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VISUAL ACUITY AND STEREOPSIS FOR MULTIFOCAL CONTACT LENS USERS

BACHELOR THESIS

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ABSTRAKTS

Bakalaura darbs uzrakstīts uz 37 lapaspusēm, satur 10 zīmējumus, 5 tabulas un 18 literatūras avotus. Darba mērķis ir novērtēt redzes asumu un stereoredzi tuvumā un tālumā pacientiem koriģētiem ar brillēm un multifokālajām kontaktlēcām. Mūsu pētījumi parādīja, ka tāluma binokulārais redzes asums visiem pacientiem ir labs – virs 0,95. Tuvuma redzes asums pacientiem koriģētiem ar brillēm ir labāks un pacienti dod priekšroku brillēm. Tuvuma stereoredze noteikta ar Titmusa mušas testu un Titmusa apļu testu pacientiem koriģētiem ar brillēm un kontaktlēcām bija laba. Tāluma stereoredzes parametriem mēs redzam atšķirību, ar brillēm stereoredze ir labāka, bet rezultātu atšķirība nav statistiski būtiska.

Atslēgas vārdi: redzes asums, stereoredze, multifokālās kontaktlēcas, presbiopijas korekcija.

ABSTRACT

Thesis is written in English on 37 pages. It contains 10 figures, 5 tables and 18 references.

The aim of our thesis is to evaluate the acuity and the stereopsis for far and near distances, for subject's corrected with glasses and multifocal contact lenses.

Our study shows that far distance binocular visual acuity for all pacients is good – more than 0,95. Near Visus with eyeglasses is better and patients examined prefers eyeglasses. Near distance stereovision data conducted with Titmus Fly and Circles tests, shows that pacients corrected with glasses and multifocal contact lenses have good stereovision. For far distance we see same difference in steovisus, with glasses steopsis is better, but our results not are statisticaly significanty different.

Key words: vision acuity, stereopsis, multifocal contact lenses, presbyopia correction.

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INTRODUCTION

Today grow number of presbiopic pacients that don't want to use glasses for vision correction. In modern lifestyles increase sports and outdoors activities and multifocal contact lenses for presbiopia correction is good alternative.

The aim of this thesis is to evaluate visual acuity and stereopsis for presbiopic pacients corrected with glasses and multifocal contact lenses.

For 20 patients were measured vision acuity and stereopsis for near and fare vision after the correction with glasses. Then the measured data were compared with the results obtained after the application of multifocal contact lenses.

For presbiopia correction we are applicated montly contact lenses "PureVision Multifocal", produced by Baush & Lomb (Illustrative materials of Baush&Lomb, 2016.).

The visual acuity was assessed subjectively using optotypes (letters, numbers, and c of Landolt and albino) in decimal progression.

The text will be described in two phases:

1. Review literature describing historical evolution and description from monofocal contact lenses to multifocal contact lenses;
2. My daily work and my experience with multifocal contact lenses on my patients.

1. REVIEW LITERATURE

1.1.Multifocal contact lenses

Bifocal and multifocal contact lenses are designed to improve vision after 40 years. At this age, it may be necessary to keep what we want to read further from the eyes to see clearly. This is “presbyopia” (Abati et al., 2002).

Bifocal and multifocal contact lenses are made of materials that are permeable to rigid and soft gases (GP). Bifocal contact lenses (like bifocal lenses for glasses) have two potentials that are used to: clearly see from a distance, and see clearly up close. Multifocal contact lenses, such as progressive glasses lenses, have a range of powers to clearly see far, near and anywhere in the middle (Lupelli et al.,2004).

1.1.1. Types of multifocal contact lenses (Lupelli et al., 2004).

Based on design, there are basically two types of multifocal contact lenses:

1. **Simultaneous vision lenses.** These lenses allow both the close areas and the distant areas of the lens to be in front of the pupil at the same time. Although this may seem impractical, the visual system will only need a short period of time to get used to what you are looking at. “Simultaneous vision lenses are the most popular among multifocal contact lenses” (https://www.opticarevision.com/eyeglasses-contacts/contact-lenses/bifocal-and-multifocal-contact-lenses/). They are almost always soft lenses and are available in two designs:

   “Concentric ring designs – These are bifocal lenses with either the distance or near power in the center of the lens, with alternating rings of distance and near powers surrounding it” (https://www.coloradoeyecenter.com/bifocal-multifocal-contact-lenses/).

   “Aspheric designs – These are progressive-style multifocal lenses, with many powers blended across the lens surface. Some aspheric lenses have the distance power in the center of the lens; others have the near power in the center" (https://www.coloradoeyecenter.com/bifocal-multifocal-contact-lenses/).

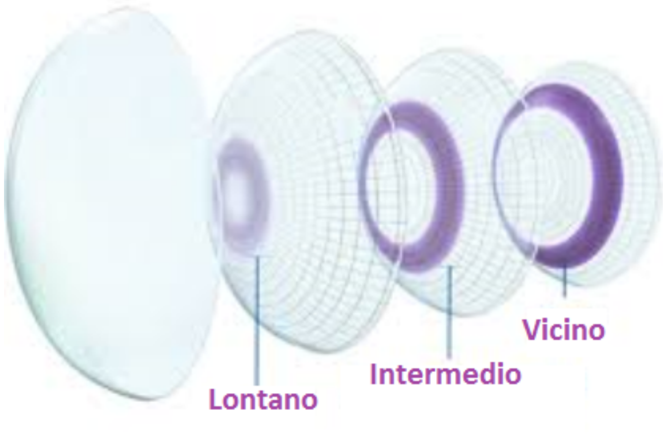


Figure 1 - Geometry of multifocal contact lenses Center /Intermediate/ Near lenses. (http://www.otticaranieri.com/it/173/Lenti_a_Contatto_Bifocali_e_Multifocali/).

2. **Alternating vision (or *translating*) lenses.** They are GP multifocal lenses with a design like bifocal spectacle lenses. The upper part of the lens has the power of distance and the lower part of the lens contains the near power. When you look ahead, the eye looks through the distance part of the lens. When you look down, your bottom lid holds the lens in place while the pupil moves into the near area of the lens for reading (https://www.coloradoeyecenter.com/bifocal-multifocal-contact-lenses/).

1.1.2. Multifocal contact lenses work

Many of the people who try multifocal contact lenses are satisfied. But when you wear these lenses you may need some compromises. For example, remote viewing with multifocal contact lenses may not see m light enough, or night-time glare may cause problems, small print is more difficult to see

Another solution for presbyopia may be the monovision or the modified monovision. In monovision, a contact lens is worn in one eye for distant vision and a contact lens in the other eye for close vision. In the modified monovision, there is a contact lens for distant vision in one eye, and a multifocal one in the other eye to improve close vision (http://www.carlsbadeye.com/ECA_Sub/Contact_Lenses_Main/Bifocal_Multifocal_Lenses/index.html).

"Researchers at the Ohio State University College of Optometry in Columbus compared visual performance and patient satisfaction among patients with no previous presbyopia correction wearing multifocal lenses and monovision (Kirkpatrick et. al, 1985).

Thirty-eight presbyopic patients were randomized to multifocals (Bausch + Lomb SofLens Multifocal) or monovision (SofLens 59). After 1 month, researchers measured near stereoacuity and high- and low-contrast visual acuity at distance and near. The patient satisfaction test was the National Eye Institute Refractive Error Quality of Life Instrument (NEI-RQL). Next, researchers fit each patient with the modality that they had not worn the preceding month and had them return a month later for the same testing. Finally, they asked patients to report which lens they preferred (https://www.clspectrum.com/supplements/2012/june-2012/multifocals-the-new-standard-of-care/evidence-for-a-better-choice).

The examination of patients who used both modalities had at least 20/20 of distance and close binocular vision in a high contrast situation. In a low contrast situation, patients with both modalities lost less than a correct line of vision for the best performance at close range, but multifocal lens wearers lost between five to six letters, and monovision wearers lost two letters. 76% of patients preferred multifocal contact lenses, while 24% preferred monovision.(https://www.clspectrum.com/supplements/2012/june-2012/multifocals-the-new-standard-of-care/evidence-for-a-better-choice).

Another study carried out by researchers at the Clinical Eye Research Facility - University of Alabama (Birmingham, School of Optometry) compared the vision with multifocal lenses to that of monovision (both with omafilcon A). The 46 patients were randomly distributed between the two modalities, wearing one modality for one month and the other for the following month. After the experimentation phase, 14 of the 46 patients preferred monovision, while 32 chose multifocal lenses. It should be noted that only two of the six patients who previously preferred monovision continued to choose it, and two of the former former multifocal carriers preferred monovision. Interestingly, the results of visual function tests were not related to patient preferences (https://www.clspectrum.com/supplements/2012/june-2012/multifocals-the-new-standard-of-care/evidence-for-a-better-choice).

1.1.3. Soft multifocal simultaneous image contact lenses

In recent years multifocal soft contact lenses exploded because of the growing number of presbyopic patients requiring visual solutions. The cornerstone for multifocal contact lens for presbyopia compensation is based on the interpretation and the tolerance of blur of multiple images superimposed on the retina created by various powers of a contact lens. Manufacturers have brought out a wide variety of soft simultaneous image lens to satisfy patients needs, but their wearing is not yet satisfactory in some cases. Some presbyopes interrupt the use of contact lenses due to some limitations of visual quality that can be surpassed with appropriate selection of contact lenses based on a preliminary assessment (Lupelli et al, 2004).

The presbyopia is primarily due to the a decrement of the crystalline elasticity. Other causes can be the increment of the equatorial diameter of the lens, the loss of elasticity of the Bruch's membrane and the reduction of mobility of the ciliary muscle. The human accommodating amplitude decreases progressively with age, starting from the second decade of life or maybe before. Presbyopia usually begins between 38 and 45 years and the prevalence is practically 100% from 50 to 52 years (Liuzzi et al,. 2002).

In the last two decades, there has been an increment of presbyopic people in Europe. In 2009 the 18.9% of the European population were between 50 and 65 years, 2.3% more than 1998 in the same age range. Since 1950, the percentage of elderly people (over 60 years) has increased from 8% to 11% in 2009 (Pérez-Prados et al., 2016).

In recent years the number of multifocal contact lens users has grown, even if only around 10% of contact lens users in the UK received a presbyopia correction in 2008. A recent international survey showed a remarkable variability among countries regarding adaptation to contact lenses for presbyopia. It is interesting to note that the same survey showed that 63% of the presbyopes had non-presbyopic corrections, with the remaining 29% and 8% of the users respectively corrected with multifocal or monovision lenses. The most presbyopic contact lens users are equipped with a distance prescription and additional reading glasses for close work. Many contact lens users stop wear contact lenses at the beginning of presbyopia. The main reasons for the low rate of prescription of monovision or multifocal contact lenses are lack of adaptability, lack of availability of a "perfect" multifocal contact lenses that offer good comfort and simultaneous optical images without compromise for all distances. The training of contact lens professionals in the application of presbyopic contact lenses should be increased all around the world to satisfy the needs of contact lenses users ((https://www.clspectrum.com/supplements/2012/june-2012/multifocals-the-new-standard-of-care/evidence-for-a-better-choice).

Presbyopic patients have a variety of options to correct their refractive error with contact lenses. These are of three types: (1) correction of extra glasses on contact lenses, (2) monovision and (3) multifocal contact lenses. The extra correction involves reading glasses, while in monovision one eye is corrected for distance while the other is optimized for close vision. Monovision doen not depend on the pupil size and therefore there is no compromised visibility in low light conditions or low contrast conditions; however, there is a decrease in stereoacuity, especially when the patient needs high addition powers.

There are some different multifocal lens: a division can be performed to include all types of multifocal goals currently available: translating multifocal lenses, and distance vision zones and simultaneous image lenses. In correcting presbyopia multifocal (contact) lenses are used 3.6 times more than monovision ones. The success rate of multifocal contact lens prescription is between 67% and 83% after three months. The actual success rate for long-term wearers is lower, in most cases between 30% and 40% (Pérez-Prados et al., 2016).

Simultaneous vision is reached when the patient suppresses the blurred image and chooses the clearest one. This concept is based on the interpretation of blurring and / or blurring of multiple images overlapped on the retina and created by different powers of the lens. retinal. Image overlay produces a decrease in contrast sensitivity that gets better with time. The problem is acute in low light conditions and particularly affects close vision.

Considering that simultaneity occurs thanks to the visual system rather than calling the phenomenon 'simultaneous vision' we should call it 'simultaneous image'. To obtain pure simultaneous images, near and distance contact lens areas must rest within the pupillary area for all gaze positions. If this does not happen, we do not obtain a pure simultaneous image, but a simultaneous image combined with alternating images depending on the area of the lens in which the pupil is located. Monovision and simultaneous image are similar because two images are processed simultaneously. Monovision uses one eye for distance and the other for close vision. The purpose of simultaneous imaging lenses used to compensate presbyopia is to increase the depth of focus, the distance interval beyond which the visual measurements of performance exceed a certain threshold. Therefore, it is possible to counteract the effects of decreasing the amplitude of the accommodation in the aging eye. This increase in focus depth involves a compromise between depth of focus and image quality that depends on various causes related to the patient. In the simultaneous correction of the image, the rays of light that pass through the pupil to form the retinal image encounter corrections both at a distance and near or a gradual transition in power between distance and near corrections. Therefore, any region of the retina receives in-focus and out-of-focus images. The brain should select the in-focus stimulus in the fire, while suppressing the out-of-focus stimuli but really the contrast of the in-focus image is reduced by the out-of-focus image. The multifocal designs imply a gradual and progressively symmetrical gradation of the power from the center to the edge of the optical area of the contact lens. This result is obtained using one or more aspherical surfaces (Pérez-Prados et al., 2016).

These are three types of contact lens designed to correct presbyopia:

- Concentric or annular designs. They are designed with an annular central area, which provides both distance and near power, surrounded by a peripheral ring that respectively guarantees close and distant vision.
- Aspheric designs. They have a gradual change in curvature along one of their surfaces based on the geometry of the conical sections. The eccentricity is greater than single-vision lens designs, thus creating more power to the lens's periphery. Aspheric designs are truly multifocal because they have a gradual transition in the power of the lens between the distance and the near. Even if the best image on the retina with these contact lenses suffers a degradation caused by spherical aberration, this is overcome by the increase in the vergence range.
- Diffractive designs. These are the only ones that make no difference betweennear and distant powers. A central area focuses images at distance by refraction and close by diffraction by zone echelettes. Considering that the light passes through the distance and the near elements of the lens in equal way, the diffractive designs can be considered independent from the pupil. This design implies a loss of contrast of the image caused by the fraction of light entering into higher diffraction orders. It can provide unacceptable comfort for the patient and some visual problems at low light. The diffractive contact lenses are not currently available on the market.

1.1.4 Fitting of contact lenses.

The patient should be informed about the use of multifocal or bifocal contact lens, explaining what the benefits of independence from glasses may be and what improvements they can make to quality of life. In this phase, patients must become aware of the visual compromises to which they are going, choosing one of the various types of contact lenses for presbyopia. Patients should be informed that it is necessary to have glasses for a possible replacement of contact lenses; or that glasses can be helpful when there is a reduced luminosity. (Lupelli et al, 2004).

The professional must have the opportunity to try different types of lenses. It is necessary to have the possibility to try different types of lenses. In addition, a period of 15 to 20 minutes is required to allow the lenses to stabilize before the adaptation can be assessed. Trial lenses or flipper bars should be used for patient over-refraction to provide a more natural environment and to control binocular vision to simulate a real environment. When the patients have to walk into the office and perform common visual tasks, and indicate the visual tasks they are satisfied with or are not satisfied with. (Lupelli et al, 2004).

Each patient requires a personalized approach for wear of multifocal contact lenses. To achieve success it is important to know how patient spend their time and what their common visual task are. This wil help to choose the best multifocal design.

Adaptation to multifocal contact lenses is not a sudden process. The brain needs time to get used to the images presented for each distance. In the adaptation periot, older people can tolerate blurring more than young people. The vision with contact lens can deteriorate in the first days. Also patients should be informed about possible shadowing and ghost images in the first four to seven days of using multifocal contact lenses.

Traditional testing of acuity and other objective measures are not generally helpful. Traditional testing of acuity and other objective measures are not generally helpful. Performance decrease that are subjective do not correspond to the reduction of visual acuity when measured using conventional methods. Other aspects are as important as visual acuity, i.e. visual quality, comfort, ghosting, haloes perception and facial recognition (Pérez-Prados et al., 2016).

How to choose the right lens design. There are some factors that we must consider to choose the right lens for our patient. Let's see. (Lupelli at al., 2004).

Age. Age affects the success of contact lens fittings, not only because of the increase in contact lens addition required with age but also because there's a decrement in the pupil diameter with age and a higher tolerance to defocus. The last two factors contributed to an increase in the subjective focus depth of about 0.027 D per year (between the age of 21 and 50). The behavior of the multifocal lenses in terms of distance will change among patients of the same age and sometimes in the same patient in different situations. As a result, if results have been obtained with a particular multifocal contact lens in a single patient, the same type of lens can not be used with other patients just because they belong to the same age group.

Pupil size. The pupil diameter should be assessed both in normal room lighting and with dimmed light before fitting multifocal contact lenses. It must be considered that the size of the pupil depends on the retinal luminance and the state of adaptation, on the state of the central nervous system, on psychic influences and on age. The diameter of the pupil reduces with the advancement of presbyopia and decreases during binocular observation by about 0.5 mm for the luminance photopic range. Therefore, while contact lens wearing the pupil diameter is influenced by a wide variety of factors. Some studies have shown the relationship between vision with multifocal contact lenses and pupil size. The pupil dynamics are extremely important in correcting presbyopia with contact lenses. A large pupil is not common in the presbylic people, but there was, aspherical designs would be unsuitable because of the glare and ghost images in low light situation. We will find a pupil with a diameter of more than 6.0 mm only in young presbyopes and in low light situations. The performance of progressive aspheric designs depends on the diameter of the pupil, especially in case of simple parabolic power profiles. Then, there is an interaction between the pupil diameter and the lens power profiles. The pupil size has an important impact on a patient's ability to tolerate defocusing in optical systems that are based on spherical aberration or multifocality. The eyes with larger pupils tolerate the myopic defocusing better than those with smaller pupils. While in case of smaller pupils distant vision when eyes are emmetropic (Pérez-Prados et al., 2016).

Tear film. The most important physiological change that affects the presbyopic patient is the reduction in tear production that is linked to the advancement of age. Furthermore, there is an increment in tear retention after 40 years, because of the change of the shape of the lid and the decreased facility of punctal drainage. Similarly, some elderly patients may have a decreased tear flow because of a disease, or because they take drugs that can reduce tear volume.

It has been discovered that the discomfort caused by dry eye is the main reason for the interruption of the use of contact lenses. Furthermore, a reduction in tear pH could influence the adaptation for some soft contact lenses with a high water content. Soft contact lens wearers may choose to discontinue the use of lenses because of dryness. As a result, the assessment of the quality and volume of tears is important. It's important to consider the tear break-up time with fluorescein (BUT). A 10-second or greater BUT tear was recommended for successful all day long wearing, while a lower time of BUT can prelude to the onset of problems over time. If the BUT is between 6 and 9 seconds, patients should be informed that full-day wear can not be guaranteed and safe. These people could wear gas permeable lens (using rewetting drops). A 5-second or less BUT does not suggest contact wearing. (Lupelli at al., 2004).

Also, the quality of the tear can be influenced by Meibomian gland dysfunction or blepharitis, and hence, these conditions must be resolved before contact lens fitting. The blink interval is important when it is planning multifocal contact lens fitting. If a patient blinks less then a normal interval (4-5 seconds), contact lens wear may be adversely influenced. The inhibition of ocular blinking could constitute an adaptive reaction to minimize the loss of visual information and is related to the level of involvement of a person with what is observed. This fact can influence the presbyopic people that work with computers or electronic devices (Pérez-Prados et al., 2016).

Aberrations. There is an interdependence between ocular aberrations and the aberrometric profile of the corrective lens. Ocular spherical aberration plays an important role in the optical performance of the eye. Contact lenses can cause a considerable change in the level of aberrations of the eye. The astigmatism produced by multifocal contact lenses can even amplify the multifocal behavior of the lenses, causing a greater depth of focus with worse peak performance. Furthermore, we have to regard that the use of contact lenses can bring additional aberrations because of the flexure of the lens.

The induced aberrations are considered as a way of presbyopic correction to increment the depth of focus. Spherical aberration of the eye is very different among people and grows with age. The large gamma of spherical aberration values for different individuals helps to explain why some users may find the lenses useful, while others do not. Despite the benefit of spherical aberration in close vision, it can also be a decisive factor in the reduction of image contrast, which decrement as spherical aberration increment. Radial power variation across the lens surface results in greater focusing depth. There is a loss of depth of focus when there is 1.00 D or more of residual astigmatism. More complicated aberrations, i.e. coma and spherical aberration combined with astigmatism, can also be more visually damaging. Another important aspect to regard in multifocal contact lenses is the joining of the spherical aberration of the eye with the power profile of multifocal lenses. Therefore, the eye-lens coupling will show a lower value of negative spherical aberration than that the out-of-eye lens. This could decrease the "addition" effect caused by the lens. Furthermore, dynamic elements (tear film and accommodative system) can also concur to the decrement and variability of the "added effect". Some studies have reported an evolution of spherical aberration from a positive value in relaxed eyes to a more negative value when accommodation raises.

Ocular dominance. Ocular dominance has been usually regarded relevant in presbyopic correction, both in monovision and multifocal modes. The influence on visual acuity and contrast sensitivity of the dominant eye must be tested. It is possible that the function of dominant or non-dominant eye correction for distance has minimal influence on visual performance and so, selection of one or the other can be arbitrary (Pérez-Prados et al., 2016).

1.2. Visual Acuity and Stereopsis Analysis

The eyes are two but the two images that we perceive are united by the brain in one. They are however a little dissimilar and this generates the stereopsis that is the ability to perceive the depth of the images. It is the highest evolution of binocular vision. Even monocularly there is the possibility of appreciating, in a rough way, the depth, but only by experience. Only the presence of single binocular vision and a good visual acuity, allow to obtain the maximum of stereopsis. (Kirkpatrick at al., 1985 and https://www.clspectrum.com/supplements/2012/june-2012/multifocals-the-new-standard-of-care/evidence-for-a-better-choice).

Having excellent stereopsis is essential in many daily activities such as driving, home and work activities.
The most used tests are:
The Stereotest of Lang is the most used, consists of a rigid postcard, presented at 40cm away, where the subject can perceive the presence of figures that appear in relief on different floors. It is carried out without having to use lenses. (Gianelli at al., 2012).
Titmus test provides a coarse stereopsis. It consists of a polarized image, a fly, presented at a distance of 40 cm, the subject is asked to grasp the tip of the fly's wings which rise above the body. We use a pair of glasses with polarized lenses.

1.2.1 Lang Test

Lang Stereotest 1 is a table to perform the Lang Test in which the images (a cat, a star and a car) are located behind a dense series of small transparent cylinders that function like double prisms faced to the base so to divert the part of the figure destined for it to the corresponding eye. (Gianelli at al,. 2012).

In monocular vision these stereograms do not reveal any boundary while in binocular vision the areas that produce a horizontal disparity are seen in relief.

The Lang Test must be carried out at about 35-40 cm distance in a light condition that does not disturb the subject. It should however be remembered that the test has a very high predictive value for the recognition of strabismus but is less sensitive in the determination of amblyopia.

The test is very simple to perform and does not require anaglyph glasses such as for the TNO test or polarized as for the LEA test.

From the clinical point of view, version 1 of the Lang Test is more effective (compared to version 2 of the same test) because it goes to avoid the false positive, not allowing the user to use mono-ocular strategies that would alter the result of the test.

In version 2 of the Lang Test a figure is always visible.

Test indicated to perform stereopsis screening from 12 months of age.

1.1.1 Titmus Test

This test was designed to quickly determine the presence of amblyopia, strabismus and other problems of binocular acuity by stereopsis (depth perception) for preschool subjects no to adults.

Perception of depth: (n) the ability to perceive spatial relationships, in particular the distances between objects and the three dimensions.

Lea® Symbols: (n) 4 symbols: house, circle, square and apple, developed by Lea Hyvärinen, physician, for the screening of children with any level of linguistic development, designed in such a way that everyone adopts the same form once passed the threshold of differentiation of the observer - children see only one form when the symbol becomes too small to be clearly seen.

1.3. Effects of Soft Contact Lenses on Contrast Sensitivity and stereopsis

This study attempts to resolve conflicting relationships related to the contrast sensitivity function and soft contact lens wear. Contrast sensitivity was measured on 19 subjects with correction glasses or soft lenses. The measured amounts of residual astigmatism and residual sphere were corrected using a trial frame and lenses. Furthermore, the data have been evaluated on more than one occasion to investigate the effect of time on visual performance with lenses. The results show a measurable decrease in contrast sensitivity only for the highest of the spatial frequencies analyzed (22.8 c / deg) when soft lenses were worn. For those eyes that demonstrate a clinically important reduction in contrast sensitivity, the responsibility seems to be shared by both the contact lens and the cornea. There were no significant changes in CSF (contrast sensitivity function) over the time. In spite of recent progresses in the field of soft contact lenses, the problems are still there. One of these is the reduction in "visual function" that is often found in patients with soft contact lenses. Although their ability in many cases to achieve a visual acuity comparable to that of glasses, these patients often complain that their new vision is not quite so acute as had previously happened with glasses. The anomalies in the CSF are usually related to defects in either the optical system (eye-lens), or in the retina-brain system (Kirkpatrick & Roggerkamp, 1985).

In some study comparing visual acuity in both hard and soft contact lens wearers, it is expected that approximately 25% of people will show a reduced acuity even when the refractive error is completely corrected. This conclusion has been reached by comparing the best glasses acuity with that measured with contact lenses. Another evidence was that the reduction in visual acuity of soft contact lens wearers was higher than that of hard lens wearers.

There are many possible reason for this phenomenon. For example the hard and soft lenses surface is optically poorer than the corneal one. Some studies show that spherical aberration is the most important aberration in contact lenses and that a soft contact lens with spherical surfaces produces more longitudinal spherical aberration than the spectacle lenses. For these reasons it is possible that the retinal image can be improved or degraded by the contact lens.

The visual acuity of myopic subjects in contact lens wearers degrade more quickly with contact lenses than with spectacles as the luminance decreases. Then the consequence of luminance decrease, spherical aberration and lens surface imperfections can be the cause of a decrease in visual function.

Another possibility for the reduction of visual function is the contribution of the cornea. With contrast sensitivity testing, it has been shown that vision reduction comes from corneal distortion and edema. A decrease in visual function may occur for one of the following causes:

1. quality of contact lenses;
2. corneal changes caused by the contact lens;
3. or a combination of the quality of contact lenses and the corneal changes caused by the contact lens.

The CSF is believed to give a more definitive assessment of visual performance with soft contact lenses than standard measurements of visual acuity. It is presumed to be true when visual performance is determined only with Snellen letters with high contrast and high spatial frequency.

Other studies have shown a positive correlation between soft contact lens wear and CSF decrease. These studies point out that decreases in the CSF, even if minimal for the high spatial frequencies, are more evident for the range of intermediate spatial frequencies from 2 to 4 c / deg. The differences between spectacle lenses and contact lenses have been shown to be greater for those who wear soft lenses than those who wear hard lenses. The resulting lower quality vision with contact lenses has also been demonstrated to be unmeasurable through the use of conventional or correctable evaluation methods by means of refraction.

However, these studies have been criticized for some reason:

1. they don't consider residual astigmatism that can reduce sensitivity to contrast;

2. they don't used inferential tests to evaluate the statistical significance of the differences between glasses and contact lenses;

3. they generalize from small numbers of subjects.

Studies conducted after extended wear with caution of soft contact lenses revealed little evidence to support visual degradation caused by soft contact lenses. However, in a recent study, the sensitivity to contrast at spatial frequencies of 0.4, 1.0, 2.5, 5.0, 8.0, 10.0 and 14.0 c / deg for the subjects tested was lower with soft lenses than the glasses and when tested again after 2 weeks of lens wear, the CSF had decreased even more. Statistical analysis has shown an important difference in contrast sensitivity when wearing soft lenses compared to glasses. A significant decrease in contrast sensitivity was also noticeable for subjects without residual astigmatism during the use of soft lenses (Kirkpatrick & Roggerkamp, 1985).

In this study we dealt with the correlation between possible changes in contrast sensitivity and wear of soft contact lenses, and also of the aspect of the optical system responsible for this effect.

There were two hypotheses: first, the contrast sensitivity for a group of patients recently equipped with soft contact lenses will not be reduced compared to the profit contrast sensitivity with glasses. Secondly, in patients with soft lenses, the responsibility for a significant decrease in contrast sensitivity can be attributed to the cornea, the contact lens or the set of these two. For these patients, a quick removal of contact lenses should attest one of three different conditions:

1. no appreciable improvement in contrast sensitivity, implying changes in the cornea as the main cause of decreased in CSF;
2. an increase in contrast sensitivity at a level not very different from that measured with glasses before wearing contact lenses, isolating soft contact lenses as the main cause of change in CSF;
3. an increment in contrast sensitivity, but lower than that measured with glasses.

In a study using the Nicolet Optronics CS-2000 Contrast Sensitivity Testing System, 19 subjects has been examined. All subject were potential contact lens wearers. The experimental group was selected according to these principles:

1. visual acuity correctable to 6/6 (20/20) or better with the best correction of eyeglasses;
2. age between 15 and 35;
3. refraction error limited to the spherical interval between +3.00 and -6.00 D;
4. Snellen's sharpness of 6/6 (20/20) or better with contact lenses;
5. no pathology (systemic or ocular);
6. clear media in both eyes;
7. pupils with diameter greater than 3 mm.

The CS-2000 has an integrated calibration system that limits the need for external photometric calibration. This feature guarantees standard test conditions between patients. However, since the sensitivity values provided by the CS-2000 are arbitrary, the instrument was calibrated photometrically before testing.

Test sequence, data analysis, spatial frequency and contrast were all controlled by the CS-2000 microprocessor. By emphasizing a visual angle of 5.4° vertically for 4.3° horizontally, the vertical sinusoidal grids were presented at the observation distance of 3 m. Once the calibration was completed, the average luminance for the screen was 93 cd/m^2. The uniformity of the peripheral and central fields was provided by a mask surrounding the display monitor with an average luminance of was 1.59 cd/m^2 (Kirkpatrick & Roggerkamp, 1985).

Monocular contrast sensitivity measurements were made using the contrasts increase method. After a preview of each stimulus model, the instrument was set to repeat the test grating four times in sequence to get an average contrast threshold for each spatial frequency. The contrast was varied upwards for all the tests. The "Stimuli" format was divided into eight separate tests, each of them featured a single static sine grid. The first two tests, which had grids of 1.0 and 6.0 c/deg, were used to provide practice to the observer. The remaining six, which represent grids 0.5.1.0, 3.0, 6.0, 11.4 and 22.8 c/deg presented in random sequence, were data collection tests. The top of the range from which the initial contrast was to be randomly chosen was specified as 0.001. The initial presentation of the pattern would then be performed at a randomly selected point between 0 and 0.001. A test repetition would automatically randomize the initial contrast. Providing standard tools, the tests were interrupted and/or repeated and new stimuli added at the discretion of the operator.

Before starting an experimentation, the visual acuity for each subject was measured using Snellen's letters and pupillary diameters were recorded. The test was performed at a distance of 3 m from the display monitor. Prior to fitting the contact lenses, the basic data of the contrast sensitivity for the six preset spatial frequencies were defined monocularly for each patient while the glasses were worn. After assembly, this test was repeated, but not before 30 minutes or after 60 minutes after fitting the soft lens. The measured amounts of residual astigmatism and / or sphere were corrected prior to testing using a trial frame and lenses. After completion of the second series of tests, the contact lenses were removed and the test was done again for each eye. Similar tests were performed at 1 and 4 weeks after the initial test. On these occasions all subjects had to wear contact lenses continuously between 4 and 8 (Kirkpatrick & Roggerkamp, 1985).

Six unidirectional t-tests were performed to compare profit contrast sensitivity data with those obtained after wearing contact lenses, and the residual error was corrected (initially collected when contact lenses were worn, 1 week later and 1 month later). The "t" value for all (highest 22.8 c / deg;

lower 0.5 c / deg) spatial frequencies tested was statistically negligible. The t value (baseline vs. initial; t = -1.807) for 0.5 c/deg was indicative between the level 0.05 and 0.025. This reports an important growing in contrast sensitivity for newly worn contact lens with a spatial frequency of 0.5 c/deg. The baseline vs. initial t-value (t = 2.349) for 22.8 c/deg, the highest spatial frequency tested, was notable between 0.025 and 0.01. The t-values remaining for this same frequency (baseline vs. 1 week with t = 3.390 and baseline vs. 1 month with t = 3.905), were statistically important below the level of 0.005. It is deduced that the contrast sensitivity measured with contact lenses (with correction of residual error) is remarkably lower than that measured with the glasses only for the highest of the measured spatial frequencies (22.8 c/deg). For those eyes that demonstrate a clinically important reduction in contrast sensitivity for this spatial frequency (clinically significant = 1 SD from the mean sensitivity to contrast with the glasses) were made other comparisons. To determine responsibility for this loss, a unidirectional t test was used for related measures. The data obtained with contact lenses were compared with those obtained soon after contact lens removal. Confrontations were made for the data collected at the initial wearing, after 1 week and after 1 month. All t values were statistically meaningful at the 0.005 level. It was deduced that the contrast sensitivity measured instantly after removal of the contact lens is higher than that measured when wearing the contact lens. The data detected immediately after removal of the contact lens were also compared with those collected with wearing contact lens. All the values of t showed significance with that at 1 month showing the highest meaning (p <0.01). It is deduced that even though they are slightly improved after contact lens removal, the contrast sensitivity values for these eyes are statistically different and lower than the profit baseline data. Snellen's acuities measured with glasses before wearing contact lenses were compared with contact lens acuities after 1 month of use. Nineteen eyes demonstrated a measurable reduction in vision, from one to four letters, with soft contact lenses. Fifteen eyes demonstrated no change in the acuity, while four eyes showed an increment. A clinically significant reduction in contrast sensitivity for 22.8 c/deg was measured in 11 of the eyes that showed a diminution in visual acuity, 7 of the eyes showed no variation in visual acuity, and 1 of the eyes showed an increment of visual acuity. Since each spatial frequency was tested for variation at three different times, part of the data analysis explored the effects of subsequent experimental manipulations (initial wearing-adaptation, after 1 week and after 1 month). The statistical procedure used was the single-factor analysis of the variance. The experimental group was assessed using the three contrast sensitivity values, one for each point in time, as repeated measurements for each subject. The analysis for each spatial frequency produced the following:

- 0.5 c/deg F = 1.09
- 1.0 c/deg F = 0.40
- 3.0 c/deg F = 0.04
- 6.0 c/deg F = 0.16

- 11.4 c/deg F = 0.69
- 22.8 c/deg F = 1.53

All F values occur more often than 20% of the time through random factors ($p > 0.20$). It was therefore deduced that the measured contrast sensitivity values were stable in the test session interval used in this study.

Starting from the results of the t-test, the contrast sensitivity measured with contact lenses was considerably lower only for the highest of the six measured spatial frequencies (22.8 c/deg) compared to those measured with glasses. This reduction, between 14% and 22%, was coherent for each test session. The levels of significance ranging from 0.025 to 0.0005 depended on the duration of lens wearing measured from the first day. Anyway, most subjects had problems responding to the lowest spatial frequencies (0.5 c/deg) and higher ones (22.8 c/deg) at the time of lens wearing. The significant increase ($p < 0.05$) of the contrast sensitivity for 0.5 c/deg measured at initial fitting was not repeatable in following tests probably because of an incomplete lens adaptation. For eyes showing a clinically significant reduction in contrast sensitivity for 22.8 c/deg, subsequent test highlighted that reduced sensitivity to contrast with contact lenses showed advancement when the lenses were removed. It is dedicated that the cause of reduced sensitivity to contrast associated with soft contact lens wear is due to the system contact lens-cornea. It was also deduced that there is no important variation in the contrast sensitivity values measured in the test session interval. The contrast sensitivity during wearing soft contact lenses did not vary after the initial decrement during the evaluated period. Furthermore, if we compare the results of this study with the visual acuities measured before and after contact lens wear, it is not possible to quantitatively establish that contrast sensitivity reveals more about the vision of the wearer of soft contact lenses than Snellen's acuity (Kirkpatrick & Roggerkamp, 1985).

The stereo acuity for patients corrected with multifocal contact lenses was measured by Dr. Teresa Ferrer-Blasco and Dr. David Madrid-Costa from Spain (2011). They shown that the Proclear Multifocal contact lenses provide good distance and near vision and stereopsis remain preserved. Authors confirmed that multifocal optics with one lens biased for distance vision and other for near vision minimally affects stereo acuity.

2. Research and Method

2.1. Evaluating the vision quality with eyeglasses and multifocal contact lenses

My research is based on the comparison of visual acuity with correction of glasses and correction with the help of monthly multifocal contact lenses.

This comparison was examined with:

- Visual acuity at a distance (Snellen Chart)

Figure 2 Snellen chart for visiual acuity at a distance. (https://en.wikipedia.org/wiki/Snellen_chart).

- Visual acuity chart at proximal distance.

Figure 3 Near distance de Wecker vision acuity chart.

For the evaluation of the quality of vision in general I examined tests that I use frequently for the evaluation of stereopsis.

The tests that have been used both with correction for glasses and with multifocal contact lenses are:

- Osterberg test (for far vision)

Figure 4 Screen with Polarised Osterberg far vision stereotest.

- Titmus Test (proximal distance)

Figure 5 Titmus proximal distance stereotest.

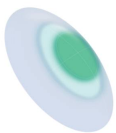
2.2. Subjects and contact lenses used

It was used a non-experimental group, comprising a non-probability sample of 20 clinical subjects (40 eyes) selected by an intentional sampling procedure. The patients were selected based on the following criteria:

- heterogeneous gender group
- eyeglasses wearers
- monthly contact lens wearers

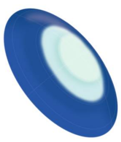
  For vision correction was used glasses with AR coated lenses and soft montly contactlenses from company Bausch&Lomb "Pure Vision 2 Multifocal".

  These contactlenses have 3 zones: near, far and intemediate zones.



Near Vision - For reading and using digital devices.

Intermediate Vision - To clearly see computer screen (and dinner date)



Distance Vision - For clear vision when driving and following presentations from the back of the room

These zones can influence pacient Visus and stereopsis carrateristics.

2.3. Methods

A useful way to collect information on the situation of the patients corrected with glasses and contactlenses was carried out various tests of visual acuity and stereopsis. More was evaluated all patient satisfaction and analysed visual parameters differences between pacients corrected with glasses and multifocal monthly contact lenses.

2.3.1 Visual Acuity for distance Assessment

To check the binocular visual capacity of the sample patients, a Snellen optotypic table was used, comparing the visus with glasses and soft multifocal contact lenses. The Table1 and Figure 6 below, shows the data:

Table.1. Far vision binocular visual acuity for pacients corrected with eyeglasses and multifocal contact lenses

	Visus with	Visus with
Patients	**Eyeglasses**	**Multifocal Contact Lenses**
1	1,00	1,00
2	1,20	1,00
3	1,00	1,00
4	0,80	0,70
5	0,90	0,80
6	1,00	1,00
7	1,20	1,20
8	0,90	0,80
9	1,00	1,00
10	0,90	0,80
11	1,20	1,00
12	0,80	0,80
13	1,20	1,20
14	0,90	1,00
15	1,00	1,00
16	1,00	1,00
17	0,90	0,90
18	1,00	0,90
19	0,90	1,00
20	0,90	1,00

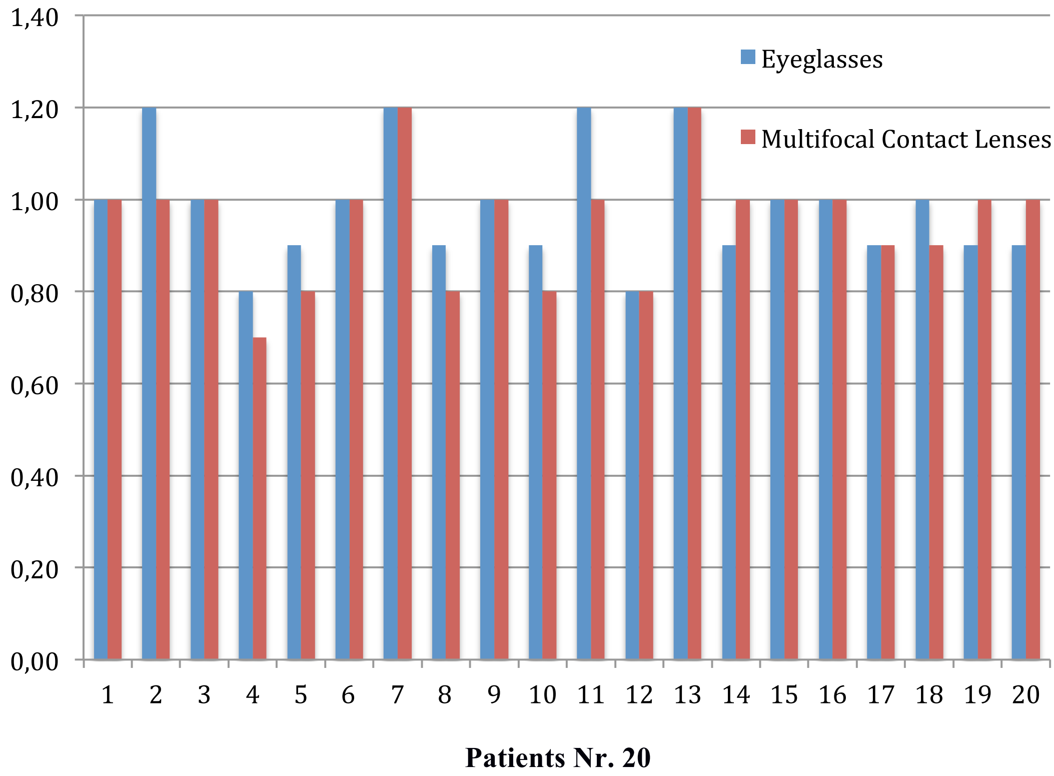


Figure 6 Difference between binocular visual acuity for distance of pacients corrected with eyeglasses and with multifocal contact lenses

For these pacients data was analysed t test statistics analyse.

	Eyeglasses	**Multifocal Contact Lenses**
Number of pacients	20	20
Media	**0,9850**	**0,9550**
Dev. standard	0,1268	0,1276
Standard. error	**0,028**	**0,028**
t	**0,7457**	
grade of liberty	**38**	
P(level of significance)	**0,4604**	

This data analyse show that for far vision all pacients have good vision (media Visus in decimal units is more than 0,95). From t test statictics analyse we not see statistically noticeable difference between the binocular visual acuity for pacients corrected with eyeglasses glasses compared to pacients corrected with multifocal soft contact lenses.

2.3.2 Visual Acuity for Near distance

To check the binocular visual capacity of the sample patients, a de Wecker optotypic table was used, comparing the visus with glasses and soft multifocal contact lenses. The table below shows the data:

Table Nr. 2. Near distance Visus for pacients corrected with glasses and multifocal contact lenses.

	Near Visus	Near Visus
Patients	**Eyeglasses**	**Multifocal Contact Lenses**
1	1,00	0,90
2	1,00	0,90
3	1,00	0,90
4	0,80	0,80
5	0,90	0,80
6	1,00	0,90
7	1,00	1,00
8	0,90	0,80
9	1,00	0,90
10	0,80	0,70
11	1,00	0,90
12	0,90	0,80
13	1,00	0,90
14	0,80	0,80
15	0,90	0,80
16	0,80	0,70
17	0,80	0,80
18	0,90	0,80
19	1,00	0,90
20	0,80	0,80

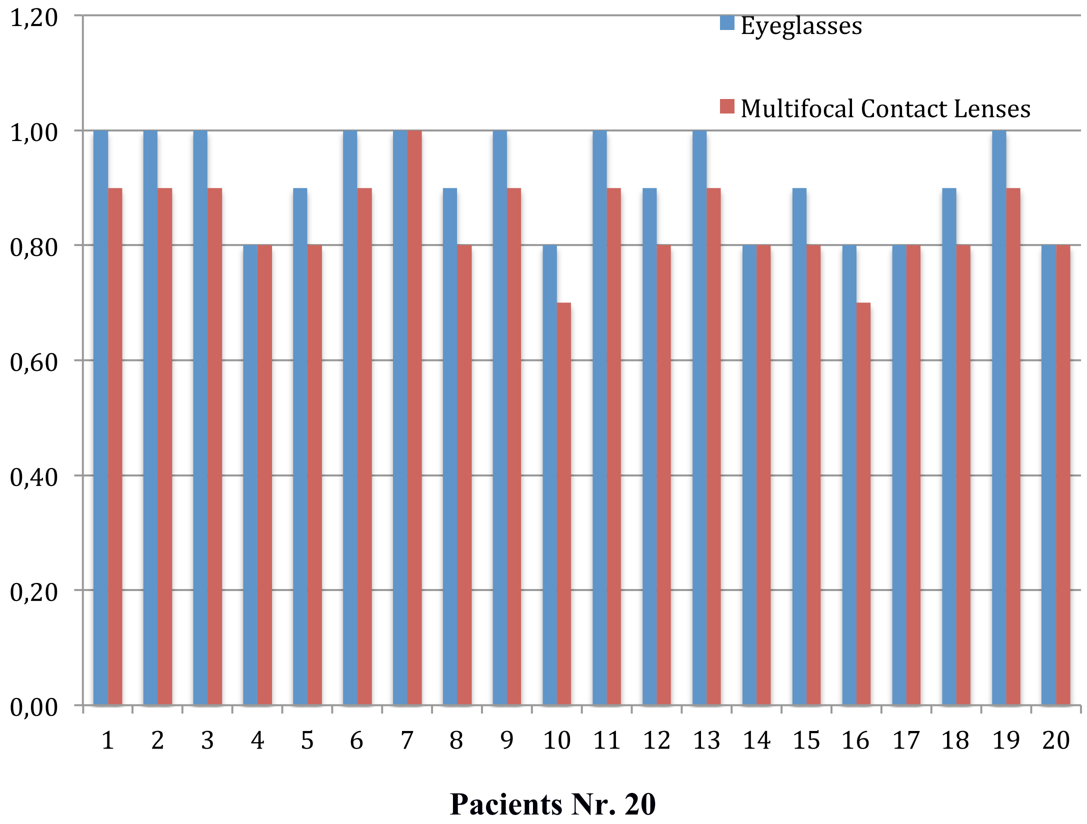


Figure 7 Difference between visual acuity for near with eyeglasses and multifocal contact lenses.

For these pacients data was analysed t test statistics analyse.

	Eyeglasses	**Multifocal Contact Lenses**
Number of patients	20	20
Average	**0,9150**	**0,8400**
Dev. standard	0,0875	0,0754
Stard. error	**0,0195**	**0,0168**
t	**2,9038**	
Grades of liberty	**38**	
P	**0,0061**	

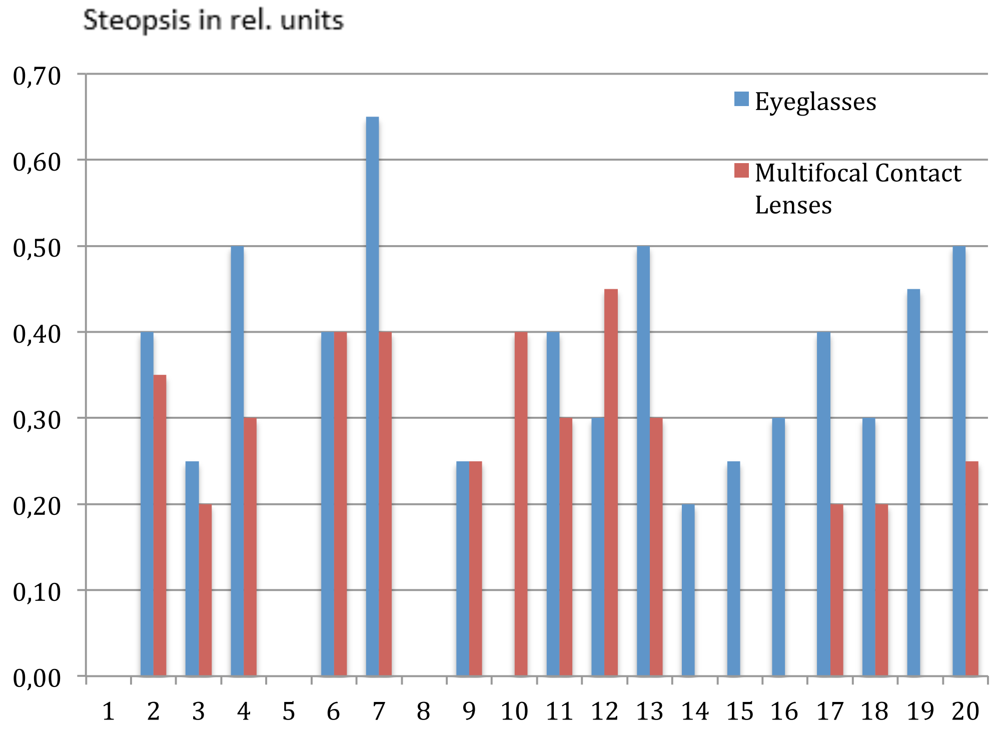
From t test statistics analyse we can confirm that there is noticeable difference in near vision binocular acuity for pacients corrected with eyeglasses compared to pacients corrected with multifocal soft contact lenses. For near vision visus with eyeglasses is better and patients examined prefers eyeglasses.

2.3.3 Osterberg Test Assessment

Subsequently the stereopsis capacity was assessed with glasses and multifocal soft contact lenses, measuring in meters the position of the "floating image" with respect to the background. The pacients data are presented in the following table:

Table. Nr. 3. Osterberg test results for pacients with eyeglasses and multifocal contact lenses.

	Steopsis in rel. units	
Patients	**Eyeglasses**	**Multifocal Contact Lenses**
1	0,00	0,00
2	0,40	0,35
3	0,25	0,20
4	0,50	0,30
5	0,00	0,00
6	0,40	0,40
7	0,65	0,40
8	0,00	0,00
9	0,25	0,25
10	0,00	0,40
11	0,40	0,30
12	0,30	0,45
13	0,50	0,30
14	0,20	0,00
15	0,25	0,00
16	0,30	0,00
17	0,40	0,20
18	0,30	0,20
19	0,45	0,00
20	0,50	0,25



Patients Nr. 20

Figure 8. Osterberg Test stereopsis assessment with eyeglasses and multifocal contact lenses

Once the data have been detected, there is immediately a drop in stereoscopic perception with multifocal soft contact lenses and was predictable due to the aspherical optical areas of which they are composed.

For these pacients data was analysed t test statistics analyse.

	Eyeglasses	**Multifocal Contact Lenses**
Number of patients	20	20
Average	**0,3025**	**0,2000**
Dev. standard	0,1895	0,1654
Standard error	**0,042**	**0,037**
t	**1,8222**	
Grades of liberty	**38**	
P	**0,0763**	

From data analyse we can see that average Osterberg test far distance stereovision for pacients corrected with eyeglasses is 0,30, but for pacients corrected with multifocal contact lenses is 0,20. T test analyse show that for our 20 pacients we not can confirm that there is statistical diffirence, because p value is 0,076. To confirm difference it can be necessary increase number of pacients studied.

2.3.4 Titmus Test (Fly test)

In the evaluation of the stereopsis in near distance the Titmus Test was used and the *Fly test* was examined separately from the test of the rims both with the glasses and after with the multifocal soft contact lenses.

Table. Nr. 4. Titmus test (Fly test) results for pacients with eyeglasses and multifocal contact lenses

	Stereopsis in Arc seconds	
Patients	**Eyeglasses**	**Multifocal Contact Lenses**
1	3625	3625
2	3625	3625
3	3625	3625
4	3625	3625
5	2075	2075
6	3625	3625
7	3625	3625
8	2075	2075
9	3625	3833
10	0	0
11	3625	3625
12	3625	3625
13	3625	3625
14	2750	2750
15	3625	3625
16	2075	2075
17	3625	2075
18	3625	2875
19	2075	2075
20	2075	2075

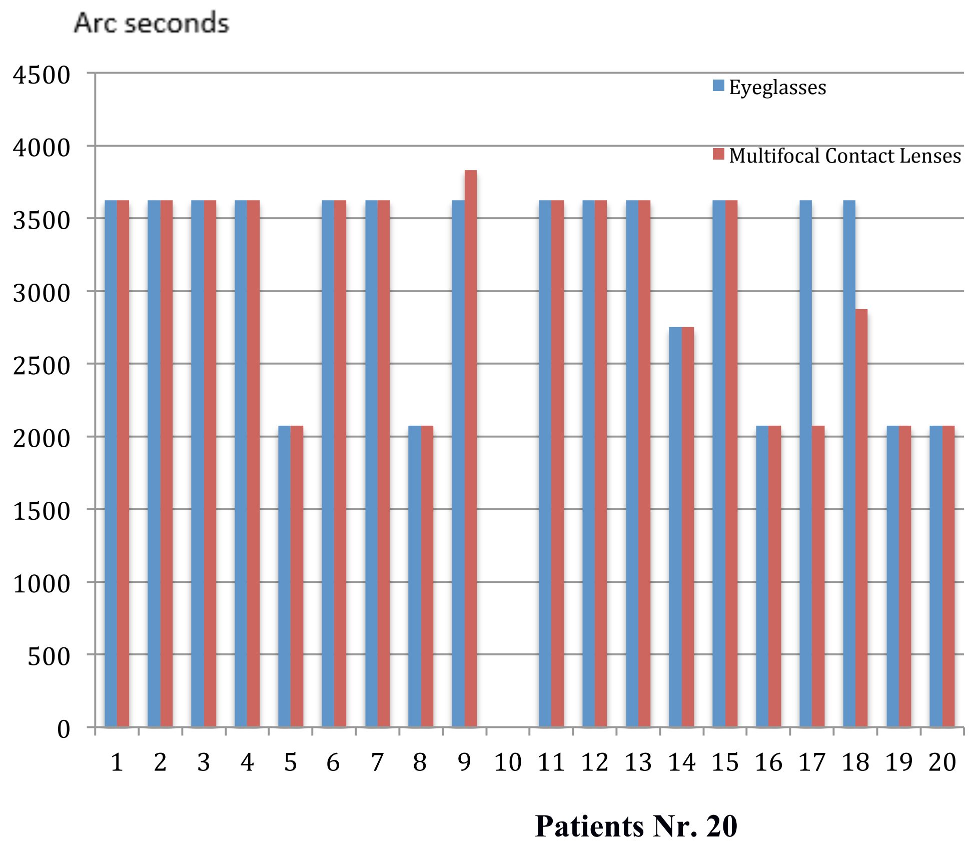


Figure 9 Titmus Test (Fly Test) Assessment with eyeglasses and multifocal contact lenses

For the patients data was applied t test statistic analyse. The mean values were calculated for both pacients groups and we can see that medium value of stepeosis for pacients corrected with contact lenses is lower as for pacients corrected with eyeglasses. But t test analyse results not confirm statistically significant difference. P value is 0,74.

	Eyeglasses	**Multifocal Contact Lenses**
Number of patients	20	20
Average	**3012,5**	**2907,9**
Dev. standard	984,5	990,5
Standard error	**220,1**	**221,5**
t	**0,3349**	
Grades of liberty	**38**	
P	**0,74**	

Here our stereovision data conducted with Fly test show that for bouth pacients group have good stereovision.

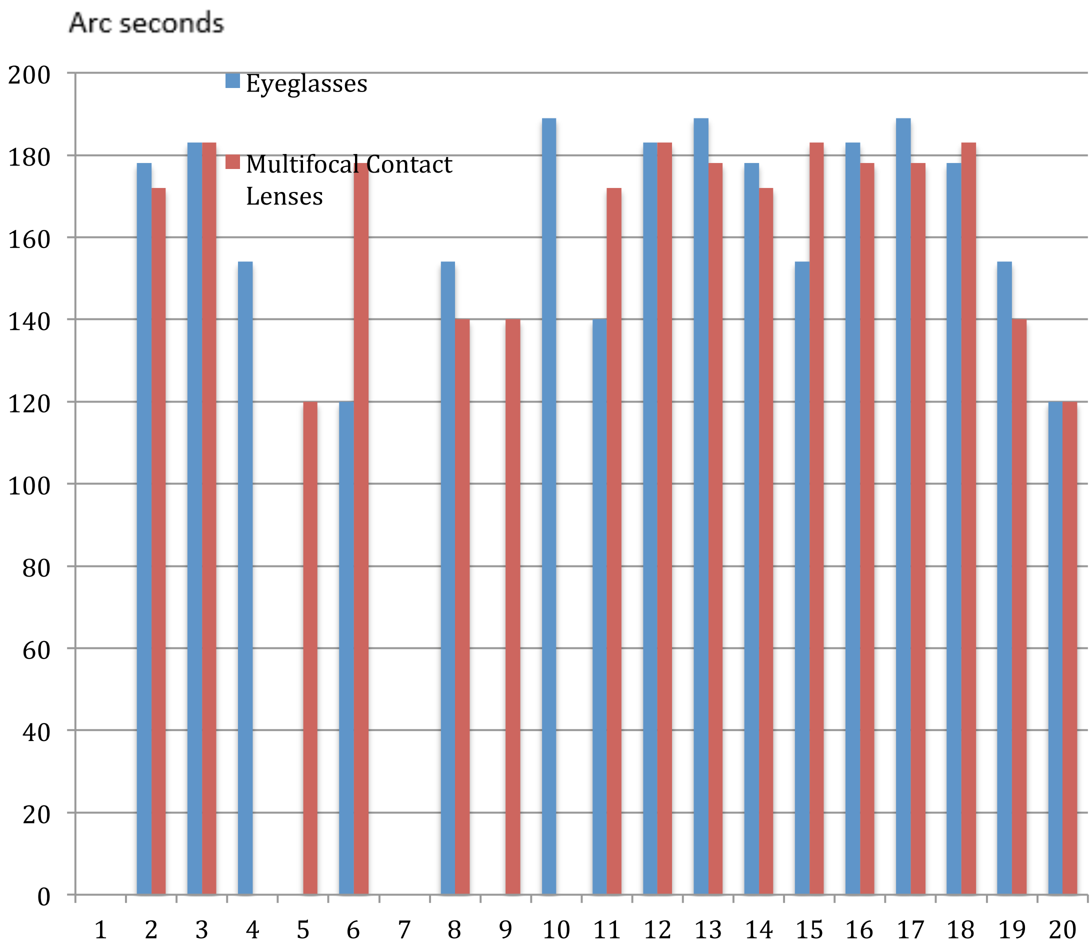
2.3.5 Titmus Test (Circles)

In the evaluation of the stereopsis at near distance was used other *Titmus stereotest - Circles test.*

For all our patients corrected with eyeglasses and multifocal contactlenses was examined stereopsis. Test results are presented in Table. Nr. 5.

Table. Nr.5. Titmus Circles test results for pacients with eyeglasses and multifocal contact lenses.

	Stereopsis in Arc seconds	
Patients	**Eyeglasses**	**Multifocal Contact Lenses**
1	0	0
2	178	172
3	183	183
4	154	0
5	0	120
6	120	178
7	0	0
8	154	140
9	0	140
10	189	0
11	140	172
12	183	183
13	189	178
14	178	172
15	154	183
16	183	178
17	189	178
18	178	183
19	154	140
20	120	120



Pacients Nr. 20

Figure 10. Titmus Circles Test Assessment with eyeglasses and multifocal contact lenses.

The mean values were calculated for both pacients groups (glasses corrected and multifocal contactlenses corrected). T test analyse results are presented below:

	Eyeglasses	**Multifocal Contact Lenses**
Number of patients	20	20
Average	**132,3**	**131,0**
Dev. standard	71,0	70,2
Standard error	**15,9**	**15,7**
t	**0,0582**	
Grades of liberty	**38**	
P	**0,954**	

We here can see that for bouth pacients groups average spereopis data are similar – 132,3 and 131,0. T test analyse show that there not are statistically significant difference between near distance stereopsis for pacients corrected with glasses and multifocal contact lenses.

3. Discussions.

Our binocular visus and stereopsis stydy results shows that latest generation (B&L PureVision2) multifocal soft contact lenses are an good substitute for the glasses. Pacients corrected with multifocal contactlenses have good far distance visual performance parameters. Our results only on near distances show same visus decrease for pacients corrected with multifocal contact lenses. The geometry of aspheric concentric zones of multifocal soft contact lenses is not very convincing and will have substantial upgrades in the future.

Stereopsis for pacients corrected with multifocal contactlenses are very similar as for pacients corrected wih eyeglasses. These results are similar to results of Dr. Teresa Ferrer-Blasco and Dr. David Madrid-Costa from Spain (2011). Multifocal contactlenses in general preserve stereopsis.

4. Conclusions

1. For far vision all pacients have good vision (media Visus in decimal units is more than 0,95). From t test statictics analyse we not see statistically noticeable difference between the binocular visual acuity for pacients corrected with eyeglasses glasses compared to pacients corrected with multifocal soft contact lenses.

2. There is noticeable difference in near vision binocular acuity for pacients corrected with eyeglasses compared to pacients corrected with multifocal soft contact lenses. For near vision visus with eyeglasses is better and patients examined prefers eyeglasses.

3. Average Osterberg test far distance stereovision parameter for pacients corrected with eyeglasses is 0,30, but for pacients corrected with multifocal contact lenses is 0,20. T test analyse show that for our 20 pacients we not can confirm that there is statistical diffirence, because p value is 0,076. To confirm difference it can be necessary increase number of pacients studied.

4. Near distance stereovision data conducted with Titmus Fly test and Titmus Circles test, shows that pacients corrected with glasses and multifocal contact lenses have good stereovision.

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