval was not needed. The patient´s parents provided consent for participation. The research method was qualitative.

3.4 Study Objectives

The first goal of the study was to conduct an extensive literature review on how optometrists can treat growing myopia and slow down it´s progression.
The second study objective was to present a single case study example for myopia management patient to describe optometrists' role in myopia management and it´s follow-up services at optometrist's clinic in Finland.

This individual case study also explained how an optometrist can perform the necessary eye examination and health examination for a myopic patient. Eye and health examinations included eye history evaluation, general, and medical examination. This study also describes the optometrist's ability to detect and recognize the need for myopia treatment and its effect on the patient. The study reveals the patient's history, initial situation, follow-up visits and their implementation, as well as conclusions about the effectiveness and continuity of the treatment.

3.5 Methodology

3.5.1 Literature Search and Appraisal

The purpose of the extensive literature search was to become aware of present proof and prospective knowledge holes to current studies. Studies were picked up based on original PubMed, Springer, and Cochrane searches. A preliminary literature search of systematic reviews (with meta-analysis), clinical guidelines, and selected references that had not been peer-reviewed in systematic reviews and were completed on 17.1.2023 using the topics: myopia treatment and myopia, myopia control, axial growth, myopia* and optometrist. Searches were made in English and German without date restrictions.

The initial literature search included only systematic reviews with meta-analysis.
Inclusion criteria were myopia, myopia treatment, axial elongation.
Exclusion criteria: were non-myopia or non-myopia treatment. Non-English or non-German literature was outside.
Literature in English and German was selected, and clinical guidelines were accepted. The so-called grey literature was selected after further searching and careful content evaluation.

3.5.2 Methods of Myopia Management

Myopia Management
Outdoor lifestyle and light
Over- or under correction
Bifocal lenses
MiSight contact lenses
Multifocal contact lenses
Orthokeratology
Pharmacological treatment
Combination treatment
Surgical strategies
Defocus incorporated multiple segment lenses, MiOYSMART

Table 1. Myopia management methods. Table: Satu Järvinen

The literature search was conducted using PubMed, Cochrane, and Springer in January 2023. One hundred twenty-nine (n =129) texts were retrieved, and ninety-nine (n = 99) articles were deemed eligible for full-text review. Seven (n = 32) studies were included in the literature review (Figure 7).

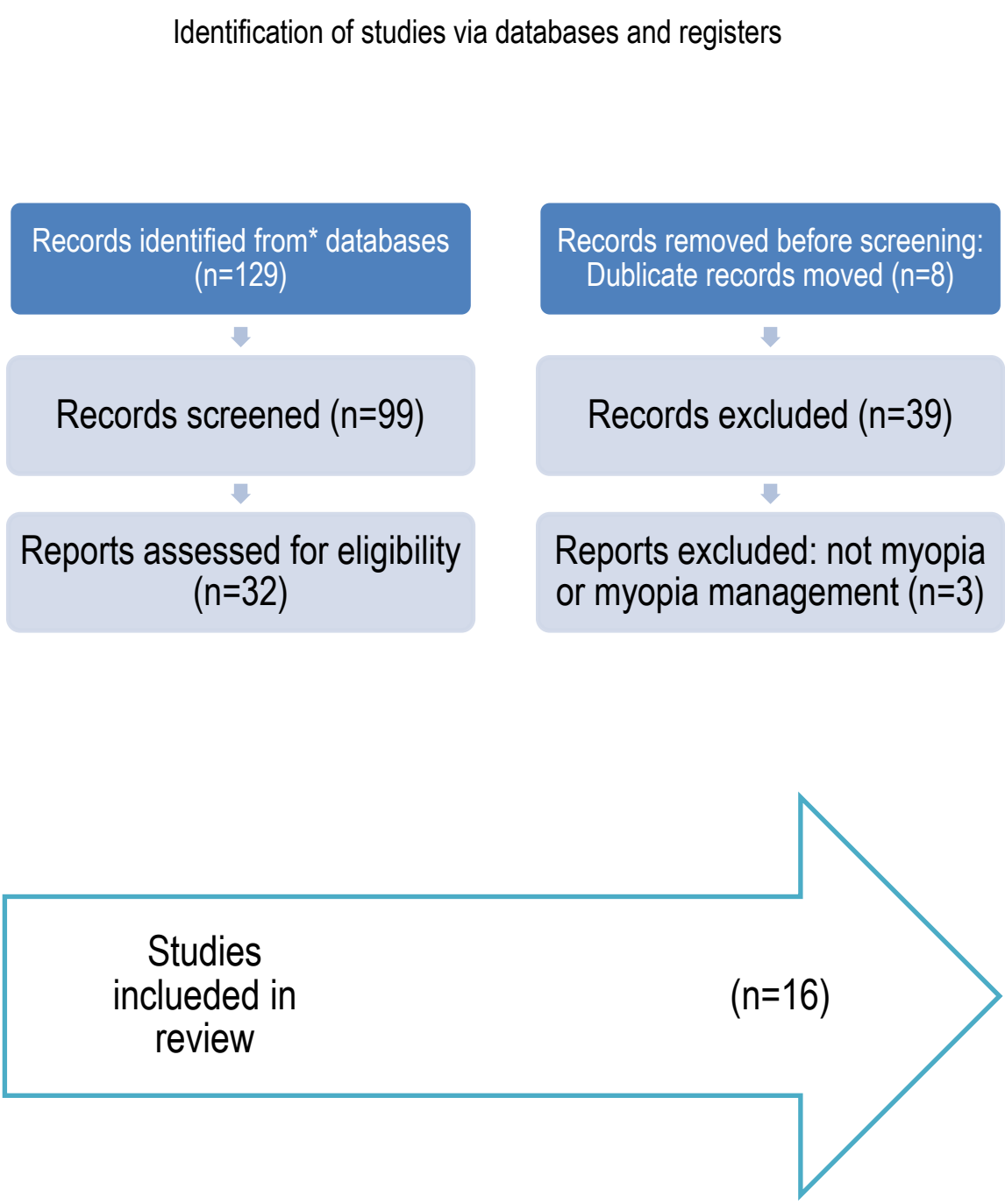


Figure 7. Identification of studies via databases and registers. Figure: Satu Järvinen

3.5.3 Setting

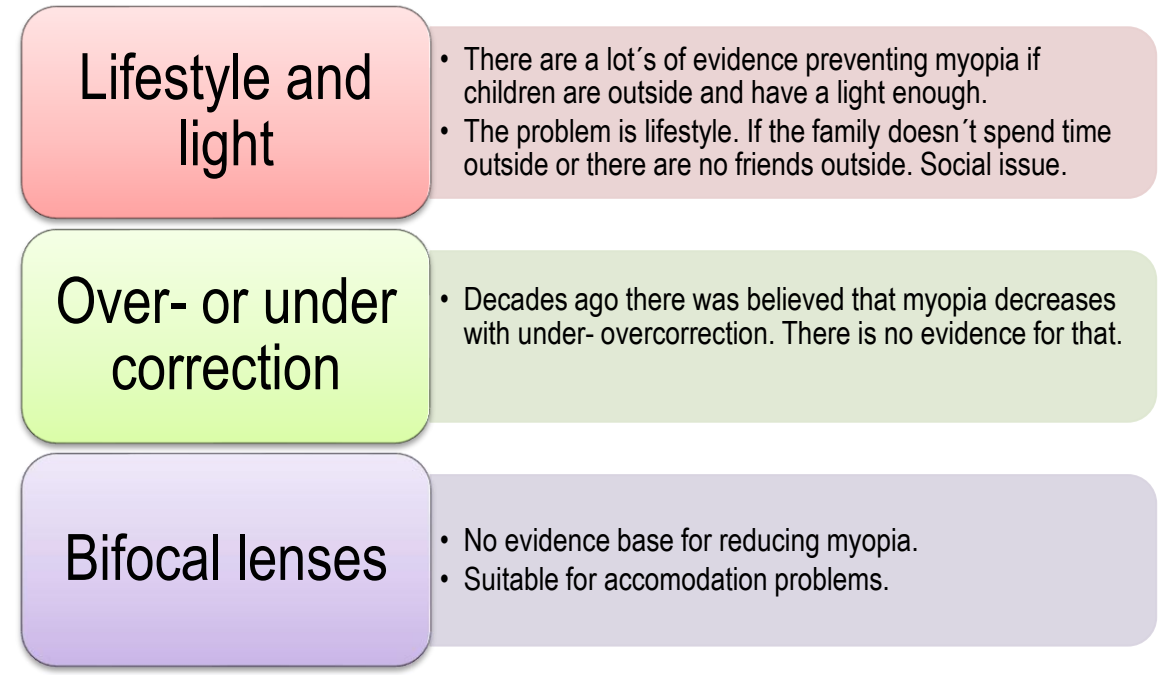
This clinical case study describes the assessment and management of a 10-year-old Caucasian female with MiOYSMART lenses at an optical-owned practice from 2021-2022. The measurements of axial length of the eye were made with Topcon´s MYAH devise. A literature review was prepared as background information for the discussion of the case study. The literature search was conducted using PubMed, Cochrane, and Springer in January 2023. One hundred twenty-nine (n =129) texts were retrieved, and ninety-nine (n = 99) articles were deemed eligible for full-text review. Seven (n = 32) studies were included in the literature review. The patient´s parents provided consent for participation. The IRB approval was not needed in this case study.

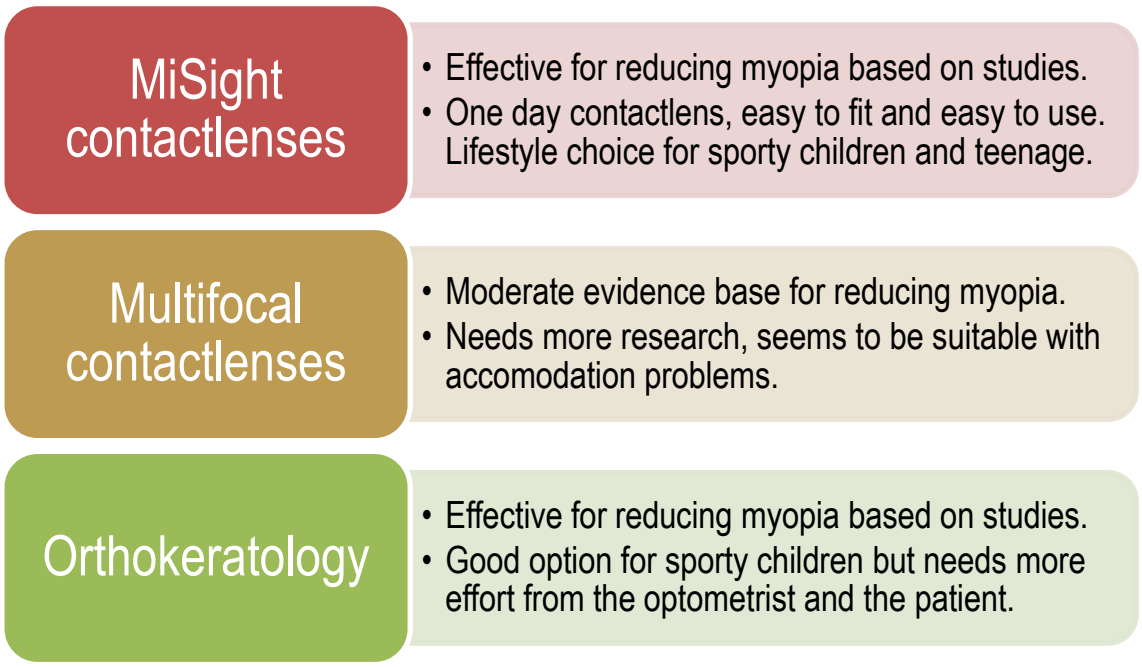
The first examination was made in August 2021, second follow-up visit in January 2022 and the last one in July 2022. The assessment was made using Topcon´s Myah device. The management was given with MiYOSMART lenses.

4 IMPLEMENTATION OF THE RESEARCH DEVELOPMENT WORK

4.1 Study Objective 1

4.1.1 Results





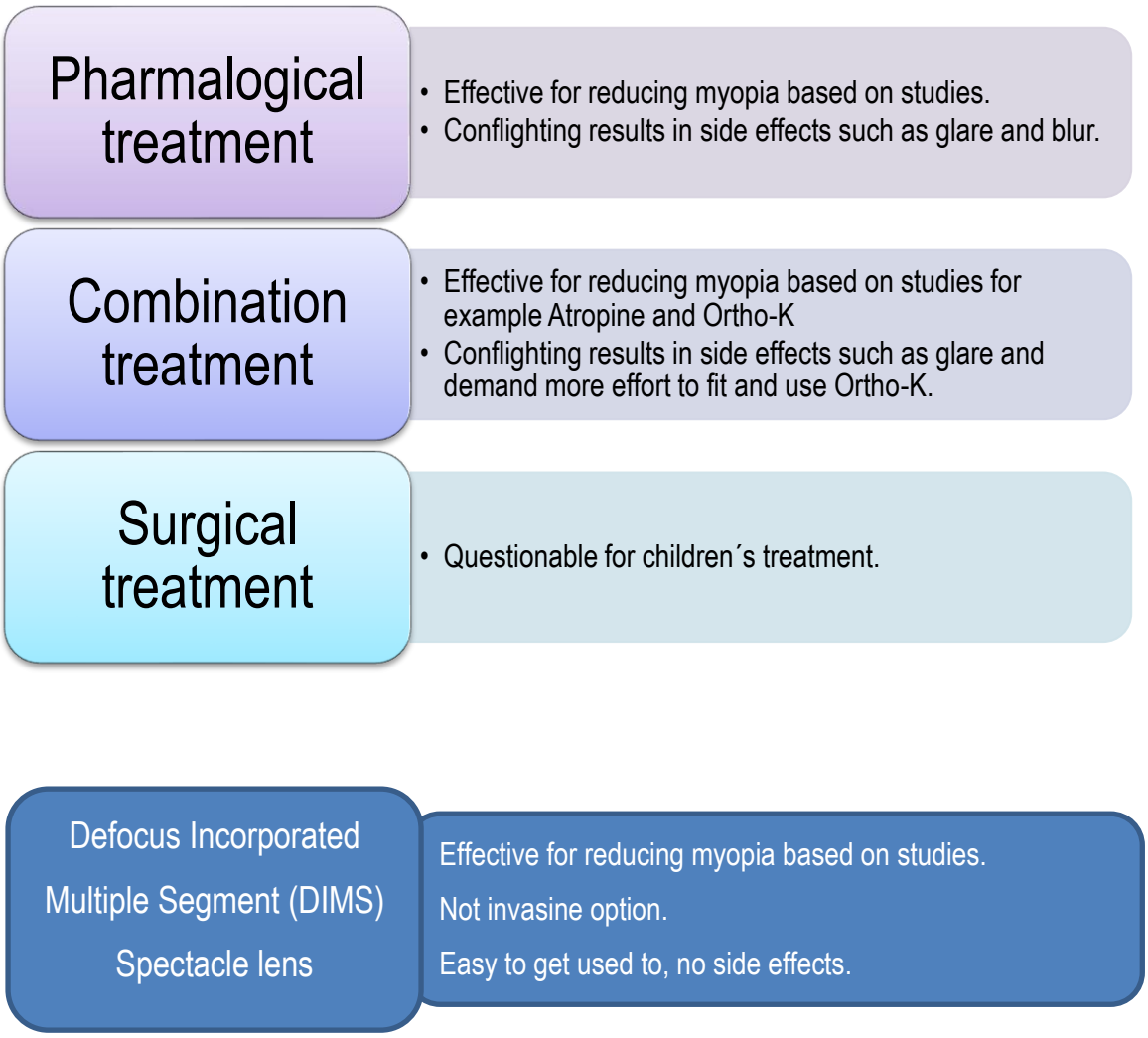


Figure 8. Based on literature different myopia management options are giving a different result.

Figure: Satu Järvinen

4.2 Study Objective 2

4.2.1 Case Study / Clinical Case Report

Ocular history before myopia management.

Ocular and family history of the patient is very familiar from many studies regarding developing myopia. This Caucasian female (later patient) got her first eyeglasses at age eight. The first meeting was held with ophthalmologist, and that appointment was in February 2018. The reason for this first appointment was problems with seeing at school and headaches on afternoons. The patient was very interested of reading and drawing. Her mother told to ophthalmologist that the patient was reading all the time and she didn´t like to be out playing with other kids. Also, both of her parents have spectacles around -5,0 diopters. They got their first glasses at teenage.

At this first visit, visual acuity without correction was od 20/40 and os 20/50 with correction 20/20 in both eyes. The first visit was at ophthalmologist and there wasn´t any notes about cycloplegic refraction separately.

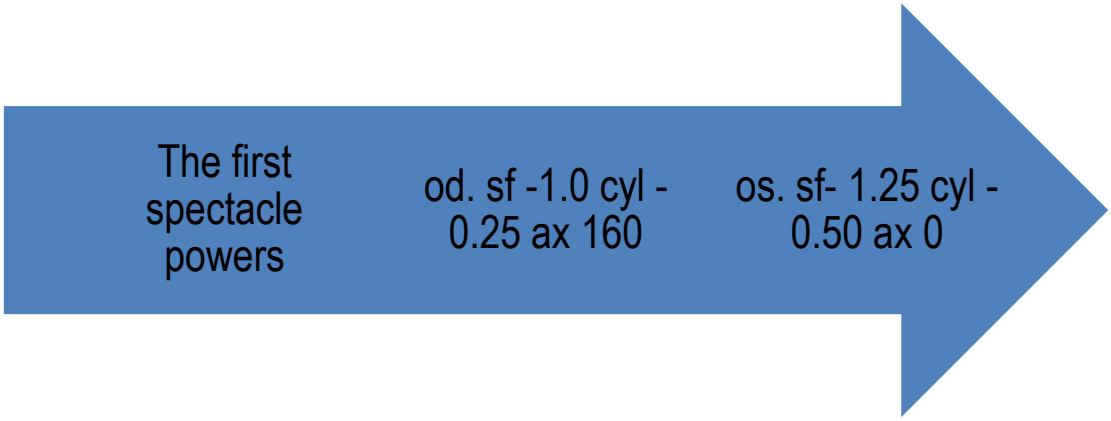


Figure 9. The first spectacle power in February 2018

The patient got her first spectacles (Figure 9), and she was happy. Her parents were told to come back to follow-up appointment in six months.

Second visit was in the end of November 2018. This was an optometrist appointment. Patient said that she has the same kind problems now as before getting glasses. She was sitting a front of class at school but still has problems with seeing to blackboard and having headaches on afternoons. Patient didn´t have any medications and parents told she was sleeping well and enough (about 8-9 hours). Healthy young girl.

I.O.P measured with iCare devise
od. 16
os. 15

Cycloplegic refraction was used Tropicamid 5 mg/ml 1 gtt in both eyes.
od. sf-2.0 cyl -0.25 ax 160
os. sf -2.0 cyl -0.50 ax 10

No problems with binocular vision, with accommodation or with colour vision.

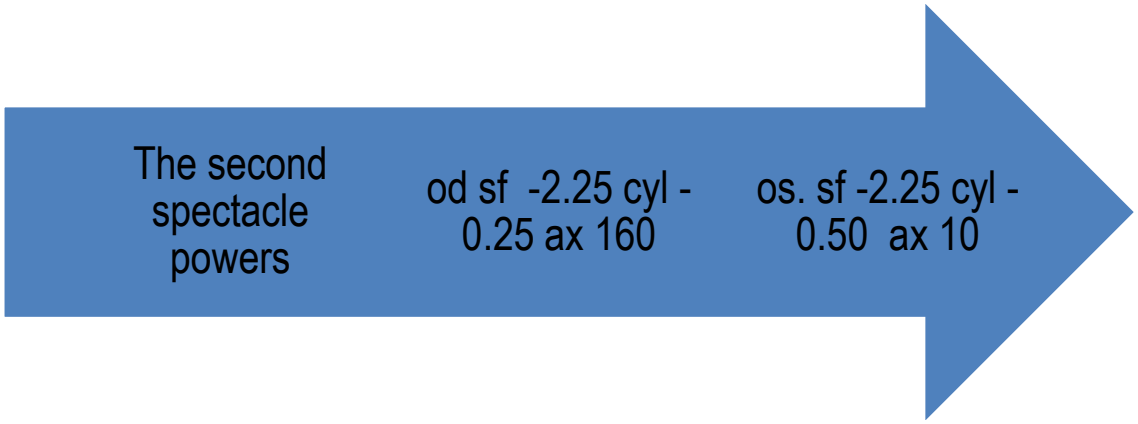


Figure 10. The second spectacle power in November 2018

Visual acuity with correction 20/20 in both eyes with new correction (Figure 10).
At this appointment parents were told first time about the myopia management. They haven't heard anything about that before and they wanted to think about it. In that time, they were offered to use MiSight contact lenses, but it sounds scary for the patient and for the parents to start use contact lenses. Parents didn´t have any knowledge about contact lenses even they were highly myopic themselves.

Her parents were told to come back to follow-up appointment in six months.

The third visit was in November 2019 with the optometrist and that was a year later from previous appointment. Symptoms were the same as before, like headache, seeing problems to far distance. The patient herself was quite happy because she like to read and she didn´t have any problems at nearby. Only thing she was sad she had a problem at school with blackboard.

I.O.P measured with iCare devise.
od. 16
os. 16

Cycloplegic refraction was used Tropicamid 5 mg/ml 1 gtt in both eyes.
od. sf -4.50 cyl -0.25 ax 160
os. sf -3.25 cyl -1.00 ax 5

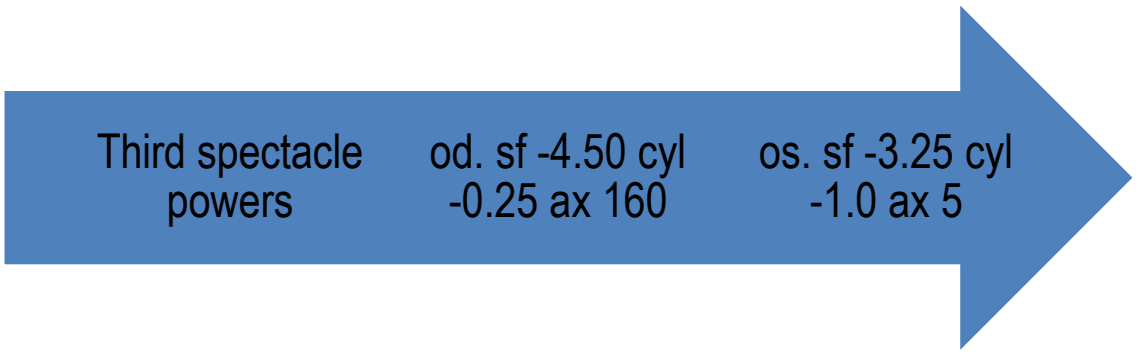


Figure 11. The third spectacle power in November 2019

Visual acuity with correction 20/20 in both eyes with new correction (Figure 11).

It took only one year to get about 2 diopters more minus. Again, we talked about myopia management, but the family wanted to wait until there are other options than contact lenses. They were explained possibilities about future problems with ocular health but the contact lens option for myopia management was too scary to start it.

Follow-up meeting was planned to be after 6 months.

But then unexpected happened around the world and Covid-19 came also in Finland. Next appointment didn´t happen in planned time.

Visit number 4 and start of myopia management with MiOYSMART lenses.

The fourth visit was in August 2021. The patient started a normal school again after a long period of distance school. She said that all went well if she was at home and studying with teams. Now she couldn´t see to blackboard or far distance clearly. Headaches had come back. She was a little bit worried about her vision. Before we started eye exam, we talked about myopia management and a possibility of a new spectacle lens correction. They were explained carefully meaning of myopia management and the treatment. Both parents and the patient were ready for that.

Her visual acuity with glasses were 20/100 on right eye and 20/150 on left eye.
No problems with binocular vision or with accommodation.

I.O.P measured with iCare devise.
od. 16
os. 15

Cycloplegic refraction was used Tropicamid 5 mg/ml 1 gtt in both eyes.
od. sf -7.50 cyl -0.75 ax 0
os. sf -6.0 cyl -2.00 ax 175

After the refraction below the parents were told about new lenses for eyeglasses. They were explained DIMS technology in simple way. They understood a bit about the lens design. They were told it is a single vision lens with hundreds of tiny segments, each providing a myopic blur. The purpose of therapeutic eyeglass lenses is to cause myopic defocus. It is inflicted on the retina's

peripheral areas to prevent myopia's progression. The family did not quite understand the technology of the lens, but they decided to try the power of the lenses as a form of treatment for myopia.

Hoya has created a protocol to exam the patient in proper way. With this patient the protocol was used as suggested.

Hoya´s protocol:

First visit

1. History and background information

A. Child's eye health and spectacle history

1. Vision and related problems
2. Age of myopia onset and rate of progression (D/year)
3. If myopia was treated before: previous treatment method
4. Outdoor activities (hours/day)
5. Number of close-ups (hours/day)
6. Current glass information: strengths and information on when the glasses were put into use

B. Parental eye health and spectacle history

1. Current fix
2. Myopia progression rate at different ages
3. Complications and pathology (if any)

2. Initial investigations

A. Visual acuity near and far without correction and with the habitual correction (in monocular and binocular)

B. Pupillary reactions

C. Far and near cover test

D. Eye movements

E. Examination of the field of vision is done, if necessary, based on the child's descriptions symptoms or family history

F. A colour vision test is performed if the child has not been examined before

3. Refraction and visual acuity

A. Subjective refraction, monocular and binocular visual acuity both far and near

B. Cycloplegic refraction or autorefractometer measurement

(not mandatory, but strongly recommended)

4. Assessment of functional vision with new correction

A. Assessment of binocular vision for far and near

B. Stereo vision

C. Amplitude of accommodation monocularly and binocularly

D. Accommodation facility statement (voluntary, but advisable)

E. Assessing visual acuity in bright and dim lighting with high and low contrast test board (optional)

5. Assessment of eye health

A. Microscopy of the anterior parts of the eye

B. Microscopy of the back of the eye (key area: optic nerve and macula)

C. Eye length measurement (recommended if possible)

D. Corneal topography

E. Eye pressure

The patient´s pupil reactions were normal and eye movements were normal. A colour vision test was normal. In microscopy exam there was no abnormal findings related to ocular surface or posterior examination.

I.O.P measured with iCare devise.

od. 16

os. 15

With Topcon´s Myah device were taken keratometry values and axial length values.

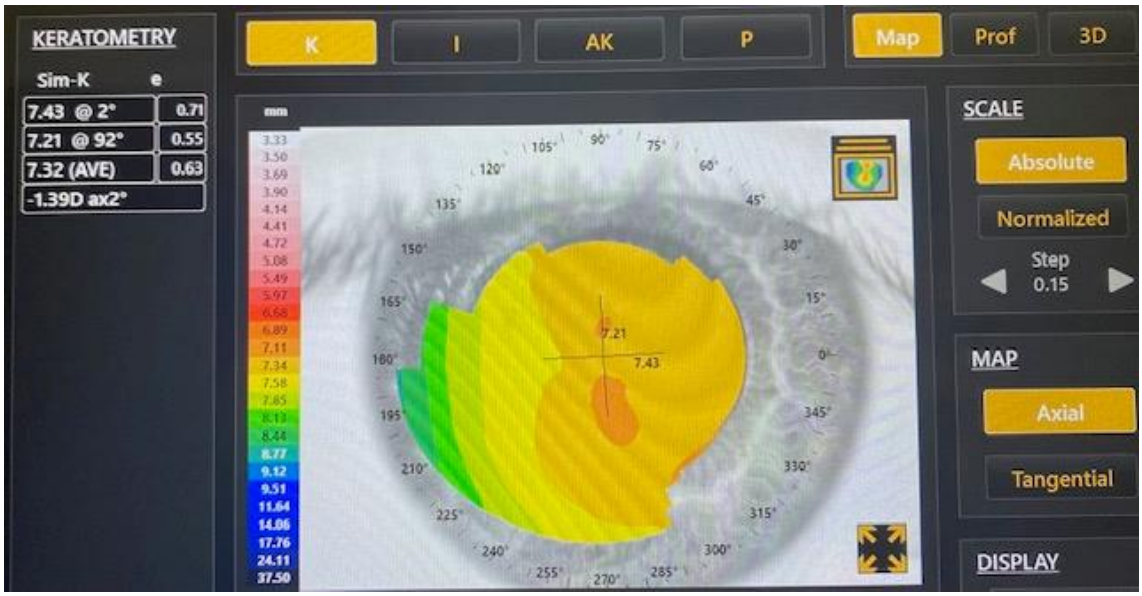


Figure 12. Keratometry on right eye 7.43 ax 2 / 7.21 ax 92 average 7.32

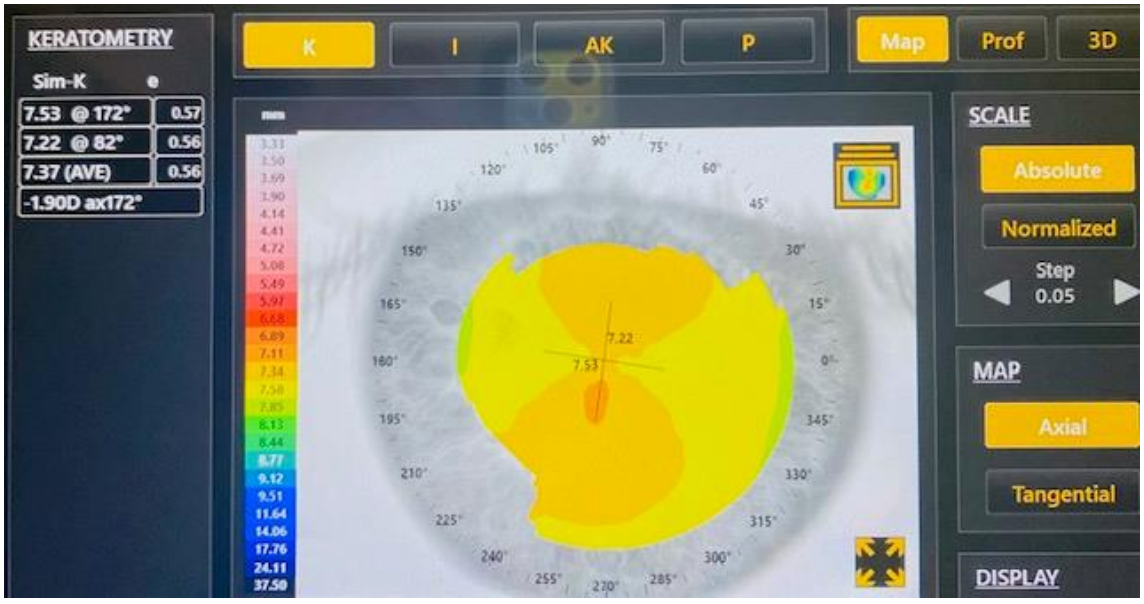


Figure 13. Keratometry on left eye 7.53 ax 172 / 7.22 ax 82 average 7.37

Axial length of eyes

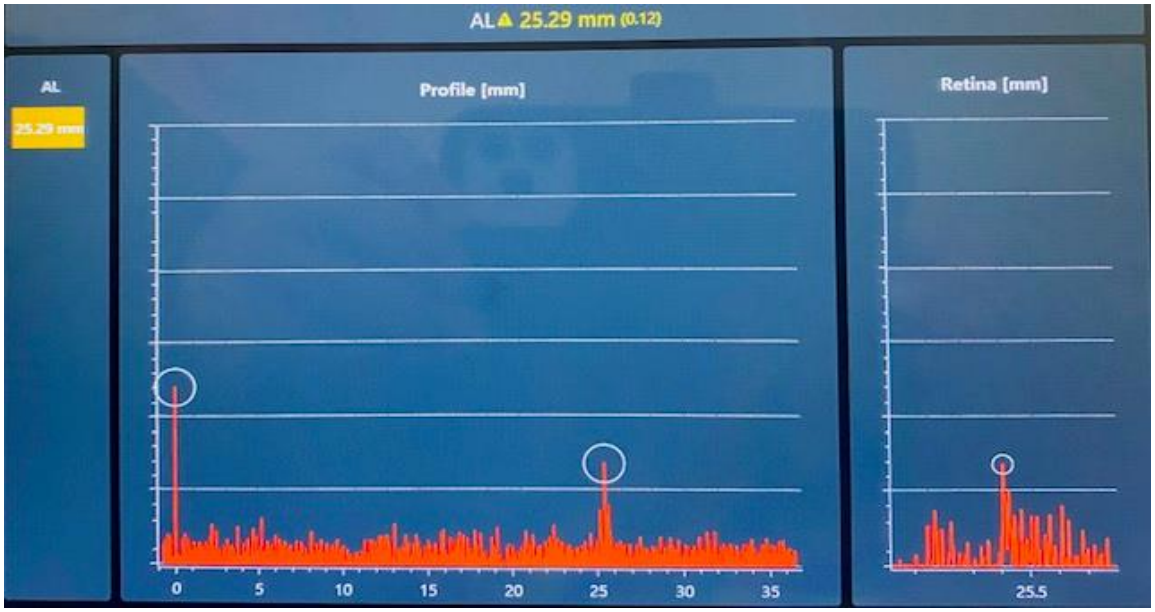


Figure 14. Axial length in right eye

Axial length is in right eye, 25.29 mm

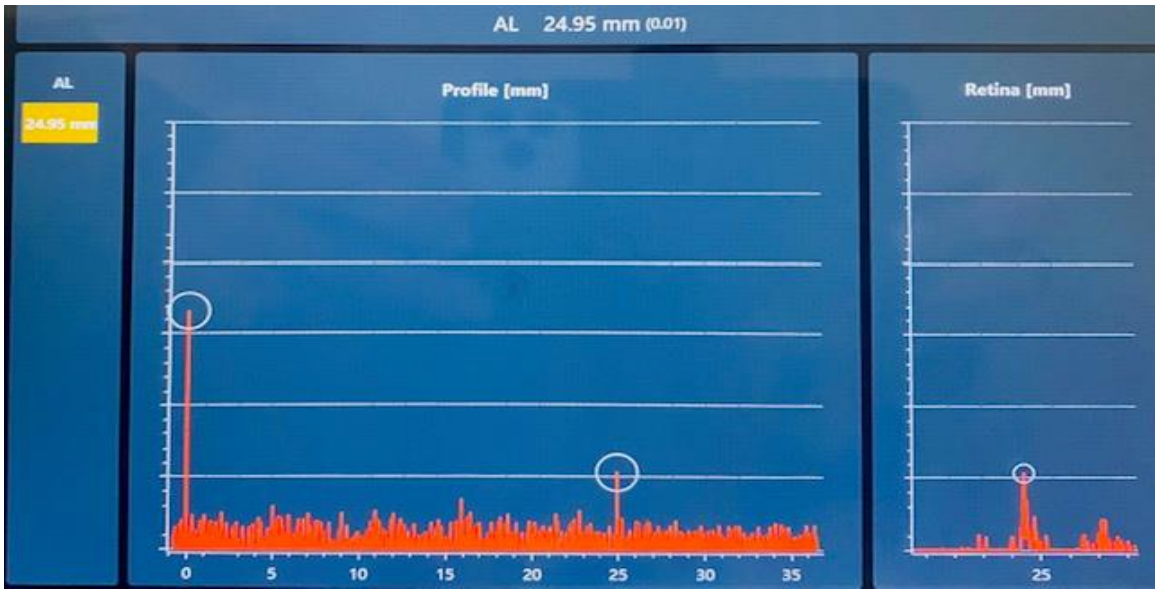


Figure 15. Axial length in left eye

Axial length in left eye is 24.95 mm.

After eye exam the power of new lenses was decided (Figure 16) and MiOYSMART lenses were ordered:

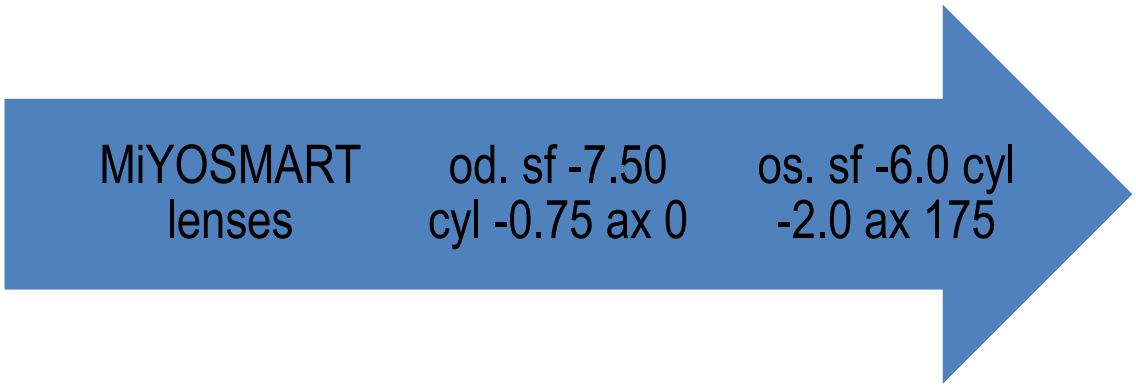


Figure 16. MiOYSMART lens power in August of 2021

It is important to observe child's way to move and use vision, and after that make a frame selection. With these quite high powers is more important to think frame selection carefully. The patient was 11-years old and wanted fashionable frame, a big one. That wasn´t an option and she had to make a compromise.

Hoya has made a guide on how to choose a suitable frame, so the lenses work as expected (Figure 17).

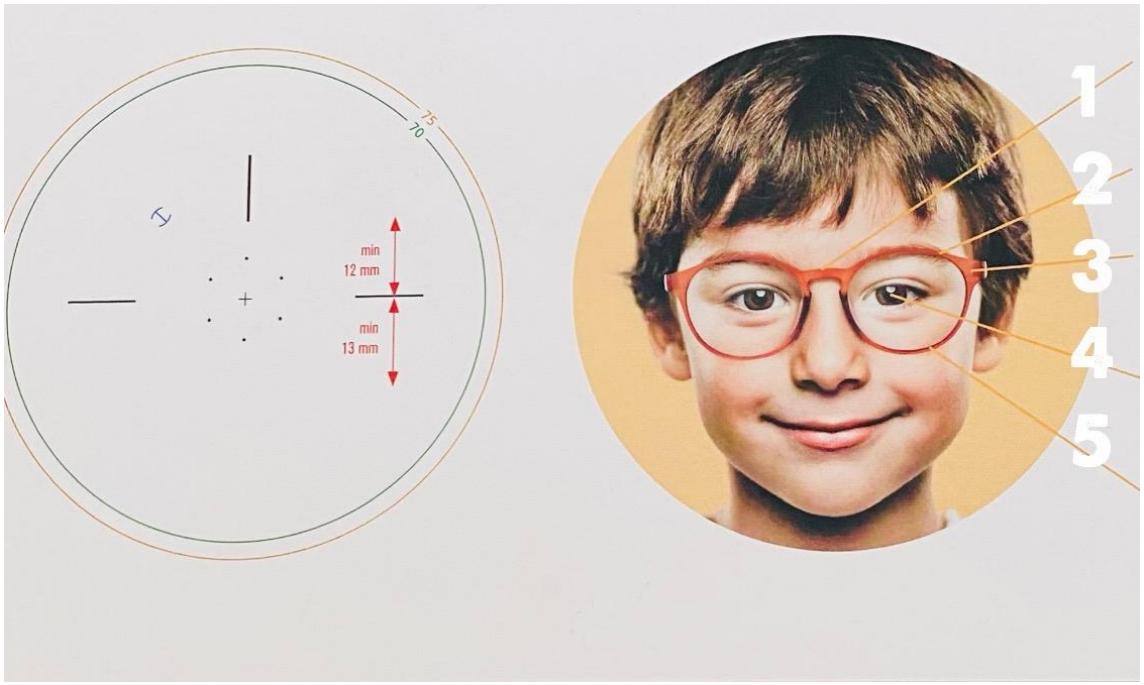


Figure 17. Guide to choose a frame. HOYA Vision Care, modified by Satu Järvinen

The main ideas for choosing a good working frame.

NR 1 Make sure the frame sits well and firmly in place

NR 2 It is recommended that the upper edge og the frame rises to the level of the eyebrows

NR 3 The frame selection is important, select a frame that fits a proportions of the child´s face suitable

NR 4 The measurement is made center of the pupil according monocular pupil distance and the height from the edge of the frame

NR 5 Recommend frame fit:

curve angle: 0-5 degrees with Hoya meter

pantoscopic angle: 0 degrees

vertex distance: under or 10 mm

Hoya´s protocol for after care

Aftercare

1. Getting used to it

During the handing over of the glasses, the first control visit can be arranged for two weeks on the introduction of glasses.
The child or young person is given glasses when they are handed over a separate tracking card, which includes e.g. getting used to and the functionality of the glasses related evaluation survey. It is a good idea to fill out this survey during the familiarization period and take it follow-up card with you for the first control visit.
During the control visit, in addition to getting used to it, it is good to make sure that the frame fits still very much on the face of a child or young person.
If necessary, a similar control visit where the fit of the frame is checked, can be agreed three and/or nine months after the glasses are put into use.

It is important to show and tell patient how to handle spectacles, for example how to clean them and take them out of the face with two hands. The frame must stay in place on the face in all situations, even in sporty hobbies. It should be emphasized to the eyeglass wearer that the glasses can be adjust more later if they become loose. It is important that the dimensions of the lens remain in the right places in the frames during daily use.

Follow-up visits

Follow-up visits are done every 6 months. Given to a child in the follow-up folder you can find e.g., assessment of environmental factors, to see and questionnaires related to habituation, which can be used during follow-up visits.

Visit number 5 was short follow-up visit in end of September 2021

Patient was very satisfied with the lenses. Her visual acuity was 20/20 in both eyes. She said lenses were working well. In couple of the first days, she noticed those blurry areas of the lens but those areas didn´t bothered her. There was no bad feelings or other side effects, like headaches. Even the change of the power was so considerable big, she didn´t feel any problems to adapt on it.
A new follow-up visit was planned for March.

Visit number 6 is proper follow-up visit on March of 2022

After six months use patient was happy with the spectacles. Her visual acuity was 20/20 in both eyes and no problems with accommodation or binocular vision. She said she was seeing well, no headaches and no other problems.

A new eye exam was done, and new measurements were taken.

I.O.P measured with iCare devise
od. 16
os. 16

Cycloplegic refraction was used Tropicamid 5 mg/ml 1 gtt in both eyes.
od. sf -7.25 cyl -0.75 ax 0
os. sf -6.0 cyl -2.00 ax 175

Prescription for glasses
od. sf -7.50 cyl -1.0 ax 0
os. sf -6.25 cyl -2.00 ax 175

Axial length mm A.P.P.(D)

Figure 18. Axial length and average pupil power diopters (A.P.P.D) in August at the first visit and in March at the follow-up visit

Right eye axial length measurements:

First line 25.22 mm in March 2022

Second line 25.29 mm in August 2021

Axial length mm A.P.P.(D)

Figure 19. Axial length and average pupil power diopters (A.P.P.D) in August at the first visit and in March at the follow-up visit

Left eye axial length measurements:

First line 25.02 mm in March 2022

Second line 24.95 mm in August 2021

It is recommended that the child changes to a new pair of lenses whenever myopia has increased compared to the previous examination ≥ 0.50D (spherical equivalent refraction or SER). Both lenses recommended to be replaced, even if the intensity has only changed in the other eye.

At this case patient didn´t need a new lens to be changed. Frame was in a good shape and the change of the power was so small, there was no need to change lenses.

Visit number 7 in July 2022, the last case study visit.

The first 12 months had done with myopia management. Patient was happy with the lenses and her parents were happy because patient didn´t have any problems with seeing or using the spectacles. School was doing well, and she had many hobbies that require a good near vision.

Visual acuity with spectacles 20/20 in both eyes.
No problems with accommodation, colour vision or binocular vision.

I.O.P measured with iCare devise.
od.16
os.16

New measurements were taken with Topcon´s Myah device.

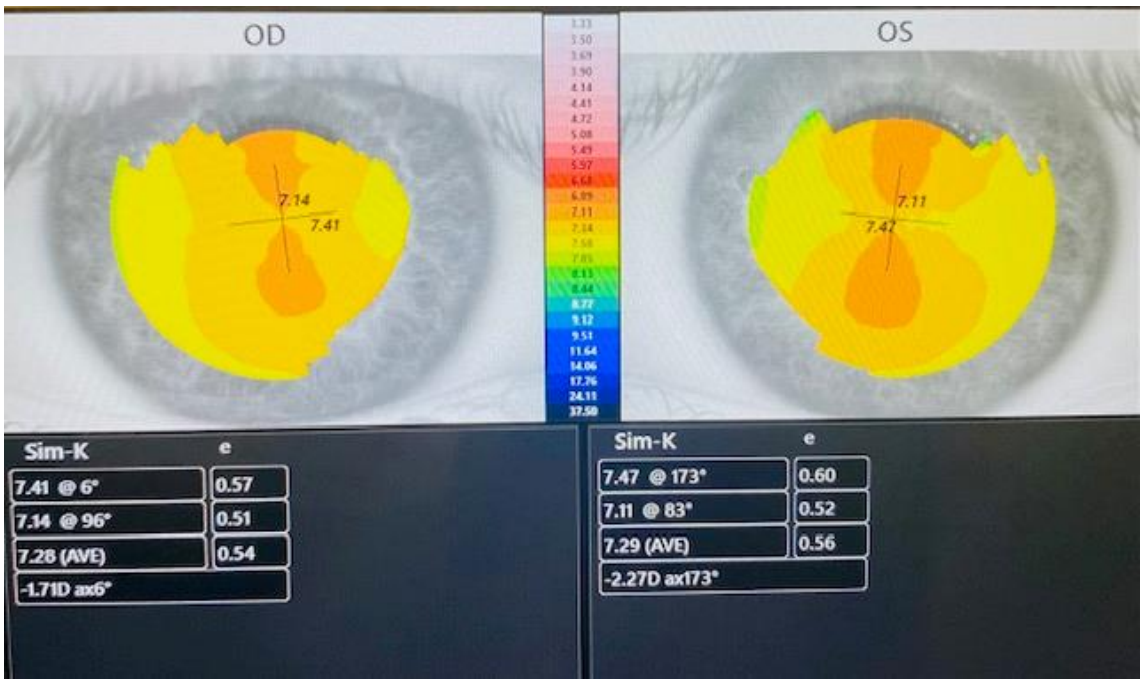


Figure 20. K-values in July 2022
Keratometry on right eye 7.41 ax 6 / 7.14 ax 96 average 7.28
Keratometry on left eye 7.47 ax 173 / 7.11 ax 83 average 7.29

Axial length

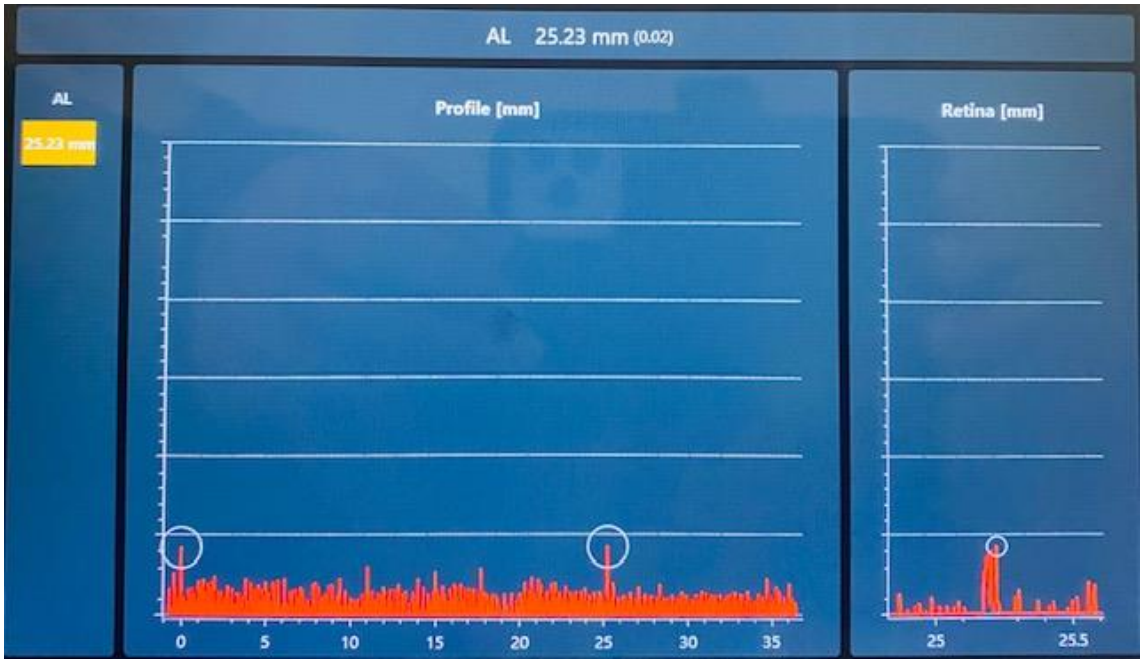


Figure 21. Axial length of right eye in end of July 2022

Axial length value in right eye, 25.23 mm

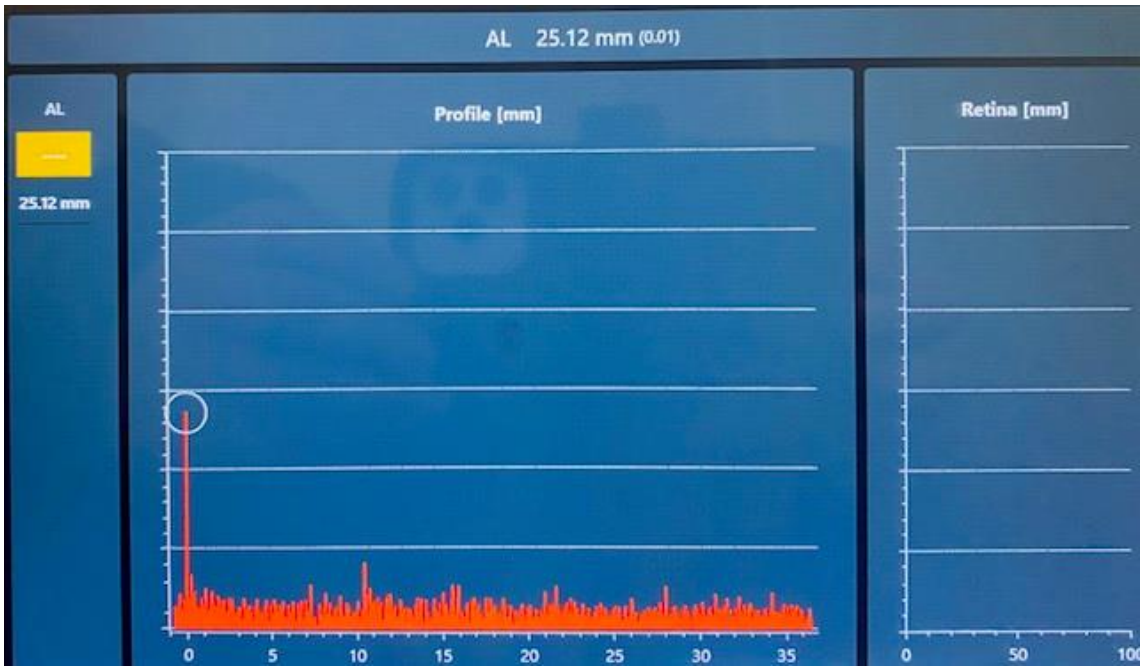


Figure 22. Axial length of left eye in end of July 2022

Axial length value in left eye, 25.12 mm.

Development of axial length from August 2021 to July of 2022

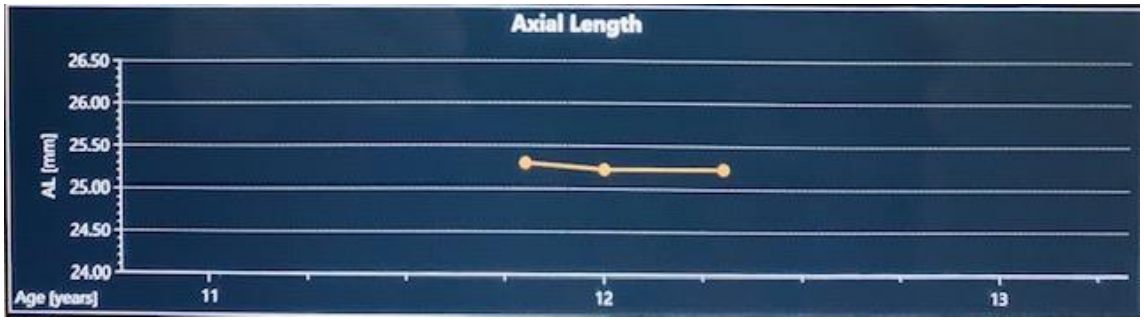


Figure 23. Axial length of the right eye

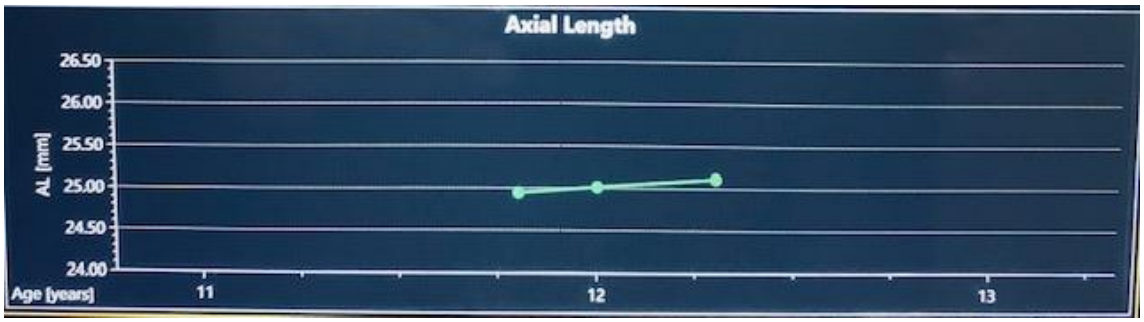


Figure 24. Axial length the left eye

Development of axial length from August 2021 to July of 2022

Right eye, first measurement was made in August 2021, the last one in July 2022

Figure 25. Axial length and average pupil power diopters (A.P.P.D)

First line axial length 25.23 mm in July 2022

Second line axial length 25.22 mm in March 2022

Third line axial length 25.29 mm in August 2021

Left eye, first measurement was made in August 2021, the last one in July 2022

Figure 26. Axial length and average pupil power diopters (A.P.P.D)

First line axial length 25.12 mm July 2022
Second line axial length 25.02 mm in March 2022
Third line axial length 24.95 mm in August 2021

Patient didn´t need new lenses, or new frame and she is very happy because it seems to stop coming more myopia. Patient and her parents were explained about axial length and its' stopped progression. There was slightly recovery on the right eye and slightly worsening on the left eye but not big changes during the year. For the patient and the family, the most understandable thing was that more minus didn't come.

The next follow-up meeting was planned to January of 2023.

4.2.2 Differential Diagnosis

Before starting myopia management with MiOYSMART lenses, or with the other management, must be excluded:

- ✓ accommodation problems
- ✓ binocular problems
- ✓ pseudo myopia

Binocular vision must be assessed before starting myopia treatment. Its assessment includes the valuation of accommodative and vergence systems. A couple of the most important accommodation tests are easy to perform. It is important to know that the extent of accommodation is normal and that can be tested with the traditional pencil test. In addition, it is worth finding out the maximum possible amount of accommodation. The accommodation can be evaluated for one eye or for both eyes. At the same time, it is worth ensuring the existence of normal convergence. Examining eye movements and ensuring binocularity must be done before starting myopia treatment. Eye movements should be normal and binocular vision of the eyes should be functional (Wildsoet et al., 2019).

It is important to make sure that it is not pseudomyopia before starting the treatment.

If the patient has a headache, blurred vision, and experiences fluctuating vision during the day, there is reason to suspect pseudomyopia. If the patient has pseudomyopia, he sees both far and near poorly, while myopia patients have a normal near vision. The variation in accommodation causes a pumping phenomenon in vision, i.e. sometimes you can see more clearly and sometimes more foggy. Objectively, the symptoms of pseudomyopia are changes in the diameter of the pupils and changes in the light reflexes of the retinoscope. Visual acuity should be examined in monocular and binocular ways and recorded separately. The only sure way to exclude the possibility of pseudomyopia is to perform a cycloplegic examination (García-Montero et al., 2022).

4.2.3 Discussion

This thesis introduces a case study on a patient starting Myopia Management with MiOYSMART lenses. It presents reviews of the literature on a different type of methods to slow down myopia. There are lots of studies regarding myopia management with very early started myopia and it is shown myopia can be controlled with many ways. Problem is when the patient doesn´t want to start myopia controlling at an early stage or the patient is not informed about it. This study is only one case but it indicative that starting myopia management is worthwhile for advanced myopia.

The examined patient is young and healthy girl with many near distance hobbies. She had never been interested of sport or playing outside. Her parents are both highly myopic. Her risk factors are high based on literature getting more myopic future.

(Du et al., 2021) as said before we are talking about high myopia with this patient. Based on the literature, a high degree of near sighted can, over time, be involved in a severe impairment of vision and several eye diseases.

Recently, there has been a debate about whether little time spent outdoors and a lot of close-up viewing is associated with an increase in myopia or even the onset of it. It is interesting to find out how much of myopia is inherited and genetic tendency, or whether the myogenic environment created by myopic parents affects the onset of near sighted. The children of emmetropic parents are playing outside and getting the sunlight much more than the children of myopic parents. At the same time they are not necessarily as much in close viewing situations (Gifford et al., 2019).

This case study work has been done objectively, openly, and carefully. The patient has been treated with respect during the process and has been honestly informed about the progress of the process. The results of this study are like previous studies on myopia management. The effectiveness of myopia treatment assessment and management supports the proposed protocol for a case study.

4.2.4 Conclusions

Case study shows it is not too late to start myopia management even we are talking a patient of high near-sighted.

It is necessary to talk with patients about new myopia management treatments and tell them about different treatment options. Telling about myopia treatments as early as possible helps preserve the patient's vision in later life. At the same time, it is also necessary to inform about the risks, which are increased by the delay in starting the treatment. Many eye diseases caused by myopia could be prevented in advance with sufficient information and treatment myopia early enough.

This case study proves preventing the growth of myopia is important for every patient regardless low or high myopia stage at that moment. Let's assume that this examined patient could have already started treatment for myopia in 2018, when the prescription was around -1.5, so presumably the situation would be completely different now.

This case study is only one patient journey for a year, but the results are very promising for slowing myopia with MiOYSMART lenses. Myopia management with the lens is safety, non-invasive treatment for the patient. The lens is easy to describe and fit from the optometrist’s point of view. It is suitable for many types of patients, for example photophobic patients can use the material of photochromic or polarized version.

The Master’s degree of Optometry studies aid the possibility to make evidence-based conclusions in challenging clinical case scenarios when managing myopic patients.

Providing myopia management treatment requires a comprehensive understanding of vision and eye anatomy. It needs optometrists’ wider education or a special interest in eye health. Thinking about the patient´s best interests, the optometrist must talk about the risks of myopia in relation to vision and eye health and about the treatment of myopia, and various treatment methods.

5 RELIABILITY OF THE RESEARCH DEVELOPMENT WORK

This case study was prepared and written by only one author. The Oulu University of Applied Sciences library's information expert and thesis mentor have been used to ensure the reliability of the thesis. The literature search and the critical evaluation of the studies have been done in cooperation with them. The supervisors guided the progress of the thesis as needed by providing new perspectives on the work's material and providing guidance. This has increased overall reliability. Together with the information specialist of the Oulu University of Applied Sciences library, we investigated the accuracy and coverage of key search terms based on the research question. We selected the relevant databases that were included in the main search. The literature search was performed using PubMed, Cochrane and Springer searches. Literature search was completed on 17.1.2023 using the topics: myopia treatment and myopia, myopia control, axial growth, myopia* and optometrist. Searches were made in English and German without date restrictions.

6 ETHICALLY OF THE RESEARCH DEVELOPMENT WORK

The guidelines of Oulu University of Applied Sciences have been used as a basis for making this case study. The work has followed the responsible research (RCR) guidelines for responsible research and procedures for handling allegations of misconduct in Finland. These guidelines were prepared and published in 2012 by the Research Integrity Board (TENK) in cooperation with the Finnish research community. TENK is a board appointed by the Ministry of Education and Culture. (Technical Integrity Board TENK 2021) Separate Institutional Review Board approval was not applied for, as the case study does not belong to the category of studies requiring IRB approval.

7 EVALUATION OF THE RESEARCH DEVELOPMENT WORK

The evaluation of research conducted with a qualitative research approach considers the research data, synthesis of previous research results, research theory, and public debate. This research-based development work progressed according to the plan.

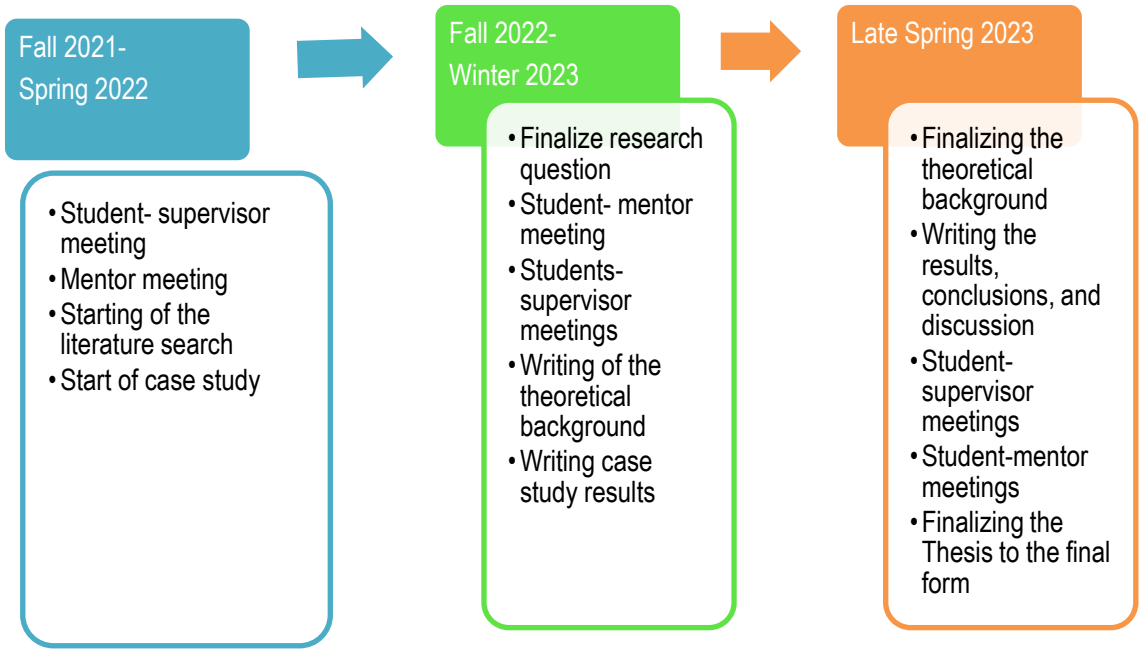
Although I worked on my thesis independently, we worked closely with the supervising teachers and mentors during the development work. The strength of the collaboration was considered by the extensive knowledge of the mentors on the topic I wrote. It provided a wealth of perspectives and thoughts for my thesis.

The assessment and feedback given by the partner or other students have not been used in the evaluation of the thesis.

The reliability and the ethical aspects have been opened more specifically before.

8 TIMETABLE AND BUDGET

The project was started immediately after the start of studies in the fall of 2021. In the beginning, time was spent on planning the thesis, searching for literature, organizing, and starting the case study. The actual writing of the thesis started in the middle of January 2023. It continued through the winter and was completed in the late spring of 2023. This is part of the master's program in clinical optometry and it was made out in the private sector without financial support, financiers, or sponsors.



ACKNOWLEDGMENTS

Warm thanks to my supervisors, Dr. Robert Andersson and Tuomas Juustila, for their invaluable guidance and knowledge with this thesis. Thank you also Petri Eskola and Terhi Peltola. My mentors, colleagues and friends in my life. This would not have been possible without you two. Thank you for your unlimited guidance, support, patience, and faith in me.

9 REFERENCES

Banerjee Srabani, & Horton Jennifer. (2021). *Lenses and Spectacles to Prevent Myopia Worsening in Children*. https://www.ncbi.nlm.nih.gov/books/NBK571917/

Bullimore, M. A., & Johnson, L. A. (2020). Overnight orthokeratology. *Contact Lens and Anterior Eye*, *43*(4), 322–332. https://doi.org/10.1016/j.clae.2020.03.018

Bullimore, M. A., Ritchey, E. R., Shah, S., Leveziel, N., Bourne, R. R. A., & Flitcroft, D. I. (2021). The Risks and Benefits of Myopia Control. *Ophthalmology*, *128*(11), 1561–1579. https://doi.org/10.1016/j.ophtha.2021.04.032

Carlà, M. M., Boselli, F., Giannuzzi, F., Gambini, G., Caporossi, T., de Vico, U., Savastano, A., Baldascino, A., Rizzo, C., Kilian, R., & Rizzo, S. (2022). Overview on Defocus Incorporated Multiple Segments Lenses: A Novel Perspective in Myopia Progression Management. *Vision*, *6*(2), 20. https://doi.org/10.3390/vision6020020

Chamberlain, P., Bradley, A., Arumugam, B., Hammond, D., McNally, J., Logan, N. S., Jones, D., Ngo, C., Peixoto-de-Matos, S. C., Hunt, C., & Young, G. (2022). Long-term Effect of Dual-Focus Contact Lenses on Myopia Progression in Children. *Optometry and Vision Science*. https://doi.org/10.1097/OPX.0000000000001873

Chuang, A.-C. (2017). How to effectively manage myopia. *Taiwan Journal of Ophthalmology*, *7*(1), 44. https://doi.org/10.4103/tjo.tjo_24_17

Dhiman, R., Rakheja, V., Gupta, V., & Saxena, R. (2022). Current concepts in the management of childhood myopia. *Indian Journal of Ophthalmology*, *70*(8), 2800. https://doi.org/10.4103/ijo.IJO_2098_21

Du, R., Xie, S., Igarashi-Yokoi, T., Watanabe, T., Uramoto, K., Takahashi, H., Nakao, N., Yoshida, T., Fang, Y., & Ohno-Matsui, K. (2021). Continued Increase of Axial Length and Its Risk Factors in Adults With High Myopia. *JAMA Ophthalmology*, *139*(10), 1096. https://doi.org/10.1001/jamaophthalmol.2021.3303

García-Montero, M., Felipe-Márquez, G., Arriola-Villalobos, P., & Garzón, N. (2022). Pseudomyopia: A Review. *Vision*, *6*(1), 17. https://doi.org/10.3390/vision6010017

Gifford, K. L., Richdale, K., Kang, P., Aller, T. A., Lam, C. S., Liu, Y. M., Michaud, L., Mulder, J., Orr, J. B., Rose, K. A., Saunders, K. J., Seidel, D., Tideman, J. W. L., & Sankaridurg, P. (2019). IMI – Clinical Management Guidelines Report. *Investigative Opthalmology & Visual Science*, *60*(3), M184. https://doi.org/10.1167/iovs.18-25977

Holden, B. A., Fricke, T. R., Wilson, D. A., Jong, M., Naidoo, K. S., Sankaridurg, P., Wong, T. Y., Naduvilath, T. J., & Resnikoff, S. (2016). Global Prevalence of Myopia and High Myopia and Temporal Trends from 2000 through 2050. *Ophthalmology*, *123*(5), 1036–1042. https://doi.org/10.1016/j.ophtha.2016.01.006

Jonas, J. B., Ang, M., Cho, P., Guggenheim, J. A., He, M. G., Jong, M., Logan, N. S., Liu, M., Morgan, I., Ohno-Matsui, K., Pärssinen, O., Resnikoff, S., Sankaridurg, P., Saw, S.-M., Smith, E. L., Tan, D. T. H., Walline, J. J., Wildsoet, C. F., Wu, P.-C., … Wolffsohn, J. S. (2021). IMI Prevention of Myopia and Its Progression. *Investigative Opthalmology & Visual Science*, *62*(5), 6. https://doi.org/10.1167/iovs.62.5.6

Kang, P. (2018). Optical and pharmacological strategies of myopia control. *Clinical and Experimental Optometry*, *101*(3), 321–332. https://doi.org/10.1111/cxo.12666

Kaymak, H., Graff, B., Neller, K., Langenbucher, A., Seitz, B., & Schwahn, H. (2021). Myopietherapie und Prophylaxe mit „Defocus Incorporated Multiple Segments"-Brillengläsern. *Der Ophthalmologe*, *118*(12), 1280–1286. https://doi.org/10.1007/s00347-021-01452-y

Lawrenson, J. G., Shah, R., Huntjens, B., Downie, L. E., Virgili, G., Dhakal, R., Verkicharla, P. K., Li, D., Mavi, S., Kernohan, A., Li, T., & Walline, J. J. (2023). Interventions for myopia control in children: a living systematic review and network meta-analysis. *Cochrane Database of Systematic Reviews*, *2023*(2). https://doi.org/10.1002/14651858.CD014758.pub2

Li, Y., Fu, Y., Wang, K., Liu, Z., Shi, X., & Zhao, M. (2020). Evaluating the myopia progression control efficacy of defocus incorporated multiple segments (DIMS) lenses and Apollo progressive addition spectacle lenses (PALs) in 6- to 12-year-old children: study protocol for a prospective, multicenter, randomized controlled trial. *Trials*, *21*(1), 279. https://doi.org/10.1186/s13063-020-4095-8

Logan, N. S., & Wolffsohn, J. S. (2020). Role of un-correction, under-correction and over-correction of myopia as a strategy for slowing myopic progression. *Clinical and Experimental Optometry*, *103*(2), 133–137. https://doi.org/10.1111/cxo.12978

Morgan, I. G., Wu, P.-C., Ostrin, L. A., Tideman, J. W. L., Yam, J. C., Lan, W., Baraas, R. C., He, X., Sankaridurg, P., Saw, S.-M., French, A. N., Rose, K. A., & Guggenheim, J. A. (2021). IMI Risk Factors for Myopia. *Investigative Opthalmology & Visual Science*, *62*(5), 3. https://doi.org/10.1167/iovs.62.5.3

Németh, J., Tapasztó, B., Aclimandos, W. A., Kestelyn, P., Jonas, J. B., de Faber, J.-T. H. N., Januleviciene, I., Grzybowski, A., Nagy, Z. Z., Pärssinen, O., Guggenheim, J. A., Allen, P. M., Baraas, R. C., Saunders, K. J., Flitcroft, D. I., Gray, L. S., Polling, J. R., Haarman, A. E., Tideman, J. W. L., … Resnikoff, S. (2021a). Update and guidance on management of myopia. European Society of Ophthalmology in cooperation with International Myopia Institute. *European Journal of Ophthalmology*, *31*(3), 853–883. https://doi.org/10.1177/1120672121998960

Németh, J., Tapasztó, B., Aclimandos, W. A., Kestelyn, P., Jonas, J. B., de Faber, J.-T. H. N., Januleviciene, I., Grzybowski, A., Nagy, Z. Z., Pärssinen, O., Guggenheim, J. A., Allen, P. M., Baraas, R. C., Saunders, K. J., Flitcroft, D. I., Gray, L. S., Polling, J. R., Haarman, A. E., Tideman, J. W. L., … Resnikoff, S. (2021b). Update and guidance on management of myopia. European Society of Ophthalmology in cooperation with International Myopia Institute. *European Journal of Ophthalmology*, *31*(3), 853–883. https://doi.org/10.1177/1120672121998960

Németh, J., Tapasztó, B., Aclimandos, W. A., Kestelyn, P., Jonas, J. B., de Faber, J.-T. H. N., Januleviciene, I., Grzybowski, A., Nagy, Z. Z., Pärssinen, O., Guggenheim, J. A., Allen, P. M., Baraas, R. C., Saunders, K. J., Flitcroft, D. I., Gray, L. S., Polling, J. R., Haarman, A. E.,

Tideman, J. W. L., … Resnikoff, S. (2021c). Update and guidance on management of myopia. European Society of Ophthalmology in cooperation with International Myopia Institute. *European Journal of Ophthalmology*, *31*(3), 853–883. https://doi.org/10.1177/1120672121998960

Raffa, L. H., Allinjawi, K., Sharanjeet-Kaur, Akhir, S. M., & Mutalib, H. A. (2021). Myopia control with soft multifocal contact lenses: 18-month follow-up. *Saudi Journal of Ophthalmology : Official Journal of the Saudi Ophthalmological Society*, *35*(4), 325–331. https://doi.org/10.4103/1319-4534.347305

Ramamurthy, D., Lin chua, S. Y., & Saw, S. (2015). A review of environmental risk factors for myopia during early life, childhood and adolescence. *Clinical and Experimental Optometry*, *98*(6), 497–506. https://doi.org/10.1111/cxo.12346

Rose, K. A., Morgan, I. G., Ip, J., Kifley, A., Huynh, S., Smith, W., & Mitchell, P. (2008). Outdoor Activity Reduces the Prevalence of Myopia in Children. *Ophthalmology*, *115*(8), 1279–1285. https://doi.org/10.1016/j.ophtha.2007.12.019

Ruiz-Pomeda, A., & Villa-Collar, C. (2020). Slowing the Progression of Myopia in Children with the MiSight Contact Lens: A Narrative Review of the Evidence. *Ophthalmology and Therapy*, *9*(4), 783–795. https://doi.org/10.1007/s40123-020-00298-y

Russo, A., Boldini, A., Romano, D., Mazza, G., Bignotti, S., Morescalchi, F., & Semeraro, F. (2022a). Myopia: Mechanisms and Strategies to Slow Down Its Progression. *Journal of Ophthalmology*, *2022*, 1–20. https://doi.org/10.1155/2022/1004977

Russo, A., Boldini, A., Romano, D., Mazza, G., Bignotti, S., Morescalchi, F., & Semeraro, F. (2022b). Myopia: Mechanisms and Strategies to Slow Down Its Progression. *Journal of Ophthalmology*, *2022*, 1–20. https://doi.org/10.1155/2022/1004977

Wildsoet, C. F., Chia, A., Cho, P., Guggenheim, J. A., Polling, J. R., Read, S., Sankaridurg, P., Saw, S.-M., Trier, K., Walline, J. J., Wu, P.-C., & Wolffsohn, J. S. (2019). IMI – Interventions for Controlling Myopia Onset and Progression Report. *Investigative Opthalmology & Visual Science*, *60*(3), M106. https://doi.org/10.1167/iovs.18-25958

William J. Benjamin. (2006). *BORISH'SCLINICAL REFRACfION*. https://doi.org/10.1016/B978-0-7506-7524-6.50043-0

Zhang, P., & Zhu, H. (2022). Light Signaling and Myopia Development: A Review. *Ophthalmology and Therapy*, *11*(3), 939–957. https://doi.org/10.1007/s40123-022-00490-2

Zhu, Q., Liu, Y., Tighe, S., Zhu, Y., Su, X., Lu, F., & Hu, M. (2019). Retardation of Myopia Progression by Multifocal Soft Contact Lenses. *International Journal of Medical Sciences*, *16*(2), 198–202. https://doi.org/10.7150/ijms.30118